Technology as a More Capable Peer

Design considerations for the design of technology to act as a more capable peer

Citona Marie Rygg and Yas Taheranpour

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Abstract

This master thesis is an empirical investigation of learning with technology in an introductory design course at the University of Oslo and its students. The overarching goal of the thesis is to make design considerations that are anchored both theoretically and empirically. In a Design Thinking process, a social constructivist framework is operationalised through a prototype to make these design considerations. The five stages of the Design Thinking process facilitated a closer look at the student's academic life, as well as their hopes and expectations for the course and the future. There was a total of 61 participants throughout 19 data collection activities. A thematic analysis of the entire research project revealed which themes were recurring throughout the Design Thinking process. These themes were then compared to the theoretical framework, leading to the findings. There were three themes with 18 design considerations. Through a discussion with relevant literature, the findings were compared and contrasted to seminal works. The findings suggest technology itself is not a more capable peer, but rather a tool to enhance scaffolding by adopting the characteristics of a more capable peer mixed with the characteristics of technology, to become a useful tool. Thus, this thesis contributes with design considerations to design digital technology that scaffold the students. While this thesis aims to contribute with design considerations, it will also contribute to the literature with new insights into the social constructivist concepts that were operationalised in the design process.

Keywords: social constructivism, design thinking, scaffolded learning, dialogue-based feedback, gamification

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1 Introduction

1.1 Background and Personal Motivation

Having attended school since the age of six, we both have many experiences with different types of school systems: both in the private and public sector. In total, we have more than 36 years of experience with different forms of education in Norway. This wide variety of experiences has led to a particular interest in how we learn and how to study most efficiently.

Growing up at the same time as the rise of the internet, we have experienced a change in what is essential to learn, how we learn, and the life-skills needed in this ever-changing society. To remember relevant knowledge used to be a vital skill before the internet, whereas now we can access most information through digital media from the tip of our fingers. Skills such as critical thinking, creativity, collaboration, and technological literacy, are expected of the 21st-century learner (Hagelia, 2017, p. 137) (full list of 21st -century skills in Appendix A). At times it has been frustrating to feel that the school system changes at a much slower pace than the digital development that happens all across the world. This frustration has led to curiosity about what we need to learn and how we should learn in order to follow the speed of digital development and become best prepared to participate in the modern society.

We came into this research with the experience that we learn best from talking to and collaborating with peers and using our knowledge to solve problems. Social constructivism believes construction of knowledge happens in our minds through interactions with one another, the community we are in, and the environment we are in (Harasim, 2017, p. 12). Therefore, knowledge is subjective in nature and something that can change through interactions with the world (Harasim, 2017, p. 12). Social constructivist learning theory supports that the context, the people in that context and the language of the community which they wish to be a part of, are significant for active learning. Vygotsky (1978) believes learning is active, and we learn by seeing, hearing and mimicking others. Scaffolded learning stems from Vygotsky's Zone of Proximal Development (ZPD) and consist of strategies that set ZPD to life by giving the learner support. The learner is supported by a more-capable peer who will help lift the student to a new level of learning. Through scaffolding, the students are given a context and motivation from which they can understand the new information (Harasim, 2017, p. 73).

Design Thinking (DT) was chosen as a methodology for this thesis because it allows us to work systematically with qualitative information with a human-centred focus (Owen, 2006, pp. 24–25). DT also promotes an optimistic approach to a problem as it is difficult to work creatively in a pessimistic and

critical mood (Owen, 2006, p. 24). These two aspects led us wanting to start an inductive research process, where we got to know the learning theories and then carry out an empirical study to find out what aspects from the learning theories are essential to consider when designing for learning technology.

As design thinkers, we have an inherent need to understand the area we are working in, in this case, learning, in order to make something that is useful and that meets the users need. Because of the digital age we live in, there is an increasing need to make learning technologies that enhance human capabilities and makes learning more accessible. The pandemic we have experienced has shown the importance of digital technologies in order to maintain our everyday life as much as possible. Conference tools, collaborative tools, and other digital tools that enable collaboration, active learning and social interaction, have become more valuable in our everyday life (Johansen, 2020; Koeze & Popper, 2020; Peters et al., 2020). However, we miss propper guidelines for designing learning technologies that are anchored in theory. In order to contribute with design considerations, we took a deep dive into the vast field of pedagogy and learning literature and let our new knowledge of pedagogy and learning guide us. We found what aspects interested us, matched with our experience, inspired us, and perhaps most importantly needed our designer minds. We implemented concepts from learning using Design Thinking to innovate a solution. The result became 18 design considerations for designing technology that can act as a more capable peer.

This thesis is an attempt at taking that abstract learning theory and operationalise it into something useful for people who design learning technologies. It will be both grounded in theory through the use of our theoretical framework and empirical data from our data collection through the making and testing of a prototype we create. We hope to contribute to the field of Human-Computer Interaction (HCI) with considerations for designing learning technologies that scaffold the students, as well as contribute to the literature of pedagogy with knowledge of what social constructivist concepts are suited to be used for scaffolding students through technology.

The literature on pedagogy, learning and education is vast. For the sake of clarity, we will refer to the literature as "the literature of pedagogy", but that does not mean that we have not included literature from learning and education. There is also interdisciplinary literature on learning and technology, which will be explicitly stated.

1.2 Research Objective

As we got to know the theories and field of learning, we could narrow down our research interest to a more specific research objective. The first objective thus became to form design considerations, for both technology designers and design researchers, that are thoroughly grounded in theory and empirically investigated through a DT process.

1.3 Research Question

The process of familiarising ourselves with the literature on pedagogy and literature on learning and technology led us to construct a theoretical framework and find related work, which in turn helped us formulate the following primary research question:

> *What design considerations should be made, when designing technology that will act as a more capable peer?*

We also chose to have a secondary research question as we, through the operationalisation of theory, will gain new and valuable insight. It is also essential for us to answer the secondary research question in order to answer the first one. The secondary research question is as follows:

> *Which social constructivist learning concepts are best to suited operationalise in digital technology when scaffolding students?*

To answer these research questions, we started by carrying out a systematic literature review (SLR) to learn about the theories of pedagogy and learning and how they cross over with the field of technology. This review then informed a DT process, which we carried out with 61 students. The DT process allowed us to operationalise the theory in practice. Through a thematic analysis, the results from the DT process was synthesised into three main themes, with 18 different design considerations. These three main themes show which theoretical learning concepts are useful in the context of digital technology and the 18 design considerations show what types of considerations to make when designing technology to scaffold students.

The contributions presented at the end of this thesis addresses our wish for design considerations for designing digital technology for learning that are rooted in theory. We also address which social constructivist concepts are best suited to operationalise in a digital technology when wanting to scaffold

students. Additionally, we hope to contribute to the interdisciplinary literature of learning and technology with our understanding of what social constructivist concepts works well with technology.

1.4 Empirical Context

We chose to investigate an introductory design course at the University of Oslo (UiO) (hereafter named as "the course") as there are mostly young students, with little to no previous experience with higher education, that attend the course. It has up to 200 students attending each fall semester. The course requires a substantial understanding of HCI terms and concepts which can be overwhelming for 1st-year university students. This is from a social constructivist perspective particularly interesting as the course is most likely where they will have their first meeting with and get to know the field of HCI. The field of HCI and its view on people and technology is a culture the students throughout the course will become a part of. Having both been through the same experience of becoming a part of design culture, we find this a compelling and well-suited context for our research. To support our choice even further, the focus of HCI is in line with the social constructivist learning theory as they are both human-centred.

The course has three different teacher roles; the course coordinator who is a professor, group teachers who are former students in the course and assignment correctors who are also former students in the course. The course consists of three different lecture formats which are voluntary, but also highly recommended by the course coordinator, for students to attend. These are lectures held by the course coordinator, group lessons held by group teachers and plenary lectures also held by group teachers. For our research project, we are most concerned with the role of the group teachers, because they are, by definition, more capable peers.

Group teachers are students who have previously attended the course and are still doing their degree at the University. Their role in the subject is to hold group lessons that facilitate active learning through collaboration, taking theory to practice, assist with the obligatory assignments and repeat that week's lecture. Additionally, they also correct and give feedback on the obligatory assignments. Because the group teachers have previously attended and passed the course, they have a higher level of understanding of the curriculum and are therefore more capable peers.

The course has four mandatory assignments the students have to complete in order to take the final exam. The final exam is a written exam that will test them on their understanding of the terms and concepts introduced in the course and how well they can reflect upon them.

The students belong to different social context and cultures. Firstly, they are individuals with different backgrounds; some students come straight out of high school, while others have studied before. Secondly, the students are from different cities; some students are newcomers to Oslo, while others are from the neighbouring area. Secondly, they are part of the bachelor community at IFI, and gradually they are becoming part of the HCI culture. Lastly, they are, as students, part of the IFI, and looking at it even more broadly; they are a part of UiO.

These contextual and cultural differences make the learning situation more complex as the students we were following had different perspectives. However, the social constructivist perspective chosen for this thesis allowed us to take this into considerations when analysing and presenting our main findings and contribution.

1.5 Thesis Structure

In **Chapter 2**, we present our systematic literature review of the literature on pedagogy, our approach, search strategy, and answers to questions regarding learning and technology.

In **Chapter 3**, we present the theoretical framework that has guided our research and analysis. The social constructivist theoretical framework in this chapter derives from the field of pedagogy.

In **Chapter 4**, we present our methodology and the methods we used for data gathering and thematic analysis. We also describe our methodological challenges and ethical considerations.

In **Chapter 5**, we present our research approach based on our methodology. Each subsection presents a phase in our design process.

In **Chapter 6**, we present our empirical data, where we discuss some of the main intermediate results acquired in each phase.

In **Chapter 7**, we will thematically analyse our result, before they are presented in light of our theoretical framework.

In **Chapter 8**, we discuss our findings and introduce our research contribution. Here we give a summary of our analysis and discussion, structured around our main findings.

Chapter 9 is our concluding chapter. Here we give a summary of our analysis and discussion, structured around our research questions. This section also contains suggestions for future research.

2 Literature Review

In the literature of pedagogy, there are plenty of theories to explain how humans learn and the most effective ways to promote learning. There are learning theories that came to be as a reaction to existing views of learning, learning theories that are complete opposites, and we also have learning theories which build on one another and showcase how learning has developed through the years. In order to have a structured approach to getting to know the literature, we took an SLR approach. The SLR gave a focus to the literature review and also ensured that we got a thorough review in order to properly gain a deep understanding of what learning is, which is needed to do a design thinking process properly.

To have a starting point for our review, since we were not familiar with it, we used the literature from two courses at UiO, who are both about learning and technology. One of the course is at bachelors' level and provided us with the two books that served as both our introduction to learning and now our theoretical foundation: 'Learning Theory an Online Technologies' (Harasim, 2017) and 'Education and Technology' (Selwyn, 2016). They have also pointed us in the direction of the rest of our literature. The other course is at masters' level and provided us with articles that build on one of the theories from the two books, social constructivism.

In this thesis, the theory presented in Chapter 2 and 3 will have the role of a shaping tool, as conceptualised by Beck & Stolterman (2016). When theory plays the role of a shaping tool, a question is posed, followed by an examination of the theory which leads to a new research question (Beck & Stolterman, 2016, p. 132). The new research question then shapes the research which inevitably leads to some findings that will answer the new research question and potentially also contribute to the examined theory (Beck & Stolterman, 2016, p. 133). We began our thesis intending to get to know the literature rather than a specific question, but the role of the theory is the same; it will guide our research and shape the research question.

After examining what learning is through the lens of the different fields and learning theories, we were drawn to the learning theories that are based on the constructivist epistemology, more precisely the social constructivist learning theory.

2.1 Systematic Literature Review

In this section, we will present our literature review, which is inspired by the SLR process. However, we will first present what an SLR is, why we were inspired by it, and what parts of an SLR we have included and why.

The most common reasons for conducting an SLR, according to Kitchenham (2004) is to summarise the existing empirical evidence, identify gaps in current literature, and to provide a theoretical framework for positioning new research activities. An SLR has commonly been used for quantitative studies in fields like medicine where there is a vast amount of literature and data that needs to be reviewed in an unbiased, systematic manner (Kitchenham, 2004, p. 1). The SLR process consists of three stages: planning the review, conducting the review, and reporting the review (Kitchenham, 2004, p. 3). Planning the review consists of identifying the need for doing an SLR and developing a review protocol that includes questions one wants the review to answer. Conducting the review consists of identifying research, selecting research, assessing the quality, extracting data, and synthesising data. Reporting the review consists of writing it up and publishing it, usually in a thesis or paper in a journal. Although this way is considered the proper way of conducting a systematic literature review, how we did it is a little different, this will be explored further in the following section.

2.1.1 Organising our Systematic Literature Review

In our case, we needed to learn about the vast field of learning and pedagogy in order to properly be able to understand how to use our design knowledge to improve a learning situation. Also, gaining this knowledge will help us further empathise with our users, the context they are in and the problem area we need to address (Lee, 2018, p. 67). As soon as we started looking into the literature, we understood that the field was vast, and we needed to be systematic and organised in the way we searched for literature and what we read. Therefore, we, chose to form a search strategy and some questions we needed the review to answer. Because we are doing a qualitative study in two fields – pedagogy and HCI– that can arguably be entirely subjective, the need to thoroughly identify, extract, and assess the data in a rigorous manner was not needed. What we needed from the SLR was the structured way of approaching the unfamiliar literature of pedagogy with specific questions to be answered and used in our research.

The SLR was mainly conducted over the spring semester of 2019 and then continued iteratively as needed throughout our research. The main activities in conducting the review were thereby to generate

a search strategy to access and identify existing literature, identify what questions we needed to be answered and find potentially relevant studies that could answer those questions.

2.1.2 Research Questions for the SLR

With our literature review, we wished to answer some more general questions about learning and some relating to both learning and technology. We have separated the questions into three categories: learning, learning and technology, and key lessons.

Learning

- What is learning?
- How do we learn?
- What learning theories exist?
- Which learning theories are relevant today?

Learning and Technology

- What does the theory say about digital technology, and how does the theory shape learning technology?
- What research exists on learning in the field of informatics, particularly the design of information technology?
- What research has been done by the field of Human-Computer interaction concerning learning in higher education?

Key Lessons

- What are the key lessons we can extract from the literature?

2.1.3 Search Strategy

In our primary search for literature, we used the curriculum of two pedagogical courses offered at UiO, PED2802 – Læring, design og teknologi (learning, design and technology), bachelor level and PED4540 – Teknologistøttet læring: Prinsipper og verktøy (Technology assisted learning: principles and tools),

master level. Both of these courses focused on learning and technology and were therefore chosen as initial searching ground. This way, we had a reliable foundation for our pedagogical questions in our search. We then searched for articles and books that were referenced in the curriculum as well as articles on Oria and Google Scholar as we learnt more about the field. The keywords we used when searching on Oria and Google Scholar, are based on definitions from the findings of our intermediate literature and are as follows:

Table 2-1 *Initial search terms for SLR*

Search Terms	***Source***
Learning	(Harasim, 2017; Schunk, 2014; Selwyn, 2016)
Learning theory	(Harasim, 2017; Schunk, 2014; Selwyn, 2016)
Constructionism	(Harasim, 2017; Selwyn, 2016)
Constructivism	Harasim, 2017; Selwyn, 2016)
Social constructivist learning theory	(Harasim, 2017; Selwyn, 2016)
Social constructivism learning theory	(Harasim, 2017; Selwyn, 2016)
Learning in a digital age	(Harasim, 2017; Selwyn, 2016)
Learning and technology	(Harasim, 2017; Selwyn, 2016)
Zone of Proximal Development	(Harasim, 2017; Selwyn, 2016; Vygotsky, 1978)
Scaffolding	(Harasim, 2017; Papert, 1996; Selwyn, 2016; Vygotsky, 1978)
Situated learning	(Lave & Wenger, 1991)

To sharpen the focus in the search for relevant theories, we used the following exclusion and inclusion criteria:

Exclusion

- Studies not written in English, Norwegian, Danish or Swedish.

- No search terms in the title, abstract, or keywords.
- No keywords.
- Duplicate reports on the same study.

Inclusion

- The author has been mentioned or referenced in our existing literature.
- Literature regarding learning technology are from the last two decades.
- Recognised literature about learning theories.

With these search terms and exclusion and inclusion criteria, we will in the rest of this chapter answer the questions we had regarding learning and learning and technology. Following is a summary of what we have found. The research gap and the key learnings will be presented in the next chapter.

2.1.4 Learning

What is learning?

Learning is the process of acquiring new or modifying skills and knowledge (Harasim, 2017; Selwyn, 2016). As a consequence of interacting with our environment, we learn from the time before our birth until our death (Thomas & Seely Brown, 2011a, p. 90). The first form of learning, play, is approached by several theorists; children experiment with the world, learn the rules, and learn to interact through play (Baume & Scanlon, 2018; Thomas & Seely Brown, 2011a; Vygotsky, 1978; Young et al., 2012). Baume and Scanlon's (2018) seven principles state that learning is most effective when (1) a clear structure surrounds, supports and informs learning; (2) high standards are expected of and made explicit to learners; (3) learners recognise and use their prior learning, and their particular approaches to learning; (4) learning is an active process; (5) learners are doing relevant activities and practices, spending much time on task; (6) learning is undertaken as a collaborative activity or at least a part of it, both among students and students and teachers; and finally (7) feedback is given to the learners on their work and which they learn from.

How do we learn?

The nature of pedagogy is to make sense of how people learn and how they should be taught (Tjeldvoll, 2018). Pedagogy is closely linked to other fields of knowledge such as philosophy, psychology, and

sociology, as these fields also try to make sense of the human mind and behaviour but with different perspectives and approaches. As such, examining how we learn and what learning is these fields of knowledge will help guide the choice of theory to use in our theoretical framework.

Philosophy is the study of general and fundamental ideas, such as reason, mind, existence, and knowledge (Tranøy & Alnes, 2019). Philosophers Socrates, Plato, and Aristotle have had a significant impact on today's formal learning through their philosophies on knowledge and how we obtain knowledge (Alnes et al., 2019). From Socrates, we have the Socratic method, which is a form of inquiry and discussion between individuals, based on asking and answering questions to illuminate ideas (Center for Teaching and Learning, 2003). The Socratic method is regarded as an excellent way of engaging students in constructing knowledge (Center for Teaching and Learning, 2003, p. 3). The two main epistemologies in the field of learning derived from the work of Plato and Aristle; objectivism and constructivism (Harasim, 2017, p. 7). Objectivism sees knowledge as an authority of objective truth (Harasim, 2017, p. 14). Because of this, it is possible to transmit the knowledge without it being affected by the mind it enters. The truth exists outside the mind and is not affected by the beliefs and perceptions of the human holding the knowledge (Harasim, 2017, p. 14). In contrast, the nature of knowledge is subjective in constructivism, and human perception and agreed-upon conventions are what affects the construction of knowledge in the mind (Harasim, 2017, p. 7). Through interactions with the world, knowledge can change and is therefore dynamic rather than absolute (Harasim, 2017, p. 7).

Psychology tries to answer the question "when does learning occur?" (Svartdal, 2017). It focuses on the mental processes which one goes through when learning. The first learning theories emerged at the same time as psychology; as such, the field of psychology influenced the learning theories that emerged during this period. These theories are behaviourism, cognitivism, and constructivism (Harasim, 2017, p. 9). Also, sociological learning theories derived from the work of psychologists, such as Vygotsky (2001; 1978) and Bandura (1971).

Pedagogical sociology uses sociological theories and empirical methods to describe, understand, and explain educational issues (Durkeheim, 2014, p. 121). These issues concern upbringing, education and socialisation (Durkeheim, 2014, p. 121). The critical belief of sociology is that there is no universal educational form of learning for all humankind (Durkeheim, 2014; Dysthe, 2001; Hoëm, 2010). Hoëm's (2010) socialising theory encourages educators and education authorities to create the best possible conditions for value and interest-sharing between the homes and the schools (Hoëm, 2010, p. 24).

Pedagogy is the study of how knowledge and skills exchanges in an educational context and the pedagogical purpose is to lead each individual to the highest possible degree of perfection (Durkeheim, 2014, p. 56). As argued by Li (2006), pedagogy reflects the different social, political, and cultural context from which they emerged, and therefore vary considerably. Pedagogical philosophy studies the fundamental issues related to pedagogical theories and practices. Psychological pedagogy focuses more specifically on the mental processes that occur during learning. Pedagogical sociology seeks to develop coherent understandings of people's lives at individual, group, institution and social level. It involves studying social interaction and how different social groups make use of the education system.

Learning can occur in an informal and formal context. Informal learning is the learning that happens in everyday life, where there are usually no formal aspects like a classroom or a curriculum (Malcolm et al., 2003, p. 314; Selwyn, 2016, p. 5). If one is pursuing a new hobby like baking, informal learning will occur both when looking up recipes and when doing the actual baking. Informal learning also occurs when one learns something new at work (Malcolm et al., 2003, p. 316; Selwyn, 2016, p. 5). Formal learning is the opposite of informal learning; it is the structured and intentional learning we know from education today (Malcolm et al., 2003, p. 314; Selwyn, 2016, p. 5). Formal learning can also happen outside the educational system, for example, if one's work requires some formal training (Malcolm et al., 2003, p. 316; Selwyn, 2016, p. 5).

What learning theories exist?

The first learning theory to emerge was the behaviourist learning theory which developed at the same time as the first directions in the field of psychology (Harasim, 2017, p. 11). The behaviourist is concerned with what is observable: how people behave and primarily how to change or elicit particular behaviours (Harasim, 2017, p. 33; Schunk, 2014, p. 21). As a response to behaviourism, cognitivist learning theory emerged. The cognitivist's focus, in contrast to the behaviourist, is on the internal mental processes and understanding how cognitive processes could promote active learning (Harasim, 2017, p. 49; Schunk, 2014, p. 22). Then the constructivist learning theory emerged from the work of psychologist Jean Piaget as a reaction to the cognitivist view of the "mind as computer" where individual learning is in focus, ignoring the social nature of learning (Selwyn, 2016, p. 80). In constructivism, the learner is actively involved in constructing knowledge with the teacher and peers. The concept of active learning where learning is a process of exploration, inquiry, interpretation, and meaning-making is at the core of constructivism (Selwyn, 2016, p. 192). From constructivism, we have two branches, social constructivist learning theory and constructionist learning theory (Harasim, 2017, p. 70; Selwyn, 2016, p. 83). Constructionism believes learning to best take place through the exploratory building of objects that are

themselves capable of doing something. Social constructivism, on the other hand, emphasises how meanings and understandings grow out of social encounters (Harasim, 2017, p. 73; Selwyn, 2016, p. 83).

Newer socio-cultural learning theories, such as connectivism and collaborativism, consider learning as a profoundly social process that can be facilitated through the use of digital technology. These learning theories emerged with the increasing use of the internet and digital technologies, as both learning theories believe that technology enables learners to see interdisciplinary connections (Selwyn, 2016, p. 85). Connectivism views learning as a process of connecting nodes of information, and technology is seen as an active participant in this learning network (Harasim, 2017, p. 83). Collaborativism is rooted in Vygotsky's social learning theory and can in some ways be viewed as the modern constructivist learning theory as it is adjusted to the technological every day of the 21st century (Harasim, 2017, p. 137). Its basic principles are collaboration and creation, which is the same as the constructivist learning theory, but adjusted to the technological aspect that exists today.

Which learning theories are relevant today?

The social theories are the ones that have seen an increase in popularity and development in newer history (Selwyn, 2016, p. 80). In social constructivism, the lecturer is a facilitator of learning and co-constructor of knowledge rather than a knowledge-holder that transfers knowledge to students who passively listen (Selwyn, 2016, p. 73). However, we can still find some behaviourist and cognitivist elements in the learning system of today's school, but the primary research and development are done in the field of social theories (Selwyn, 2016, p.76-77). As the view on learning is going towards more social theories, we have chosen to look at the branch of social constructivism and the learning theories which have emerged from this branch of pedagogy. As our everyday life gets more digital for each decade, the school systems, teaching and learning methods must evolve with them (Hagelia, 2017, p. 14). While social constructivism still is highly relevant in explaining how we learn through social interaction, it does not address the role of learning in the digital age (Harasim, 2017, p. 110). If the difference between how students learn and do things in their private lives differ from the formal educational context they belong to, knowing how to acquire knowledge effectively in an educational context can be challenging (Hagelia, 2017, p. 11). Two newer theories address this technological development: connectivism and collaborativism. These two theories will be explained further in Section 2.1.5 Learning and technology.

2.1.5 Learning and Technology

What does the theory say about digital technology, and how does the theory shape learning technology?

Experts in the fields of both technology and psychology agree that technology can enhance the learning experience by being a powerful social and informational resource outside of the learner's immediate environment (Selwyn, 2016, p. 86). Social constructivism sees technology as a tool that extends the human ability to achieve goals otherwise impossible (Verenikina, 2010, p. 20). While the foundational theories of social constructivism do not say much about the use of technology to promote learning, many of the technologies used for learning today have a social constructivist foundation. As such, the technology can be used as the more capable peer, helping the students reach higher levels of knowledge (Selwyn, 2016, p. 86). In a social constructivist classroom, technologies which promote critical thinking, collaboration, and active participation among the students are used in learning situations. Theories such as connectivism, collaborativism, and computer-supported collaborative learning are examples of social theories where technology has an essential role in the teaching approach (Harasim, 2017, p. 13).

In connectivism, the computer has the role of intelligently identify and organise the information for the learner, making the role of an instructor obsolete (Harasim, 2017, p. 81). Artificial intelligence (AI) is what takes away the need for an instructor by organising the curriculum, the information connections and directions for the learner (Harasim, 2017, p. 98). Connectivism also says that we learn by having social interactions through the internet and particularly social media (Kivunja, 2014, p. 89). Social media platforms facilitate the connectivist learning model by making resources visible, connecting people in networks and making it possible to convey information and knowledge (Hagelia, 2017, p. 103). The digital computer is a resource of information that is almost always available to us through digital technologies like smartphones and laptops (Hagelia, 2017, p. 101). The computer enables the student to immediately look up information that they might need, minimising the need for learning something because one day you might need it (Hagelia, 2017, p. 101). One example of a connectivist digital learning technology is the Massive Open Online Course (MOOCS) (Harasim, 2017, p. 93). A MOOC is, as the name describes, an online course that gives you access to video lectures and quizzes (Harasim, 2017, p. 93). No instructor organises your curriculum, part of the learning is to navigate the available content and select that which is useful for your learning, encouraging the student to make connections between the different content available and the student's previous experience and knowledge (Harasim, 2017, p. 96). The technology, or rather artificial intelligence, will then organise your curriculum and the connections between the information that you have found.

Collaborative theory is similar to other collaborative learning theories, but with the additional focus on technology enhancing human ability and facilitating collaboration (Harasim, 2017, p. 133). The belief is that through the use of technology, humans are capable of reaching a higher level of learning than they would be without the technology. Harasim (2017, p. 133) coins the terms Augmented Human Intelligence (AHI) to describe this view of technology. As mentioned, in connectivism, the role of the instructor becomes almost obsolete because the technology is the facilitator of learning. The instructor is still the facilitator of learning in collaborativism, like in social constructivism, and the technology is more of a tool to be used for facilitating the learning. A collaborativist educational application is typically a web-based forum where learners work together to both gain an understanding and produce a knowledge product (Harasim, 2017, p. 117). The instructor's role is essential as he/she facilitates the discussion and is always present as a knowledge community expert to intervene, encourage, and assist the students (Harasim, 2017, p. 117). While there are technologies today that facilitate online discourse (e-mail, forums etc.), they are not made to be used in a learning context, and therefore require much adjustment to the learning format to function (Harasim, 2017, p. 127). Using easily customisable technology is therefore essential for collaborativism, as the technology's role is to adjust to the learning context, not the other way where the instructor and learners have to adjust to the technology.

Computer-supported collaborative learning (CSCL) is another variation of collaborative learning which have roots in Vygotsky's social constructivism (Dilensbourg et al., 2009, p. 3). CSCL is characterised by the sharing and construction of knowledge among students using technology as their primary tool (Dilensbourg et al., 2009, p. 5). This approach is not limited to only support communication among secluded students but also for those in close proximity for shaping verbal interactions in different ways and for capturing, analysing, and mirroring these interactions in real-time (Dilensbourg et al., 2009, pp. 6–9). Intersubjectivity is a central concept in CSCL (Stahl, 2015, p. 209). Intersubjectivity is an inter-mental process where two individual subjects together construct meaning (Stahl, 2015, p. 209). In the context of learning, it could be an understanding between student and instructor or between students. Verenikina defines intersubjectivity as the process and product of sharing experiences, knowledge, understandings, and expectations with others (Verenikina, 2010, p. 3).

What research exists on learning in the field of informatics, particularly the design of information technology?

In our literature review, we found several articles from the field of informatics that was about learning and human-computer interaction in higher education (Begnum et al., 2019; Motschnig et al., 2016;

Shivers-McNair et al., 2018). These articles address the universities curriculum, the achieved competence of the student and the importance of the type of kind of competence taught.

Shivers-McNair et al. (2018) use user-centred design (UCD) principles in designing and structuring an advanced bachelor subject. They argue that UCD principles can and should be more than just course concepts; it should be core practices of the course, holding both students and teachers accountable for the impacts of their rhetorical choices (Shivers-McNair et al., 2018, p. 37).

Motschnig, Sedlmair, Schröder, and Möller (2016) outline an approach to how a team of instructors can implement learner-centred (also called student-centred) principles in an extensive course on HCI. This article presents a successful approach to situated learning, which is a social constructivist learning method.

National and international legislation has continuously strengthened universal design (UD) guidelines over the last decades (Begnum et al., 2019, p. 2). Begnum, Pettersen, and Sørum (2019) look into how higher education programs address legislated accessibility responsibility. This analysis of Norwegian higher education programs within interaction design (IxD), found that the study programs do not deliver sufficiently training in UD in order to fulfil the professional competencies related to ICT accessibility (Begnum et al., 2019, p. 10). Begnum et al. (2019) present five archetypes of IxD professionals; the front-ender, the full-stacker, the design thinker, the communicator and the user empath, and for each of the five, they propose key universal design expertise skill sets.

2.1.6 Key Lessons

What are the key lessons we can extract from the literature?

Social constructivism derived from the constructivist learning theory and believes that learning is interactive and exploratory (Selwyn, 2016, p. 80). The four of the fundamental principles of this theory are active learning, learning-by-doing, scaffolded learning, and collaborative learning (Selwyn, 2016, p. 80). Social constructivism and newer learning theories identify the student as an agent and the teacher as a facilitator (Harasim, 2017, p. 71; Selwyn, 2016, p. 80). This means that the instructor adjusts the learning process to help guide the students to work according to the specific discipline. From Baume and Scanlon (2018b), we have seven principles for how we learn most effectively. These seven principles are suggested as guidelines for teachers and course instructors when planning or modelling a course and are based on extensive research found on learning. The principles support the social constructivist way of teaching. Hagelia (2017) and Thomas and Seely Brown (2011a) argue for a new approach to learning

going from a teaching-based approach to a learning-based approach. In the new culture of learning the aim is to embrace what we do not know and continuing to ask questions about it in order to gain more knowledge (Thomas & Seely Brown, 2011a, p. 38). The goal becomes to take in the world and make it part of oneself as a way to recreate it (Thomas & Seely Brown, 2011a, p. 38). As stated by Hagelia (2017), the educational system and learning methods has to evolve with the digital everyday life of the students. However, we did not find substantial amount of literature about how HCI can be used to improve learning technologies.

3 Theoretical Framework

The modern learning theories presented in the previous chapter promotes a student-centred learning environment moving from the traditional teaching-based approach to the learning-based approach. In other words, the teacher becomes a facilitator of learning and co-constructor of knowledge rather than a knowledge holder that transfers knowledge to students who passively listens. We have through our literature review seen that in recent decades this approach to learning has shown significant learning outcomes and has reformed teaching styles. Therefore, we chose to get familiar with the social constructivist learning theory and the instructional methods that underly this learning theory.

Social constructivism emerged from the work of Vygotsky, and it emphasises how meaning and understanding grows out of social encounters (Selwyn, 2016, p. 83). This theory builds on Piaget's idea of the child as an active learner (Verenikina, 2010, p. 17). The first part of this chapter will explore Vygotsky's work and other related work to social constructivist learning theory.

According to Vygotsky, language and thought are the primary tools that promote thinking, develop reasoning, and support cultural activities like reading and writing (Vygotskij, 2001, p. 203). An introductory course to a field of knowledge where the student will later be an active participant, for example, an introductory course in cooking for future chefs, is where the students will be introduced and start to learn the language of their field. Vygotsky states that learning is a necessary and universal aspect of the process of human development, which is culturally and socially determined and governed in society (Verenikina, 2010, p. 17). Therefore, teaching techniques that help students become independent strategic learners, the combination of individual and group learning and promote literacy across curriculum play a significant role in knowledge construction. Also, teachers need to provide the students with the opportunity to have discussions where there is a meaningful exchange between students that results in questions that promote deeper understanding (Vygotsky, 1978, p. 90). The teacher or a topic expert play the critical role of the facilitator, creating an environment where directed and guided interaction can occur.

The foundation of what Vygotsky's social constructivist learning theory teaches is that learning always occurs and cannot be separated from a social context. As a consequence, teaching techniques that promote the distribution of expert knowledge and where students collaboratively work together to conduct, share, and produce a final project, help to create a collaborative community of learners. The knowledge that is constructed within a social context that involves student-student and/or expert-student

collaboration on real problems or tasks builds on each person's language, skills, and experience shaped by each individuals culture (Vygotsky, 1978, p. 102).

As our surroundings are still changing, we are presented with both new challenges and new opportunities (Hoëm, 2010, p. 30). Thomas and Seely Brown (2011a) argue for a new approach to learning going from a teaching-based approach to education to a learning-based approach. The primary difference between these approaches to education is that in the former case, the culture is the environment, while in the latter case, the culture emerges, and grows from the environment (Thomas & Seely Brown, 2011a, p. 38). A second difference is that the new approach focuses on learning through engagement within the world, in contrast to the teaching-based approach focuses on teaching us about the world (Thomas & Seely Brown, 2011a, p. 38). In the new culture of learning the point is to embrace what we do not know and continuing to ask questions about it in order to learn more and more (Thomas & Seely Brown, 2011a, p. 38). The goal becomes to take in the world and make it part of oneself as a way to recreate it (Thomas & Seely Brown, 2011a, p. 38). Social constructivist learning theory takes this into account and is, therefore, a learning theory one can still deploy in a modern classroom.

3.1 Social Constructivist Concepts

As Vygotsky (1978) and Wertsch (1991, 1998) point out, learning is active, and we learn by seeing, hearing, and mimicking others. Social constructivist instructional methods such as scaffolding, dialogue-based learning and collaborative learning foster learning environments where students can learn from each other and their instructor. We will now present different learning concepts from social constructivism that are relevant for this thesis.

Active Learning

One of the core principles of constructivism is that knowledge is actively constructed through interactions with the world around us. Social constructivism builds further on this by reinforcing the importance of social interaction with the environment we learn in. Therefore, knowledge is learned and constructed through interaction with the environment and the people around, rather than by just listening to others (Harasim, 2017, p. 71). Active learning can be defined as involving the students in their learning by making the students actively participate (Danker, 2015, p. 174). The students need to construct their knowledge through social interactions with their peers and instructors. The teachers' role is not to be a transmitter of knowledge, but rather a facilitator of learning through encouraging and assisting the learner in constructing their knowledge through different activities (Harasim, 2017, p. 71).

In contrast, passive learning is when the instructor acts as a "transmitter" of knowledge, and the student is a passive recipient of the knowledge. A well-known instructional format that is passive is large-scale lectures. From a social constructivist point of view, passive learning is not ideal as it does not facilitate engagement with the environment or social interactions among the students and/or instructor. However, teaching formats like large lectures are difficult to avoid, especially at universities where many students attend the same course. It is not uncommon to have introductory courses of 200 students or more.

A study done by Deslauriers et al. (2019) shows that, though students felt like they learned more from traditional lectures, they indeed learned more when taking part in active-learning classrooms (Reuell, 2019). The authors report an inherent student bias against active learning, which can limit its effectiveness and may hinder the wide adoption of active learning methods (Deslauriers et al., 2019, pp. 19255–19256).

Scaffolded Learning

'Good learning' occurs, according to Vygotsky, in the Zone of Proximal Development (Vygotsky, 1978, p. 87). This is one of the fundamental concepts in social constructivism (Hagelia, 2017; Selwyn, 2016). Scaffolded learning is a social constructivist instructional method that stems from Vygotsky's concept of Zone of Proximal Development (ZPD). It consists of strategies that set ZPD to life by giving the learner support.

Vygotsky (1978) states that learning is a necessary and universal aspect of the human development process, which is culturally and socially determined and intentionally and systematically governed in society. ZDP is the distance between the current level of development as determined by independent problem solving and the higher level of potential development as intended through problem-solving under guidance or in collaboration with more capable peers (Verenikina, 2010, p. 17). This requires teachers to provide the students with the opportunity to discuss their learning, as well as facilitating collaboration between students of different capabilities. The instructor does this by collaborating with and supporting the learner so that the learner can reach their potential development, as conceptualised through ZPD. As the learner learns more, scaffolds are removed so that eventually, the learner is independently competent without the need for support (Harasim, 2017, pp. 73–74).

As the purpose of scaffolding is to help the students reach a goal, complete a task or solve a problem, the more capable peer does not need to be a teacher. It could be a peer who has reached a higher level of knowledge or a tool such as an application with scaffolds. Through scaffolding, the students are given a context and motivation from which they can understand the new information (Harasim, 2017, p. 73).

Collaborative Learning

Collaborative learning entails, preferably, a small group of students with mixed abilities working together to solve a problem (Sullivan, 2009, p. 112). The students have to work together to ensure that everyone has acquired an understanding of the topic or concept at hand (Hagelia, 2017, p. 107). This method is one of the main approaches of constructivism to teaching and learning (Verenikina, 2010, p. 17). Knowledge is co-constructed through group interactions, as they are in real-world learning environments (Verenikina, 2010, p. 17). As the students work together and construct knowledge, they feel more ownership of the topic and gain more self-esteem on various levels (Center for Teaching and Learning, 2003). Therefore, collaboration boosts not only a student's self-esteem but also their communication, and team-player skills.

There is an essential difference between collaboration and co-operation. Collaboration is when the learners, through social interactions, co-produce an artefact, or knowledge (Harasim, 2017, p. 74). In other words, both the process and product of learning is collaborative (Harasim, 2017, p. 121). Co-operation, on the other hand, is not seen as a collaborative process, but rather a process where each group member, through the division of labour, contributes an independent piece of work to form a product (Harasim, 2017, p. 121). If they were co-operating, they would divide the task, and the individual learners would complete their parts on their own, before putting it together with the other parts at the end (Harasim, 2017, pp. 74–75). Co-operation is therefore not seen as a collaborative process, even though several group members contributed to the final product. The distinction between the two terms is essential to be aware of, as it highlights how simply putting learners together in a group will not lead to a collaborative learning experience. In addition to putting learners together in groups, we also need to facilitate the social interaction that is necessary for a proper social constructivist, collaborative learning experience.

Situated Learning

Situated learning is an instructional approach that follows the work of Dewey and Vygotsky, who claim that students are more inclined to learn by actively participating in the learning experience (Lave & Wenger, 1991, pp. 48–49). The essence of situated learning is that learning should be both meaningful,

relevant and active, using real activities of daily living (Lave & Wenger, 1991, p. 49). In other words, activities where the student is actively involved in addressing real-world problems, such as internship experiences and co-operative education, fits under the situated learning umbrella. The student is said to be "situated" in the learning experience. Knowledge acquisition becomes a part of the learning activity, its context and the culture the activity is developed and used as the students form or "construct" their knowledge from experiences they bring to the learning situation (Lave & Wenger, 1991, p. 98). Thus, social interaction and tactile activity give a successful situated learning experience.

As situated learning suggest that learning takes place through the interaction and relationships between people, the student becomes the apprentice and the teacher, or a computer becomes the master (Lave & Wenger, 1991, p. 29). In this learning environment, the teacher is a facilitator and promoter of co-operative activities where the students are challenged to use their critical thinking and physical abilities. E.g. if one is studying to become a tailor, the learning situation should be in a tailor shop, because that is where the knowledge is intended to be used. Sitting at a desk in a classroom will not give the proper skills one needs to become a tailor, one needs to spend time in the context to both learn better and remember what one learns better (Lave & Wenger, 1991, pp. 69–76).
Schell and Black (1997) describe a community of highly motivated learners which evolved from learner's self-empowerment in situated learning contexts where a culture for openness and exchange of ideas were nurtured in an environment of mutual trust and respect. Throughout their research, the element of trust emerged and its importance to facilitate such an environment.

Dialogue-Based Learning

Dialogue-based learning method such as reciprocal teaching involves small groups of students taking turns engaging each other and their teaching in dialogue about a concept or topic (Sullivan, 2009, p. 438). In reciprocal teaching the students become the teacher and with the dialogues, the group members apply four cognitive strategies (questioning, summarising, clarifying and predicting) which require students to gradually assume more responsibility (Sullivan, 2009, p. 438). This method makes the concept or topic easier to understand for the students because it is broken down into smaller bits and a small group of people are working together to understand it.

Learning-by-Doing

Learning-by-doing is a concept that stems from Seymour Papert's work (Papert, 1996), and takes constructivism one step further where the goal of the learning is to make something. Papert began to use the concept of constructionism about this learning concept, to differentiate it from constructivism. The

main goal of this approach is to teach the students how to do something, rather than just teach them about something. Papert used this approach by teaching children to become mathematicians instead of teaching them about mathematics. (Harasim, 2017, pp. 72–73).

Project-based learning (PBL) is a form of learning-by-doing, which works as a powerful instructional method (Lee, 2018, p. 159). Scheer et al. (2012) and Lee (2018) claim that Design Thinking as a team-based learning process offers teachers support towards real-life oriented modes of constructivist learning in projects. Its emphasis on real-world problems, inquiry, and collaboration makes the instructional method designed in a way that is true to how teamwork is in real life, especially in professional realms (Lee, 2018, p. 159). There are four stages with eight essential elements in PBL project design (Lee, 2018, p. 160). These stages are: (1) launch project by introducing the driving question, (2) build knowledge and skills to answer the question, (3) develop and revise products that answer the question, and finally (4) present the products (Lee, 2018, p. 160).

Reflexive Learner

Reflection is learning from experience; one does not learn from the experience itself, but by reflecting on the experience (Hagelia, 2017, p. 125). Reflection is, therefore, seen as reflection-on-action. The reflexive learner refers to the concept of educating people to be prepared for the challenges we face in the modern world (Emmanuel, 2020). Due to the information revolution, we have a vast amount of information available to us today, that is often conflicting and ever-changing (Dyke, 2006, pp. 105–106). As such being a reflexive learner is an 21st-century skill (Appendix C) students need to master. The ability to reflect on the information and evaluate it "live" is what makes a reflexive learner. A reflexive learner is also able to think critically, which entails scientific reasoning, systems thinking, computational thinking, decision-making and problem-solving (M. Qian & Clark, 2016, p. 51).

Mathetic Taboo

Papert (1996) introduces the term "Mathetic" to give a proper term to the art of learning, in the same way, that the art of teaching has the term pedagogy. He coins the term "mathetic taboo" as the taboo against talking freely about how we think and learn (Papert, 1996, p. 11). Mathetic taboo comes from the fear of being exposed to having an inferior or less intelligent mind, thus making ourselves vulnerable (Papert, 1996, p. 11). It can lead to people trying to seem more intelligent and knowledgeable than they are-(Papert, 1996, pp. 14–15). As such, speaking about one's learning process and can be confusing and scary, especially among people, we are not well acquainted with (Papert, 1996, p. 16).

Gamification

As pointed out by Harasim (2017), Hagelia (2017) and Thomas and Seely Brown (2011b) the youth of today grows to learn how to collaborate online in their spare time through games such as World of Warcraft and Minecraft. Despite this, today's school systems treat online learning as a secondary tool, rather than adjusting the system to the way the new digital generation collaborates. The act of learning through a game is called game-based learning, and the right type of game can promote key principles of social constructivist learning theory such as collaboration and communication. To be clear, when we talk about game-based learning, we are referring to learning through playing a game; and gamification when we are using game elements in an application.

Game-based learning is an environment where game content and gameplay enhance knowledge and skills acquisition (M. Qian & Clark, 2016, p. 51). These games involve problem-solving and challenges that provide learners with a sense of achievement (M. Qian & Clark, 2016, p. 51). An example of game-based learning is the game World of Warcraft (WoW), where the players learn by collaborating and researching to reach new levels and insights (Thomas & Seely Brown, 2011a, p. 108). As such the motivation for using digital games to support learning is rooted in the belief that games can act as a foundation for active and more in-depth learning (Ke et al., 2016, p. 1183). In this digital age, there is a valuable new skill set, and these are critical thinking, creativity, collaboration and communication (Hagelia, 2017, pp. 11–13; M. Qian & Clark, 2016, p. 51). Games provide a means of assessing these hard to evaluate skills, which the traditional educational practices often have difficulties in assessing and evaluating (M. Qian & Clark, 2016, p. 51).

Game-based learning and gamification are not the same. Gamification is defined by Deterding et al. (2011, p. 10) as "the use of game design elements in non-game contexts". In other words, the application that uses gamification is not in itself a game, but it uses elements from games to promote something, typically joy of use, engagement or improvement of the user experience (Deterding et al., 2011, p. 12). Typical game-elements used in gamification are, according to Sailer et al. (2017, p. 373) points, badges, leader-boards, performance graphs, meaningful stories, avatars and teammates. In the context of social constructivism and learning, leader-boards, performance-graphs and teammates are the most relevant elements as they promote collaboration with peers and scaffolding of learning. Sailer et al. (2017, pp. 371–372) states that the typical use of gamification is to promote motivation and performance for a specific activity but that the question of *how* gamification motivates has not been properly addressed. They use self-determination theory to figure out what gamification aspects affect what psychological needs, specifically the need for competence, the need for autonomy and the need for social relatedness.

Buckley and Doyle (2016, p. 1164) make a comparison between today's educational system and games by saying that there are many game-like elements in education. One example of this is how, when one passes a course, one is rewarded by "levelling up" to take a more advanced course. Rewards can also be grades, where one is rewarded with a grade if one passes a test or course, and one receives a better reward when one performs better.

Motivation in Social Constructivism

From a social learning theory perspective, motivation is a socially negotiated process that results in observable interest and engagement (Sivan, 1986, p. 210). Social constructivism allows us to discuss the contextual and cultural influence on motivation (Sivan, 1986, p. 216). Also, the role of interpersonal relations would be emphasised in discussions of motivations within the social constructivist perspective and, therefore, address the issue of cognitive and affective needs of the individual student (Sivan, 1986, pp. 221–222). Sivan (1986, p. 224) argues that social constructivist perspective can be used by teachers to combine instruction and motivation in order to meet the student's cognitive and affective needs within the context of instruction in the ZPD. Through scaffolding, students can be encouraged to improve themselves, both emotionally and cognitively (Sivan, 1986, p. 226). The nature of the relationship between the more capable peer and the student provides, according to Sivan (1986), a framework for motivation to be integrated into instructional practices and motivational competence to be achieved (Sivan, 1986, p. 226).

Human motivation requires consideration of intrinsic psychological needs for competence, autonomy, and relatedness to understand it; therefore, social contexts and individual differences should support the student's basic needs which will improve their motivation, performance and well-being (Deci & Ryan, 2000, p. 232). If competence, autonomy and relatedness are prevented, the motivation, performance and well-being of the students are regarded as poorer (Deci & Ryan, 2000, p. 236).

3.2 Related work to learning theories and technologies

We will now present related work to social learning theories and technologies. In the search for related work, we focused on related work where the social constructivist concept mentioned in the previous section had a role in the technology. This presented us with different instructional methods and frameworks meant to help the teacher facilitate learning that would improve the skills students need in the 21st-century (Appendix C).

Bloom's Taxonomy

Bloom's taxonomy is today a framework used to make learning objectives. The original intention of Bloom's taxonomy was to make it easier to prepare the yearly examinations at universities by having different banks of test items that test the same educational objective (Krathwohl, 2002, p. 212). The original taxonomy consisted of six different categories: (1) Knowledge, (2) Comprehension, (3) Application, (4) Analysis, (5) Synthesis, (6) Evaluation. The framework gained popularity and was translated into 22 different languages, with one of the primary uses of the framework being making curricular objectives (Krathwohl, 2002, p. 213). Analyses were made on the curricular objectives showing that the objectives frequently required knowledge only on the first level of the taxonomy; knowledge, whereas it is usually objectives that requires understanding and use of knowledge that are considered the most critical educational objectives (Krathwohl, 2002, p. 213). The framework was later revised and now consists of these six different levels (1) Remember, (2) Understand, (3) Apply, (4) Analyse, (5) Evaluate, (6) Create. Each consisting of subcategories to further explain what each level is about (Krathwohl, 2002, p. 215). Each level is more complicated than the other which means there is a "natural" hierarchy as to what level you should reach first, but the revised version allows for overlap between the levels as well (Krathwohl, 2002, p. 215).

Flipped Classroom

The instructional strategy flipped classroom, is a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside the classroom (O'Flaherty & Phillips, 2015, p. 85). Activities that may have traditionally been considered homework is moved into the classroom, replacing the previous class content, such as teacher-led instruction. Through the completion of preparatory work and being more interactive during class, the flipped classroom fosters student ownership of learning (O'Flaherty & Phillips, 2015, p. 85). It also has the potential to cultivate critical and independent thought, which builds the capacity for life-long learning and thus preparing future graduates for their work-place context (O'Flaherty & Phillips, 2015, p. 94). However, the only way a flipped classroom can function successfully is if the teacher and the student both fulfill their obligations to each other; teachers must develop the materials before class begins, and students must view the information they are given at home to participate in the discussions (Danker, 2015, p. 175). It takes time, skill, and willingness for this learning style to work.

The flipped classroom is a SCL approach that focuses on the use of active learning methods in the classroom, where the instructor is a facilitator rather than a transmitter of knowledge, and the passive learning happens outside of the classroom (Danker, 2015, p. 173). The flipped classroom approach is

made possible through the use of digital technologies for the passive learning, most often by watching video recordings of lectures outside the classroom or reading digital literature (Selwyn, 2016, p. 194). The use of digital technology to view lectures allows the students to work at their own pace outside the classroom, pausing or playing at a lower/higher speed if needed (O'Flaherty & Phillips, 2015, p. 85).

Massive Open Online Courses

Massive Open Online Courses (MOOC) are based on the connectivist learning theory and are online courses transmitted through video lectures with quizzes to test the students' knowledge (Harasim, 2017, p. 93). Usually, MOOCs consist of a set schedule of topics where the participants are often free to engage with content and material as they please (Selwyn, 2016, p. 152), resulting in different learning experiences of the students taking a MOOC, as the students would use different approaches to learning (Selwyn, 2016, p. 152). As MOOCs are self-directed and non-linear in nature of learning engagement, the students must be able to determine and structure their learning (Selwyn, 2016, pp. 163–164). This type of teaching method is found to be most beneficial to well-resourced individuals who have already successfully engaged in higher education and are therefore better equipped to make headway through university-level learning (Selwyn, 2016, p. 163). Harasim (2017, p. 112) criticises this type of teaching method as it replaces the human teacher, which she argues is an essential aspect of social learning theories.

Multiple Representations

Learning with multiple representations has shown to enhance the students' performance when they can interact with appropriate representation and is a powerful tool if used correctly (Ainsworth, 2006, p. 183, 2008, p. 206). With the use of interactive representations and digital support, students are able to connect theory to practice (Kluge, 2019, pp. 1071–1072). Beginners learn with the support from others, either peers or teachers, as they are not able to use powerful tools to achieve the same results as an expert (Ainsworth, 2008, p. 206). When designing tools, one should, therefore, consider what enables learners to develop their expertise (Ainsworth, 2008, p. 206; Furberg, 2009, pp. 406–407). In order to create a great learning environment, the learner needs to understand how to interpret the representation, and one also needs to consider how the learning environment is embedded within particular social contexts (Ainsworth, 2008, p. 197). Ainsworth (2006) presents the Design, Functions and Tasks (DeFT) framework and the pedagogical functions that multiple representations serve. The DeFT framework for learning with multiple representations integrates research on learning, the cognitive science of representation and constructivist theories of education (Ainsworth, 2006, p. 184). This framework is useful to identify a broad range of factors that influence learning and was developed by reviewing a

broad range of research from a variety of perspectives (Ainsworth, 2006, pp. 183–184). Valuable insight can be gained into how to design prompts and how these prompts can be a productive part of a students' inquiring learning process when using a social-cultural perspective (Furberg, 2009, p. 407).

Gaming in Education

Agent-based computer games have the potential to offer a valuable venue for education, but inexperienced learners need structured guidance in combination with reflective techniques to help them achieve deep understanding (Moreno & Mayer, 2005, p. 127). Moreno and Mayers (2005) implemented four instructional concepts into an agent-based multimedia game in order to derive instructional design principles for agent-based multimedia learning. These four instructional concepts were: interactivity, reflection, feedback and guidance. These concepts had two cognitive process they were intended to prime: organising/integrating and selecting.

Virtual worlds and multiplayer online games can promote a collaborative learning environment (Y. Qian, 2018, p. 141; Thomas & Seely Brown, 2011a, p. 108). These types of games usually have avatars and chat functions, making it possible for scaffolded learning and collaboration among peers (Y. Qian, 2018, p. 153). Virtual worlds and multiplayer online games give the teacher a new way of reaching their students as some of them are games the students are already familiar with, such as WoW and Minecraft (Mørch et al., 2018, p. 51).

Studies on the negative effects gamification have in educational context, has shown that gamification can lead to the loss of performance (Toda et al., 2017, p. 11). Toda et al. (2017) has done did a study about the negative effects that gamification can have in an educational context. Through reviewing the literature, they found four different negative effects gamification can have in the context of education; indifference, loss of performance, undesired behaviour and declining effects (Toda et al., 2017, p. 11). Additionally, Hanus et al (Hanus & Fox, 2015) wrote about the effects of gamification in a classroom by using motivational, psychological and behavioural measures. They are were critical to the benefits on gamification on these measures and particularly the effects on intrinsic motivation; the students who were in the gamified classroom generally had a lower intrinsic motivation over time and eventually got lower grades than the ones in the more traditional classroom.

Feedback in higher education

Nicol (2010, p. 501) did a study on how to improve the often monologue-based written feedback that students receive in higher education. He states that just as learning does not happen by the transmission

of knowledge from one person to another, neither does feedback (Nicol, 2010, p. 503). He goes on by explaining that:

> *"While the quality of the comments is important, the quality of the students' interaction with those comments is equally, and perhaps more, important." (Nicol, 2010, p. 503)*

Cloud applications and web-based learning environments

Cloud applications and web-based learning environments, such as the ones mentioned in Appendix A, are unique in their ability to facilitate real-time collaboration, availability of resources and scaffolded learning (Barak, 2017, p. 287). In Hagelia's (2017, pp. 163–173) book on study techniques, she encourages students to create an online professional identity by using blogs, YouTube and other platforms to spread their knowledge and create a presence online. Using cloud applications and mobile devices can take learning out of the classroom and in different contexts and therefore making the information more accessible (Barak, 2017, p. 287; Chen et al., 2008, p. 78). The choice of web-based or cloud-based tools can enable good communication flow between students and teachers, as well as students and students (Elsrud, 2019, p. 63). However, the choice of platform should take into consideration not only where the students already are and that the use of those platforms correspond to how we conduct activities through them (Elsrud, 2019, p. 93).

3.2.1 Summary of Related Work

To summarise our related work, we present a Venn diagram which illustrates the different categories we have touched in this thesis so far. The digital technologies are the related work that has a specific digital technology in focus in their research, such as cloud applications, MOOCS and flipped classrooms. HCI consists of the related work that says something about how to design for the learning concepts that are being discussed.

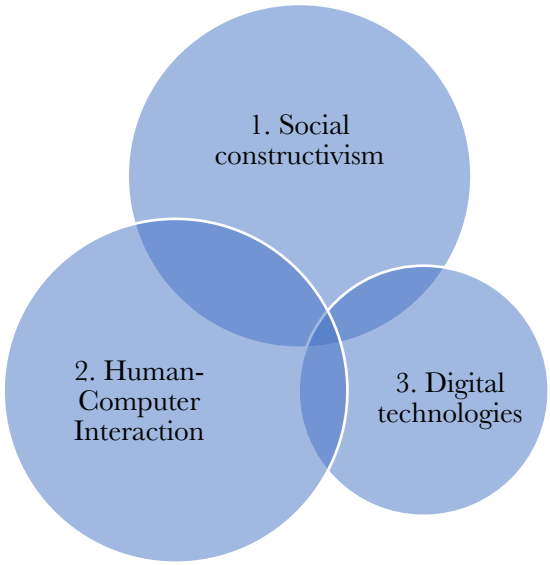

Figure 3-1 *Social constructivism, HCI and digital technologies make up our theoretical framework.*

Table 3-1 presents the related work tagged with the appropriate social constructivist concept and which category in which they belong.

Table 3-1 *Related work.*

Source	***Related work***	***Social constructivist concept***	***Category***
(Krathwohl, 2002)	Blooms taxonomy	Scaffolded learning, Reflexive learner, Active learning	1
(O'Flaherty & Phillips, 2015)	Flipped classroom	Active learning, Reflexive learner, Learning by doing, Scaffolded learning	1, 3
(Harasim, 2017; Selwyn, 2016)	Massive Open Online Courses	Active learning, Collaborative learning, Scaffolded learning	1, 2, 3
(Ainsworth, 2006, 2008; Furberg, 2009)	Multiple representations	Scaffolded learning, Active learning	1
(Hanus & Fox, 2015; Moreno & Mayer, 2005; Y. Qian, 2018; Thomas & Seely Brown, 2011a; Toda et al., 2017)	Gaming in education	Gamification, Scaffolded learning, Collaborative learning, Mathetic taboo, Active learning	1, 2
(Nicol, 2010)	Feedback in higher education	Scaffolded learning, Active learning, Reflexive learner, Dialogue-based learning	1
(Barak, 2017; Downing, 2001)	Cloud applications and web-based learning environments	Collaborative learning, Active learning, Scaffolded learning	1, 2, 3

3.2.2 Positioning Our Thesis

The related literature contains a variety of research in the fields of social constructivism, Human-Computer Interaction and digital technologies. We position ourselves in the middle of these three fields with our main focus on social constructivism and HCI (see Figure 3-1).

A well-known journal on education and technology, International Journal of Educational Technology in Higher Education, points out in two different thematic editions the importance of investigating how technology is used in Higher Education. In the thematic edition named "More than tools? Critical perspectives and alternative visions of technology in higher education" the editorial paper calls out the importance of focusing on what the education technologies used in higher education today focus on (Castañeda & Selwyn, 2018). Even though they often contain the word "learning" in their title (e.g. Learning Management Systems), they might not contribute to learning at all (Castañeda & Selwyn, 2018). Bartolome et al. (2018, p. 14) state that research on educational technology, specifically for personalisation in educational technology, lacks an epistemological foundation. This is problematic because researching technology for an educational context without thoroughly considering the context, and then publishing research that reaches a vast amount of people, will lead to a field that lacks the basic understanding of the context they are researching (Bartolomé et al., 2018, p. 15). Because we have a theoretical framework with a social constructivist foundation, learning is at the core of our research. The DT process, due to its user-centred focus will help us form design considerations that are based on the learners' needs, thus making them student-focused. We, therefore, position our research with a proper epistemological and theoretical foundation to contribute needed research in the field.

In another thematic edition named "The universities of the future: educational and organisational challenges" two of the articles contribute with insights on why MOOCs can introduce challenges in higher education. The first points out the tension between the more traditional beliefs the faculty that produce the content has and their realisation that they have to transform their practices when implementing courses in a MOOC (Freitas & Paredes, 2018, p. 9). The other article saw that the quality of the multiple-choice questions implemented in MOOCs was problematic because authors did not stick to the standard-issue guidelines when making the multiple-choice questions (Costello et al., 2018, p. 12). Another recent study reports similar issues in content production by faculty for online learning in higher education (Kebritchi et al., 2017, p. 21). As previously stated in Section 3.2., MOOCs attempt to replace the role of the teacher, which is arguably not in line with social constructivism where the teacher is an active facilitator of learning. From the research by Freitas & Paredes, Costello and Kebritchi, it is clear that the teacher is still needed for MOOCs to promote learning. However, we are more interested in

investigating through a technology that values the relationship between teacher and learner and will therefore not contribute to the discussion on how teachers find it challenging to implement content into MOOCs.

The related work we have reviewed consists of three widely used technologies in higher education; Flipped Classrooms, MOOCs and Cloud Applications and Web-Based Learning Environments. The framework has its foundation in social constructivism, which is student-centred. Gaming for Education, Multiple Representations and Feedback in Higher Education are all considered by us to be modern learning concepts that are relevant and interesting to operationalise in a DT process.

3.3 Our Theoretical Framework

The foundation of Vygotsky's social constructivist learning theory teaches us that learning always happens and cannot be separated from a social context. Social constructivism builds on the idea of the child as an active learner, where the primary tool for a child to develop reasoning, support cultural activities and promote thinking is language and thought. Combining individual and group learning can result in a deeper understanding of the subject at hand, with a facilitator that makes sure that the work and discussions are relevant. Instructional strategies that promote knowledge through collaboration creates a collaborative community of learners, which, in return, builds on each person's language, skills, and experience. The students can reach higher levels of development through collaborative problem-solving with a teacher or a more capable peer. As mentioned, the distance between the actual level of development as determined by independent problem solving and the higher level of potential development as determined through this kind of problem-solving, is called the Zone of Proximal Development Social constructivism's recognition of the importance of context, results in a modern classroom that changes as both new challenges and new opportunities arise. Throughout our literature review, we came across many different solutions to teach, engage and promote collaboration among the students with technologies. Some are collaborative tools that teachers can use in the classroom, while others are virtual classrooms. Because the subject of the virtual classroom is well covered, we decided to focus on technological solutions for learning that does not involve simulations.

The teacher's new role as a facilitator is similar to the role of a facilitator in a design workshop, making the social environment an essential consideration as the participants will have to work together in order to learn and solve problems. Another similarity between academia and real-life context is project-based and collaborative work, and thus highlight the importance of instructional methods that promote skills needed in project-based and collaborative work in learning situations.

Our final theoretical framework draws on the literature from social constructivism, HCI and digital technology. It has 10 different concepts within these three fields that show what we are concerned with within these three fields. In Table 3-2 we present investigative components for each concept that will inform our DT process and thematic analysis.

Table 3-2 *Table of social constructivist concepts and their investigative component(s)*

Source	***Concept***	***Investigative component***
(Danker, 2015; Harasim, 2017)	Active learning	• Do the group lessons in the course facilitate active learning, and if so, how?
(Vygotskij, 2001; Vygotsky, 1978)	Scaffolded learning	• How does the course scaffold its students, and what is the group teachers role in the scaffolding?
(Hagelia, 2017; Harasim, 2017; Sullivan, 2009; Verenikina, 2010)	Collaborative learning	• Do the students collaborate? • How do they collaborate? • Why do they collaborate?
(Lave & Wenger, 1991; Schell & Black, 1997)	Situated learning	• What does the course teach its students about their future work context? • Does the course facilitate any situated learning?
(Center for Teaching and Learning, 2003; Sullivan, 2009)	Dialogue-based learning	• How is the dynamic in the group lessons? • How do the students talk to each other about their mandatory assignments?
(Lee, 2018; Papert, 1996)	Learning-by-doing	• Does the course facilitate the making of something that is relevant to their learning?
(Dyke, 2006; Emmanuel, 2020; Hagelia, 2017)	Reflexive learner	• What do the students think about how they learn? • Are they prepared for the challenges we face in the 21st century?

Source	***Concept***	***Investigative component***
(Papert, 1996)	Mathetic taboo	• We will be aware in our data collection that the students might find it difficult to talk about how they learn • How do the students talk to their group teachers and peers about their learning?
(Deterding et al., 2011; M. Qian & Clark, 2016)	Gamification	• How does gamification elements affect the students learning?
(Sivan, 1986)	Motivation in social constructivism	• What motivates the students?

4 Methodology

Social constructivist learning theory believes that technology should enhance and extend our possibilities instead of replacing them. As such, we decided to use a human-centred design methodology for our thesis. In this chapter, we will present our methodology, data collection, and analysis methods for our empirical research, reflect on our role as researchers and reflect on relevant ethical considerations. Also, we will shortly discuss other human-centred design methodologies and the reasons why we did not choose them.

4.1 Design Thinking

Design Thinking (DT) is a methodology which focuses on the people we are designing for, and it consists of five phases; (1) empathise; (2) define; (3) ideation; (4) prototype; and (5) test (Lee, 2018, p. 47). DT promotes an optimistic approach to a problem as it is difficult to work creatively in a pessimistic and critical mood (Owen, 2006, p. 24). Also, DT allows us to work systematically with qualitative information with a human-centred focus (Owen, 2006, pp. 24–25). The context of the design challenge is also of importance. Throughout the DT process, we have approached problems with both divergent and convergent thinking.

As mentioned in Section 3.1, social constructivist learning theory supports that the context, the people in that context (in our situation, the students) and the language of the community which they wish to be a part of are significant for active learning. In other words, learning is student-centred. With the support of our theoretical framework, we believe the context our students are in is important, just as it is in DT, which makes this methodology suitable for our thesis. In addition to the five phases, Lee (2018, p. 68) states that research can be done in order to gain more clarity in the ideation phase and gain more empathy in our empathy phase. Therefore, the SLR can be viewed as our initial phase of the DT process, and that the following phases are influenced by this initial phase, which we will call our initial phase.

Phase one of our DT process was the empathy phase, which was focused on getting to know the people we are designing for, our target group (Scheer et al., 2012, p. 13). The social constructivist theory believes that scaffolding, active learning, collaborative learning, among other teaching techniques are key to a student's learning. As we had already researched learning in our initial phase, we investigated whether social constructivism is a part of the students learning experience in this phase. The goal of the empathy phase was to gain a deeper understanding of the people's needs and wants through qualitative data collection methods, such as interviews, observations and research (Lee, 2018, pp. 49–50). Throughout

this process, we thought broadly and kept an open mind so that we in the define phase would have a greater understanding of where the focus needed to be.

The define phase is where we made the information and insights gathered during the empathy phase into a problem statement (Lee, 2018, p. 93). We went from a divergent to a convergent mindset; bringing the focus back to identifying the key problems and solutions (Scheer et al., 2012, p. 13). The problem statements were used to guide us through the DT process to reach a desirable solution (Lee, 2018, p. 97). In order to do this in the light of our theoretical framework, we used affinity mapping to categorise needs, behaviour and wants, identifying underlying themes as well as prioritising our insights. Then we created a journey map to illustrate and explore the design problem further.

We continued to the ideation, where the purpose was to generate many solutions based on the insight from the empathy phase that can potentially solve the target groups' problems (Lee, 2018, p. 101). In other words, we returned to a divergent way of thinking. This phase consisted of activities which allowed us to generate many ideas as well as gaining more understanding for our target group (Scheer et al., 2012, p. 13). In this phase, we invited our target group to a future workshop and a co-creation session, as well as using this opportunity to empathise with our target group even further. We used what we have learned from social constructivist learning theory and the previous phases of our DT process to choose the right activities for the participants to get into the right headspace in the workshop.

We then began to prototype a solution that the target group could experience or preferably use to solve the problem statement. We created this prototype to solve our target groups problem regarding learning, and as such, we converted instructional methods from social constructivism into elements of our prototype. With the prototyping phase, we aimed to build, explore and test assumptions, by narrowing down the focus back to one or two fundamental problems or solutions (Lee, 2018, p. 131; Scheer et al., 2012, p. 13). Considering our time frame, we used prototyping methods that generated low fidelity prototypes. We tested and improved these low fidelity prototypes, bringing this phase and the test phase closer.

The final phase of a DT process, testing, gave us the opportunity to gain insights and feedback on the job done so far (Scheer et al., 2012, p. 13). Through testing our prototype, we were able to improve the prototype while getting another chance to empathise and learn from our target group (Lee, 2018, pp. 146–148). Lee (2018, p. 148) presents four aspects of testing from the creative community/mindset of Stanford university, d.school, that enabled us to bring the focus back to the people we are designing for.

These are (1) the prototype, (2) context and scenario, (3) the interaction between the user and designer, and (4) the process and method used to observe, capture feedback and reflect (Lee, 2018, p. 148). For our testing phase, we chose activities that enabled us to test often and with as many people from our target group as possible.

4.1.1 Design Thinking vs. Other Design Methodologies

There were other design methodologies we considered for this thesis. These methodologies were Service Design (SD), Participatory Design (PD) and User-Centred Desing (UCD). In this section, we will present each design methodology, compare them to DT and argue for why we did not choose this methodology.

Service Design vs. Design Thinking

SD is the name of the activity for planning and organising people, infrastructure, communication and material components of a service in order to improve it is quality and the interaction between service providers and customers (Stickdorn et al., 2018, p. 18). Its goal is to design according to the needs of participants, making it human-centred, so that the service is user-friendly, competitive and relevant to the customers (Stickdorn et al., 2018, p. 19). Both SD and DT are well suited to handle complex problems with a human-centred and empathic perspective (Stickdorn et al., 2018, p. 26). The processes are very similar, as well as the methods used for each stage of the process (Stickdorn et al., 2018, p. 26). Also, both methodologies require multidisciplinary teams and create an environment for people to work together in order to maximise support and draw from different expertise (Stickdorn et al., 2018, p. 26). The main difference between these methodologies is that DT is more like a recipe one can follow or adapt to define and solve problems, while SD often uses DT to solve more abstract problems, such as a service (Stickdorn et al., 2018, p. 18). In other words, SD is about applying DT or other design methodologies to improve immaterial products. Our theoretical framework is student-centred; although SD is human-centred, it intends to make businesses thrive (Stickdorn et al., 2018, p. 4). One can use the theoretical framework presented in this chapter as a lens for viewing the educational system as a service to enhance the student's lives. As the SD is more business-oriented, focusing on delivering a better service for customers rather than the customers themselves, SD will not give us the right focus for this thesis. DT, on the other hand, will allow us to operationalise our theoretical framework better.

Participatory Design vs. Design Thinking

PD is another human-centred design methodology which takes into consideration the variety of stakeholders (Kensing & Greenbaum, 2013, p. 33). In order to increase the number of perspectives and ideas being considered, and to ensure their varying needs and goals are met, the participants in a PD

process are intimately involved in the design process (Simonsen & Robertson, 2013, pp. 5–6). Besides, the PD methodology puts a strong emphasis on the power relations between stakeholders and the importance of subjective opinions (Bratteteig et al., 2013, p. 139). While we believe, based on our theoretical framework, there are power relations between student and teacher, taking into account the subjective opinions of the different stakeholders will lead to an impasse. This is a challenging aspect of PD, and if done poorly, can result in "design by committee" (Simonsen & Robertson, 2013, p. 33). While in DT if there are options A, B and C, DT would ask questions like "How else might this problem be solved?", and often results in new and better options which meets the needs better than any of the existing solutions. This made DT far more suitable for our innovative approach to learning.

User-Centred Design vs Design Thinking

UCD is a methodology where the main goal is to improve the usability and user experience of a specific product or service (Preece et al., 2015, p. 322). UCD and DT both emphasise the importance of knowing the user, empathising with them and being out of one's own biases and assumptions (Preece et al., 2015, p. 324). Also, UCD, like DT and the other methodologies mentioned above, encourage collaborations between multiple perspectives as well as reframing problems into opportunities (Preece et al., 2015, p. 323). The primary focus in UCD involves users throughout the design and development, while DT's focus is on resolving both vague and 'wicked' problems. DT, therefore, puts a greater emphasis on solution-focused strategies. UCD is more focused on the individual user, while our theoretical framework is focused on the learning situation as a whole (the students, their context, language and culture and the relationships between students and students and teachers). Also, UCD looks to solve existing frictions and problems. As we also are looking at innovation in learning in this thesis, which requires creative and innovative solutions, DT is the preferred methodology of these two.

4.2 Our Role as Researchers and Facilitators

A dilemma that could arise is our position in the study, as we are both students at IFI and already have an established perception of the subject at hand. Staying as neutral as possible was very important. Especially considering our previous experiences, who we are and where we come from can affect what we see and how we interpret the world (Walsham, 2006, p. 321). This is in line with the interpretive paradigm described in 4.2.1 and the theoretical framework of this thesis. As students at IFI, we can be regarded as deeply involved in the context we are researching in and finding a new or different perspective on the situation several years after entering it will be difficult. As such, during the analysis of the collected data, it was utmost important to let our theoretical framework and methodology be the

primary guide to what was of importance and keep our assumptions and experiences to influence analysis as little as possible. With the help of students who have previously attended the same bachelor as our target group, we broadened our view. Our experience helped us identify the dilemmas that could arise under different circumstances.

As we will later describe in Sections 5.1 and 5.2, observations, diaries, interviews and journey mapping helped us to get into the students' perspective and gain an understanding of their pain points and journey through the design course. We also involved students in a co-creation session in order to get feedback on ideas and progress that we had made.

4.2.1 Interpretive Paradigm

Our theoretical framework states that learning always occurs and cannot be separated from a social context; as such, we identify with the interpretive paradigm. As Höem (2010, p. 30) stated, new challenges and new possibilities are presented to us as our surroundings change, and this is in line with the interpretive paradigm which believes reality is only accessed through social construction (Myers, 2013, p. 39). Vygotskys' (1978, p. 102) social constructivism says that knowledge is constructed through language, shaped by the individual's culture and their shared meanings. Just as in social constructivism, an interpretive researcher believes that data is constructed through an intersubjective understanding (Myers, 2013, p. 40). In other words, an interpretive researcher is concerned with the opinions and attitudes people have about the phenomenon one is studying and then recognises the researcher's relationship and impact on the environment (Myers, 2013, p. 39). Thus, one must be conscious of what power relations exist and one's role towards the users.

4.3 Ethical Considerations

When participants are involved in the research, it is essential to consider the participants' rights and safety (Lazar et al., 2010, p. 381). It is important to provide the participants with enough information to make an informed decision to participate or not (Lazar et al., 2010, p. 381). It is also important to inform the participants on their rights and the confidentiality regarding their personal data and how to withdraw from the research (Lazar et al., 2010, p. 381). Another topic to consider is compensation for the work and effort put in by the participants. How much to compensate young adults is something that needs to be considered and if the compensation has any impact on the behaviour of the participants (Lazar et al., 2010, p. 375).

The participants were given a consent form with information about the study, what kind of personal data we would gather, how they were stored and more information in order for them to make an informed decision (See Appendix B). The participants were informed that all personal information was to be anonymised and that they could withdraw their consent at any time. This way, the motivation of the students to participate was mainly their self-interest in how to hold interviews and workshops.

4.3.1 Additional Ethical Considerations with User Participation Online

In order to safeguard the privacy of our participants, we followed Datatilsynet's checklist for businesses (Datatilsynet, 2018). The two of us switched between being facilitator and observer, and therefore, there was always one who had their primary focus on taking notes and collecting data while the other could focus on talking to the participant. By not recoding the data collection activities, and by avoiding using gender-specific pronounce and names in our notes the data was anonymised.

4.3.2 NSD

Data collected from participants are stored according to their level of sensitivity and following the General Data Protection Regulation (GDPR). Norwegian Centre for Research Data (NSD) approved our data collection methods and storage to be in accordance with their guidelines.

4.4 Methods

Table 4-1 gives an overview of the methods presented in this section, as well as the phase in which they were used.

Table 4-1 *Overview of the methods we will use, the duration and the phase they will be used.*

Phase	***Method***	***Duration***
Empathy	Survey	15 minutes
	Mobile diary	1 week
	Survey	15 minutes
	Observation	1 hour
	Observation	2 hours

	Observation	2 hours
	Individual interviews	1 hour
Define	An inductive approach to thematical analysis using affinity mapping of mobile diaries and surveys data	2 hours
	An inductive approach to thematical analysis using affinity mapping of observations and interviews data	2 hours
Ideate	Future workshop	4 hours
	Digital co-creation workshop	2 hours
Prototype	Low-fidelity prototyping	
	High-fidelity prototyping	
Test	User testing, survey and interview iteration #1	15 minutes
	User testing, survey and interview iteration #2	20 minutes
	User testing and interview iteration #3	30 minutes
	User testing and interview iteration #4	60 minutes

4.4.1 Survey

The starting point of our research was broad after the SLR, and in order to narrow down our research interest, we used surveys. Surveys enabled us to reach a greater audience during a short period as well as giving us a broad understanding of the participants view on the subject at hand, letting us capture the "big picture quickly" before we dive deeper into the subject (Lazar et al., 2010, p. 100). The surveys had both open-ended and closed questions. The surveys were mainly used to get an overview of the students' expectations, efforts and attitude towards the design course and collaboration in an academic context. Because they were self- administrated by the participant, data collected from the surveys was not as in-depth as other research methods, such as ethnography or interviews (Lazar et al., 2010, p. 101). This made it difficult to ask follow-up questions or go back and ask detailed questions if interesting phenomena start appearing (Lazar et al., 2010, p. 101). Considering this, we used the surveys to recruit students for voluntary interviews where we hoped to gain an in-depth understanding of our target group.

4.4.2 Observations

Observations gave us a greater understanding of the context the participants are a part of when we observe them in natural settings (Lee, 2018, p. 62; Walsham, 2006, p. 321). It was a way for us to fill the gap between what the participant said and what they did. The nine ethnographic dimensions guided our observation; (1) what is the physical space of research; (2) who are the actors; (3) what are the activities performed by the actors; (4) what are the objects that are relevant and present, or used by the actors; (5) write down the specific individual actions carried out by the actors; (6) record particular occasions that surface from the research; (7) what is the sequence of events; (8) what are the actors' goal, what are they trying to accomplish; (9) how do the actors feel in a given context (Myers, 2013, p. 139). A consequence of observation is the Hawthorne effect (Lazar et al., 2010, p. 38), and to avoid this we decided to participate in the lectures we were observing as students for a week.

4.4.3 Interviews

We conducted semi-structured interviews with open-ended questions, allowing the interviewees to respond freely and focus on what they found most relevant. Interviews are a great way to gain an in-depth understanding of the participants' experiences and expectations with the design course and their learning (Lazar et al., 2010, p. 178). We recorded the interviews using UiO's service "Diktafon", which securely stores the data. Data collected from the observation and surveys informed the interviews. Participants were chosen based on the answer they gave in the first survey, or if they were group teachers in the course. Interviews were held at IFI in one of the colloquium rooms during the last three weeks of October of 2019. Among the potential difficulties summarised by Myers (2013, pp. 125–126), the Hawthorne effect and lack of trust are probably two of the most important issues we could have faced during our interviews as we were asking people to talk about their knowledge and learning habits. However, by choosing a familiar setting and trying to create a relaxing atmosphere we managed to minimise possible Hawthorne effect during the interviews. Also, mathetic taboo was a challenging factor as the fear of being seen as inferior or less intelligent can make it difficult for participants to answer questions regarding how much they work, how they work and how they learn honestly.

Group Teacher Interviews

Interviewing experts is a great way to learn about a topic and gain valuable domain knowledge, as they know what information is vital to the field of knowledge (Lee, 2018, p. 52). In our thesis, the group teachers were our "experts". Group teachers have varied perspectives and experience, as they have worked as group teachers for a number of years, been to educational workshops under the supervision

of course instructors, and are well acquainted with the course and the students. Also, the group teachers have themselves previously attended the design course.

4.4.4 Mobile Diary Study

Mobile diary studies aim to gain insight into the participants' real-life experience with the use of a portable device such as a mobile phone or laptop (Stickdorn et al., 2018, p. 124). The participants create entries in the context of their location, capturing the "moment of truth", and therefore filling the gap between the observations in natural settings and surveys (Lazar et al., 2010, p. 127). During our mobile diary study, we asked the participants to use their laptops, as this is their working tool. Participants were instructed to write their thoughts and feelings as they were working. At the end of the week, the diary entries were collected from the participants and analysed. This method is commonly used at the beginning of a research process, and the data and insights captured from people's real-life experiences are used to identify exciting insights and adopt them in a project (Lazar et al., 2010, p. 127). We used a hybrid feedback and elicitation diary in this mobile diary study. Diaries give a different perspective than observation and interviews and are therefore helpful in triangulation when researching a target group (Lazar et al., 2010, pp. 128–129).

4.4.5 Persona

Personas are detailed descriptions of the typical users of the product that is being developed (Preece et al., 2015, p. 357). The most important information about a persona is their goals relating to the product in addition to characteristics about them that make them feel real (Preece et al., 2015, pp. 357–358). Personas are based on information about the real users of the product and their common characteristics (Preece et al., 2015, p. 357). They are not representations of any one single user, but a collection of them, and are intended to be realistic representations of the users (Preece et al., 2015, p. 357). The persona allowed us to speak about the needs of our users and also to validate ideas.

4.4.6 Journey Mapping

A journey map, also called a user journey map, is a visual representation of the process that a stakeholder goes through in order to accomplish a goal (Stickdorn et al., 2018, p. 44). The mapping begins with compiling a series of user actions into a timeline, followed by their thoughts and emotions in order to create a narrative (Stickdorn et al., 2018, p. 46). With the journey map, we mapped out a student's experience before, during and after their journey through the design course. There are many different variations of journey mapping; these are user journey map, experience map, service blueprint and user story map. An experience map is broader, more generic, than a journey map. It is based on a generic

person underdoing a broad experience, and most commonly used to understand general human behaviour in contrast to a customer journey map which is specifically focused on a particular business or product (Stickdorn et al., 2018, p. 44). Service blueprint visualises the relationships between different components at various touchpoints within the service in a specific customer journey; this form of mapping is more business-oriented (Stickdorn et al., 2018, p. np). A user story map is a visual representation of a user story, and while it may look similar to a journey map, the user story map is meant for planning and implementing while journey maps are meant for discovery and understanding (Stickdorn et al., 2018, p. 54). This process forces conversation and aligns our mental model, leading to an agreement on how to improve user experience. The resulting map also helped us communicate our intermediate results. Our journey map included the elements; events, touchpoints, mood, narrative, thoughts and frustrations the students may encounter during the semester.

4.4.7 Future Workshop

This method requires much preparation by the facilitators and moderators, and the preparation phase is usually included as the first phase in a future workshop (Simonsen & Robertson, 2013, p. 152). Future workshop is a method that aims to have stakeholders design their desired future through critiquing, visioning, and implementing (Simonsen & Robertson, 2013, pp. 152–153). Following is the critique phase, where the stakeholders actively participate in investigating the problem critically and complete manner (Simonsen & Robertson, 2013, pp. 152–153). Brainstorming on the problem is performed, and through this phase, the critical question concerning the problem is framed. During the fantasy phase, also called the visionary phase, participants are encouraged to try to work out a vision of the future no matter how farfetched they may be. The future possibilities in the fantasy phase are then brought into the realisation phase, also called the implementation phase. The ideas are evaluated and discussed in regard to their practicability and the critical question from the first phase in order to achieve the vision.

4.4.8 Brainwriting

Like brainstorming, brainwriting is a method to develop ideas, but instead of verbally presenting the ideas, the ideas are written down (Stickdorn et al., 2018, pp. 180–181). Brainstorming is used when the team does not feel comfortable with either drawing or presenting (Stickdorn et al., 2018, pp. 180–181). We used brainwriting in order to prevent participants from influencing each other. This made it easier to identify themes that were interesting and created a greater variety of ideas. Brainwriting was also used to analyse our understanding of the collected data.

Brainwriting in the Define Phase

We used brainwriting as a means of defining the problem area. The activity was conducted in the same manner as mentioned above, to identify problems rather than ideate solutions. We do this in order to organise our assumptions after gaining insights from our target group.

4.4.9 Remote Co-Creation Workshop

Co-creation is a method from service design where we bring the people we are designing for into the design process (Stickdorn et al., 2018, pp. 27–28). Through co-creation, we got feedback and valuable insight into our ideas as well as building further on those ideas with the people that will eventually be using the solution. This will make the community they are a part of far more likely to adopt the solution, when they have helped create it (Stickdorn et al., 2018, pp. 252–255). Usually, the co-creation session is held in close proximate where one can encourage and engage the participants to collaborate to come up with solutions to the problem at hand. Initially, only the first two iterations were supposed to be individual ideation before considering each input, with the last iteration being a brainstorming in groups. However, brainstorming over video conference which mutes the participants when they speak at ones counteract the point of brainstorming. We modified this activity to use digital tools that enabled us to facilitate the workshop remotely. We went through three iterations of ideation, discussion and voting. For each iteration, we instructed the participants to work individually before discussing each contribution. After each discussion, the participants were to vote on the idea they liked the most before building further on the most voted solution.

4.4.10 Prototyping

Low-Fidelity Prototyping

Paper prototyping is a quick and cheap way of gaining insights (Lazar et al., 2010, p. 252; Preece et al., 2015, p. 389). It presents the function but not the aesthetic of a proposed design. We used paper prototyping to communicate ideas for the concept's functionalities, and wireframing for the interface, navigation and layout. As we were not able to be together and co-create prototypes, we shared pictures of our prototypes to communicate possible solutions based on users' evaluations throughout the phase. We created the wireframes once we had a rough draft of an idea and before we moved to details (Rosenfeld et al., 2015, p. 407). The wireframes allowed us to communicate ideas with each other, as they are simplified outlines of all the different elements on a page (Rosenfeld et al., 2015, pp. 407–408). They are used to get feedback on the layout, interface, navigation and functionality of a website (Rosenfeld et al., 2015, pp. 407–408).

High-Fidelity Prototyping

When our concept began to form, we created clickable prototypes — these high-fidelity prototypes were presented to and tested with our target group. The high-fidelity prototype looked like a finished product; however, the prototype did not work as a finished product as this would require more time and iterations to become finalised. High-fidelity prototypes are used to simulate the aesthetics of a proposed design, and to check if the design behaves as intended (Preece et al., 2015, pp. 391–392).

4.4.11 Remote User Test

This method gave direct input into how real users use the system, which is valuable for the success of the final product. Our prototyping and testing phases were conducted iteratively consisting of a total of five rounds of prototyping and remote user testing. There are two ways of doing a remote user test. Synchronous involves real-time communication between the evaluator and the user and asynchronous, which involves them working separately (Andreasen et al., 2007, p. 1406). This approach was chosen as we could not perform Guirella testing as planned, due to the restrictions caused by COVID-19. The remote testing reduced our control over the testing environment and the distractions and interruptions experienced by the participants' in their native environment. When conducting remote user testing, we are dependent on doing this in an ethical way that preserves the participant's privacy. We tackled these challenges by informing our participants of how the test will occur and what they need to prepare before the test.

The asynchronous user test allowed the participants to explore the prototype in their own time without being observed. As the participants were on their own, guiding the participants when testing the prototype was difficult. For the asynchronous user test, the participants received an e-mail with the consent form, a link to the survey, the prototype and time for video conference for when they have finished the test. The participants were instructed to explore and test the prototype before answering the survey. The deadline for answering the survey was the same day they received the e-mail. This way, the participants could take their time, test the prototype when they had the time and preferably less distracted. Following this, we held a short interview in order to fill in some of the gaps that occurred.

For the synchronous user test, the participants received an e-mail with the consent form, a link to the prototype and the video conference. The participants were instructed to enter the video conference, open the prototype and share their screen with us. We used the thinking-aloud method as it enabled us to identify and understand problems and misunderstandings that they might have felt (Lazar et al., 2010, p. 345). After the walkthrough, we held a short interview to deepen our understanding of their experience

and to clarify our assumptions and possible misunderstandings. When using the thinking-aloud method during a user test, one must be prepared that this type of walkthrough takes more time than letting the participants explore the application in silence (Lazar et al., 2010, p. 272). The reason for this is that it requires more focus from the participant as their cognitive flow is interrupted when they try to complete a task (Lazar et al., 2010, p. 272). Another issue with the thinking-aloud method is that made some of our participants feel uncomfortable expressing their concerns because of their role, level of education, and their cultural background (Lazar et al., 2010, p. 289).

User Test Interviews

We conducted semi-structured interviews with open-ended questions, allowing the interviewees to respond freely and focus on what they found most relevant after user test to get a more in-depth insight into the thought process of the participants and clarification on the feedback we received from them.

Evaluation Reports

For each of our user test iteration, we wrote an evaluation report of the user test results consisting of a summary of the intermediate results (what went well, badly and other learnings) and actions for the next iteration. Reports were based on data from the surveys, remote interviews, and observation notes from the synchronous tests.

4.5 Thematic Analysis

Thematic analysis can be used within almost any theoretical framework as long as the theoretical position of the thematic analysis is made clear (Braun & Clarke, 2006, p. 81). Social constructivism stems from the constructivist epistemology which believes that knowledge is constructed in our minds through interactions with one another, the community we are in and the environment we are in (Harasim, 2017, p. 12). Since our theoretical framework has a social constructivist foundation, we are concerned with how meanings and understandings grow out of social interactions. For our research, that means that we are interested in seeing how the students learn through interactions with both their peers and more knowledgeable peers (group teachers). As previously mentioned, we are, as interpretive researchers, concerned with the opinions and attitudes that people have about the phenomenon we are studying, which in our case is the student's opinions on how they learn with peers and how they learn through technology. The methodology for the thematic analysis will be presented in Chapter 7.1.

The combined data we gathered during the different data collection methods, presented in Section 4.3, were field notes, audiotapes, and empirical data from workshops. We will use Braun and Clarke's (2006) thematic analysis on our observation notes, interview transcriptions and user test notes, to look for emerging themes and to understand the context or phenomenon they belong to. Thematic analysis is an iterative process which describes how to turn messy data to a map of the most critical themes in the data (Baume & Scanlon, 2018, p. 79). We will use it on our observation notes and interview transcripts in the define phase to identify themes in our results and a problem statement. At the end of our design process, we will use thematic analysis to identify, code, and analyse essential themes throughout our design process with our theoretical lens.

4.6 Implications as a Result of COVID-19

As of March 12th, the Norwegian Health Department introduced measures due to the COVID-19 pandemic, and as a result of this, we had to change and adapt our data collection methods accordingly (Helsedirektoratet, 2020). These measures were introduced during our final data collection in the ideation phase and throughout the prototype and testing phases of our DT process. This affected both our data collection and recruitment methods; some methods were modified; other methods had to be replaced in its entirety.

As we had a short timeframe, we did not have the time or means to get acquainted with all the different collaborative online tools and therefore, might have solved a problem more inconveniently than necessary. A recurring theme throughout this process was:

- Keeping the time frame for the activity, as the methods we had chosen would prove to require more time online than anticipated.
- Keeping conversations professional and on topic, as well as avoiding disturbance from family members would prove to be more difficult as the weeks continued, both for us and our participants.
- Engaging our user test was difficult as the participation was no longer low-threshold participation.

For our workshop, we required a tool for facilitating workshops, allowing the participants to collaborate as well as allowed us to hold conversations. We did a quick search and found among other tools, Mural,

Whimsical, and Notion. These are excellent collaborative tools, but as we did not have time to get familiar with the tools, the required paid subscription was not an option, and our participants had to create accounts. Therefore, we decided that we would use the tools available from UiO (a summary of the tools is presented in Appendix A). In order to choose the right available tools, we did a quick test to see if they met our needs and continued to use these for our workshop. For high-fidelity prototyping the planned tool to use was Sketch, but as we could not meet and discuss in person and the Sketch application not being suitable for real-time collaboration, we began using Figma instead. As Figma has many of the same features as Sketch in addition to online collaboration, it was not as time-consuming to switch tool for our prototype phase. A challenging aspect of doing collaborative work online was that it was more tiresome to have video conferences rather than face-to-face meetings.

For the user test, we had planned to perform Guerrilla testing to create a low-threshold for participating in the user test, in the hopes of getting more participants, hence giving us more insight. A significant challenge was finding a user testing method that would suit the situation we were in a while maintaining the participant's privacy. Additionally, getting in touch with potential participants and recruiting enough participants for our user testing was difficult as we were dependent on them to check their e-mails and using social media actively.

4.7 Summary

From our theoretical framework, we believe that technology should enhance and extend our possibilities, instead of replacing them. The human-centred methodology DT was therefore chosen. With our DT methodology, we focused on the people we were designing for, namely students attending the design course at the UiO. Through the five phases of our DT process, we used qualitative data collection and analysing methods to learn more about the people we were designing for and their context.

Figure 4-1 presents our research process and when the theoretical framework had an active part in both being shaped and shaping the DT process and analysis. However, the actual DT process (shown as blue circles in Figure 4-1) consisted of us jumping from one phase to another in a non-linear manner based on need, but for clarity, we will present the process in linearly fashion in the two proceeding chapters. The iterative process is illustrated in Figure 6-1.

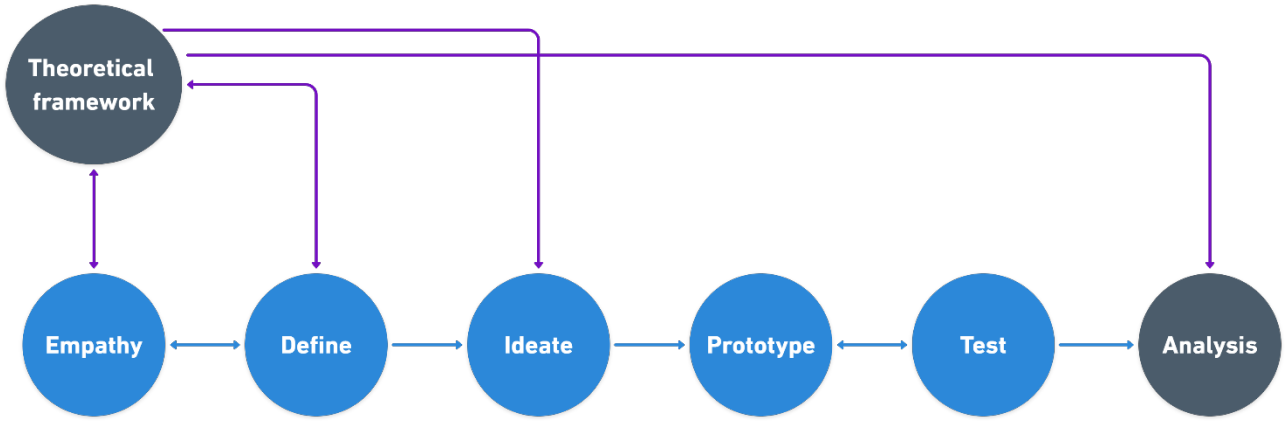

Figure 4-1 *Our research process.*

5 The Design Thinking Process

In this chapter, we will present the different activities in each phase of our design thinking process, and later in Chapter 6, we will present the results of the method in each phase in the light of our theoretical framework. The variety and number of methods we used allowed us to gain both a broad knowledge of the course and a deeper understanding and empathy for the students and group teachers. Our methodology allowed us to converge and diverge throughout this process, as well as working iterative and be flexible in our approach. During our data collection, we had in total of 61 participants, where 12 were recurring. These participants were students from across year levels and programs. What they all had in common was that they all attended the design course.

Table 5-1 *Overview of DT activities, as well as actors who were involved in the various events.*

Phase	***Method***	***Duration***	***Participants (n of participants)***	***Context***
Empathy	Survey	15 minutes	Students attending the design course (21)	Voluntary part of the first mandatory assignment
	Mobile diary	1 week	Group teachers (2)	During the feedback period after the first mandatory assignment
	Survey	15 minutes	Students attending the design course (7)	Voluntary part of the third mandatory assignment
	Observation	1 hour	Students attending the design course and the professor	Lecture
	Observation	2 hours	Students attending the design course and the group teacher	Group lecture
	Observation	2 hours	Students attending the design course and the group teachers	Plenary lecture
	Individual interviews	1 hour	Group teachers (3) and students (4)	Colloquium room at IFI

Ideate	Future workshop	4 hours	Students (5)	Design lab at IFI
	Co-creation workshop	2 hours	Students (3)	Online, through Teams video conference.
Prototype	Low-fidelity prototyping		The authors of this thesis	Online, using Teams video conference
	High-fidelity prototyping		The authors of this thesis	Online, using Zom and Figma
Test	User testing iteration #1	15 minutes	Students (5)	Online via Figma and Google Drive. Interview through Microsoft Teams
	User testing iteration #2	20 minutes	Students (2) and group teachers (2)	User testing via Figma and Google Drive. Interview through Zoom
	User testing iteration #3	30 minutes	Students (4)	User testing via Figma. Interview through Zoom
	User testing iteration #4	60 minutes	Students (1) and group teachers (2)	User testing via Figma. Interview through Zoom

5.1 Phase 1 – Empathise

The goal of this phase was to get acquainted with our target group. The methods chosen for this phase was based on getting in touch with participants without being too intrusive and intimidating. As we got more acquainted with our target group, we chose more interfering methods. During our empathy phase, we conducted two surveys, three observations, seven interviews and two mobile diaries in order to empathise with our target group. The first iteration of data collection for the empathy phase consisted of one survey sent to all students attending the course and mobile diaries conducted by two group teachers. Our second iteration of data collection consisted of three observation and another survey that was distributed to all students. The three observations were carried out in the three different lecture formats. The third and last iteration of this phase consisted of seven interviews. This triangulation helped clear any misconception and reinforced assumptions we made.

5.1.1 Surveys

We chose to have two surveys as they can reach more people and are less time consuming for both parties in this early stage of empathising. Our two surveys were distributed to the students as a voluntary part of their first and third mandatory assignment. The surveys were digital and made with UiO's service Nettskjema (Figure 5-1). The surveys were voluntarily and anonymous, and we had a total of 28 students answering the two surveys. Our aim with these surveys was to use the result to guide our research and come in contact with the students attending the design course.

The goal of the first survey was to get an overview of the students attending the design course; their expectations, work habits, and experience of the course. The questionnaire was based on our SLR and focused mainly on collaboration, how they preferred to learn and their use of technology in a learning situation. We chose to include questions about the students' background; such as their age, whether or not they have attended higher education before, and how far they had come in their education. We did this to see if there were any significant difference between the generations when it came to technology in learning situations. Those born in 1996 or later (Gen Z) have grown up in a more digital world, while those born before 1996 (Millennials and older) grew up at the same time as the world became digital. We also wanted to see if there were any difference between the first-year design students and third-year students from another informatics program as we believed that the senior students would have learned some study techniques along the way. We used our intermediate results from this survey to create interview guides.

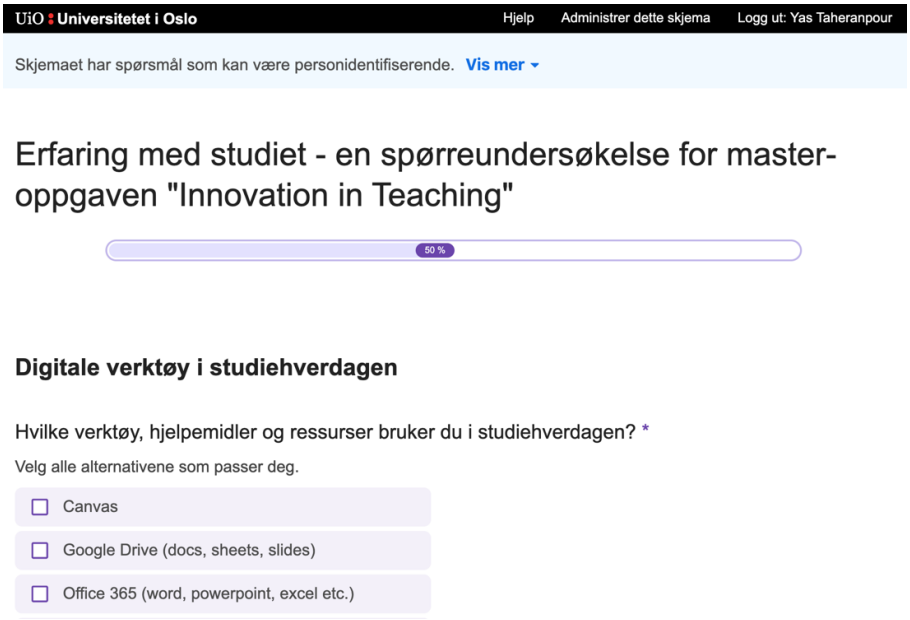

Figure 5-1 *Screenshot of a survey example in Nettskjema.*

The goal of the second survey was to get a better understanding of how the students experienced the mandatory assignments, how information related to the design course was communicated to them, and again if and how they collaborated and used digital technology in a learning situation. Intermediate results from this survey were used to confirm/debunk assumptions we made after the first survey.

5.1.2 Mobile Diary Study With Group Teachers

For this study, we chose a hybrid feedback and elicitation diary as we wished to use both data from the diaries and have the ability to dive deeper into each data point when we later interviewed one of the group teachers. We chose two group teachers for our mobile dairy study; one taught the plenary lectures and corrected obligatory assignments; the other taught a group class and corrected obligatory assignments. They are both experienced with how the students learn and work in this course. We instructed them to write down their thoughts when working with preparations for their class, correcting obligatory assignments or any other work related to their job as a teacher for a week. During this week, the group teachers were correcting the first mandatory assignment as well as doing their regular weekly tasks related to their job. The duration of the diary was chosen based on how the course is structured; every week, the students are introduced to a new subject within interaction design and user experience.

5.1.3 Observations

The main goal of the observations was to get a better understanding of the environment, the educational program and the resources available to the students. The observations were held in natural settings as

we joined different lectures as participants. We took notes on student-teacher and student-student relations, their behaviours, and our thoughts and experience of the setting. In order to document what happened and avoid our own subjective interpretation, we created two observation notes each; one for what we saw, and the other one was our thoughts and impressions of the event. We observed the three different lecture formats that the course offers. They each have their structure and purpose, giving the students different representation of the same information which, we will look further into in Section 6.1.3.

5.1.4 Interviews With Students and Group Teachers

By holding interviews, we gained a deeper understanding of the student's interest, motivation, own learning process and understanding of the course. We held interviews with four students and three group teachers. The discoveries made during our previous data collection influenced the interviews. We chose to include group teachers as they have previously attended the course, also, they are very familiar with the students. Their input will give us a broader picture of what the students are experiencing and the course as a whole. The interviews were held in familiar settings for the students to make them feel more comfortable and less intimidated. The length of the interviews varied from 30 minutes to an hour, depending on the informants.

5.2 Phase 2 – Define

The data collection done during our empathy phase gave us a considerable amount of data which in return gave us a better understanding of our target group. We used our new insights in the define phase of our DT process to define and narrow down our subject of interest. This phase was conducted in two iterations. Following the two first iterations in the empathy phase, we started our first iteration in the define phase by defining our problem area using brainwriting and affinity mapping. After the third and final iteration in the empathy phase, we began on the second iteration of the define phase by creating a persona and mapping our students' journey using the journey mapping method to understand them further and narrow down the subject of interest.

5.2.1 Analysis of the Surveys and Mobile Diary

In order to structure and analyse our collected data from the survey and mobile diary, we used thematic analysis before we continued our analysis with brainwriting and affinity mapping. In the analysis, we categorised the data based on which age group participants belonged to, before comparing the age groups. The comparison and data were then analysed further. Figure 5-2 illustrates this process, where

orange post-its were used to separate data that were pure interpretation from the actual data. These methods, brainwriting and affinity mapping, helped us categorise and prioritise ideas and knowledge on the subject (Figure 5-3). During the brainwriting, we individually wrote down all possible perspectives we could think about, based on the work done so far. We then went through each possible perspective and grouped them using the affinity mapping technique. This method helped us name, rank, and understand relations between groups of information.

Further, we chose four critical points and created six new ideas and solutions based on these four. The ideas generated in this session were then sorted, as shown in Figure 5-4, into three categories; were category A was "Start now"; B was "Within a month"; and C was "Long-term ideas". With this new perspective and ideas, we continued to the final iteration of the empathy phase.

Figure 5-2 *First part of our analysis of the survey and mobile diary data.*

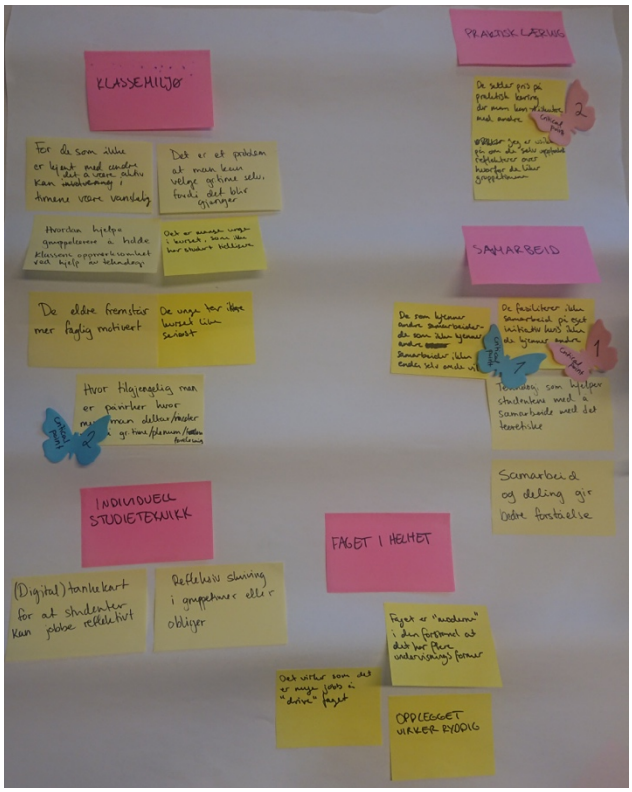

Figure 5-3 *From our affinity mapping of ideas from brainwriting.*

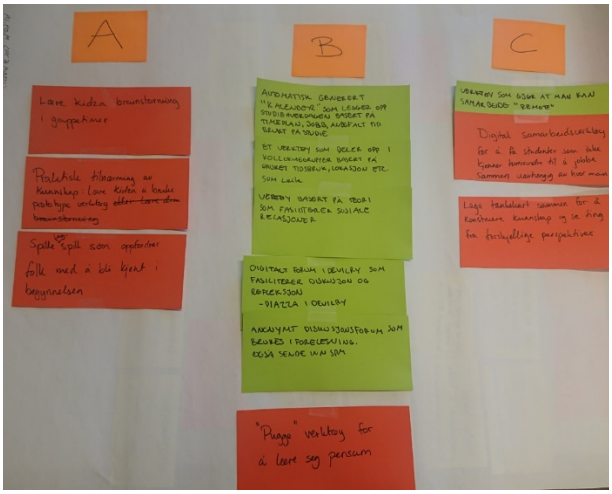

Figure 5-4 *From our A/B/C sort, the colour of the stickers has no significance to the value of the data.*

5.2.2 Analysis of the Interviews and Observations

After collecting sufficient information from our target group, we began the last iteration of this phase by creating a persona. We transcribed the interviews individually before coding the transcription together. This approach allowed us to keep a fresh view of the interviews as we transcribed and created an overview. It allowed us to get a fresh pair of eyes on the interview we transcribed, as well as getting an overview of all the interviews. We based the persona on the needs they had in common and goals of the interviewees. Also, we used affinity mapping to categories and priorities the data collected in the interviews and observations. This way, the problem area became more defined. The persona was based on the themes and similarities that we identified in the third affinity mapping.

5.2.3 Creating a Journey Map

We began to map our students' journey based on the persona creating journey maps. The journey maps gave us an understanding of the target groups journey and narrowed down the subject of interest even further. We created three different journey maps for the student persona, one was an experience journey map of the student's first semester, the second was a user journey map focused on a week during the semester, and the third was a merger of the first two journey maps. The experience journey map (Figure 5-5) starts from when the student accepts the offer to study 'Informatics: design, use, interaction' from UiO and ends the student receives their exam results. The user journey map (Figure 5-6) starts the weekend before the first lecture and ends with the accompanying plenary exercise. The third journey map became our final mapping of the student's journey, and it illustrates the students travel throughout the semester and how the obstacles, mandatory assignments and final exam, are viewed by the students.

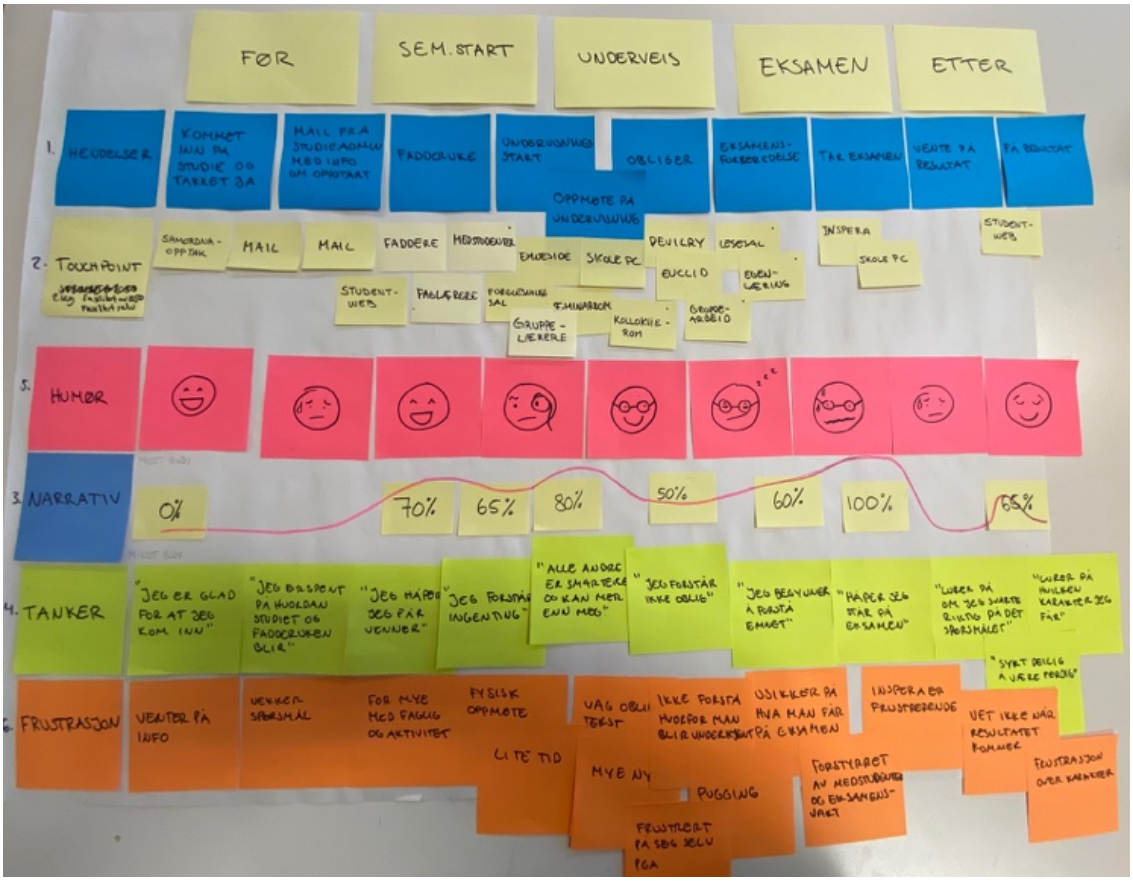

Figure 5-5 *The student's journey map capturing the student's journey throughout the semester.*

Figure 5-6 *The student's journey, before, during and after delivering a mandatory assignment.*

5.3 Phase 3 – Ideate

After defining our problem area, we went on to generate ideas with our target group. We did this by inviting people from our target group to two collaborative workshops, future workshop and co-creation session. In this phase, we included students across the bachelor and master level who had previously attended the design course to get a broader focus as the first-year students might be too close to the situation.

5.3.1 Future Workshop with Students

We began the ideation phase with a future workshop, where we invited students across educational levels who had previously attended the design course. The previous phase defined what we would be focusing our future workshop on and whom we needed to invite. We contacted first-year design students through email, and we attended one of their lectures to promote our research and encourage the students to attend our workshop — the remaining where contacted through Facebook. The workshop lasted for three hours, and the participants began with the critiquing stage, followed by the fantasy stage, and we ended the workshop with the realisation stage. The workshop started with the participants individually brainstorm criticisms of the subject, before presenting them to the group. Each individual voted for the three most compelling critiques. To further understand their frustrations regarding the design course, we asked them to create scenarios.

Figure 5-7 *During the future workshop, the students were instructed to create scenarios.*

The next stage of the future workshop, the fantasy stage, began with the participants writing down their preferred future for the design course and the technology needed for this to happen (Figure 5-7). Participants performed this exercise individually before presenting their ideas to the group. Further, we asked the students to choose an idea as a group that they were going to further explore in the next individual brainstorming. We ended this stage by instructing the participants to vote on the ideas they had come up with during this stage that they wished to bring into the realisation stage.

In the last stage of the future workshop, the participants were asked to sort the ideas from the fantasy stage based on how realistic they were. Ideas that are possible to realise within a year was then used to build further on individually, making them more realistic and feasible. At the end of the workshop, the participants were encouraged to present and discuss their solutions.

5.3.2 Co-Creation Session with Students

Following the future workshop was a co-creation session. This workshop consisted of different students than the previous workshop, as the previous ones were not available. The workshop was held digitally due to the COVID-19 measures. We did a quick research on available tools for online collaboration for workshops, brainstorming and prototyping. After careful consideration, we decided to use Microsoft Teams for video conferencing and Google Drive for filling out the concept sheets. For the prototyping, we asked the participants to draw on paper and send it as a photo to the workshop group. We chose these platforms as this were a place the participants already were familiar with and had an existing

account. It also required minimal effort for them to say yes to participate in the digital version of the workshop. Figure 5-8 shows a screenshot of this workshop; to the right is the concept file in which the participants were given access to, and on the left is the team's conference we held in order to communicate with the participants and facilitate the workshop. On the far left is the teams chat.

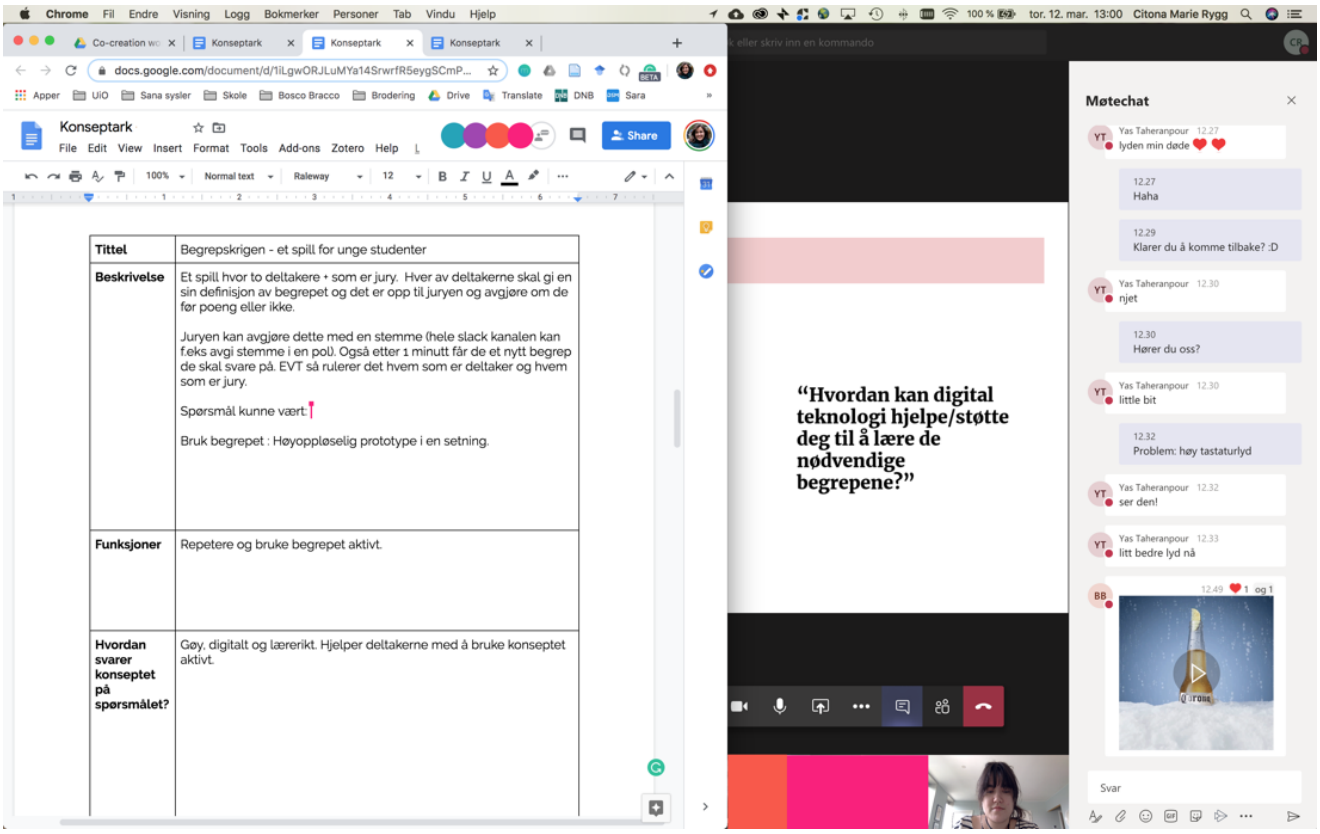

Figure 5-8 *A screenshot from the co-creation session.*

The workshop started with the participants individually writing down three digital technologies that they had used in a learning situation, why they chose to use these tools, and write down the pros and cons of each tool. We asked the participants to present their tools before we continued to the next activity.

The following activity was brainstorming on tool concepts that they believed would help them learn the professional terms. We then asked the participants to sort their concepts by giving them the right priority based on the concept's plausibility. Concepts that were rated highly plausible were then presented to the group, and they had to choose one concept that they wanted to prototype individually in the next stage of the workshop. They could choose either their concept or from another group member. After the rapid prototyping, each individual presented their prototypes and voted to for the prototype which they will bring to the next stage. In order to help them decide which prototype to move forward with we asked them to look at the different concepts and find similarities, barriers, and limits for each. Making the participants look at their concept with a critical lens will help them identify weaknesses to the concept

and help them decide which concept is plausible, but also solves the problem, and deserves pursuing. The concept they chose were then built further on individually before the last presentation of their final prototypes and a discussion on their thoughts behind their chosen concepts.

5.4 Phase 4 – Prototype

In the next phase of our DT process, we began prototyping, and we will in this section, describe the prototype and the reason for the design choices before presenting the result in Chapter 6. Throughout this phase and the next, we focused on one abstract concept (presented in Section 6.4.1) which we have based on insights and ideas from our ideation phase and user tests, in addition to the theoretical framework. For each version, the concept got more and more defined. Each prototype and corresponding test where created and carried out within a week's time frame, except the third iteration as this was a larger prototype than its successors.

5.4.1 The Concept

To guide our prototyping and make sure that our concept was different from the tools we looked at in Appendix A, but still had value for a design course in higher education, we asked ourselves:

- What are the key features the tools have that meets our users need and makes it suitable for a social constructivist learning environment?
- What is the purpose of our concept? How does it differ from those tools?
- What are the key features our concept has that meets our users need and makes it suitable for a social constructivist learning environment?

Also, we needed the concept to help the students succeed at reaching the learning outcomes of the design course – the students completing this course will know the key concepts and methods in design, use and interaction with digital technology. During this conceptualisation process, we used paper prototypes and wireframes to communicate our ideas and solution for the first prototype version.

5.4.2 The First Version of the Prototype

For our first version prototype, we began to brainstorm and create paper prototypes and wireframes, individually as we were in quarantine, making sure we got the most relevant key features embedded in the prototype. The high-fidelity prototype was created in Figma and consisted of a few functionalities just to give the participant a sense of the concept. It would save us time as well as keeping the focus on

concretising a useful and desirable concept before moving on. Also, we wanted to know what kind of feedback was appropriate for the concept we were creating.

5.4.3 The Second Version of the Prototype

After analysing the evaluation for the first iteration, we created a few paper prototypes and wireframes in order to explore solutions before we made a few adjustments to the high-fidelity prototype. In addition to functionalities shown in the previous version, this version consisted of different tasks and types of feedback. We kept the gamification elements from the previous version. From testing the first version of the prototype, we decided that the goal for this iteration was to keep working on defining the concept, making this version of the prototype more advanced than the previous.

5.4.4 The Third Version of the Prototype

We began expanding our prototype, creating more components to interact with based on feedback from our user test participants. Among these is an "inbox" where feedback on tasks is stored in a message format. This way, the group teacher will know what to give feedback on, and the communication between the teacher and the student will flow more freely. To clarify the feedback part of the application further, we explained the purpose of the long answer questions and how it works. Another component we added to this version is the concept of levels and rounds. These levels are based on Bloom's taxonomy and therefore consist of different tasks and difficulties. The levels are presented in Section 6.4.1. Each level has three rounds consisting of ten questions, except the last level that only consists of ten questions. Finally, we added different kinds of feedback based on the level and task the user is at. The feedback for the two lower levels is more in-depth and become less and less so as the user advances in the subject. Between each round, the user receives feedback that they have successfully finished the round.

5.4.5 The Fourth Version of the Prototype

For the fourth version of the prototype, we added more functionalities and did some minor graphical user interface (GUI) changes based on the feedback we had received from our participants. Firstly, we added a screen before level 5, and 6 tasks begin. Also, we added the peer-reviewing function for the students. Secondly, we added a category which was a mix of all the categories in the design course. Third, we received some feedback that suggested that the statistics on the home page was a little confusing and unrelatable to the rest of the application. As a result, we changed the performance graph layout, and the information screen in between rounds to give the students a sense of accomplishment and independence for each advancement. For this version, we created a "helper" function for the student. This function is available from inside the rounds to help the students if they need it. Finally, we

did some minor GUI changes based on the feedback given by our user test participants. Among these minor changes was the colour of the progress bar on level six, and new names for the rounds and levels.

5.4.6 The Fifth Version of the Prototype

The final version of the prototype consisted of some GUI changes based on the feedback given by the participants from the fourth user test. These changes were made as the participants felt that some of the GUI elements used were confusing and hard to read. We changed the colours to WCAG 2.0 AAA-approved colours. Also, we changed the home page of the application, giving the performance graph, help- and profile-button a new look in hopes of it being less confusing for our next participants.

5.5 Phase 5 - Test

Our approach to remote user testing was to do both synchronous and asynchronous remote testing, depending on the feature that was to be tested and the participant's availability. The synchronous remote testing was held by video conferencing with the participant. We held the asynchronous remote tests by giving each participant instructions to where they could access the prototype and the survey, where our questions were. This made the participating in the user test less demanding for our participants. Another positive aspect of the remote testing was that it would be held in the natural setting for our prototype, and we learned much about how to deal with the contextual variables as well. In this section, we will for each iteration present the goal of the user test, the target group, where and how many attended the user test.

5.5.1 Test of the First Iteration – is the purpose of the concept clear?

When the first version of the prototype was ready, we began recruiting participants to an asynchronous user test on our prototype. We did the test digitally using Facebook Groups to recruit, Figma for creating and displaying prototype, Google Docs for documentation of the user test and Microsoft Teams for the interview after they tested the prototype. Our primary goal for this user test was to evaluate the concept and get initial feedback to see if we were on the right track. It was at the very beginning of the prototype phase; therefore, the focus was not on the interaction in detail, but instead, if the prototype fulfilled its purpose. The survey asked each participant about:

- What are their thoughts on the applications tasks and feedback?
- What do they perceive as the right amount of questions?
- What do they think is the purpose of the application?

We had six second year master students from the informatics: design, use, interaction program, who have attended the design course during their bachelor's degree. Participants were instructed to explore and test the prototype before the scheduled feedback interview. We asked the participants on their thoughts were on the applications used and on the different features available, in addition to what they thought the purpose of the application was.

5.5.2 Test of the Second Iteration – is the concept clear and useful?

For the second iteration of the prototype, we recruited participants to an asynchronous user test on our prototype. As we still were testing the clarity and usefulness of the concept, we invited students that had not already participated in the previous test. Before the test, the participants where e-mailed instructions and the agenda for the remote user test as this iteration consisted of a 10-minute interview after the participants had time to get to know the prototype. This test had three main objectives, where we wanted to find answers to these questions:

- Is the concept clear, and is it viewed as useful to the target group?
- What do they think of the feedback in the two different tasks?
- What do they think of the levelling up system?

We had four participants in total where two of the participants had been group teachers in the design course and were at their first year of their master's degree study. One of them had also participated in previous data collection activities for this thesis. The remaining two participants had also worked as group teachers, though in different design courses. These two participants were at their second year in their master's degree study. All four participants have attended the design course during their bachelor's degree. Participants were instructed to explore and test the prototype before the scheduled feedback interview. We asked the participants on what their thoughts were on the usefulness, the different features available, and to what they thought the purpose of the application was.

5.5.3 Test of the Third Iteration – is the concept useful and does it meet the user's need?

Participants for the third test were recruited through the Facebook group for design students at UiO, also, by inviting previous participants through e-mail. For this test, we only tested the central part of the application, i.e. the student view of the application, as the group teacher view was much like the messaging system in the student view. We did this to make sure the central part of the application met its purpose before diving deeper into the concept. In this user test we wanted to find the answer to the following question:

- How are the concept's tasks and feedback; is it useful and relevant to the students?

The user tests were held using Zoom and Figma, and each test was held individually. The participants were instructed to enter the Zoom meeting room and share their screen with us. Our participants were two design master students, from different year levels, and two design bachelor students, also from different year levels. We asked the participants to walk us through their chain of thought as they interacted with the prototype. After the walkthrough, we held a short interview and asking the participants for their thought on the applications used and their thoughts on the different features available. Besides disturbance from the participants household and some minor typos in the prototype, the user test went smoothly. Some of the participants felt awkward to speak out loud to themselves during the walkthrough.

5.5.4 Test of the Fourth Iteration – how are the interaction and graphical design perceived?

As the concept is thoroughly tested, and the participants find the concept useful and desirable, we could now move on to test the interaction and graphical design of the application. Therefore, this iteration consisted of three main goals:

- Are the new feedback formats better?
- Is the new functionality useful, and does it support their learning process?
- To test the graphical design and the interaction; Does it need improvement?

We focused on the user experience aspect of developing a concept. We recruited participants using the same platforms as the previous iteration, and the test was held individually using Zoom and Figma. This test consisted of two participants whom both have attended the design course, and our focus was on the concept's user experience. Our participants were two design master students from different year levels. The participants were instructed to enter the Zoom meeting room and share their screen with us. We asked the participants to walk us through their chain of thought as they interacted with the prototype. After the walkthrough, we held a short interview and asking the participants for whether they found the applications useful and their thoughts on the different feedback formats available. As our participants are design students taking their master's degree, this was a fruitful and elaborate data collection. There was an unstable network on one of the participant's side, making it sometimes difficult to understand what was said during the walkthrough.

5.5.5 Test of the Fifth Iteration – have we created a useful and desirable concept that facilitates scaffolding?

We decided that we wanted to invite participants who have previously participated in our DT process into this final user tests. The participants in this iteration were chosen as they were from different year levels on their master's degree in informatics: design, use and interaction and had previously attended the design course, also, to have participated earlier in our design process activities. As such, the goals of this user test were to answer the following questions:

- To test the graphical design and the interaction; Does it need improvement?
- How is the variation of tasks and feedback perceived, and are they useful and relevant?
- Have we created a useful and desirable concept that facilitates scaffolding?

These tests were held individually using Zoom and Figma. The participants were instructed to enter the Zoom meeting room and share their screen with us. We asked the participants to walk us through their chain of thought as they interacted with the prototype. For this test, we showed both the student and the group teacher view of the application as this was our final test, and we wanted the group teachers' input. After the walkthrough, we held a short interview to follow up on some of the things they mentioned during the walkthrough. As our participants are design students taking their master's degree, this was also a fruitful and elaborate data collection.

5.6 Summary

In this chapter, we have presented our approach to the DT process. We have described which, how, and why each activity was implemented for each phase. The variety and number of methods we used allowed us to gain both a broad knowledge of the course and a deeper understanding and empathy for the students and group teachers. This DT process resulted in 15 design activities with 61 participants, where 12 were recurring. In the next chapter, we will present the results of each activity and present the learnings of each phase.

6 Results

In this chapter, we will present the results and our analysis of each data collection method for each phase. As our theoretical framework is a shaping tool in this thesis, it will guide our research and help us identify important themes as we go through our DT process. As we had recurring participants in this design process, Student #X, Group teacher #Y, and Student #Z will be referring to the same student throughout this chapter. Our iterative process is presented in Figure 6-1, which shows how we moved from one activity to another through the different phases and when the theoretical framework played a part in our process.

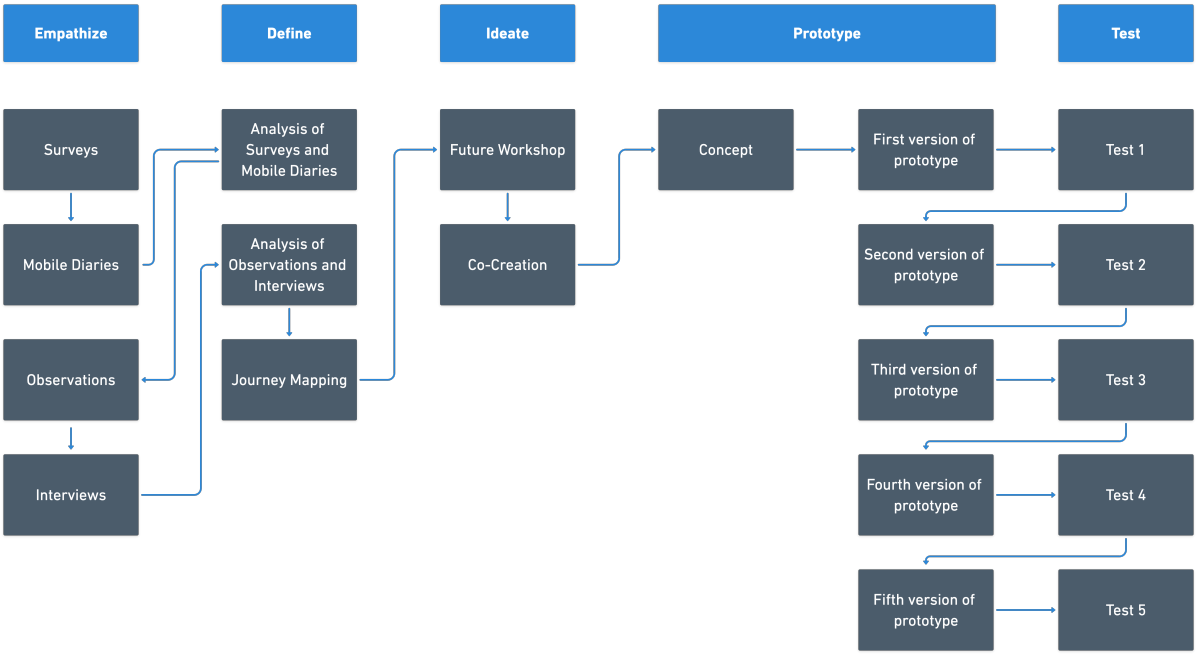

Figure 6-1 *Our iterative DT process*

6.1 Phase 1 – Empathise

6.1.1 Survey

The first survey resulted in 21 responses, and the data gathered was analysed by identifying the themes and the students' opinions on their learning and participation. As the goal of this survey was to map the subject, the students and their impressions of the subject, our intermediate results general but were useful to guide our research. The challenge of this survey was the misunderstanding of the Norwegian word "*samarbeid*" as it can both mean co-operation and collaboration in Norwegian. Additionally, most of the participants viewed this activity as creating something together, rather than discussing and helping each other with the mandatory assignments. We wanted to see if the students collaborated in the course, whether it was reading the curriculum, discussing the assignment or anything relating to the course.

Many who answered the survey said that they did not collaborate on the assignments unless it was explicitly required in the assignment. We used what we learned from this survey when we were creating our interview guide. Our intermediate results from the first surveys were as follows:

- Sex makes no significant difference in their answers, but age makes a bigger difference.
- Many found the assignment text challenging to understand, which led to misunderstandings on the assignment.
- Their expectations of learning outcomes in the subject match the subjects learning goals.
- When they collaborate, they do so by discussing the curriculum and assignments.
- They do not facilitate any collaboration like colloquium groups on their own
- They do not see the value of facilitating collaboration

The second survey resulted in seven responses, but during data analysis, we discovered that one student had an answered the following:

> *"Honestly, I only answered this [survey] so that you would have more responses. So yw [sic]."*

Because of this statement, we cannot rely on the answers given by this participant, therefore, excluded this data item from our intermediate results. The rest of the data gathered were analysed by using affinity mapping. We identified themes regarding the students' opinions on their learning, participation, and collaboration. Another challenge with this survey was again the misunderstanding of the Norwegian word "*samarbeid*" (collaboration). Our intermediate results were as follows:

- The students do not collaborate unless they wish to gain new points of view, get the concepts explained in new words and be social. The students mostly collaborate during group lectures; however, they mostly co-operate. They do not collaborate to co-create knowledge.
- The screencasts are used, not only for students who are not present but for repetition after attending the lecture.

Although the second survey had considerably lower response rate than the first, this survey did confirm what we discovered about what was necessary for a student's learning ability and motivation in the interviews and observations.

6.1.2 Mobile Diaries

The mobile diaries gave a broad insight into the frustrations and challenges the group teachers might face during a semester. The two group teachers were recruited through direct messages on Facebook Messengers and presented with the instructions for participation. The duration of this activity was based on the layout of the design course, each week a new subject is presented, and also, this particular week the group teachers were correcting the first mandatory assignment as well as doing their regular weekly tasks related to their job. The intermediate results were as follows:

- The overall quality of the mandatory assignments delivered by the students was considered to be weak due to many students failing their mandatory assignments. This led the teachers to question why the quality of the students' assignment was not better.
- They perceived the students as more stressed over the assignments than they had been in previous years.
- The course mainly consists of first-year students with no prior experience of studying on a higher educational level.

6.1.3 Observations

We observed the three different instructional methods available to the students. The lectures taught by the professor introduces new information and marks the start of the week. These lectures are held in a large auditorium. The plenary exercise lectures are also held in the auditorium, and this type of lecture is a repetition of the most critical aspects of the week's subject. The whole exercise marks the last day of the week. In between these lectures, the students have the opportunity to attend group lectures. During our observation of the lectures and the plenary exercises, we positioned ourselves in the far back, as shown in Figure 6-2.

The group lectures are much more intimate than the auditorium. Therefore, being just a face in the crowd becomes much more difficult, and the students are expected to participate in the class. This made our observation less discreet and may have, in some ways, affected the students and how they behaved, as we did not participate in the practical group assignments. During this observation, we positioned ourselves in the far back left corner of the classroom, as shown in Figure 6-3. The illustration also shows were the group teacher (the black box) and the students sat (the black circles). Our hypothesis that students are more active in group lectures and ask more questions during plenary lectures than in the regular lectures were confirmed in our observation.

As such, we intend to put more focus on these two instructional methods going forward. Another discovery we made during our observation was that the group lectures facilitate active learning, as the students are encouraged to participate in group activities and discussions that promote reflection and understanding of the topic.

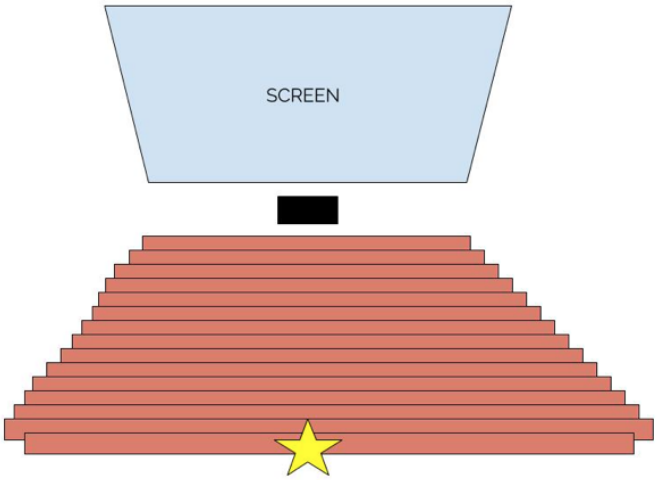

Figure 6-2 *The auditorium where the plenary exercises and lectures where held.*

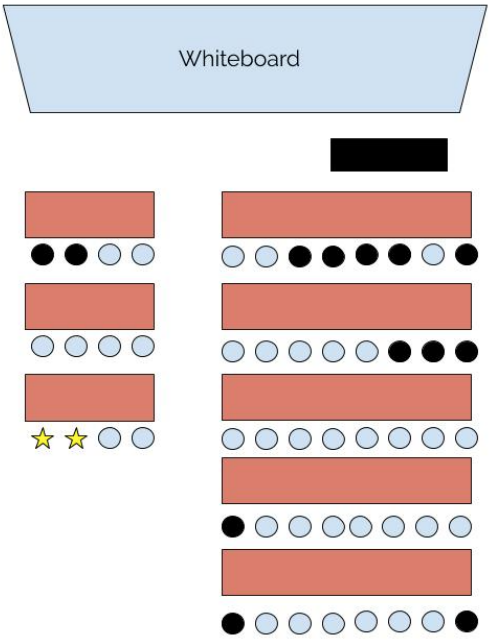

Figure 6-3 *The group lecture room.*

6.1.4 Interviews

During our interviews with the students and the group teachers, we discovered both frustrations and gratifications regarding the design course. Overall, the participants we interviewed were pleased with the instruction methods available to them, and most of the participants attended all of them.

On the topic of being inspired or motivated to learn, the students were bright that they felt more inspired and willing to learn if the information presented to them were relevant to their future studies or work. Two remarkable quotes from the interviewed students where:

> *"It is fun working with tasks and feels like you are doing something that is helping you towards the exam, or if it will help you when you get a job in the future, or if you wish to learn more about it later." (Student #3)*

> *"In order to be inspired to learn something new, I have to be shown what I can make or do with it." (Student #2)*

These claims support the importance of situated learning, but it is also a contradiction to what the students said they preferred. The students preferred the lectures as they were well structured and informative, and minimised the need for reading the curriculum on their own. One recurring theme throughout the interviews was "applying theoretical knowledge into practical assignments". This was especially critical for the students' understanding of new concepts.

> *"Much of the practical [assignments] are based on the theoretical concepts etc. So if you have not understood the difficult [concepts], then it becomes difficult to do the practical stuff. So you can easily notice if you know or do not know something, or if you need repetition." (Student #1)*

The group teachers seemed to have the same impression as the students. We asked them about their experiences with the course when they first attended it:

> *"There is much confusion around the concepts. It is much new information from all of the three courses in the first semester. I remember wondering what I was doing and working on explaining the new concepts. Answering questions like 'What is user-centred design?' And I see that is also something my students struggle with" (Group teacher #3)*

This further amplifies the importance of the students' understanding of new concepts. On the subject of feedback on mandatory assignments from the group teachers, the group teachers felt that their time spent on giving thorough and constructive feedback was wasted because the students did not seem to read them.

> *"Sometimes, I feel like I am giving longer feedback than what the students themselves have written in their mandatory assignment. All of the group teachers are good at giving long, thorough and constructive feedback and it is a shame that they [the students] do not read them" (Group teacher #2)*

Nevertheless, what we learned from the students participating in the second survey contradicts this. The students had shown much appreciation for the feedback from the group teachers, especially regarding their learning and understanding. Most of the students attended the three different lecture formats available to them and found each one very important to their understanding of the course material. One student voiced the reason for why they would not attend all group lectures:

> *"I feel a little cheated when they say that it [the group lecture] is relevant to the mandatory assignment, and then it is not aimed at it at all. Or it is aimed at the assignment, but I cannot use it directly in my assignment because it is meant to make you see something in a different way." (Student #3)*

On the subject of collaboration with peers, we needed to clear up the misconception of "*samarbeid*" from the first survey. We asked once again if our interviewees collaborated with peers. After digging deeper into their answers, we found out that our interviewees do indeed work with peers. They collaborated with peers to gain a different perspective or if they needed help with understanding the mandatory assignments – implying that group lectures should not only a place where students can apply their newly learned knowledge into practice but also a place where they can actively use what they have learned in their mandatory assignments.

6.1.5 Summary of Intermediate Results in the Empathy Phase

As we end our empathy phase and move to the define phase of our DT process, these are the key learnings we will take with us:

- Students who have no prior experience with higher education tend to find the language of the mandatory assignments to be difficult. As a result, the group teacher we followed in this phase considered the quality of the mandatory assignments to be weak, and many had failed their first attempt.
- The different communication channels between students and teachers, confused the students.
- Students sometimes collaborate or co-operate in order to gain new insights and discuss the curriculum and assignments on their own, but most of the time they only participate in collaborative work if the lecture facilitates for such activities.

- Students use screencasts both for catching up when they have missed a lecture, as well as for repetition.
- The group lectures facilitate active learning the most, as group activities and discussions that promote reflection and understanding of the topic are facilitated.
- In order to reach an active state of learning in the group lectures, the students have to understand the basic concepts presented to them in the lectures.
- Although there is evidence that the students are more motivated and engaged in the group lectures, the students still prefer regular lectures as the course material is resented to them in an understandable manner.
- Most students feel more motivated to attend group lectures if they are directed towards their mandatory assignments.

With these key intermediate results, we continue our research by defining our problem area and identify critical themes for the ideation phase.

6.2 Phase 2 - define

6.2.1 Analysis of the Surveys and Mobile Diaries

The analysis of the surveys and the mobile diary indicated where some of the pain points were. We began this analysis by identifying themes and grouped responses based on the participants being a student or a group teacher. Within the student category, we categorised responses based on whether the students were born before 1996 (Millennial's and older) and those born in 1996 or later (Gen Z). For each generation, we grouped the responses based on the student's previous experience with higher education; those straight from high school and those who had previously attended other higher education courses. Our intermediate results from this analysis are as follows:

- We compared the responses of the different generations and discovered that their age did not matter, but instead, if they had previous experience with higher education.
- Participants answered that they collaborate through discussions. While some students collaborate to gain new viewpoints and to be social, most of the participants answered that they had not participated in any collaboration as this was not part of the mandatory assignment.
- Participants were overall pleased with the instructional methods that were available to them, and most of them answered that they used screencast from the lectures as a way of repletion.

- The main frustration seems to be the language of communication. Students find the language of the mandatory assignments challenging to understand, which the group teachers believe is because of their lack of experience with assignments on higher educational level. This is believed to be the reason the students failed their first mandatory assignment.

6.2.2 Analysis of the Observations and Interviews

When analysing the interviews and observations, we began by identifying themes in transcripts and observation notes followed by filling each identified theme with quotes and personal notes from interviews and observations. The themes we identified were collaboration, critical thinking or reflection, situated learning, concentration, student-teacher dynamic, resources, motivation, repetition behaviour, and participation. With this information mapped out, our key intermediate results were as follows:

- Active learning happens in group lectures, where the lectures facilitate collaboration and active learning. The other two instructional methods facilitated passive learning. In group lectures, there is room for reflections and activities in these lectures are more work relevant.
- Course resources for solving mandatory assignments and tools assisting students in their learning is presented in lectures as well as shared between peers.

Certain themes discovered in the survey and diaries' analysis reoccurred in this analysis as well. This led our focus to the topics of collaboration, active learning, and study techniques in the following phases. Also, we used the recurring themes from different interviews to create our student persona (Figure 6-4). These students are not a good representative of all the students attending the course, as they are very motivated and interested in the course subject and participate in extra curriculum activities. Therefore, this persona is instead a representation of the trait students need to accomplish the design course. Having this kind of persona might overlook the reason why some students fail the course, which we will keep in mind as we move forward. The persona shows what motivates and interests the students, as well as the goals, likes, dislikes and weekly routines they had in common. The persona's goals, interests, weekly routine, motivation, likes and dislikes are based on interviewees. The quote is from one of the participants, which summarised what we had learned about our target group.

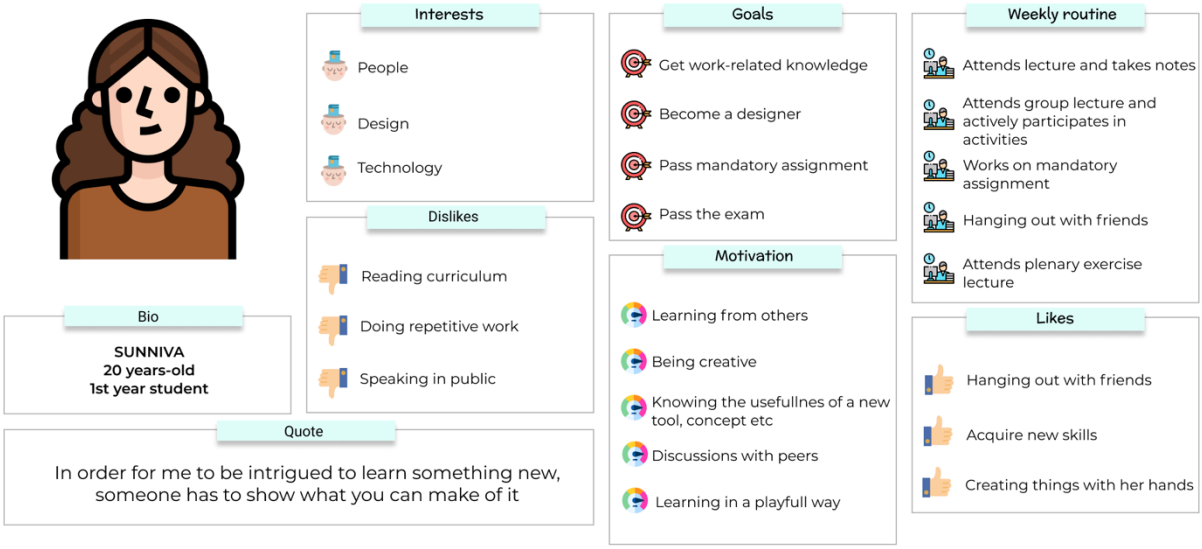

Figure 6-4 *Our student persona.*

6.2.3 Creating a Journey Map

To get an overview of our intermediate results and a deeper understanding of our users, we made three different journey maps. The journey maps helped us visualise what we already suspected about our data; as soon as the students master the new concepts presented to them the final journey before the exam becomes easy and the exam itself becomes doable. These journey maps were based on our student persona (Figure 6-4), and they gave us an understanding of the target groups journey and narrowed down the subject of interest even further.

The first map was an experience journey map of the student's first semester. This journey map made it clear that our focus should be on time between semester start and the exam. Students were more active during this timeframe; attending the three different lectures and doing mandatory assignments, as well as collaborating with peers in order to gain different perspectives. Aspects that this map covers are the stages of the journey, events that occurred in the different stages, touchpoints, the student's mood, narrative, thoughts, and frustrations. The narrative is an indication of how active the students participate in the course as well as their learning.

We then converged our attention to map out an average week in the course, starting with the lectures presented by the professor and ending with the plenary lectures. Aspects that this map covers are the stages of the journey, events that occurred in the different stages, touchpoints, the student's mood, narrative, thoughts and frustrations. This map highlighted the importance of the three different instructional methods to the students learning and understanding. Here, the student's narrative represents how actively they participate in their learning. We identified two stages where active learning

occurred during this journey; one was during the group lectures; the other in "between-group lesson and plenary exercise lecture" phase if the student actively participated in their learning.

With these discoveries, we made a third and final journey map for this phase, as shown in Figure 6-5, which illustrates the student's journey throughout the course. The illustration shows how obstacles, mandatory assignments and final exam, are viewed by the students as the students travel "through" the course they encounter different obstacles, which are illustrated as mountains, hills, rivers and different weather conditions. The hills and mountains represent how the students view the difficulty of the mandatory assignments and the exam. With the students are their backpack and the different tools they obtain throughout the journey. The tools represent the knowledge they have acquired and need to master the next obstacle. What this journey does not illustrate is *how* the student acquired knowledge.

Figure 6-5 *The final journey map shows the journey of the student throughout the semester.*

6.2.4 Summary of Intermediate Results in the Define Phase

During the define phase, we have defined our problem area, while empathising even further with our target group. As we end our define phase and move to the ideation phase, these are the key learnings we will take with us:

- Most students do not perceive the active learning in the group lectures directly relevant to their mandatory assignments and therefore undervalue it. This is more a critique of how the group

lecture is presented to the students giving them false expectations, rather than a critique on how the group lecture is structured and carried out.

- Students who do not attend the lecture before attending the group lecture do not gain the foundational knowledge required to participate in the group lectures unless they read the course curriculum on their own. If the student does not attend the lecture or read before a group lecture, keeping up and the chance to gain meaningful insights will be minimised. As we have learned from the interviews and surveys, students find reading curriculum boring and tend not to do so unless something is triggering their curiosity
- Although students name the lectures as their preferred instruction format when talking about when they feel most inspired to learn, situated learning and most importantly, active learning is preferred. This contradiction is exciting, and something we will explore further in our research.
- Active learning occurs in the group lectures and when students work with their mandatory assignments and weekly tasks, by students actively participating in their learning between semester start and the exam. Reflection over one owns learning occurs during group lectures, plenary lectures and when they work with the curriculum own their own.

With these key intermediate results, we continue our research by focusing on the themes of active learning, collaboration, group lectures and reflection in the next phase of our design process.

6.3 Phase 3 – Ideate

6.3.1 Future Workshop

By bringing the four themes from the define phase into the future workshop, our participants were able to diverge in multiple ideas. We began the workshop with ice breakers that both warm-up creative though and facilitates collaboration, as we were worried that the first-year design student would feel intimidated to be in a group with three master students. This made our participants very social and comfortable with each other, and likely minimised the intimidation the first-year student might have felt. This workshop lasted for three hours and was held at IFI.

The underlying theme of the critique stage voiced by the participants was understanding and learning new concepts. The students discussed and agreed that the design course consisted of much new information presented in a short amount of time. This includes a lot of activities which they should participate in, such as the different instructional methods and mandatory assignments, and still have time to read the curriculum that consists of a book and articles.

In the fantasy stage, the participants came up with many different ideas (Figure 6-6). When analysing these concepts, we found the following key features:

- More capable peer, either in the form of a chatbot/AI or a group teacher
- Information is presented in different ways, e.g. podcasts or different visual representations
- Learning terms and concept that are relevant to the knowledge community one is a part of.

All their ideas were mainly focused on solving one specific problem: passing the exam. As the participants pointed out in the previous stage, there is much new information presented to the young students, and it can feel overwhelming. As a consequence, students memorise terms and concepts enough to pass the exam but not always enough to gain a deep understanding of the terms and concepts.

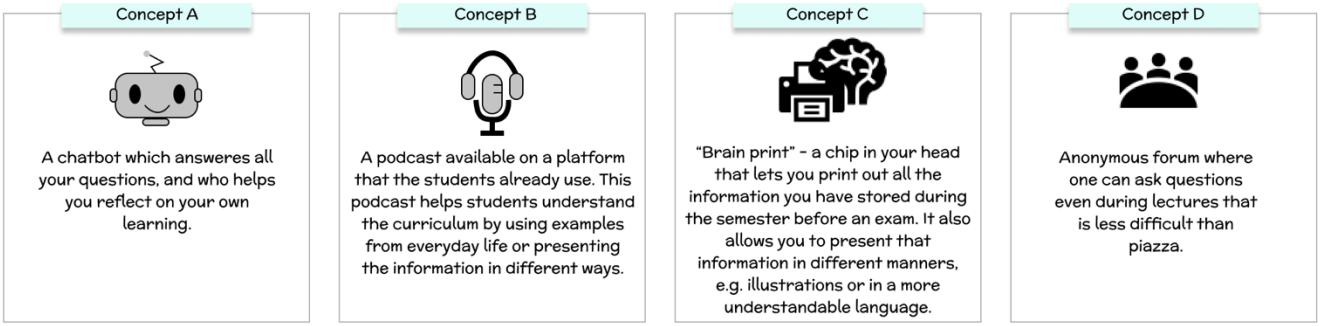

Figure 6-6 *The recurring concepts of the fantasy stage.*

In the realisation stage of the workshop, the participants sorted their concepts into three categories based on their enabling; "right away"; "within the next year"; and "sometime in the future". The participants chose each concept that they wished to build further on from the two first brackets. Following this, they voted on the best solutions (Figure 6-8).

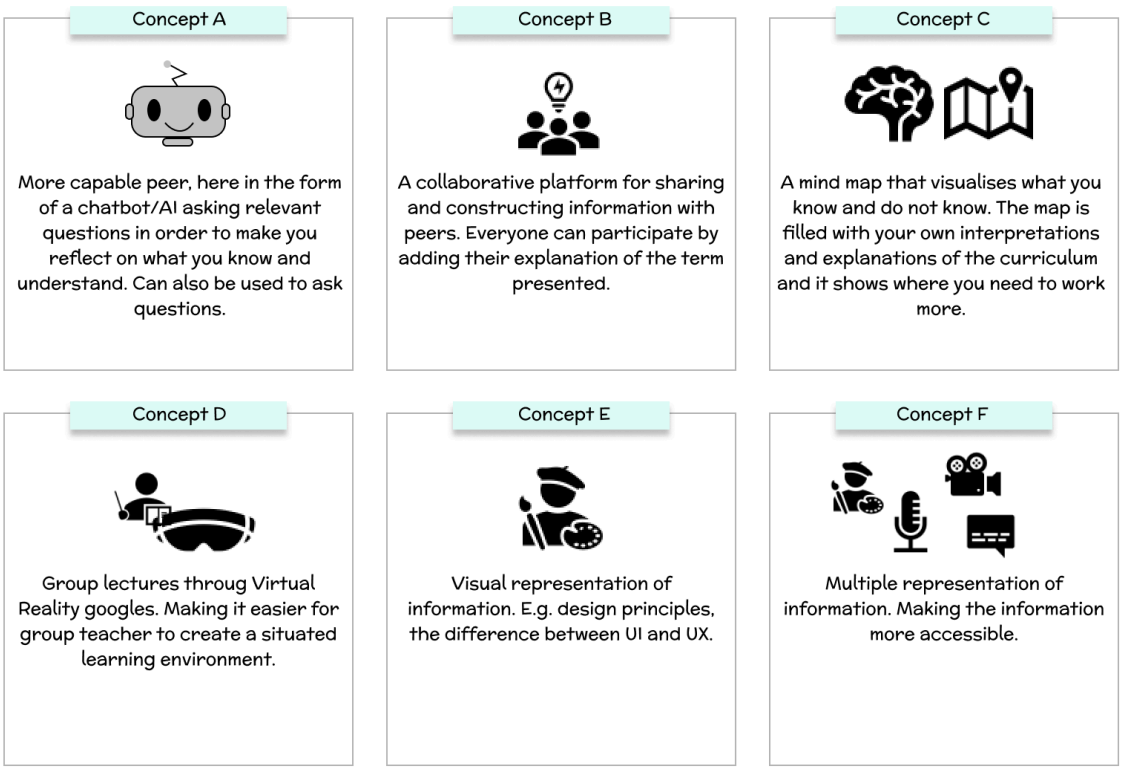

Figure 6-7 *Illustrations of the concepts that got the most votes from the participants.*

When we analysed the solutions and scenarios they had created, we identified three main themes which we took with us further in the design process. These themes were:

- Scaffolding with the help of a more capable peer.
- Visualisation of one's progress in the course.
- Multiple representations of information.
- A collaborative platform for constructing knowledge together.

6.3.2 Co-Creation Workshop

This workshop was based on the four themes we identified during the future workshop. Before brainstorming, we asked the participants to name technologies that they have previously used in a learning context. These technologies were Google Drive, Microsoft One Note, lecture podcasts and slides, Devilry, GeoGebra, and Stack overflow. Common traits of these different technologies are the possibility for collaboration, feedback, and visualisation. Most of these tools are free for everyone with an account from the respective web sites, while others require licenses which the students have received for free through the university.

The participants moved on to the next brainstorming session. They were instructed to brainstorm concepts which they believed would be helpful when learning new terms, more specifically, the terms of the knowledge community interaction designers belong to. The themes that emerged from the brainstorming were memorising, gamification, and visual representation. They began a rapid prototyping session before each chooses one low-fidelity prototype they wished to continue building on. This co-creation workshop ended with two low-fidelity prototypes by each participant; one based on a concept they liked the most; and one that was a mix of all the prototypes. Figure 6-9 shows the characteristic features of the participant's prototypes.

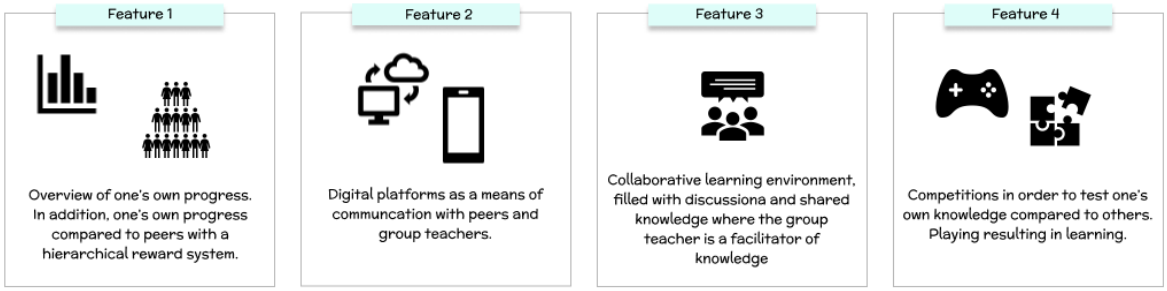

Figure 6-8 *The characteristic features from the prototypes of the co-creation.*

Following insights were made from the co-creation workshop:

- Participants used technology as a tool for communication with peers. The technology facilitates collaboration, rather than collaborating with the technology to construct knowledge.
- Viewing one's process (strength and weaknesses, knowledge gap) was repeatedly mentioned as an essential aspect of one's learning.
- Scaffolding with the help from a group teacher in the beginning, then slowly use peer guided scaffolding was mentioned as a right way for students to both learn from each other and be confident with one's knowledge.
- Two of the three participants viewed competition as a healthy way to motivate students. While the third participant saw the value in gamification, they did believe that too much focus on competition would create a bad environment.

Our search for tools for the co-creation workshop awakened an interest to further research design and collaboration tools available online (Appendix A). Some of the tools we analysed were mentioned by our participants, both in this phase and previous phases. We will use what we have learned from these tools to define our learning technology concept.

6.3.3 Summary of the Ideation Phase

As we round up this phase of our DT process, we encountered these five recurring themes:

- Scaffolding, with the help of a more capable peer, being a group teacher or peer, is essential for the students learning process. As this is a good way for students to both learn from each other and be confident with one's knowledge.
- Visualisation of one's progress in the course; viewing one's strength and weaknesses, the knowledge gap, in a course curriculum was repeatedly mentioned as an essential aspect for one's learning.
- Multiple representations of information.
- A collaborative platform for constructing knowledge together: participants used technology as a tool for communication with peers. The technology facilitates collaboration, rather than collaborating with the technology to construct knowledge.
- Game-based learning increases motivation. A majority of our participants viewed competition as a healthy way to motivate students. While some of the participants saw the value in gamification, they did believe that too much focus on competition would create a bad environment.

As the resulting themes in each workshop, consisting of different participants each time, were these five themes, we can conclude that they are the most critical factors to increase learning in the design course. Before we continued our DT process, we gathered our key insights and dived back into the literature of pedagogy in order to focus our attention even more. Figure 6-6 is an illustration of our inductive process, which lead us to four key areas where ZPD and scaffolding would play a role in technology.

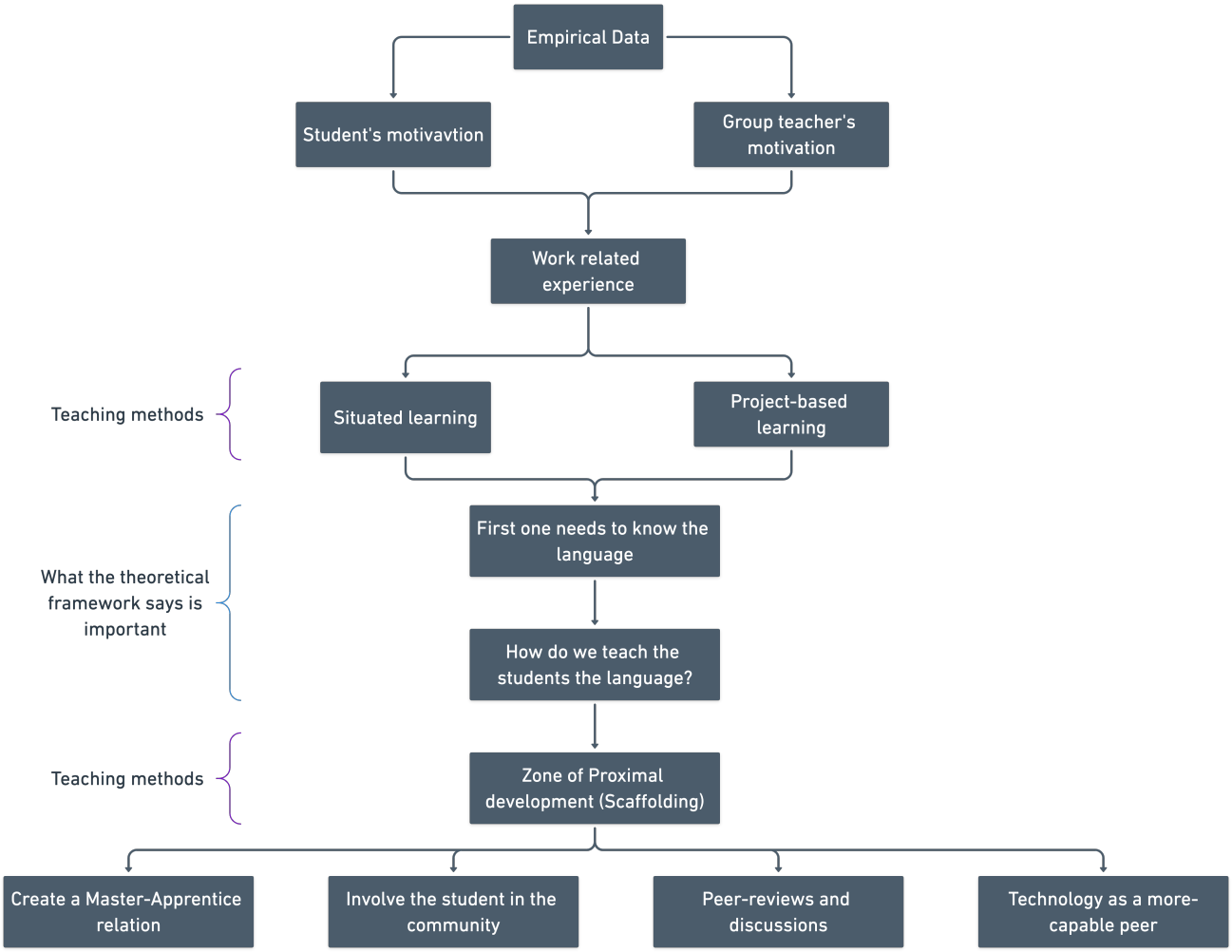

Figure 6-9 *Our inductive process after the three first phases of DT resulting in four areas to focus further on.*

6.4 Phase 4 – Prototype

6.4.1 Our Concept

This concept will be a digital technology that will act as a more capable peer by levelling up the students in the different categories, encouraging the student to be even more independent, and having feedback that uses the language of the knowledge community. The levelling up and performance graphs introduce a game aspect to the technology, which will also motivate the students to use the application. We created a concept based on the previous three phases of our design process, using social constructivist learning theory as a guide to decide what is relevant and not relevant, for the student to use it in their spare time we chose to create an application for smartphones, as this is the technological tool that they always have with them.

Our concept will consist of six levels, which are based on Bloom's taxonomy. These levels consist of different tasks and difficulties. These levels are as follows:

1. **'Remember'** – the students will be tested on their ability to recall facts and basic concepts. Tasks on this level are true/false questions and filling in the missing words through drag-and-drop.
2. **'Understand'** – testing the students on their ability to explain ideas and concepts. For this level, we chose multiple questions and short answer questions.
3. **'Apply'** – testing the students on their ability to use information in new situations. On this level, the students will be asked to interpret pictures and identify the concept, match concepts with explanations in addition to multiple-choice questions.
4. **'Analyse'** – the students will be tested on their ability to draw connections among ideas. Tasks on this level are questions with two alternatives as answers and questions which requires the students to list their answers.
5. **'Evaluate'** – testing the students on their ability to justify a stand or decision. For this level, students are instructed to list their answers to the question.
6. **'Create'** – testing the students on their ability to produce new or original work. This level consists of long answer questions, where the students are asked to discuss and justify their stand. This level is also the first level where the students receive feedback from a peer or a group teacher.

In Appendix A, we mention collaborative technological tools. These tools have features that are suitable to our theoretical framework. The features which the tools have in common are:

- Collaboration across platforms
- Collaborative writing
- Feedback from peers
- A platform where the students already are or a platform which allows the students to log in with their student account (no need for a sign up), and preferably free
- Dialogue-based learning

We wanted our concept to meet the target groups need for learning and collaboration, but we also wished to create a concept that stood out from all the other applications available to them. Therefore, the concept is a mobile application that builds on different parts of social constructivism. These are scaffolding, more specifically Vygotsky's *Zone of Proximal Development*, peer-reviews, and gamification. Also, the concept is to be tailor-made for the course the student is attending, which in our case is the design course. This means the questions; the types of tasks, and the number of categories is based on the course structure.

6.4.2 The First Version of the Prototype

For our first version of the prototype, we designed the basics of the concept. Figure 6-10 shows the landing page for students. We focused on implementing the social constructivist concepts, scaffolding and gamification, also, to present the initial concept. This landing page consists of the user's statistics and buttons which represents subjects from the course. Each of these buttons starts a quiz based on the topic the user chose (Figure 6-11). By showing the user's progress in the different subjects, we are showing them their understanding of each subject and where they need to focus more, hopefully encouraging them to build on their existing knowledge. As such, we are bringing in the scaffolding element into the concept.

The prototype has an element of gamification, as participants in previous phases repeatedly sad that competition, quizzes and other game elements, made learning more motivational and fun. This version of the prototype only consisted of only true/false questions, which is only one of the four intended types of questions. The elements of game design in this version are performance graphs, as shown in Figure 6-10, and the feedback that is designed to encourage more interaction with the application and their learning, as shown in Figure 6-12 and 6-13.

In addition to the game element, we focused on giving the students meaningful and long feedback making the prototype the more capable peer in the student's learning. From our theoretical framework, we have scaffolding as a way of helping the students reach a higher level of knowledge within the field with the help of a more capable peer. The more capable peer can be a student who is more familiar with the field of knowledge, a teacher or a tool. In our case, it is the latter. The feedback consists of a visual example of the answer, an explanation, and a reflective question at the end. As the students felt, it was essential to give them visual representation in addition to textual ones.

Figure 6-10 *The landing page for students in version 1*

Figure 6-11 *An example of a true/false task*

Figure 6-12 *Feedback from the right answer*

Figure 6-13 *Feedback from the wrong answer*

6.4.3 The second version of the prototype

The second version of our prototype builds on the previous version as it was well received, with a few remarks. We continued implementing functionalities which supported the social constructivist concepts, scaffolding, and gamification. In this version, the home page, Figure 6-14 consists of four categories in addition to the user's statistics. These four categories are:

- "Øv på begreper" – Practice on concepts/terms category takes the student to another page, Figure 6-15. This category is for practising before levelling up to the next level of difficulty within a subject. The goal becomes to reach level five in order to open the exam category on the home page.
- "Test deg selv" – Test yourself category takes the user to another page, similar to Figure 6-15. Here the user can test their knowledge in a subject, and if they pass, they will level up and receive more difficult tasks next time they are practising on concepts/terms from that subject.
- "Gi feedback til andre" – Allows users to give other peers feedback on their long answer questions.
- "Prøve deg på eksamen" – Allows the user to test their knowledge with old exam questions. This category takes one directly to a quiz filled with questions from across the subjects and difficulties.

For each level in the application, there is a task type associated with the level. These tasks are chosen based on the difficulty they represent, as some types of tasks require more independent thinking than others. For instance, in this prototype, we have true/false questions as the easiest form of task because it requires the student only to recall, and long answer questions which are the most challenging form of tasks because it requires the students to recall information, explain and justify their answer. These two levels are based on Bloom's taxonomy level one (remember) and five (evaluate) respectively.

We added long answer questions to the application in this version as well as the concept of levels. The long answers questions build on the scaffolding element in our prototype, as well as adding a reflexive thinking process, and an understanding of their knowledge. Figure 6-18 shows this feature. For the long answer questions, we decided, based on the social aspect of our theoretical framework, that the user could decide whether to get feedback from a peer or a group teacher. We added one more gamification element to the concept, which are the levels, as shown in Figure 6-15. The user has to finish all five levels in order to "fill up" the category colour.

We changed the feedback for true/false questions from a long text to a short explanation and the possibility to learn more, as some of the participants felt the previous version was too long, as shown in

Figure 6-16 and 6-17. This will also make the scaffolding element of the application more visible to the user. For the long answers, the user can choose to receive feedback from other peers or their group teacher, as shown in Figures 6-19 and 6-20. We chose this element as it adds another scaffolding element to the application. The user who gives the feedback will learn from this experience by having to recall information, explain and justify their feedback, and the user who receives feedback.

Figure 6-14 *The new landing page for students.*

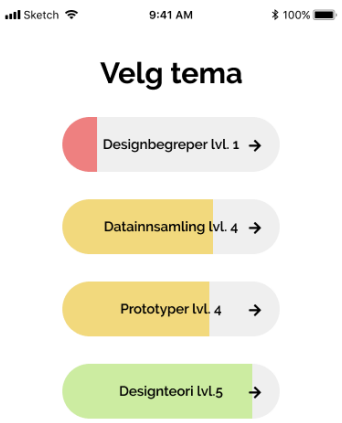

Figure 6-15 *The page for choosing a subject and the level the user is on.*

Figure 6-16 *Feedback for the right answer.*

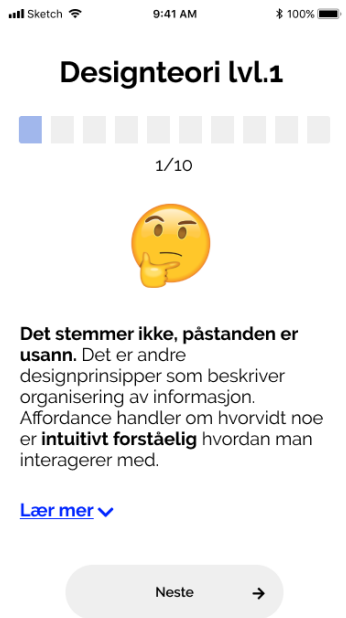

Figure 6-17 *Feedback for the wrong answer.*

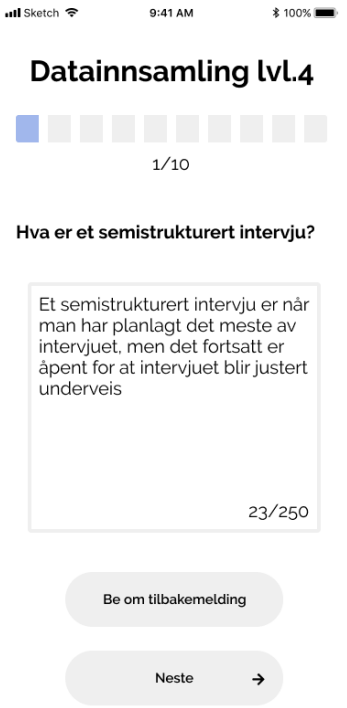

Figure 6-18 *An example of a reflective task.*

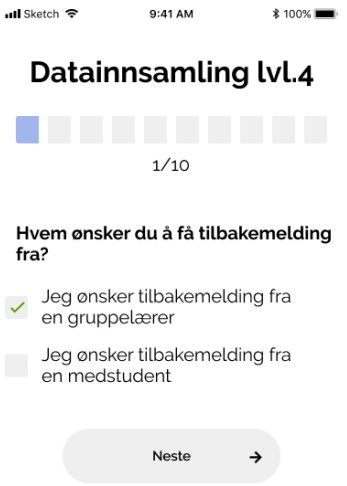

Figure 6-19 *Interface for choosing whom one wishes feedback from.*

Figure 6-20 *Feedback from system confirming the user's choice.*

6.4.4 The Third Version of the Prototype

The third version became a large prototype with many features. These features are (1) six levels consisting of different tasks and difficulties, (2) feedback formats based on the task done, (3) an inbox for feedbacks, and (4) the group teacher view. These additional features make the user actively engage in their learning as it promotes scaffolding, gamification, and collaborative learning through feedbacks.

We began expanding our prototype, creating more components to interact with, after a suggestion from our user test participants. Among these is an "inbox" where feedback on tasks are stored in a message format, where the subject of the message will be the question answered, and the first message will be the students answer for the question (Figure 6-21). This way, the group teacher will know what to give feedback on, and the communication between the teacher and the student will flow more freely. Another new component is the concept of levels and rounds. These levels are based on Bloom's taxonomy and therefore consist of different tasks and difficulties and are presented in Section 6.4.1. Each level has three rounds consisting of ten questions, except the last level which has one round consisting of ten questions. Finally, we added different kind of feedback based on the level and task the user is at (Figures 6-39 to 6-

46). Between each round, the user receives feedback that they have successfully finished the round, as shown in Figures 6-48 and Figure 6-49.

After our user evaluation, we changed the layout of the home page and the level overview. In this version, the home page consists of a performance graph, an inbox icon and categories based on the design course's themes (Figure 6-21). The performance graph has Y- and X-axis, where the Y-axis consist of the different categories and the X-axis show the user's progress in that category. The X-axis is in six sections that gradually fills up as the students advance in the category from 'level 1 - knowing' to 'level 6 - evaluate'. Each category leads to a level overview where the six different levels are presented to the user, as well as the 'peer-review' functionality (Figures 6-23 and 6-24). As the user advances in the categories, each level unlocks, as shown in Figures 6-25 and 6-26. For each level, there are two rounds of tasks, where each round consists of one type of task. To unlock the second round, the user has to score a certain amount of points. Each round consists of ten questions, but as this prototype is only meant to give the participants a feeling of how the end result would be, we will only implement two questions for each level. Level 6 is the only level that consist of one round as the tasks associated with this level requires more independency and time from the user. Each level is to test the user's knowledge, and in those different levels, each task is chosen based on how much information and independency it requires from the student (recalling or reproduce fact), as shown in Figures 6-27 to 6-38. This will also force the student to think differently in order to solve the problem at hand, as the tasks require a different representation of information.

For levels 1 to 5, the feedback given to the user is based on the answer they choose. The feedback for the two lower levels is more in-depth and become less and less so as the user advances in the subject. In addition, we have added feedbacks after the user finishes one round or level to encourage the user to continue their learning. When the user reaches level 6, they are presented with discussion-based tasks and for each completed task they can determine if they want feedback from a group teacher or a peer, similar to the previous version. In order to improve the users experience, the system gives them an approximate for when they will receive their feedback from group teachers (Figure 6-47). Peer-reviewing is a social constructivist learning method which we have decided fits well when the user has reached the last level of the category. To lower the possibility of mathetic taboo, the users are given pseudonym in the peer-reviewing making them anonymous which will preferably lower the threshold for users to use this functionality. The user can find back to the peer-review and/or group teacher feedback by entering the inbox from the home page (Figure 6-22). This inbox looks and works like a classical smartphone messaging system, which is a familiar territory for most interaction design students. When a user receives a feedback or a response, the inbox icon gets a red notification bubble on top of it signalling that there is unread content in the inbox (Figure 6-21). Inside the inbox, messages marked with bold text (Figure

6-22). Inside a message, the task and corresponding answer is in a grey chat bubble, the message from the counterpart is green, while the messages from the user is blue making the conversation easier to read and the dialogue between the two, float freely.

In addition, this version has also a group teacher view, as shown in Figure 6-50. This view consists of a home page and inbox. The home page has a lot of similarities with the student view, except the group teacher view only consists of a statistical graph of all the students attending the course and categories based on the themes in the design course. When the group teacher enters a category, they are presented with an inbox with tasks performed by the students (Figures 6-51 and 6-52). This is similar to the student's inbox and messaging system, but instead of having pseudos' the group teacher can see who the sender is.

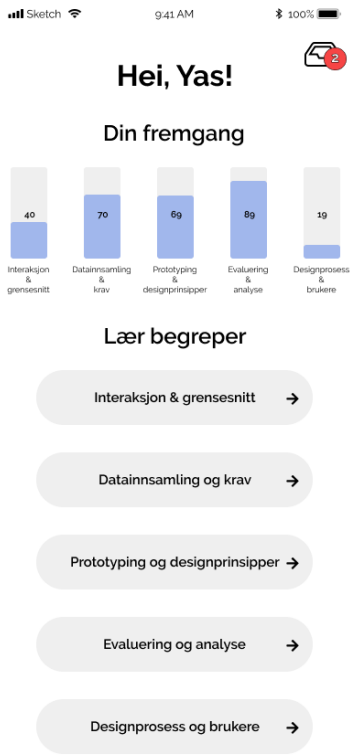

Figure 6-21 *The student landing page with the new GUI and inbox*

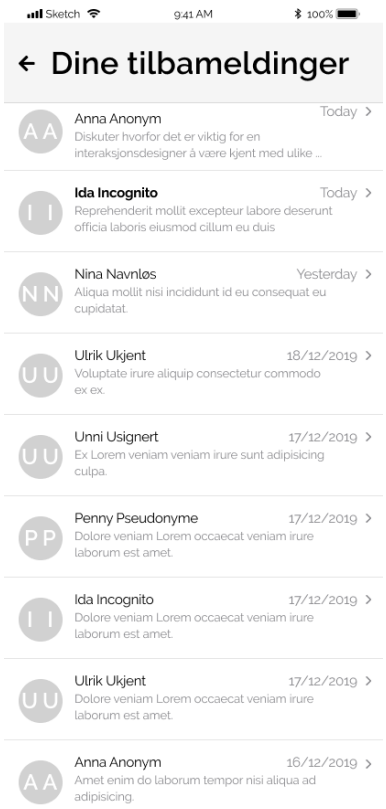

Figure 6-22 *The student inbox for feedbacks from peers and group teachers*

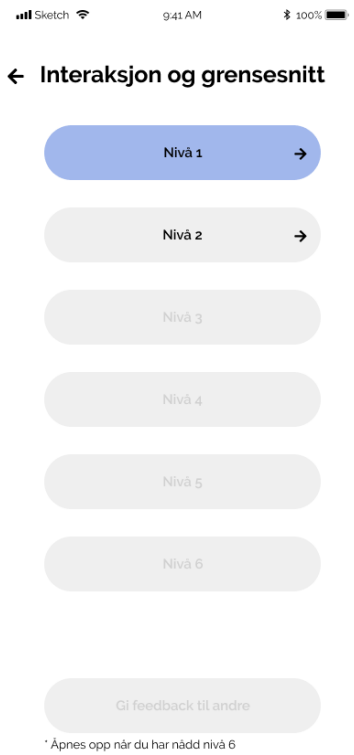

Figure 6-23 *Overview of levels. Here level 1 is completed and level 2 open*

Figure 6-24 *Overview of the levels. Here all levels are available*

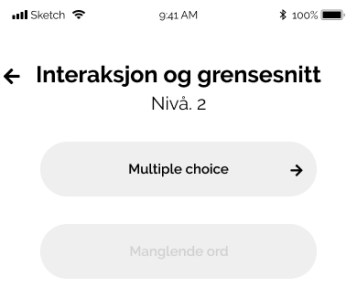

Figure 6-25 *Overview of rounds*

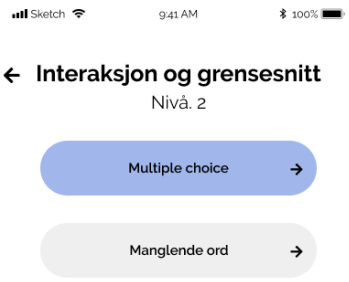

Figure 6-26 *Overview of rounds. Here all levels are available.*

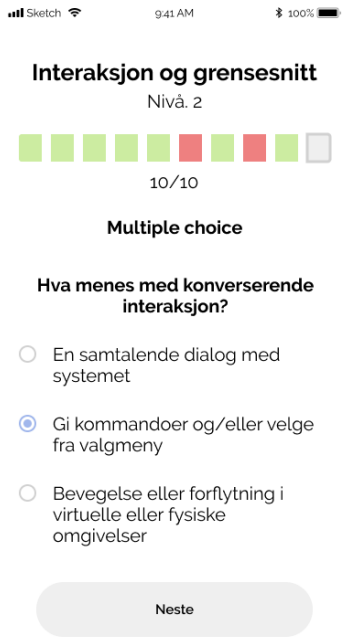

Figure 6-27 *Example of multiple-choice tasks*

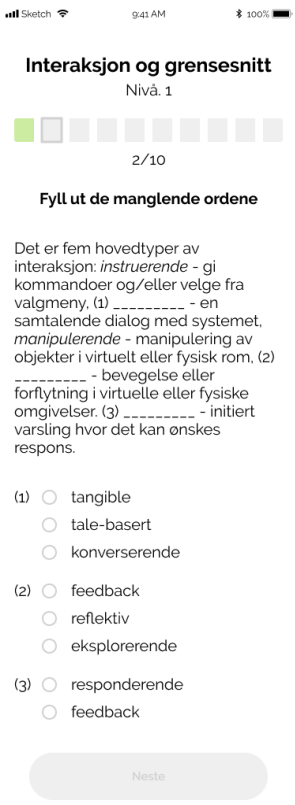

Figure 6-28 *Example of Level 1 - fill in the words task*

Figure 6-29 *Example of Level 1 - fill in the words task with words filled in*

Figure 6-30 *Example of Level 2 - fill in the words task*

Figure 6-31 *Example of Level 2 - fill in the words task with words filled in*

Figure 6-32 *Example of Level 3 - Keywords task*

Figure 6-33 *Example of Level 3 - Keywords task with words filled in*

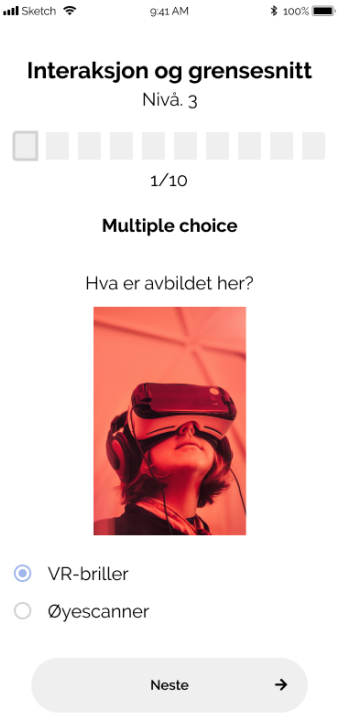

Figure 6-34 *Example of multiple-choice task in Level 3*

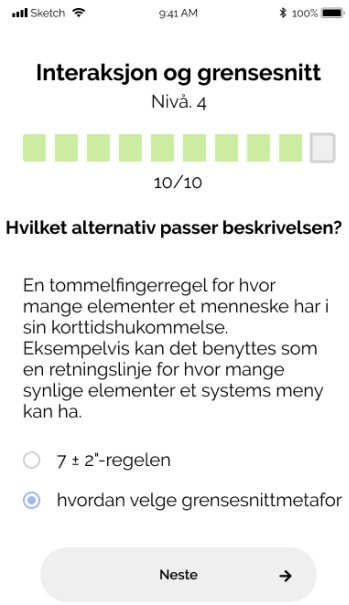

Figure 6-35 *Example of Level 4 - two alternative tasks*

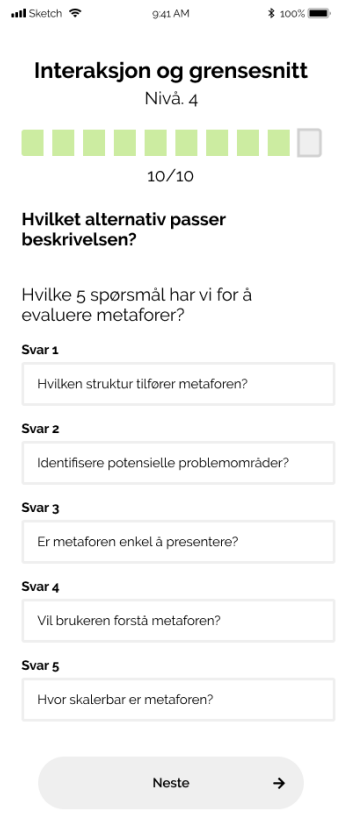

Figure 6-36 *Example of Level 4 - short answer question*

Figure 6-37 *Example of Level 5 long answer question*

Figure 6-38 *Example of Level 6 long answer question*

Figure 6-39 *Example of feedback for level 1*

Figure 6-40 *Example of level 2 feedback*

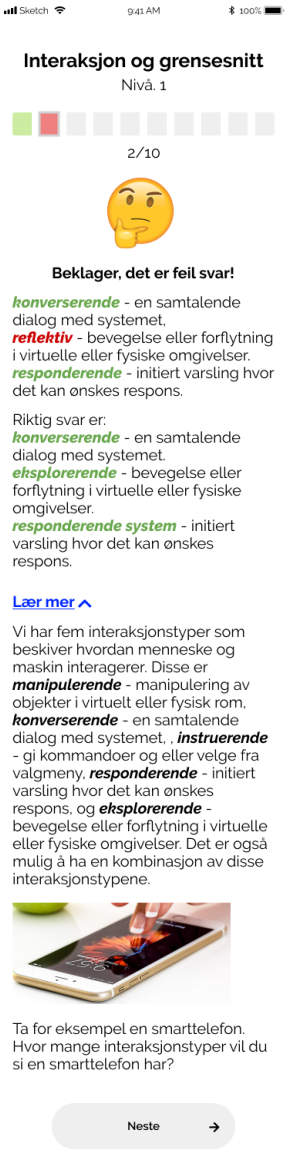

Figure 6-41 *Example of level 1 feedback with "learn more" expanded*

Figure 6-42 *Example of level 3 feedback for keywords*

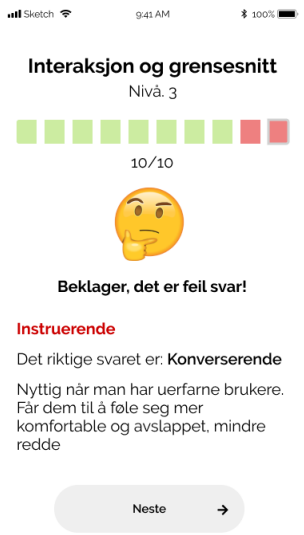

Figure 6-43 *Example of level 3 feedback for multiple choice*

Figure 6-44 *Example of level 4 feedback for short answer*

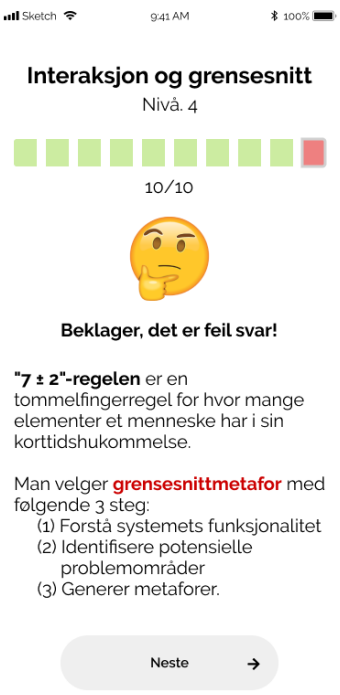

Figure 6-45 *Example of level 4 feedback for two alternative questions*

Figure 6-46 *Example of feedback for level 5*

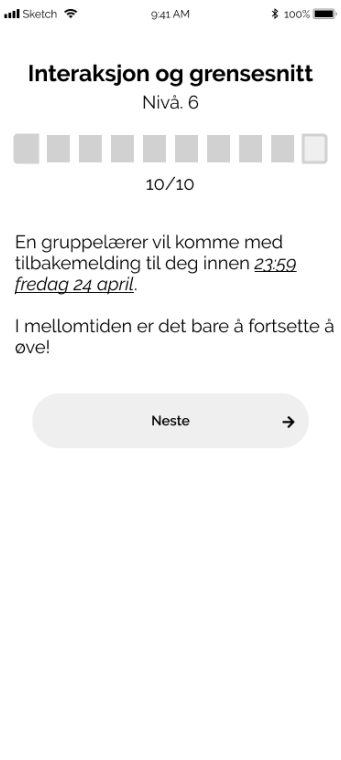

Figure 6-47 *System feedback for group teacher feedback*

Figure 6-48 *Example of system feedbacks after a successful round*

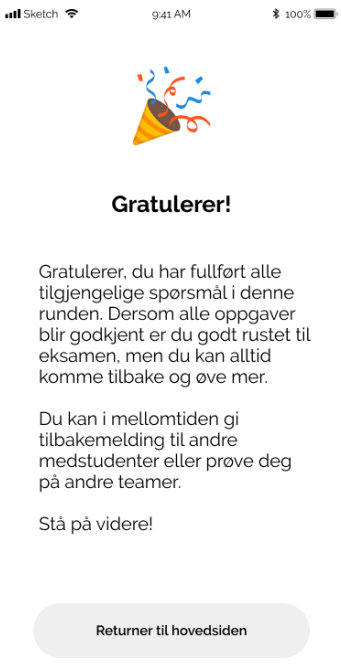

Figure 6-49 *Example of system feedbacks after a successful level*

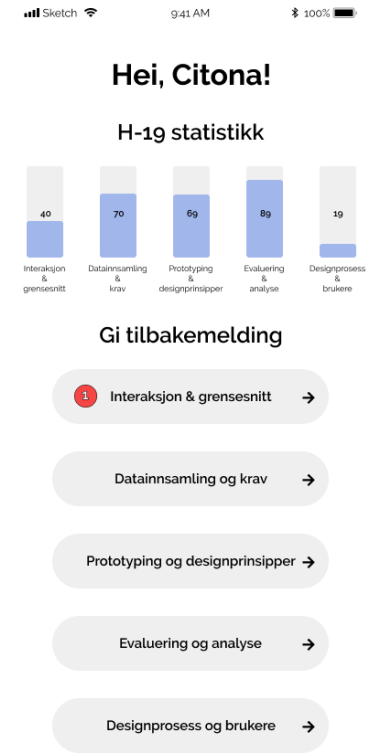

Figure 6-50 *The group teacher landing page*

Figure 6-51 *The group teacher inbox for giving feedback to students*

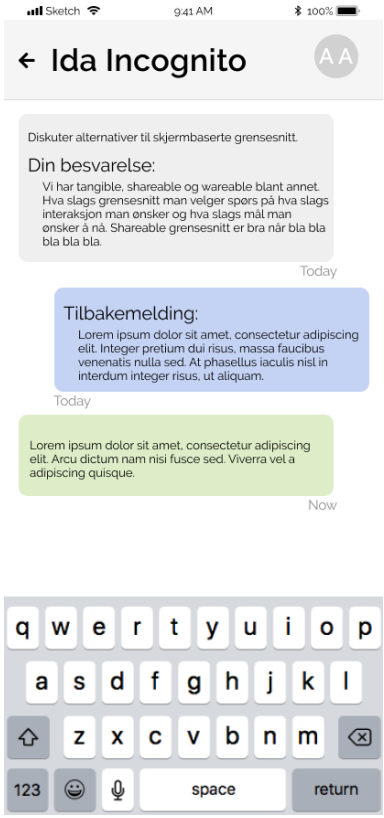

Figure 6-52 *The message exchange between a group teacher/peer and student.*

6.4.5 Fourth Version of the Prototype

The fourth prototype builds on the previous version with new features. In this version, we focused on adding more of the social constructivist learning elements in the application, adding more to the feedback section of the application and improving existing features. The new functionalities in this version are (1) different level 5 tasks, (2) a 'helper', a 'reading list' and a 'terms/concept list', (3) better feedbacks between rounds and levels, and lastly (4) added informative screens. Just as the previous version, these new functionalities help the user to actively engage in their learning through scaffolding, gamification and collaborative learning. Also, we did some GUI changes which were colour of the progress bar on level 6, new names for the rounds and levels, and lastly, we changed the design of the inbox and added a user profile icon.

After feedback from our user test, we decided to change the format of level five tasks long answer questions which is corrected by group teachers and add a category consisting of a mix of other categories. The new level 5 format requires the user to write long and immersive answers, to show the group teacher that they understand the subject before they get to level up. The category of mixed questions was suggested several times during our user test. The participants wanted an opportunity to test their knowledge of the entire curriculum, just as one will be in an exam. We added this functionality, as shown in Figure 6-54. To build further on the ZPD aspect of the prototype, we decided that we could implement a 'helper' which will be available inside the rounds in levels one to four (an example is shown in Figure 6-53). This 'helper' tells the user where to find information about the task at hand, and if they wish, they can add the reading to their 'reading list' so they can read it later. Additionally, the user can choose to add new terms into a list of terms and concepts in the application. This future becomes like a reference book for the students, which they fill in with their explanation and examples.

Feedbacks between rounds and levels were changed, giving the user more information about why they passed/failed the level (Figures 6-63 and 6-64). The screen has a barometer showing how well the round went for the user. The colour of the barometer, in addition to the textual information, tells the user if that were enough to pass the round or not. Also, if the user does not pass the round, the reading list is updated with reading material for the subjects the user failed at. We changed the feedback format for level 5 (Figures 6-62 and 6-63). The buttons for entering one round turns green and yellow based on if one passes or fails the round (Figure 6-58). Also, we added encouraging illustrations. To improve the user experience, we added informative screens before the home page and before each round started (Figures 6-54 and 6-59). The informative text before the home page, explains the purpose and the new functionality, the 'helper'. This information explained the learning outcome of the application.

On the landing page, we changed the inbox icon to a profile icon, signalling, where the student could find profile-specific content (Figure 6-54). For the inbox GUI, we changed the icons beside the sender's

name to signal whether it was a peer or group teacher feedback (Figure 6-55) and changed the GUI for the chat so it shows clearly who the message is from (Figure 6-56). Another GUI change in this version was to add more description to the levels, as the user test participants did not fully understand the meaning of the level names in the previous version, shown in Figure 6-57. Lastly, the progress bar colour of level 6 for finished tasks was changed to blue (Figure 6-61).

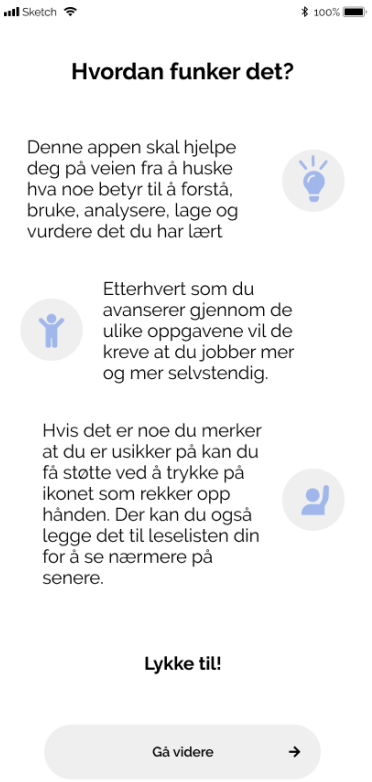

Figure 6-53 *Welcoming information screen for new users of the application.*

Figure 6-54 *The new landing page for the student user.*

Figure 6-55 *New inboxes GUI differentiating messages from peers and teachers.*

Figure 6-57 *New GUI for levels.*

Figure 6-56 *New and improved GUI for the chat interface.*

Figure 6-58 *New GUI for rounds with colours.*

Figure 6-59 *Information screen before each round.*

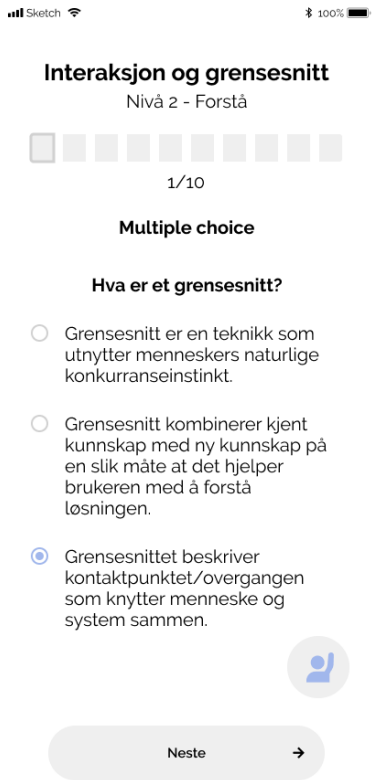

Figure 6-60 *An example of a task with the 'helper' in the right corner.*

Figure 6-61 *New GUI for the level 6 progress bar.*

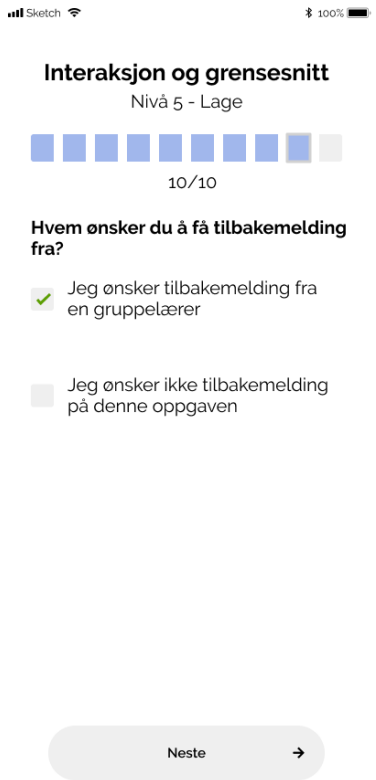

Figure 6-62 *New feedback format for level 5.*

Figure 6-63 *System response to the user choosing group teacher feedback.*

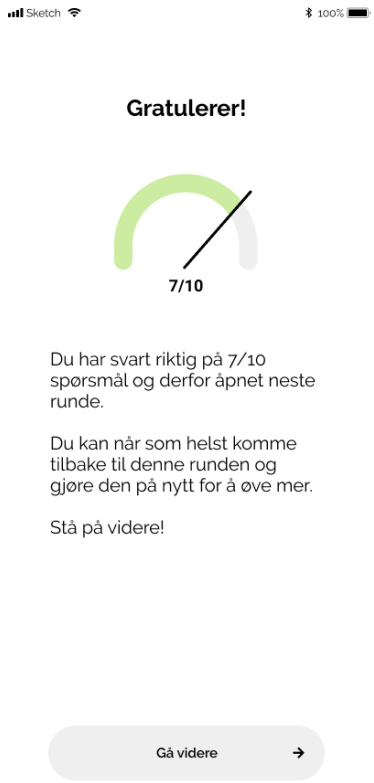

Figure 6-64 *Example of barometer after a successful round.*

Figure 6-65 *Example of barometer after an unsuccessful round.*

6.4.6 The Final Version of the Prototype

The final version of the prototype consisted of changing the GUI to make content more readable and to make clear which content is related to each other. Among these changes was another version of the home page, progress bar for all rounds, additional illustration, and lastly more defined colours on every element.

This version of the home page and information pages have more defined lines between header and content sections, as well as sharper colour contrast (Figures 6-66 and 6-67). These changes consisted of defined lines between header and content Section, sharper colour contrast and larger progress bar. The reading list and terms/concept list is moved from the user profile menu and down under 'Practice'. The practice category consists of all the course-related subjects, which were on the home page in the previous version.

We changed the profile icon to an email icon, signalling that this is the inbox for where feedbacks will be received. When the user has an unread message in the inbox, there is a red notification bubble on the icon, and inside the inbox the messages are clearly marked as new as there were some confusion around the previous GUI (Figure 6-68).

When the user has new reading items or concepts, the reading list and terms/concept list has a blue version of the notification bubble. Also, when inside either the reading list or terms/concept list, each new item is marked with a 'new'-tag (Figures 6-69 and 6-71). Figures 6-70 is an example of how the user can add terms and concepts to their list by adding description and pictures of the term.

As there where some confusion with the previous progress bar, we changed in order to show more clearly where the user was, how much they had left and how well they had performed previously (Figure 6-72). We moved the feedback choice of level 5 and 6 to the beginning of the round, as some of the participants

felt the previous version were repetitive (Figures 6-72 and 6-74). Finally, we added a celebratory emoji inside successful barometers, as shown in Figure 6-75.

Figure 6-66 *Improved contrast for the information page*

Figure 6-67 *New GUI for the student landing page.*

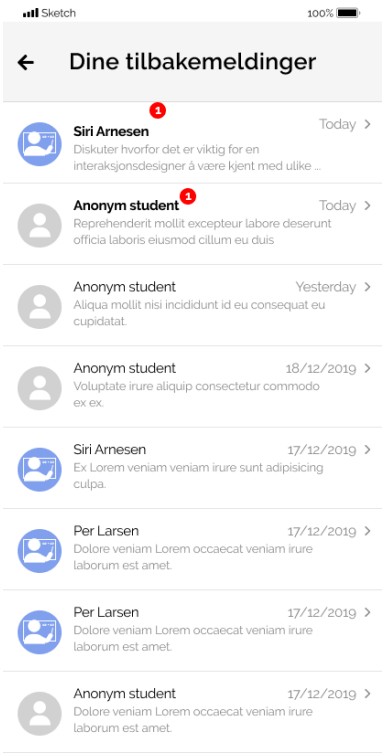

Figure 6-68 *New GUI for Inbox, which shows new messages.*

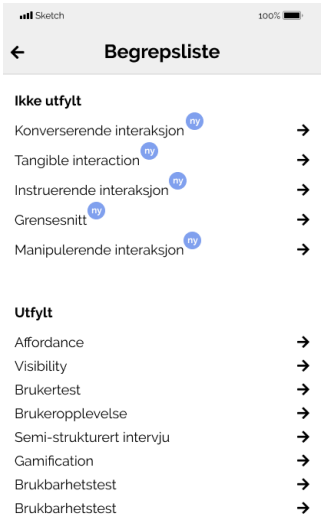

Figure 6-69 *List of terms and concept the user has been introduced to.*

Figure 6-70 *Interface for describing term/concept.*

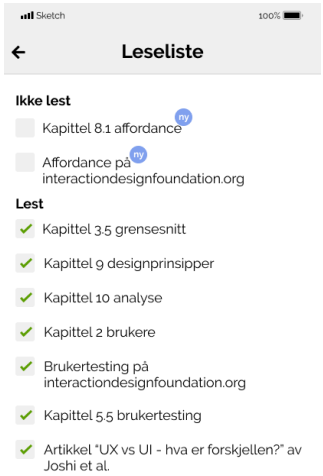

Figure 6-71 *The reading list.*

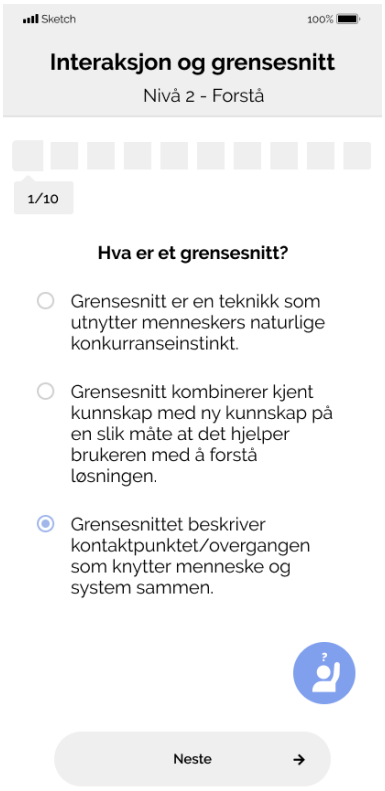

Figure 6-72 *Example of a task with the new progress bar.*

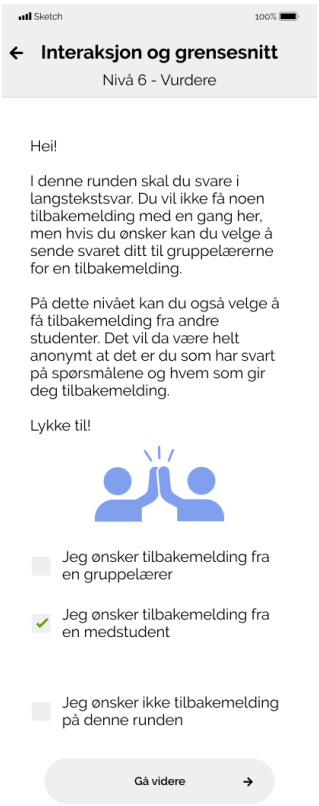

Figure 6-74 *New information screen before level 6 rounds.*

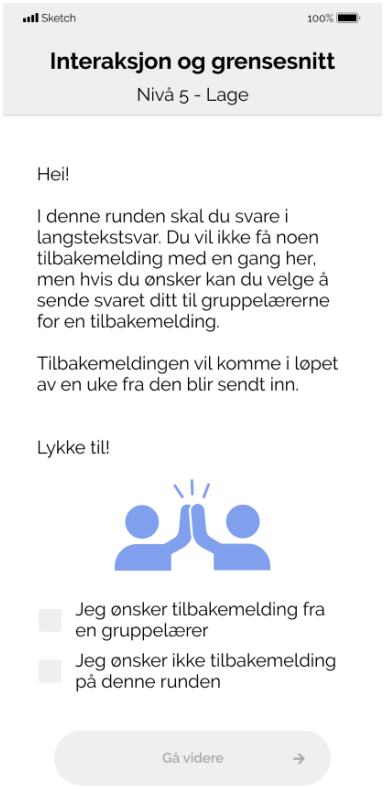

Figure 6-73 *New information screen before level 5 rounds.*

Figure 6-75 *New barometer for the successful rounds/levels.*

6.4.7 Summary of the Prototype Phase

As we round up this phase of our DT process, we encountered these four recurring themes:

- Make information and illustration from the application consistent and clear.
    - The progress bar and performance graph must show the user how they relate to the round and generally to the subject, respectively.
    - The use of emojis and barometer both motivates the user and make it clear how the round went.
    - For the buttons to make sense for the user, the names needed to be reflecting the content which they lead the user to.
- Elements of gamification are motivational. However too much gamification can lead to change of focus from learning to winning. Either way it engages the student to use the application.
- Automated feedback from the application and feedbacks from peers and group teachers should clearly state the right answer, the answer given by the user and were to learn more regardless of how advanced the user have come.
- Directing the focus of the application to help students prepare for the exam makes the application stand out and more desirable to use.

The themes of this phase are closely linked to the learnings and intermediate results of the testing phase, which we will be presented in the next section.

6.5 Phase 5 – Test

In this section, we will present our report for each user test iteration. These reports are based on the user's evaluation of the prototype. For each iteration, we will present a summary of the feedback we received from our participants and based on the evaluation; we will present the actions for the next prototype version.

6.5.1 Test of the First Iteration – is the purpose of the concept transparent?

The goal of this iteration was for the participants to evaluate the concept to see if whether the concept was clear or needed more defining.

Summary of Feedback from the Participants

The purpose of the application was evident as everyone understood it was meant to help the students learn the relevant curriculum. One participant also noted that they thought the purpose of the application was to measure how much knowledge one has in each subject of the curriculum.

The quiz in this iteration was thought to be a nice, simple, and relevant task for exam preparations, but the participants would like other types of questions in addition to this. One participant pointed out that the true/false aspect makes one focus and read the text more closely before answering to make sure one has not misunderstood the question. When regarding the length of the quiz, participants had different opinions on how long it should be. One participant said between 25-30 depending on the task, while another said 10. The third participants suggested an infinite scrolling effect like Instagram's explore page, where the user is just mindlessly captured by the application and just keeps going and going until they get tired and can then leave whenever they want. Another suggestion was exploring having different modes available for the student. Making it possible for them to choose "test yourself in the questions you have most answered wrong in the past" as well as the regular test.

The participants liked both the celebratory emoji and the thinking emoji in the feedback they received from the application. The feedback text was viewed as relevant, but too long, and the participant would prefer to have the choice of reading more if they are intrigued. A participant suggested that we rephrased the feedbacks for wrong answered questions to ensure that the user does indeed read the feedback. The reflective question in the feedback was believed by participants to be a good solution for reflection and an opportunity for students to learn more. Lastly, one of the participants mentioned that the visual representation in the feedback made it easier for them to remember the content.

They were positive to the concept, as the application would require less work than a regular flashcard application and that the application showed the student's progress using diagrams, making it easier for the students to know their strength and weaknesses in the course. Otherwise, they did not believe the concept stood out from other flash-card applications. The participants believed that maintaining an application like this for a course could be very demanding.

Actions for the Next Iteration

Based on the user evaluation summarised above, we will, for the next iteration, show more aspects of the concept in order to define its purpose even further. This evaluation has shown that the target group are positive to such an application as the participants were curious to learn more about the concept. We also needed to rephrase the questions that were answered wrong to ensure that the user did not merely get used to the specific way the question is phrased, but that they read the feedback properly. Also, we

have found a suitable number of questions to answer for each round and also shorten the feedback. We did this to make sure the students are engaged with the application but not overwhelmed by the number of questions.

6.5.2 Test of the Second Iteration – is the concept clear and useful?

The goal of this iteration, like the last one, was for the participants to evaluate the concept to see if whether the concept was clear or needed more defining. Also, we wished to see if the participants found the concept useful for their learning.

Summary of Feedback from the Participants

Just as in the previous iteration, participants in this iteration understood the purpose of the application. Much of the focus was on the application being a supplement method for learning, with a few seeing that it also facilitates reflection and repetition. One of the participants also mentioned that they assumed the purpose of the application was to repeat the terms after they are introduced in a lecture. Another one also pointed out that the purpose is to show the user's progress in the course, thus helping one with knowing what one knows and what one does not know.

All the participants say they would probably use the application for repetition before an exam, while some also would use it to test their knowledge and progress during the semester as well. One of the participants mentioned that they would probably not correct other students' answers as they view this as a group teachers' job. One also mentioned that they think this is an appropriate way to practice for the exam in the design course being as learning the different terms is very relevant for the exam.

The quiz aspect of the application was what they saw as most useful and what would draw them towards the application in addition to the thorough feedback. One participant did not understand that the type of task depends on the level one is at. They thought the tasks were different depending on the theme one was practising. Another participant understood the need for both type of tasks but was clear in stating that they would prefer the more quiz-like questions. For the true/false questions, several participants mentioned that they liked the "learn more" button being as they could choose whether to read more or not. They also appreciated that the feedback is more extensive than just a "correct" or "wrong" answer, but that it might be annoying if the same long feedback shows up every time one answers the same question. The participants clarified that more informative feedback would mean that they would learn even more knowing why they were right or wrong, but that this feedback should not be too time-consuming to read. For the long answer questions, two of the participants were sceptical of choosing to receive feedback from other students as they know they would not bother to give feedback to others. They would, therefore, prefer to receive feedback from a group teacher. One of the participants, who

have been a group teacher in the subject mentioned that as a student they would have probably thought that writing a long-form answer was boring, but as a group teacher, they see the value of it because they know it makes for better learning.

The feedback methods were, in general, received well, and one of the participants felt this made the application differ from other applications. For the true/false questions, the participants were positive to the length and the information given in these feedbacks. One participant wished more visual representation in the feedback. The participants felt that the feedback was helpful in order to learn more, and the emojis made sense. One participant also mentions that it would be nice if one could press the "other design principles" and be shown what they are and learn more about them instantaneously if you want to. The "learn more" button is pointed out by several participants as valuable, and they are curious as what will be displayed when you press it. The participants appreciate that one does not have to see all the feedback at once, but that one can choose to learn more if one wants to. For the long answer questions, one participant pointed out that this would require group teachers and peers to give descriptive feedback as "good" and "wrong" would not give anything to the students. Another participant pointed out that the feedback given by peers also needs to be validated, so students do not receive the wrong information. One participant also mentioned that they wish for more predictability for when the feedback would come. They also suggested that maybe one could get some instantaneous feedback like in the true/false task. All participants agreed that the group teacher feedback is useful and that this is what they would use the most. The peer-review function would probably not be used as much, and they would most likely not review their peers. They also pointed out that this would mean much work for the group teachers, but they view the value of feedback from the group teacher as more critical. One participant also pointed out that the group teacher feedback would be a low-threshold service for the students as they do not need to ask for help face-to-face. Finally, the participants were curious about where they would receive feedbacks for the long answer questions; would it be in the application on e-mail or somewhere else?

The participants did not understand that there were levels in the application, and when made aware of the levels, they did not understand how they were intended to function. One of them regarded the colours to show one's progress in that subject. They said that it was motivating to see these colours fill up. The participants were favourable to the concept of levels, as the students could use it to view their position in the subject and their progress. Nevertheless, it had to be made more explicit as none of them fully understood that this feature was available. The levelling up part was also not clear. The group teachers where positive to the idea of levels as this would give them insights into what the students struggle with the most. In other words, the concept of levels makes communication of knowledge easier for both parties.

When asked about the four themes, the participants felt the need for subcategories as the existing categories were too broad. Overall, they agree with the four chosen themes, but the suggestion to merge "Designbegreper" and "Designteori" were made. They were also confused about what type of tasks should be in each of the themes.

To sum up, the participants had some pointers to the next iteration of the prototype. The participants wished for a clear difference between the test and practice mode. Also, they missed reflective tasks in the application, as well as making it possible to interact with the diagrams in order to see more details over their progress. Finally, one participant pointed that if using the application was a mandatory part of the course they would be more likely to use it, but as it is an additional voluntary way of learning they would prefer to use their methods; using pen and paper to memorise the curriculum.

Actions for the Next Iteration

Based on the user evaluation, in the next iteration we categorised the questions differently, as well as clarified the purpose of the application even further by changing the levels. Also, we needed to show how the "learn more" functionality was of use to the students by adding an example of its content, as the participants of this iteration were curious. Thirdly, some of the participants did not fully understand the purpose of the long answer feedbacks, and therefore, we explained further the purpose of the long answer questions and how it works to clarify this in the next iterations. Lastly, we tried a way to make the application more attractive for the students to use, as some of the participants did not believe they would use at it was voluntary to use.

In addition to existing functionalities, for the next iteration, we will implement a few new functionalities that we believe will improve the concept as the participants will view these new functionalities as helpful and usefulness. The first will be creating an "inbox" where feedback on tasks is stored. This way, the group teacher will know what to give feedback on, and the communication between the teacher and the student will flow more freely. A second functionality we will need to add is the group teacher view of the application. The functionality will give the group teachers an understanding of what is expected of them in the application, and to test whether this is useful for both parties. A third new functionality will be adding discussion tasks to the application and figuring out an excellent way to facilitate collaborative learning in this kind of tasks.

6.5.3 Test of the Third Iteration – is the concept useful and does it meet the user's need?

As our concept was evaluated and the participants in the previous tests found the concept to be clear, we wished to test the usefulness of the concept further. The goal was for our participants to evaluate the usefulness of our concept: the feedbacks, tasks, levels, and information it consisted.

Summary of Feedback from the Participants

The application was well received by the participants, especially the group teacher feedback option. The participants managed to navigate effortlessly between the levels and rounds and found the different tasks useful and fun.

> *"I feel like this is more of a 'how much do you remember' app rather than a 'learn new things' app. It shows where you have holes in your knowledge." (Group teacher #4)*

> *"Is this a concept that you will be launching?" (Student #19)*

The participants agreed that the application was more a place for repetition, reflection and be aware of their strengths and weaknesses in the course, rather than learning the curriculum from the application. Therefore, the application would be preferably used in the middle towards the end of the semester, not in the beginning of the semester.

> *"I feel like I am learning now, that is nice" (Student #15)*

One participant pointed out that the smartphone application would be useful for practising in different context and locations including those one would normally not associate with such activity, for example on the bus or tanning in a park. The same participant said that as the tasks will be created by the same people who will create the final exam, the statistics in the application will give a more realistic expectation to one's academic understanding before the exam. Another said it would be excellent for filling downtime in group lectures, in addition to being a term and concept encyclopaedia. Besides, the participants missed a category consisting of a mix of all the questions:

> *"A category with a mixture of all the questions, just like a [mock] exam would help me prepare for an exam even further." (Student #18)*

> *"A mixture of all the questions would be nice! I would definitely use that category before an exam." (Student #15).*

The participants believed that this application would be more useful for the repetition and reflection part of their learning process. As the application promoted the students to recall information, discuss and justify their understanding of the concept. Our participants found the feedback and communication feature with a group teacher as the essential part of the application and the future that made it stand out. Also, the feedback types were well received. One participant said they would wish for functionality to ask a question related to a specific task in addition to the existing functionalities, arguing it would improve their learning even further. The feedbacks between each round were viewed as less useful, as they did not read it properly, and it did not give them new information. One participant found it confusing as the feedbacks between rounds, and the feedbacks between level-ups were similar. The "learn more" functionality was viewed as useful for their understanding of why they gave the correct or wrong answer. They especially liked the use of colours to mark which aspect of their answer was right or wrong and that the right answer presented in full below. The explanation is given in the "learn more" functionality help them find and gain more information regarding the concept at hand. In other words, it enables more engagement with their learning as they are provided with a source of information.

> *"I like the different types of questions. It forces me to think differently in order to solve the tasks at hand." (Student #19)*

The levels in the application were not noticeable to the participants as they were more focused on other aspects of the application. One participant suggested we change the names for each level to one that would give the user a better understanding of what kind of tasks would be in the level, e.g. "Level 1: Recall facts and basic concepts", or perhaps give the user a message such as "If you answer this correctly, you will be unlocking the picture tasks". Another participant pointed out that they noticed the tasks required more and more independent thinking. The participants had different perspectives on the different tasks; some appreciated the multiple-choice questions others preferred the fill-in-the-words tasks. All of the participants were positive to the picture tasks and the discussion tasks:

> *"This [talking about the picture question] is fun!" (Student #15)*

> *"I would prefer more of the 'think by yourself' questions, such as the discussion tasks. I feel like I learn more from those than the multiple-choice questions." (Student #19)*

One of the participants pointed out that the lecturer advised the students at the beginning of the semester to create a word document with a summary of all the various course concepts and terms, but keeping this document updated and structured was difficult. As such, this application would be a right place for such an overview.

We wished to add push notifications to the user in the next iteration and asked our participants when and if they felt that notifications would be appropriate and not annoying. The participants believed that the only time they would like a notification was when they received feedback from a group teacher or peer. Otherwise, they would prefer as little notification as possible. Overall, the participant seemed to be very satisfied with the application, and they wished it existed when they attended the design course.

Actions for the Next Iteration

For the next iteration, we changed four GUI elements in the application as a result of the user evaluation. First, the progress bar on level six will needed to be revisited. One of the participants felt it was too grey and not much motivation to continue the interaction on level six. Therefore, we added more colour to that level. Second, the blue colour on the finished or visited rounds in the application made it a bit confusing for the participants. Therefore, the colour of the buttons was changed for the next according to how well the round went, e.g. green button for successful rounds, a yellow button for less successful rounds and orange buttons for failed rounds. Third, in order to make the levels more distinct and give the user a sense of what is expected of them added a description to the level names, e.g. "Level 5 – Evaluate". Fourth, to show the relationship between the levels and the statistics on the home page, we changed the layout of the statistic. This made the user's progress more visible. Finally, for the feedbacks in between the rounds and levels, we changed the layout and texts so that they give some value and preferably motivates the user to continue using the application.

In addition to the minor GUI changes, we changed a few of the functionalities in the prototype. One of the new functionalities was the ability to change the feedback and task format for level five tasks. The level five tasks needed to be explained and clarified further, and the tasks at this level also needed feedbacks from a group teacher. As the tasks in this level are long answers questions consisting of a short answer and a longer answer arguing why the short answer is correct, the participants found that personal feedback from a group teacher much more useful rather than general feedback based on the short answer. We also added a peer-review option to the level six feedback choices, as this is also a more personal feedback format and maybe less scary as it is from a peer. Also, the participants felt that the "learn more" option should be available on all levels as it would help them become even better at the subject. With these changes, we can facilitate collaborative learning and active learning, increasing their learning outcome and making the scaffolding aspect of learning more available. We will, in the next iteration, implement two new elements to the application based on the user evaluation:

- A term and concept overview in the application based on requests from our participants.

- A category which contains a mix of all the tasks types and categories.

6.5.4 Test of the Fourth Iteration – how are the interaction and graphical design perceived?

For the fourth iteration, the participants were instructed to evaluate the interaction and graphical design. The goal of this iteration was to get data to improve the interface aspect of our concept, as the concept itself was transparent, useful and well-liked in the previous user tests.

Summary of Feedback From the Participants

The information text which the participants are greeted with the first time they open the prototype intrigued them, but as they also pointed out, the text was a bit too long. Overall, the participants were delighted with the visual hierarchy in the application, as they could always find wherein the application they were. However, there was some confusion around the progress bar inside the rounds. The participants also suggested stronger colours on the buttons and more defined hierarchy between content on the home page and on inside the rounds. The participants were carefully reading each rounds title, naming these titles has to be carefully chosen as it is essential for their understanding and expectation before each round.

The participants understood the purpose of the performance graph, as they saw that the different bars represented the progress in each subject. One of the participants exclaimed:

> *"Damn, it looks like I am really good at prototype and design principles" (Student #14)*

The graph was well-received, however, there were some confusion in the beginning as to what the text on the X-axis meant. Another problem with the graph was the gradient colour, which made it difficult for the participants to see the lightest blue colour. One of the participants suggested different colours for each subject in order to visually show the relationship between the performance graph and the subjects better.

Although we focused mostly on the interaction and design of the application, we also received more feedback on the different task types. Firstly, one of the participants liked the 'match concept' task on level 3 as this required the students to recollect information and not just recognise it, while the other did not quite understand the task. Second, both participants agreed that writing long texted answers and discussions using a smartphone is awkward and clumsy. One of the participants suggested creating a browser version of the application as a solution. The readability of some questions was also a challenge,

especially the "fill in words" task on level 2. This resulted in confusion as to where they were supposed to write their answer. Also, the feedback format for the "fill in the words" task on level 2 were confusing to the participants as there was too much information for them at one page. Another issue with the "fill in the words" tasks and short answer questions, was that a user could fail if they did not give the correct answer word for word. This would lead to the user becoming less motivated and frustrated when using the application. One of the participants suggested adding examples, such as illustrations, to the level 3 questions to help the user towards the right answer. The participants recognised the questions as they are from the previous exam and believed this would help the user to prepare and get used to the way questions are asked in the exam. Lastly, one of the participants felt it was unnecessary with the title 'multiple choice' as the question format is very familiar.

In between rounds, the user receives an information screen which tells them how the last round went and whether they have passed it or not. The participants felt this was a right way of summarising the user's achievements in the round, but felt it needed to state which part the round the user failed on and where to find more information for rounds that did not give the user 10/10. Another point made by the participants was that requiring the user to answer a minimum of 7 out of 10 questions might be unmotivating and maybe move the focus from learning the curriculum to just pass the rounds without fully understanding the content.

In the feedback users receive after answering a question, they especially liked the different colours to indicate which part of their answer was wrong/right and if relevant what the right answer would be. There were some drawbacks to the phrasing of the feedback; an example is feedback for questions related to the five interaction types as this feedback has much text and the presentation of information in 'learn more' is confusing. Another drawback is the inconsistency in the way we have presented the feedback; some words are bolded out others in italic and the use of bold green, red and black text. For instance, feedback to the level four was we use bold black to show the right answer to the question and bold red for the question the user had given as it was wrong. The user expected the right answer to be green. We did receive a positive response to the feedback types on level 5 and level 6. The participants were pleased that their answers had an estimated time until they received feedback from the group teachers. They also liked the fact that they on level 6 could get feedback from both teacher and student. One participant suggested that we add an information screen before the user starts the round, prompting them to choose whether they want feedback on this round or not, and if so whom. This will make it even more apparent to the user that on these levels, they will receive feedback from humans, not machines, and the user will only need to choose once for the whole round. As the user advances to level 5, the participants wondered whether it is the group teacher that decides if the user can level up or that the user automatically levels up after answering and receiving feedbacks regardless of the results of the feedback.

As the 'learn more' function and the reference to where to learn more were well received in the previous test, we kept it in this iteration, and the participants in this user test were also very positive to this functionality.

> *"It is very nice that I can choose whether to learn more or not" (Student #14)*
> *"I have experienced that the students appreciate us telling them where to look for more information, so this [referring to the book referral in the feedback] is very useful" (Group teacher #5)*

The reading list, which is a new implementation in this iteration, was well received by both participants. The "concepts and terms" list was also a success. There was some confusion as to what concepts and reading material was added to the lists, which we needed to clarify for the next iteration.

The illustrations we added to create encouragement were well-received by the participants. this created engagement and encouraged the students to keep working. They also appreciated the pictures which they said would help them in connecting the theoretical with the practical. One participant suggested adding animations, and the other suggested adding the celebratory emoji to the information screen between rounds when the user has completed the round successfully. In the user's inbox, the participants wanted a clear difference between messages from peers and group teachers, as well as read and unread messages.

Overall, the participants were delighted with the application and would definitively use it. The application can be used whenever and wherever and works primarily as a replacement for the flashcards they used before the exam as it would be a verified and approved source of information. Both participants focus mainly on the usefulness of this application before an exam, and how the different tasks require different ways of thinking and explaining what one knows. Also, just like our previous participants, these participants were very concerned with the implementation of the application, which can be a result of them being informatics students.

Actions for the Next Iteration

For the next iteration, we implemented some improvements to our prototype based on the feedback from this user test. These changes were:

- Fixing minor typos in the prototype and adding a '*' for the peer-review button so that the relationship between the descriptive text and the button is clear.

- Increase the colour contrasts in the prototype.

In addition to these minor changes, we also worked on clarifying what is added to the reading list and changed the phrasing for the information screen on failed levels and rounds to something more encouraging. For the feedbacks on level 5 and 6 we made it possible for the user to choose whether they wish for feedback or not. This choice will be available to make before the round starts and will apply throughout the round.

6.5.5 Test of the Fifth Iteration – have we created a useful and desirable concept that facilitates scaffolding?

For our final user test, the goal was to re-evaluate the concept with the focus on the usefulness of tasks, levels and information, and the overall interaction and graphical appearance. The participants were to evaluate whether the concept helped facilitate scaffolding.

Summary of Feedback From the Participants

As we began our final user test, we noticed that the participants were pleased with the new welcoming information screen and home page. The performance graph in this iteration was understood, and the two recurring user test participants liked this version of the performance graph better than the previous one. They still use some time to understand the relationship between the performance graph and the categories in the 'practice terms' category.

When we got to the page with levels, the participants did not fully understand that the names for levels were based on Bloom's taxonomy and thought it would be appropriate with an explanation of the names available somewhere in the application. There was some confusion between the difference of one round and a level, until the participants finished the first round and the concept became clear. When we got on the subject of information text between rounds and levels, and the participants agreed that these were useful. One participant missed an additional information screen that informed the user that they had unlocked a level. Another point made by the participants was: the name of the levels did not tell the user what to expect when entering and that in each level, there are different types of tasks waiting for them. Although we did not implement the peer-review, the idea of such functionality was well received by the participants.

> *"Wow! I can become a super student! That is very cool. I like that." (Student #11) when seeing the peer-review button at the bottom of the level screen.*

The information screens before the round start received mixed reactions; one participant did not believe they would read the text after a few times as the text did not change that much before each different round while another participant read the information very carefully each time. The participants were curious about how one advances from level 5 to level 6; is it the group teacher that decides this and what happens when one of the tasks is not approved?

> *"It sucked that I did not pass this round, but I was almost there. I would probably take the round once more and try to pass the round without familiarising myself too much with the subject at hand." (Student #11)*

As the participant went on to try testing the task inside one round, one troubling discovery was made at this point of user testing was that the participant's reaction to not passing one round. The participants focus shifted from testing their knowledge to "winning" the round. One user points out that the type of task for level 1, round 2 feels like it should be a much higher level as he/she feels it requires a much higher degree of understanding in order to solve.

> *"That is fun! That is really fun!" (Student #11)*

The participants find the variation of task types useful and intriguing as this will require the user to think and answer differently on questions about the subject. They also liked that the word they chose in the "fill in words" tasks on level 1 was put in the sentence before they continued to see the answer. Also, the word's corresponding numbers in these tasks were a bit confusing for our participants, and as such, we look into the design of this task. On the questions with longer text, the participants felt it look too messy, and it was difficult to read. Another challenge with the level 1 tasks, is the true/false tasks as the user can guess and have a 50% chance of being right although they do not know the answer. This is also a challenge with the multiple-choice, "two-alternatives" and "match concept" tasks. As they advanced to level 2, the participants noticed that the tasks required more independence from the users, but they appreciated that this level had a similar task as the lower level thus feeling secure as the format is much the same just requiring more independence. One thing the participants felt confusing was the question layout on this particular task, as they expected to fill in just one word for each dotted line just as one does in Hangman. The help button inside the rounds was also well received as this helping hand was more than just a hint to the right answer. When reaching the levels 5 and 6, the participants react negatively to the term "long answer question" as it is an intimidating phrasing for first-year students. Also, the participants did not believe that the users would bother to write very long answers on their phone as this can be perceived as cumbersome:

> *"Oh, I do not want to write a long answer on my phone. Especially when there is ten of them!" (Group teacher #1)*

"Oh, I would probably not bother to write long answers on my phone" (Student #11)

"Long answer questions are not as convenient as multiple-choice questions" (Group teacher #2)

One of the group teacher participants suggested adding a description telling the user how many words was required for the long answer questions. The participants also assumed the topics follow the design course's semester plan with helpful and exam-oriented tasks. Although this was not stated anywhere in the application or by us, but rather something the participants in this iteration and previous ones have assumed, this is something one should look into closer when creating such an application. The participants like that the questions were formulated like exam questions as this would make the user more familiar with the exam language. However, the user must not believe that finishing these levels in all the subjects will automatically qualify them for an A. The participants also appreciated that they could choose whether to receive feedback from a group teacher on level 5 or not and on level 6, choose between group teacher feedback, peer-review or none. The participants had the following to say about the feedback on passed/failed tasks:

"You actually learn something when you fail the question" (Group teacher #2)

"I like how I can choose to learn more even when I passed the question" (Student #11)

"The feedbacks make it clear all the way what is important and how to improve oneself." (Group teacher #1)

They also liked the bold, coloured text indicating right/correct (green) and wrong (red) answers. The group teacher participants were concerned that first-year students might not take full advantage of the peer-review functionality as they are young and on unfamiliar territory. They did, however, believe that it helped with the anonymisation of users. The feedbacks given with examples were also received positively, as it helps the user to remember the facts presented to them. They liked receiving an immediate response, instead of waiting until the end of one round to view their progress. Some of the feedback text could become very long and difficult to read, and the participants emphasised the importance of formulating understandable feedback. Consistency in the feedback format was also preferred as this implementation of the prototype did not have it; for example, some 'learn more' texts referred to sources in the curriculum while others did not. The participants were sceptical to the feedback text exclaiming they were well prepared for the final exam as this would lead to false expectations. Another textual change they would like for the feedbacks were for when the user gets 10 out of 10

questions right; they would like the feedback here to be more encouraging than the feedback text for rounds that they passed but did not get full marks on.

The "learn more" button and its contents are again pointed out as very helpful as they can choose to learn more right away instead of having to remember to look it up later on. Although, in order for the text in to be useful it has to be easy to read, with essential words highlighted, and also shortly state why the user got the answer wrong if they answered incorrectly. The images with real-world examples help to anchor the knowledge in real life, which helps their understanding further. Although the images need to be useful, preferably and example from the real world, otherwise it will just be confusing. The reflective question at the end also helps to encourage individual thinking and reflection. The question needs to be phrased so that they understand that it is not something one has to know or something that has a set answer, but its purpose is to make one think and engage in one's learning. The reference to chapters in the textbook is appreciated as it encourages the students to read the curriculum. The sources presented in the application from outside the curriculum, must be stated as approved by the lecturer.

> *"I like this [reading list]!" (Student #11)*

The reading list is first introduced to the participants in this prototype when they click on the help button inside one round. The participants seem to like this feature very well, but the automatic addition of reading material based on the student's performance in one round was not liked. One of the participants said the following regarding terms being automatically added to the reading list:

> *"It [the reading list] does not feel like it is my own. [...] It should be stated something in terms of 'the application suggest you read....'." (Student #11)*

The same participant added that if it is possible to add reading material manually as well, then it should be stated clearly in the reading list which item is added by the application and which is added by the user. In addition to this clarification, the participants felt there should be more explanatory text in the reading list. The participants like the different sources the reading list have, such as books, web pages, articles etc. One of the participants suggested adding a 'add to reading list' button inside the 'learn more' section when book chapters are mentioned.

The participants liked the list of concepts and terms as they are as students of the design course encouraged to create such a list for the semester. How this list was updated was unclear to the participants as we had not implemented that in the prototype. Therefore, there is a need for an explanatory text on this list as well. The participants suggested it could follow the course lectures, adding

terms and concept from that lecture automatically, or as they are introduced to these terms and concept through the tasks in the application. Another element that made this list confusing for the participants was the purpose of the 'new' tag on terms and concepts, where which one participant said:

> *"Ah, so it is like I am collecting terms and concepts. That is very cool, especially for this course! I especially like the functionality that allows one to add a photo which describes the term." (Student #11)*

This user test, like the previous ones, emphasised the importance of text and illustrations in such an application. Text and illustrations that encourage are essential and appreciated. The participants reacted joyfully upon seeing the celebratory emoji and the high five illustrations, stating:

> *"It feels like someone is cheering on me!" (Student #11)*

However, as the participants interact with the prototype and see this high-fiving illustration, they do no longer see the meaning of it, as it comes before and after finishing one round. Therefore, the meaning behind the high five goes from being encouraging to be ignored as it is always there.

The new design of the inbox was well-received as the students could separate the group teacher feedbacks from their peers. The participants wished the messages were titled with the task they had completed and not the person who had given them feedback, as they could receive feedback from the same person on different tasks and making it difficult to find the message one was looking for. Nevertheless, the participants found this functionality to be both useful for the users to create a bond with fellow students and to reach a group teacher and ask for help less demanding.

In addition to the student view of the application, we showed the group teachers the group teacher view. The participants suggested three changes to this view, and these were:

- Changing the graph in to show which subject they had given most feedback for rather than how the students did it in each subject.
- Make it possible for group teacher to 'lock' the conversation so that the student cannot continue texting the group teacher long after they have received feedback and answered relevant questions to the feedback.
- Show how the different tasks are divided among the group teachers. Does the group teacher choose them or is it automatically assigned to a specific group teacher?

Overall, this is an application all participants, in this user test and in the previous test, believe is useful and necessary. They are favourable to all the functionalities in the application as it helps the student to learn in different ways, with some concerns of implementation. However, gamification can overshadow the purpose of the application, which is learning.

6.5.6 Summary of the Test Phase

As we round up the final phase of our DT process, we will now summaries the learnings and intermediate results from this phase and the previous one.

Through our five iterations we found that for the long answer questions, the participants wanted feedback from a human more capable peer rather than the application itself. Also, feedbacks from group teacher in the application allowed a low threshold communication between the group teachers and the students. For the user's understanding of why they passed/failed a task. we learned that feedback is essential.

The "learn more" function helps the user learn more and therefore be more prepared for the exam. The participants also liked that it referred to a chapter/page where they could read more on the subject.
The reflective questions at the end of the "learn more" were great opportunities for the user to apply theoretical knowledge into practical use, thus gaining a deeper understanding of the subject. As the application will be managed by the course instructor and the group teachers, the participants felt that the information in the application was trustworthy. Additionally, the design students are encouraged to create a "terms and concepts"-list as it will help them to prepare for the exam, as such, functionality that supports the students in their preparation for the exam is essential. We implemented a "terms and concepts"-list to meet their needs.

Gamification is essential for the student's motivation. However, the focus might shift from engaging with the application in order to learn to focus on 'winning' and levelling up mainly. Also, Implementation of all six levels of Bloom's taxonomy has shown to be a positive aspect of the application, as the participants felt it was similar to the exams and therefore, more motivated to use it.

How information is presented to the user is essential for their engagement and understanding of system responses. Our automated feedbacks consisted of colour-coded and styled text to clarify how the task went. Also, we used emojis to encourage and motivate users as they progressed in the application.

Participants found the performance graph and the progress bar to support their understanding of how they were doing in the subject and task. This gave a visualisation of their learning, which in return helped them reflect over their learning process.

7 Analysis and Findings

This chapter presents our analysis from our DT process. We begin by thematically analysing our findings to identify recurring themes in our research before we present the results in the light of our theoretical framework from Chapter 3. We did this to connect the intermediate results of our testing phase to the previously collected data, in order to consider when to implement social constructivist learning elements into a technology artefact to promote scaffolding. We will use this to later propose some principles/considerations for designing learning technology.

When it became clear what themes were relevant throughout the entire research process, we compared the themes to our theoretical framework from Section 3 to find out how they relate to the literature in order to make principles that are both grounded in the well-established learning theories and the empirical data we have gathered.

As social constructivists, we are concerned with how meanings grow out of social encounters. In this research project, we have attempted to find out how the technology can act as a more capable peer; therefore, we see the interaction between the students and the application as social interaction per the social constructivist theory of learning. This social constructivist lens guided what we were concerned with and found interesting and relevant in our thematic analysis.

7.1 Thematic Analysis

The thematic analysis was conducted after the last data collection. Following the procedure described by Braun & Clarke (2006, p. 79), we will hereafter refer to all data collected for this research project as the *data corpus*, while the data that was chosen for this analysis as the *data set*. A *data item* refers to a single data gathering instance like a specific interview while lastly, a *data extract* refers to a single piece of data that has been identified within a data item.

The thematic analysis will consist of two phases; the first phase will be an inductive thematic analysis of all the results from the entire DT process; the second phase will be a theoretical thematic analysis of the results from the first analysis. The first analytical phase will focus on coding the data without attempting to fit it into a pre-existing coding frame and the second phase will be theoretically driven, focusing on tying the empirical data to our theoretical framework to answer our research question (Braun & Clarke, 2006, pp. 83–84). Braun and Clarke (2006, p. 97) state that one of the possible pitfalls of thematic analysis is that it "has limited interpretative power beyond mere description if it is not used within an existing theoretical framework that anchors the analytical claims that are made".

As interpretive we are naturally concerned with doing a thematic analysis on a latent level, looking for the underlying assumptions, ideas and conceptualisations that shape the semantic or surface content of the data (Braun & Clarke, 2006, p. 84). Because this process involves interpretative work, as we have to interpret the data we see beyond the semantic level, the analysis produced will already be somewhat theorised and influenced by us. While we will conduct a unique analytical process at the end of the data gathering, we would like to clarify that the analysis will also happen naturally after ever data collection as we discuss it between us. As we discuss one data collection, we will relate to other data collections in the research project, allowing us to continually process the data, making the analysis a recursive process that develops over time (Braun & Clarke, 2006, pp. 86–87). We as researchers will not come into the thematic analysis with "blank" minds without any preconceptions; we will come into it with a greater understanding of our data because it has been processing in our minds throughout the research process.

We collected all data from our data corpus, identified the relevant data extracts from the data items and sorted the data extracts by the data gathering activity and design thinking phase in which it belonged. The prototype phase was excluded as it is not a data-gathering phase, but it is naturally included through the testing phase as they happened iteratively. As we have a social constructivist framework, we are focused, in the thematic analysis, on finding out what the students themselves think about how they learn through social interactions. In the analysis of the first three phases of our DT process, the focus was mainly on how they learn through interactions with their peers, and then in the analysis of the final phase of the DT process, the focus was on how they interact with the technology we are making.

After the sorting, the data extracts were coded. We started by coding the extracts with themes that were based on what we learned about pedagogy and learning from our systematic literature review and discussions we had after every data gathering activity. Despite the systematic literature review playing a role in the thematic analysis, it was still inductive as the theory did not guide us but instead helped us give a language to what we observed in our data. The themes did not "emerge" from the data but were identified based on what we found compelling and relevant to our theoretical framework. As social constructivists, we focused on identifying where the concepts presented in Section 3.1, were embedded or mentioned by participants. This allowed us to identify the most critical concepts in our research.

The data set was analysed in several rounds, clarifying and adjusting the themes as we gained more insight and understanding of our data set. Initially, we started with 15 different themes with sub-themes, which we ended up narrowing down to three main themes, with different sub-themes. The themes are *learning opportunities*, *motivation,* and *feedback*. These themes represent what we consider the most relevant results of our data collection, sorted into sub-themes to clarify why they are essential.

7.1.1 Themes and Sub-Themes

The first version of the thematic analysis consisted of 15 different themes, most with their sub-themes. The themes were based on similarities and interesting aspects we saw during the analysis of the data extracts. During the analysis, the themes were adjusted and readjusted as we continued to analyse more data extracts. The first 15 themes and their respective sub-themes can be seen visualised as a mind map in Figure 7-1.

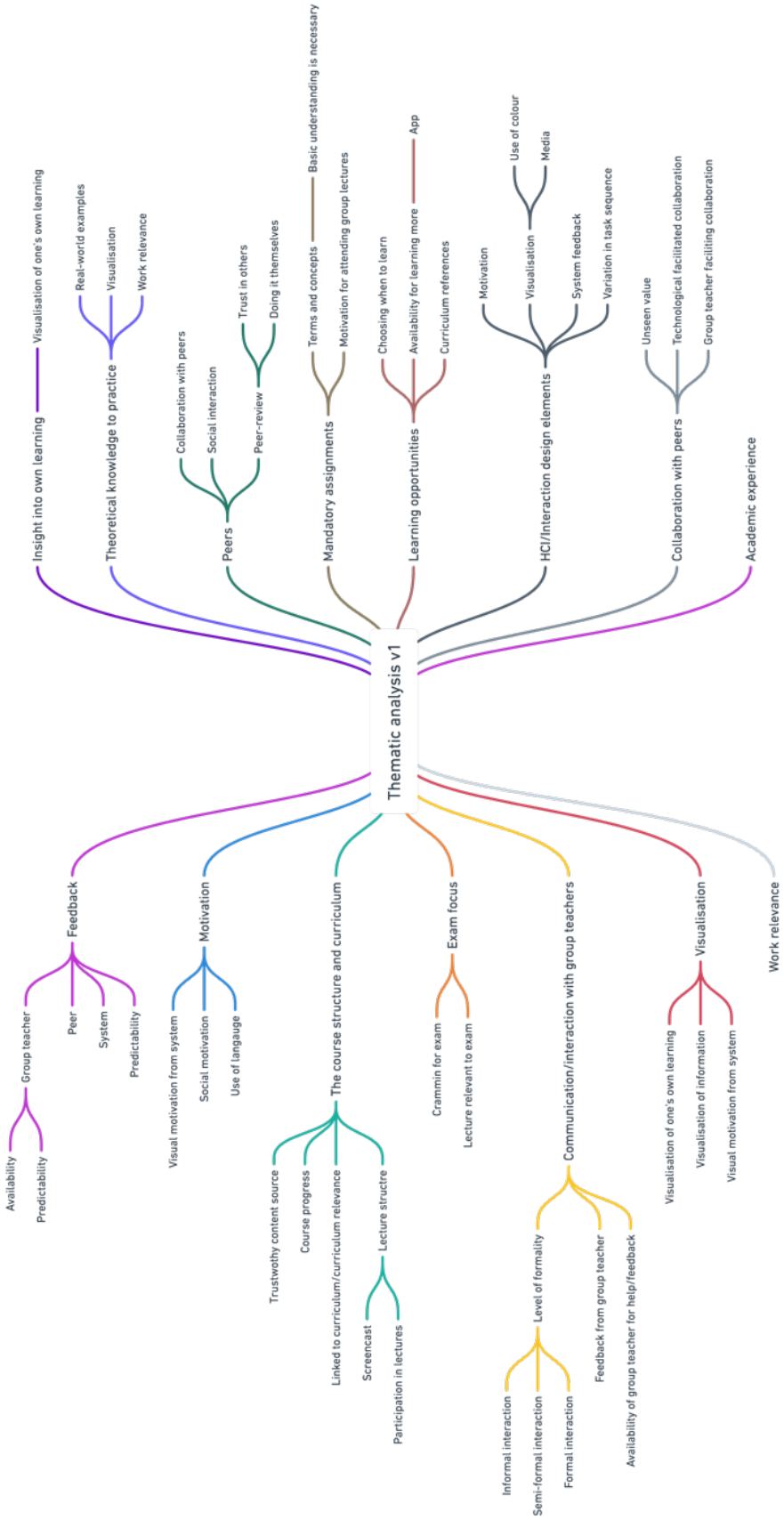

Figure 7-1 *The first 15 themes and their respective sub-themes*

After the first mind map was constructed, we did a second round of analysis, asking ourselves what the different themes had in common and if they could be either joined or separated further and if they were even interesting or relevant at all.

After this second round, we asked ourselves "what are these themes really about and what do they have in common?". This question allowed us to focus in on what aspects were latent and why. After the third round, we had five different themes.

We did a final evaluation of the themes and reached the final three themes with their respective sub-themes which can be seen as a mind map in Figure 7-3. These themes and sub-themes will now be presented with an explanation as to why they are of interest and how they are relevant from a social constructivist perspective.

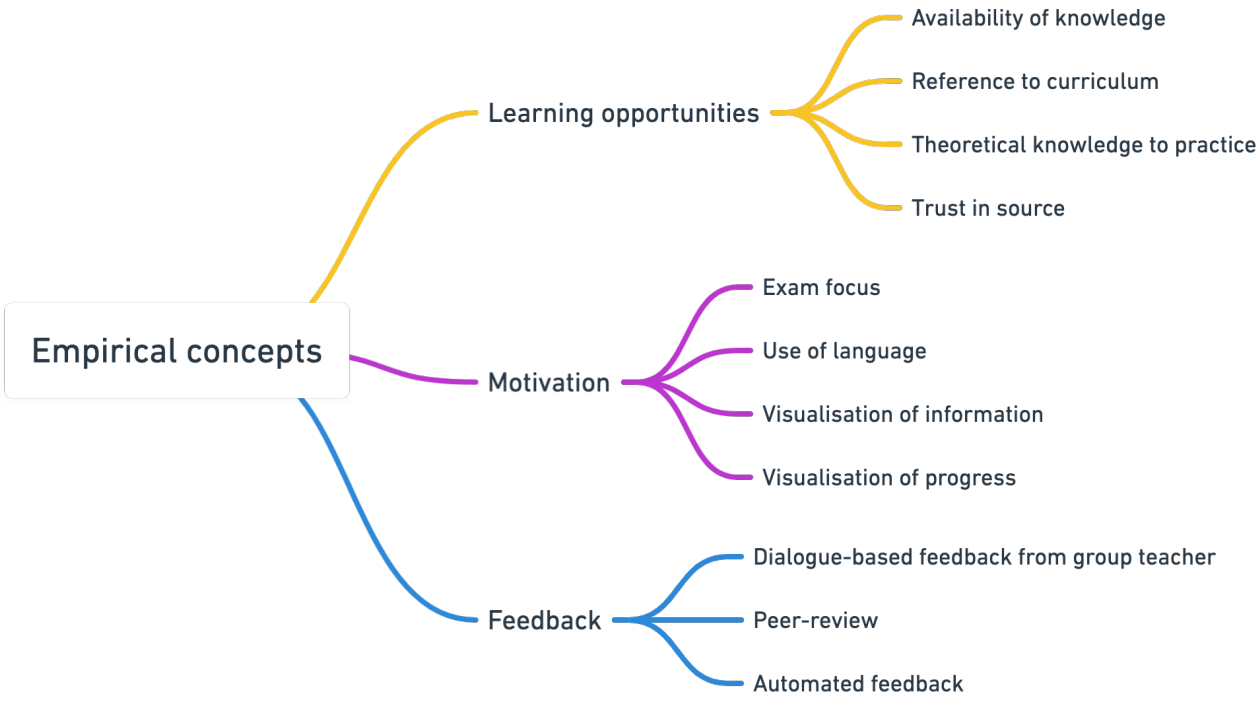

Figure 7-2 *Final three themes of our thematic analysis*

7.1.2 Learning Opportunities

The theme *learning opportunities* summarise the data extracts that were about giving the students several opportunities to learn, not just by answering questions and completing a task, but also integrating opportunities into the feedback and other areas of the application. This helps to cultivate both scaffolding

and active learning in the students learning. This theme consists of four sub-themes which presents four essential aspects of learning opportunities that one should implement in the design of a learning tool.

Learning Opportunities – Availability of Knowledge

The "learn more" function in the application received positive feedback as the students could choose whether to learn more about the subject right away or save it for later. This made it possible for the students to learn more as they were interacting with the application, instead of remembering to read about the subject later on. It helps the students to learn or remember more of the subject. However, it is essential that the information given is relevant and perceived as essential to their understanding. Additionally, the option of adding the subject to a reading list for later reading was appreciated as this would let the students learn more when it suited them.

> *"It is very nice that I can choose whether to learn more or not" (Student #14)*

> *"I like the different types of questions. It forces me to think differently in order to solve the tasks at hand." (Student #19)*

Learning Opportunities – the Reference to Curriculum

Making the information from the curriculum available motivated the students to read the curriculum and not only rely on what little information was given in the application. Referencing where in the curriculum they could find more information about a subject, encourages the students to get familiar with the curriculum and not only rely on the information presented to them through the various lecture formats or the application. The application then becomes both a source of information and reference for where to find more information, encouraging the students to become active participants in their learning.

> *"I have experienced that the students appreciate us telling them where to look for more information, so this [referring to the book referral in the feedback] is very useful" (Group teacher #5)*

Learning Opportunities – Theoretical Knowledge to Practice

The learning opportunities should also focus on complementing the information and knowledge with examples that help tie the theoretical knowledge to practice. Giving the students these examples, accompanied by a "food for thought" type of question helps the students reflect more on what they are learning and remember it better. Helping the students tie the theoretical knowledge to practice has been identified as a motivation for the students to engage in their learning actively.

Learning Opportunities – Reliability

The content in the application is from reliable sources such as the course lecturer or group teacher; the students, therefore, trust the information. The students feel the feedback they receive and the information in the "learn more" function is reliable as it is from a trusted source, rather than their notes or copy/paste from the curriculum which may be in a language they do not fully understand.

7.1.3 Motivation

There are two main motivational aspects we are concerned with; what motivates the students to learn and what motivates them to keep using the application. Since very early in our research, it has been clear that the student's primary motivation to learn and their main concern is to pass the exam, preferably with a decent grade. The motivation to use the application is, therefore, the same. The second type of motivation is the motivational aspects of the application, which have different formats, and serve the purpose of motivating the students the keep using the application and keep learning. Facilitating active learning for students is one of the fundamental concepts of our theoretical framework. As such covering this theme is essential. This theme consists of four sub-themes which each explain what motivates and drives the students to use a learning tool.

Motivation – Exam Focus

A recurring theme to throughout our DT process was the focus on the final exam. The students were indeed focused on preparing for the final exam. Their approach to learning is very much based on what they experience is a good way of preparing for exams, as well as what they had learned from peers and the internet. Making it clear in the application that the tasks will help them towards the exam, motivates them. Also, the structure of the application is similar to an exam. This makes the students familiar with the language and structure of the exam, which in turn motivates them to use the application.

Motivation – Gamification

Gamification aspects like the performance graph, progress bars, and different levels, motivate the students to keep using the application. However, there was a concern that having too much emphasis on gamification could get in the way of learning. One participant explained that their focus would shift from wanting to learn to want to get to the next round. Another participant highlighted another challenge resulting from gamification, which was the element competition. Having too much focus on competition would for some be motivating, while for others, it would be daunting and intimidating.

> *"It sucked that I did not pass this round, but I was almost there. I would probably take the round once more and try to pass the round without familiarising myself too much with the subject at hand." (Student #11)*

Motivation – Visualisation of Information

The way we visualise different information in the application can motivate the students. An example of this is the progress bar for each round and using consistent colour indications like green and red for right and wrong answers. Another is the use of the barometer to visualise how close/far they were from passing one round, thereby motivate them to try again or move to the next round. Students can also be motivated by how the feedback is articulated and by the use of positive emojis or other positive illustrations. It was very important for the students that the application used a language that encouraged them. This made the students more motivated to keep practising and using the application. The visual elements in the feedbacks are just as essential for the students' motivation. By using visual elements to motivate like illustrations gave the students a feeling of the application itself, cheering them on.

> *"It feels like someone is cheering on me!" (Student #11)*

Motivation – Visualisation of Own Progress

The performance graph visualising the students' progress in the different subjects, help show them what they know and what they need to practice more on. By knowing their progress, the students were motivated to engage more with the application, which also makes them learn more. The students were primarily concerned with having help to understand how much they know through visualisation, a sort of "translation" of what they have in their head, visualised. The performance graph did this by dividing the subject into the most important themes and then showing the individual progress for each theme.

7.1.4 Feedback

The application gives feedback in three different ways from three different sources; dialogue-based feedback from the group teachers; peer-review feedback from peers; and automated feedback from the application. The three sub-themes represent the three different kinds of feedback one can implement in the application and the response from the students on them. From a social constructivist perspective, we are concerned with feedbacks as they are social interaction that occurs typically in the classroom or are written feedback from teachers or peers. Evaluating how feedback is received in an application is, therefore, relevant.

Feedback – Dialogue-Based Feedback from Group Teacher

Having the opportunity to have dialogue-based feedback with the group teachers gave the students a chance to get lower-threshold feedback that did not feel as formal as the extensive feedback they received on the obligatory assignments. It also became an opportunity to reach the group teachers for questions and help, that is less formal than e-mail and less private and invasive than social media for the group teachers (Elsrud, 2019, pp. 82–83).

Feedback – Peer-Review

The opportunity to give and receive feedback from peers received mixed feedback from the students. Some expressed that they did not trust their peers to give feedback they could trust. The participants who were group teachers appreciated the opportunity to give and receive peer feedback because they knew the value it gave to the students learning. When we introduced the restraint to only be able to give peer-feedback when one reaches level 6, they seemed more excited about giving and receiving feedback from their peers. Although, there were still some students that were sceptical about receiving feedback from peers as they did not trust their peer's knowledge as much as the group teachers. This is interesting as we did not encounter this dilemma during our literature review. From a social constructivist perspective, collaborating, engaging in discussions and peer-reviews are viewed as excellent teaching methods, but we did not find evidence in the literature that suggested that the students did not view these activities as credible.

Feedback – Automated Feedback

The automated feedback in the application is given to students when they complete a task, one round or level. This instant feedback is crucial because it encourages the students to keep using the application. The instant feedback is short and consists of both text and a visual element to make it easy to read. Even though the instant feedback is short, it still explains why the student was right or wrong, which encourages more in-depth learning and not just cramming. Also, in these feedbacks, the students have access to the "learn more" function, which allows them to expand on the concept if they want to.

7.1.5 Thematic Analysis Summary

Our theoretical framework gave us a language to understand what we observed in our data, resulting in identifying 15 different themes with sub-themes in the initial round of analysis. After several rounds, we ended with three main themes and in total 12 sub-themes. The themes are *learning opportunities*, *motivation* and *feedback*. Table 7-1 presents the themes we consider the most relevant for data collection, sorted into sub-themes to clarify why they are essential, and with significant observations for each sub-theme.

Table 7-1 *Our main themes, their key observations and the DT phase the theme was notable.*

Empirical themes	***Sub-theme***	***DT phase***	***Key observations***
Learning opportunities	Availability of knowledge	Test	Having the correct information available at the right time is essential.

Empirical themes	***Sub-theme***	***DT phase***	***Key observations***
			"It is very nice that I can choose whether to learn more or not" (Student #14) *"I like how I can choose to learn more even when I passed the question" (Student #11)*
	Reference to curriculum	Test 2-5	Knowing where to find more information is essential. *"It is fun working with tasks and feels like you are doing something that is helping you towards the exam, or if it will help you when you get a job in the future, or if you wish to learn more about it later." (Student #3)*
	Theoretical knowledge to practice	Empathy (interviews)	Practical use of theoretical knowledge is motivating. *"In order to be inspired to learn something new, I have to be shown what I can make or do with it." (Student #2)*
	Reliablity	Test	The students trust the information in the application as the source is reliable.
Motivation	Exam focus	Empathy (interview)	The students are very concerned about spending time on things that are relevant for the exam. *"A category with a mixture of all the questions, just like a [mock] exam would help me prepare for an exam even further." (Student #18)*

Empirical themes	***Sub-theme***	***DT phase***	***Key observations***
	Use of language	Ideation (future workshop)	Using positive and encouraging language motivates them to interact more with the application and their learning.
	Visual motivation from the system	Test	Using positive and encouraging illustration motivates them to interact more with the application and their learning.
	Visualisation of information	Test 3-5	Given subtle clues in the textual feedback is motivating as they easier understand what is right, wrong and essential. *"This [talking about the picture question] is fun!" (Student #15)*
	Visualisation of own progress	Ideation	The performance graph motivates the students to do better and to have more realistic expectations for the exam. *"I feel like this is more of a 'how much do you remember' app rather than a 'learn new things' app. It shows where you have holes in your knowledge." (Group teacher #4)*
Feedback	Dialogue-based feedback from group teacher	Empathy (interview)	Having a low threshold opportunity to communicate with group teachers makes the students feel less intimidated to ask for help, which in return improves their learning experience.
	Peer-review	Test 1-5	Although some students do not necessarily trust in their peer's feedback, they do agree that peer reviewing others are helpful for their learning.

Empirical themes	***Sub-theme***	***DT phase***	***Key observations***
	Automated feedback	Test 1-5	This instant feedback is crucial as it encourages the students to keep using the application. Even though the instant feedback is short, it still explains why one was right or wrong, which encourages more in-depth learning and not just cramming. *"You actually learn something when you fail the question" (Group teacher #2)*

7.2 Theoretical Analysis

After the thematic analysis was conducted, we conducted a theoretical analysis of the data set that now consists of the three themes and their respective sub-themes. The theoretical analysis was executed by comparing the concepts from the theoretical framework to the empirical themes in order to anchor the empirical themes in a theoretical foundation. The analysis can be seen, visualised through a mind map in Figure 7-4. Additionally, through the theoretical analysis, we were able to see how we might have gained a different perspective on the theoretical concepts in our framework now that we have conducted our empirical work.

There were three of the concepts from the theoretical framework that did not stay relevant for our research after the analysis of the data collection. These three are *collaborative learning, situated learning, and learning by doing.* The three concepts will be presented at the end of this section with an explanation as to why they were no longer relevant.

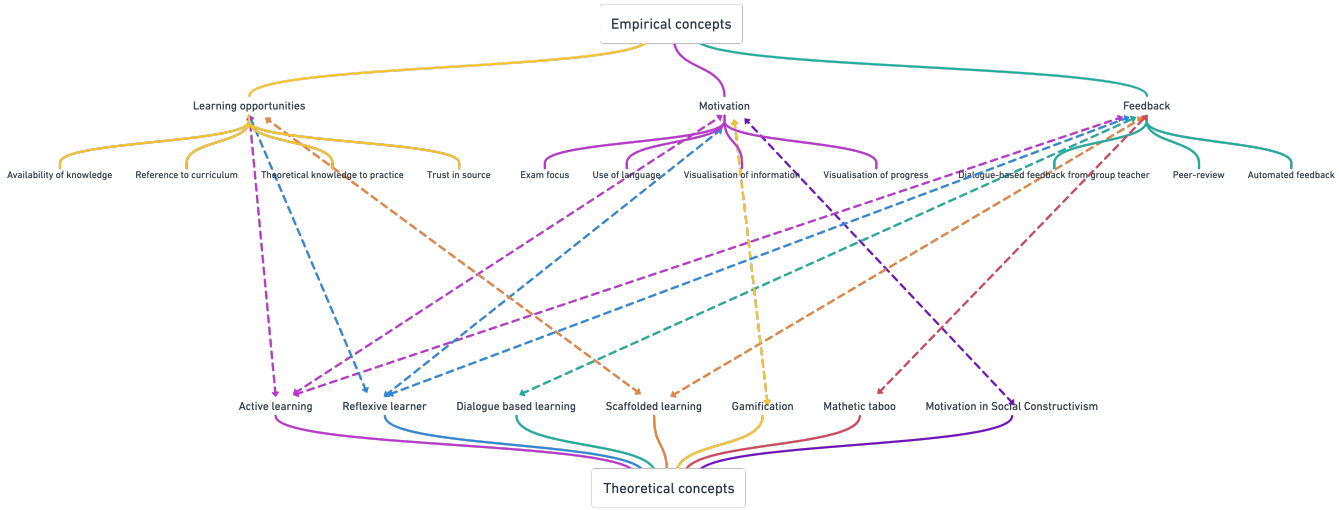

Figure 7-3 *The themes from our thematic analysis and the corresponding theoretical concepts.*

7.2.1 Learning Opportunities

From a social constructivist perspective, the theme *learning opportunities* support scaffolding and active learning in the students by giving them different opportunities to learn. Learning opportunities help the application act as a more capable peer as it guides the students to more information, thus helping them reach a higher level of knowledge and achieve the tasks.

Learning Opportunities – availability of knowledge

The "learn more" function in the feedbacks scaffolds the learner by presenting them with more information on the subject. Also, the reference to the curriculum in the "learn more" function **scaffolds** the learner by helping them find out where to learn more. It also encourages **active learning** by encouraging them to read the curriculum and helping them find their way in the curriculum.

Learning Opportunities – a reference to curriculum

By referencing to the curriculum, they can read more about a specific subject or concept **scaffolds** the learner by helping them learn where to look when wanting to learn more. It also encourages **active learning** by encouraging them to read the curriculum and helping them find their way in the curriculum. This helps them reach their goal of learning the curriculum.

Learning Opportunities – theoretical knowledge to practice

Using real-world examples when explaining a concept to a student helps anchor the knowledge, thus **scaffolding** them by showing the same knowledge in different formats. Also, students are more motivated to learn when they know how the theory can be applied in practice as the knowledge becomes tangible. In an introductory course, such as the one we have investigated, is the goal to teach the students

the language of the knowledge community. We have found evidence that students are motivated by tasks where theoretical knowledge is used in practice. This is a way situated learning can be facilitated in small scale for higher education.

Learning Opportunities – trust in the source

Trusting the feedback source is essential for the students **scaffolded learning**, as well as seeing the value of feedbacks and the application. Students do not automatically trust their peers to give them valuable feedback, therefore leading to them not to give or wish to receive feedback from peers. However, the students trust the applications automated feedback as the group teachers and course instructor control them, hence trusting the technological more capable peer. Preferably, the students want feedback from a group teacher on all levels of knowledge, as this is the source, they trust the most. As they trust the content in the application, the application **scaffolds** them. If they did not trust the content and information given in the application, it would be of little value.

7.2.2 Motivation

Motivation has been a big theme as it has popped up in all the other themes. The students' interest in learning or the encouragement from the application or both is the reason they decide what to do. Motivation in social constructivism takes into consideration the contextual and cultural influence. Scaffolding can be used as a framework for motivation to be integrated into instructional practices.

Motivation – exam relevance

In contrast to what social constructivism says about motivation for learning, we found that the students' primary motivation was to learn relevant information in order to pass their exam. The work on motivation in social constructivism does not directly consider passing an exam as a motivational factor, therefore it does not explain the motivation we observed for using the application, as their primary concern was to be prepared for their exam.

Motivation – gamification

Gamification is useful for motivating the students to keep using the application. Sailer et al. (2017, p. 373) described the purpose of points in gamification to be the giving of immediate feedback and as a reward. In our application, we use levels to serve the same purpose as Sailer et al. (2017) says points serve. The levels and the progress bar inside each round visualise the student's progress in the course. **Gamification** could, on the other hand, gamification could also get in the way of **reflexive learning**, **active learning** and **scaffolding** because it could shift the students' focus from learning to winning.

Motivation – visualisation of information

Visualising information and feedback in the application through the use of colours like red and green for right and wrong gives clear feedback which helps **scaffold** the students. Using motivating language accompanied by visual elements **scaffolds** the student by making them feel supported, which in turn motivates them to use the application. The use of encouraging language also supports the student in **actively learning** more and become a **reflexive learner** as they are encouraged to work and learn more from the application. This is in line with **motivation in Social Constructivism**.

Motivation – visualisation of own progress

Visualising information about the students' progress in the application, thus visualising their progress in the course curriculum, helps **scaffold** the student because it helps them gain an understanding of how much they know and how much they have left to learn in order to reach their goal of being prepared for the exam, as shown in our persona (Figure 6-4 in Section 6.2.2). This makes the students more **active** participants in their learning and reflect on how much they know, thus making them more **reflexive learners**. The use of progress bars is a commonly used **gamification** element that has shown to be valuable for the students to understand their learning.

7.2.3 Feedback

The different forms of feedback in the application approaches **scaffolding** in the students learning process in various ways. Scaffolding is, as mentioned earlier, an essential social constructivist concept. Also, the feedbacks we implemented in the application promote **reflective** thinking and **dialogue-based learning**, which are also an essential social constructivist concept. Also, we focused on how mathetic taboo might play a role in the feedbacks.

Feedback – dialogue-based feedback from group teacher

The feedback from the group teachers and the possibility for dialogue with the group teachers in the application could help the students to learn to talk about their learning, making them **active** and **reflexive learners**. The possibility of dialogue with the group teachers also facilitates a possibility for the group teachers to **scaffold** the students by answering questions and helping them. The formality level of chatting makes it easier for the students to interact with their teachers because it is and feels lower threshold, thus reducing the chance of **mathetic taboo**. According to **motivation in social constructivism** the relationship between the more capable peer and the student creates a motivational competence.

Feedback – peer-review

The peer-review function encourages **reflexive learners** because they have to reflect on why something is a right or wrong answer in order to give valuable feedback. It also gives them a chance to see what someone else has answered on the same task as themselves. The peer-review function also opens up for **dialogue-based learning** because they can reply to the feedback and thereby start a dialogue. It again, because it is dialogue-based can help the students become more comfortable talking about their learning, thus reducing the chance of **mathetic taboo**.

Feedback – automated feedback

The application gives the student automated pre-formatted textual, and visual feedback after a task or round is completed. Because the automated feedback consists of more than just "right" or "wrong", but also gives a quick explanation of why it helps the students become more **reflexive learners** if they read it and reflect on why they were right or wrong. It also **scaffolds** them by giving them instant feedback on their work so they can keep learning.

7.2.4 Collaborative Learning, Situated learning and Learning by Doing

Our theoretical framework consisted of three additional Social Constructivist concepts that ended up not being relevant in the thematic analysis. We have not researched enough on the concept to say that they are excluded because they cannot be implemented in digital technology. The empirical context of our research could have had an effect as well. Therefore, we cannot conclude on whether these concepts are suitable to implement in a digital technology to scaffold students.

7.3 Findings

In this section, we will present our main findings the answer to our primary research question:

What design considerations should be made when designing technology that will act as a more capable peer?

Our main findings consist of three themes with 18 design considerations to consider when designing technology for learning contexts. We have reached these through familiarising ourselves with the vast field of pedagogy and learning and using that theoretical knowledge to understand and explain what we have learned through our empirical data collection.

7.3.1 Designing for Learning Opportunities

Make knowledge available when it is needed

Making more knowledge available through a "learn more" function made it possible for the students to take an active part in wanting to learn more about a specific subject. Starting with the option of "hiding" the "learn more content" made some students curious as to what more they could learn. Others appreciated that the additional information was not forced on them. We chose a mobile platform for the technological more capable peer, as this is the platform the students use the most. When adding such learning opportunities to the application, the following should be considered:

1. The functionality should be worded to entice them to make the choice of learning more. Our application used "learn more", inspired by "read more", which seemed to inspire them to expand on their knowledge.
2. The additional knowledge should be formatted in a way that it is still quick and easy to read. It should not be a deep dive into that specific subject but a proper explanation, preferably with an illustrative, relevant image/illustration and a reflective question at the end.
3. The image and illustration used should help tie the theoretical knowledge to practice by showing a real-world example of the term/concept at hand if possible.
4. The additional knowledge should guide the students towards the curriculum for more extensive explanations. There is also an opportunity here to reference other valid sources than the curriculum like research articles or websites.
5. Making the accessible knowledge can and should also be done by choosing the right platform.

7.3.2 Designing for Motivation in Learning

Make the content relevant for the final evaluation (exam)

The student's primary motivation to learn is when they are learning something that is perceived as valuable for their exam. The students perceive memorising the terms and concepts as the best way to prepare for the exam; however, the group teachers believe the students need to practice more for the long-form answers that require reflection in the exam. When making the application exam relevant, the following should be considered:

6. The students are familiar with the questions from the previous exam; it is, therefore, valuable to use them as a basis when developing the questions and tasks for the application.

Use Gamification to Engage Students

Gamification works well for motivating the students to use the application but does not in itself lead to more learning. It is, however, important because the students need to use the application in order to learn. An excellent way to solve this is to evaluate different degrees of gamification in the application with potential users by asking them to walk through their chain of thought as they interact with the different degrees of gamification. When using gamification in an application that is intended for use in a learning context, the following should be considered:

7. Gamification should be implemented to increase the motivation for continual use of the application. This means using gamification elements like progress bars to show the progress during a round, and levels to show and motivate progress.
8. Gamification could get in the way of learning when having too many gamification elements can move the focus from learning to win in order to proceed. One way we saw this in our application was in the number of questions required to get an answer correct. Therefore, it is necessary to investigate the threshold for how many questions they need to have correct in order to proceed to the next round/level.
9. Another gamification element to show the student's progress is the performance graph, which visualises the student's learning progress. This graph motivates the student to engage more with the different subject in order to reach higher levels. However, the performance graph should not contain too much information as it can be confusing or even hard to read, thus not being beneficial. A performance graph could be divided into the most critical subjects in the course to show the students individual progress in each subject.

Use Motivational Language and Visual Elements

The use of motivational language and visual elements had a definite effect on the students. Almost every single participant in the user tests vocally reacted when seeing the celebratory emoji for when they got an answer correct. The motivational visual elements were accompanied by short motivational text to amplify the visual element further. When using motivational information in an application, the following should be considered:

10. When implementing visual elements meant to motivate the students, they should be familiar, for example, emojis.
11. The visual element should be accompanied by an appropriate, short text that explains what the visual element is communicating.

7.3.3 Designing for Feedback

Give Automated and Instant Feedback

Receiving instantaneous feedback from the students after every task scaffolded the students every step of the way through the application. The instantaneous feedback from the application proved especially crucial because of its ability to be an instant and constant presence in the application. When designing feedback from the application, three essential aspects need to be present:

12. The format of the feedback has to be consistent. Even though the tasks and the information that is given might vary, the feedback should always have the same format with the same elements.
13. The feedback should be a mixture of representations of information to make it quick and easy to read. Using an emoji or another easily recognisable visualisation to quickly inform the student if they got the answer right or wrong, followed by a short and concise explanation for why the answer was right or wrong is enough to scaffold them.
14. There needs to be more information available in the feedback, in case the student wants to learn more, but the information should be optional to see. Making the information available through a "learn more" button is an example of how to implement this. The information that is made available can be more extensive than the first information, but it still needs to be quick and easy to read, accompanied by visual examples of the information presented. Additionally, the feedback can contain a reflective question at the end to promote reflection and thus, more in-depth learning in the student.
15. When the feedback text is too long, the students will most likely skip past it.

Create Dialogue-Based Feedback with More Capable Peers

The opportunity to receive dialogue-based feedback in the application proved to give the students a lower-threshold way of communicating with their group teacher in addition to receiving more frequent feedback on smaller tasks. When designing for dialogue-based feedback from more capable peers, three essential aspects need to be present:

16. The dialogue-based feedback should happen in a chat format, similar to that of messaging applications.
17. Both the task and answer given by the students should be "sent" to the chat visible to both parts.
18. When the more capable peer gives feedback on the task, it should also be sent as a message in the chat, facilitating a conversation so that the student can send a reply with a question.

19. There should be one chat per more capable peer so the student can go back and read the feedback and also use it as a communication channel with the group teacher if they have questions.

7.4 Main Findings

The three main themes we have presented in this chapter, along with the considerations are as intertwined as they are parts of a whole, and not independent findings. Our main findings consist of 18 design considerations that belong to three different main themes. The main themes represent what we consider to be the most important aspects to implement when wanting to scaffold through digital technology.

Table 7-2 *Summary of our main findings and themes they belong to.*

Main theme	***Sub-theme***	***Main finding***	**#**
Designing for learning opportunities	Available knowledge when it is needed	The functionality should be worded to entice them to choose by learning more.	#1
		The additional knowledge should be formatted in a way that it is still quick and easy to read but also give a proper explanation, preferably with an illustrative, relevant image/illustration and a reflective question at the end.	#2
		The image and/or illustration used should help tie the theoretical knowledge to practice by showing a real-world example of the term/concept at hand if possible.	#3
		The additional knowledge should guide the students towards the curriculum for more extensive explanations.	#4
Designing for motivation	Exam/final evaluation in	Use previous exam questions as a basis when developing the questions and tasks for the application.	#5

Main theme	*Sub-theme*	*Main finding*	#
	The use of gamification	Use gamification elements like progress bars to show the progress during a round, and levels to show and motivate progress to motivate continued use of the application.	#6
		Gamification could get in the way of learning if too many gamification elements are introduced, shifting the focus to winning in order to proceed.	#7
		The performance graph visualises the student's learning progress and motivates the student to engage more with the different subjects in order to reach higher levels.	#8
	Motivational information	When implementing visual elements meant to motivate the students, they should be familiar, for example, emojis.	#9
		The visual element should be accompanied by an appropriate, short text that explains what the visual element is communicating.	#10
Designing for feedback	Automated feedback format	Even though the tasks and the information are given might vary, the feedback should always have the same format with the same elements.	#11
		The feedback should be a mixture of representations of information to make it quick and easy to read.	#12
		There needs to be more information available in the feedback, in case the student wants to learn more, but the information should be optional to see.	#13
		When the feedback text is too long, the students will most likely skip past it.	#14

Main theme	*Sub-theme*	*Main finding*	#
	Dialogue-based feedback	The dialogue-based feedback should happen in a chat format, similar to that of messaging applications.	#15
		Both the task and answer given by the students should be "sent" to the chat visible to both parts.	#16
		When the more capable peer gives feedback on the task, it should also be sent as a message in the chat, facilitating a conversation so that the student can send a reply with a question.	#17
		There should be one chat per more capable peer so the student can go back and read the feedback and also use it as a communication channel with the group teacher if they have questions.	#18

8 Discussion

Our main findings present considerations for designing technology that will act as a more capable peer. These findings and the related work have in common that they make the students equipped with the needed skills of the 21st-century (Appendix C). The design considerations proposed by us helps the students become more independent, collaborative, and reflective learners. We believe, as per the constructivist epistemology, that technology should be used where it is superior to the humans (Harasim, 2017, p. 93). Through our research we have presented 18 considerations in which technology enhances human abilities, such as remembering, reminding, listing, and visualising, while reserving interaction abilities, such as understanding of social cues, empathy, and interpersonal relationships, should be reserved for human users.

We will now discuss the significance of our main findings by aligning and comparing them with the arguments and findings from related work before we present our contributions.

8.1 Designing for Learning Opportunities

When designing for learning opportunities, we found it was important that functionalities should be worded in a way that encourages active learning, such as "learn more". Kluge (2019) argues, which we support, for using interactive representations and digital support to help students connect theory to practice. Our "learn more" is formatted in a way that is quick and easy to read with relevant images/illustrations and a reflective question at the end. Additionally, knowledge becomes more accessible to students. The images and illustrations used helped the students tie theoretical knowledge to practice through real-world examples. Learning with multiple representations has shown to enhance the student's performance when they can interact with an appropriate representation (Ainsworth, 2006, p. 183). The representation of information we chose for our participants learning were easy to understand and work well together, as such the representations were appreciated for the students. Kozma (2003) presents a study on the role of multiple representations in understanding science, where they examine the difference between expert chemists and chemistry students in their use of representation. We have found that choosing the right representation helped students to recollect information. Also, giving them the opportunity to create representations, such as adding multimedia to the concept described in the "terms and concept list" (main finding #3), promotes their skills as reflective learners. However, as Kozma (2003, p. 224) found in his study, novice students are less skilled in the use of representation and rely on their surface features for meaning. As such, we argue that the multiple representations chosen by course instructor should choice good examples of representations so that the students understand and preferably scaffold them to choose the right representations in the future. Our focus on multiple representations has not been as in-depth as the work of Ainsworth (2006, 2008), Furberg (2009) and

Kluge (2019). Nevertheless, our findings show that not only teens and children benefit from multiple representations as our participants were students attending higher education.

Ainsworth (2006, 2008) argues that student's comprehension improves with different representations; moreover, the students must understand how to interpret the representation. Our findings suggest that the combination of textual information and illustrations improved the students understanding of complex terms. We have in our findings found this to be accurate as some of the representations we chose to illustrate more complex terms, such as affordance, did improve their comprehension after they read the factual text under the picture. Also, we found that the combination of multiple representation and reflective questions makes the technology act as a more capable peer and support them to become a more independent learner. Ainsworth's (2008, p. 206) argument that the beginners learn with the support from others and that they are not able to use powerful tools to achieve the same results as an expert without guidance, highlights how important it is with a more capable peer when using powerful tools like multiple representations. However, in Ainsworth (2008) research, the more capable peer is a teacher guiding their students in person and not an application prompting the students with information like our application. We will argue that as Ainsworth (2006, 2008), Kluge (2019) and Furberg's (2009) research is on children and teens; these groups of learners need more guidance as they are at the beginning of their educational journey and therefore not as experienced with self-regulated learning as our target group. As such, implementing technology as a more capable peer is suitable, and we will argue that this will help students become even more independent learners. Ainsworth (2006, 2008) and Furberg (2009) both use a socio-cultural cognitivist approach in their research, and therefore their focus is more on the process of the mind and how the different socio-cultural aspects affect it. We argue that our theoretical framework gives a different perspective as we were more concerned with how the application helped the user to connect the multiple representations with knowledge, thus presenting design considerations which instructs what presentation to use and how one should design and present.

Additional learning opportunities, such as the "learn more" and the "helper" functionality, should guide the students towards the curriculum for more extensive explanations helping them become more structured self-regulated learners. This functionality helps boost the student and achieve the task at hand. Additionally, the opportunity to learn should be available as possible for the students, and therefore, the choice of platform for our prototype was a mobile application. Our findings showed the students appreciated the enabled possibilities, such as learning while on the bus or at a park. Another way of making learning more accessible is through MOOCs. MOOCs are online courses transmitted through video lectures with quizzes to test the students' knowledge and usually have a set schedule of topics were the participants are often free to engage with content and material as they please (Selwyn, 2016, p. 152). However, with MOOCs the teacher is usually replaced by some form of AI (Harasim, 2017, p. 112).

Although our approach is similar in the way we test and support the students, when the students reach higher levels of understanding, the technology goes from being part of the interaction to the interacting intermediary between students and peers/group teachers. Another difference, is that they are created with different theoretical frameworks. MOOCs are created using a connectivist perspective which views learning as a process of connecting nodes of information, and technology is seen as an active participant in this learning network (Harasim, 2017, p. 93). The basic principles of connectivist learning theory are collaboration and creation, while our theoretical framework focuses more on Vygotsky's ZPD and therefore emphasising the importance of human interpersonal relations (Verenikina, 2010, p. 4). Also, our empirical work has shown us that feedback and guidance given to the students must come from a human more capable peer when they reach the reflective and discussing tasks, we will get into this in Section 8.3. Similar to MOOCs, our approach to creating a learning technology lead to a technology that allows the students to learn at their own pace and the students are responsible for integrating this technology into their daily studies in order to gain something meaningful from it. MOOCs, also, require more independent learning as the whole learning situation is digitised. Therefore, we will argue that our concept only enhances the opportunities of students and the group teacher. Additionally, it does not discriminate against students with less academic experience. Instead it supports and helps them become familiar with the language and independent learners.

As mentioned, we chose a mobile application as our platform in order to enable learning opportunities where the students usually would not engage with the curriculum. Other platforms such as the cloud applications and web-based learning environments mentioned in Appendix A also enables this learning opportunity. However, one should choose the platform carefully. Their unique way of facilitating real-time collaboration, availability of resources and scaffolded learning can take the learning out of the classroom and in different contexts (Barak, 2017, p. 287; Chen et al., 2008, p. 78). Elsrud (2019) argues in her thesis that the choice of such a tool can enable good communication flow between the student, their peers and teachers. However, she also argues that when choosing a platform, one should consider not only where the students already are but also that their use corresponds to how they conduct activities through them. Which supports our choice of a mobile platform, as this is a tool the students use in a different context to achieve different goals. Elsrud (2019) used activity theory, as well as a different approach to investigating the use of tools in the same design course. Activity theory conceptualises technology as a tool at both individual levels and a higher level within a complex system of goal-oriented activities (Verenikina, 2010, p. 7). Our theoretical perspective does not put as much emphasis on the role of the tool but does see it as an essential part of the student's culture and context. We support Furberg's (2009) argument that using a socio-cultural framework can enhance our understanding of the positive and negative effects of students' engagement. Nevertheless, we argue more specifically for a social constructivist framework, as it enables the researcher to not only take into consideration the social

and cultural aspect but also how to facilitate "learning by doing" when choosing, introducing, or implementing a learning platform. This perspective can also give valuable insights into how to design additional learning opportunities within an application and how these functionalities can be a productive part of the student's learning process.

Our concept takes some part of the learning process out of its usual context in order to make the students active and self-regulated learners. A different approach would be the flipped classroom teaching method. The flipped classroom reverses the traditional learning environment by delivering instructional content, often online, outside the classroom (O'Flaherty & Phillips, 2015, p. 85). Through flipped classroom, the instructors cultivate critical and independent thought (O'Flaherty & Phillips, 2015, p. 94). Our findings suggest that this can be done by implementing a tool which allows student-teacher relations without the need of attending group lectures and plenary lectures. A challenge with flipped classrooms is that it is dependent on teachers and students fulfilling their obligation to each other in order to be successful (Danker, 2015, p. 175). In contrast, our concept does imply some teacher-student obligations; however, they are not that dependent on each other as the students are guided by automated feedback until they reach reflective questions. As such, the time, skills, and willingness for a flipped classroom style of learning are not needed to get students to become active learners. Our concept takes the students freedom to work at their own pace outside the classroom even further as there is no deadline to complete the assignments in order to keep up with the course.

As we have analysed our data sets with a social constructivist perspective on learning, like Kluge (2019) and Jornet and Roth (2015), some findings regarding memory and cognitive load, becomes less important in our thesis. However, one can use a different perspective, such as social cognitivism, where findings regarding memory and the cognitive load becomes as essential as the social and cultural context. As a cognitivist, one is focused on the internal mental processes and understanding of how cognitive processes could promote active learning (Schunk, 2014, p. 22). The application helped the users to remember, therefore relieving them of using extra memory in order to access more information. However, we are not social cognitivists, and our focus is therefore on how meaning is created through experience and social interaction, but we believe one can find useful and essential findings with social cognitivism as well.

8.2 Designing for Motivation in Learning

When designing for motivation in learning, we found that the students' primary motivation to learn was when it was perceived as relevant to their exam. Gamification proved to be a motivation for continued

use of the application but could also get in the way of learning if the focus shifted too much to competition and "just getting to the next level".

The main motivational factor we saw in our research was exam relevance. To promote exam relevance, the use of previous exam questions to develop tasks for the application was a way to operationalise this motivation. Another way to operationalise it was through the use of the gamification element performance graph. Sailer et al. (2017, pp. 371–372) state that the typical use of gamification is to promote motivation and performance for a specific activity but that the question of *how* gamification motivates has not been correctly addressed. Through the use self-determination theory Sailer et al. (2017), amongst other, found that participants that were exposed to the gamification elements of badges, leaderboards, and performance graphs had a significantly higher perceived task meaningfulness than those who were exposed to the control condition. They offer one possible explanation for this, which is that those elements can also create meaning at the game level, but do not expand on why it can create meaning at game level (Sailer et al., 2017, p. 378). We argue that the performance graph can lead to increased task meaningfulness because it helps the students understand how far away/close they are to reach their goal (main finding #8), which in our case is being prepared for the exam. Being able to visually see that the work one is doing (solving tasks) is leading you closer to your goal (being prepared for the exam) leads to motivation to learn. Our social constructivist framework allowed us to see the importance of showing the students that they are actually progressing in their learning, giving them the confidence to keep learning. Sailer et al. (2017, p. 374) use social determination perspective in their research, which focuses on motivation and how the environment can affect motivation. This perspective allows them to measure how gamification impacts motivation, but it did not allow them to see the bigger picture of why. Because we use DT as our methodology, we spent time getting to know our future users and their needs and goals (as shown in Figure 6-4 in Section 6.2.2) and could, therefore, understand that it was of importance for them to visually see their knowledge in order to gain a better understanding of their own learning.

Buckley and Doyle (2016, p. 1164) studied how gamification impacted students with different types of motivation, intrinsic, motivation and extrinsic motivation. The study confirms their main hypotheses which are that all students will have improved knowledge of the subject at hand due to the gamified learning environment used for testing. Therefore, they argue that gamified learning environments have a positive impact on learning outcomes, but they also point out that it requires careful design to make sure that the gamification elements are tied to the learning outcomes. Learning outcomes are closely tied to learning objectives, as the objectives are based on what learning outcome one desires. We based the levels in our application on Bloom's taxonomy and several students remarked how the tasks in the application were very relevant for what they were expected to know for their exam. We argue that this

supports Buckley and Doyle's (2016, p. 1171) statement that in order for the gamified learning activities to have a positive impact on the learning outcomes they have to be carefully designed to be closely tied to the desired learning outcomes. Following Blooms taxonomy will scaffold the students by gradually requiring deeper knowledge, thus helping them on their way to the desired learning outcome. But this is in itself not a guarantee for success, as Hanus and Fox state (2015, p. 159)

> *"It should be noted that all of our game mechanics were aligned with learning objectives; the badges were designed to promote additional learning and engagement, and yet students in the gamified classroom were less intrinsically motivated and in turn earned lower exam scores than those in the non-gamified classroom".*

This indicates that even though the gamification elements are appropriately adjusted to the given objectives in the course, gamification can still lead to lower motivation.

Buckley and Doyle (2016, p. 1172) also argue that their study supports the notion that game design elements can be used as a tool to control and increase student engagement and participation. While we agree with that on a general basis, we would like to add that the use of gamification elements in an educational context does not necessarily lead to more learning. Other studies support this notion that gamification can hinder learning (Hanus & Fox, 2015; Toda et al., 2017) and one that even suggests that it has no real cognitive impact (DomíNguez et al., 2013). In Toda et al. (2017) they see a pattern of loss of performance across the literature of gamification and learning, but do not expand on why because they do not do any empirical investigation. Because we operationalised gamification for learning, we could see that increased engagement and participation did not necessarily lead to more learning if the goal of the student changed due to the game design elements. This is relevant for elements that promote competition (main finding #7) which does not necessarily have to be between students but could also be competing with the application or oneself to make progress, level up and "beat the game". Goal can then shift from wanting to learn and be prepared for the exam to wanting to win, thereby missing out on the learning opportunities. Therefore, we will argue that the focus on raising engagement and participation through gamification could get in the way of the students learning, specifically because the student's goal could shift. This was expressed by our participants, one in particular said:

> *"It sucked that I did not pass this round, but I was almost there. I would probably take the round once more and try to pass the round without familiarising myself too much with the subject at hand." (Student #11)*

This is a different argument to the one's others have made regarding adverse effects due to a competitive gamification element. Hanus and Fox (2015, p. 159) state that competition could have a negative impact on the student's motivation in an educational context, but not specifically on the students learning.

DomíNguez et al. (2013, p. 390) found that the element of competition was necessary for some, while others did not like the competitive element it could create among peers. Both of these studies used leaderboards to encourage competition amongst the students, which gave a negative effect. In our case, we did not promote any competition among the students because one could not see the progress of anyone else. Nevertheless, we still saw a negative effect on learning from the students being competitive with themselves and the application. Because we have a social constructivist perspective, it also allows us to understand that the course we were investigating was a course consisting mainly of young adults in their first semester in higher education. They have yet to get to know how they learn and study best, which could make it frustrating for them to feel like they need to perform in order to unlock the rest of the levels. We argue this could lead to feelings of inadequacy and harm their self-confidence.

A study by Moreno and Mayer (2005) investigated how university students learned to take care of plants from a multimedia game. Through the research, they study the cognitive abilities that different instructional concepts promote cognitive thinking. These four instructional concepts were interactivity, reflection, feedback and guidance and promoted different kinds of cognitive thinking (Moreno & Mayer, 2005, p. 118). This study has some similarities to our study. An example is their four instructional concepts: interactivity, reflection, feedback, and guidance (Moreno & Mayer, 2005, p. 118). What they refer to as feedback and guidance in their study are instructional concepts which we call automated and dialogue-based feedback, respectively, in ours. However, Moreno and Mayer (2005) have chosen a cognitivist approach and therefore focused on how these four instructional concepts promote cognitive thinking. While we focused on how the students would construct knowledge with and through a technological, more capable peer in ours. A disadvantage with a cognitive theoretical framework is that it does not take into consideration the ideas and beliefs the students have in advance as they come from different contexts and cultures. As their ideas and beliefs may vary greatly, some game elements might motivate some while scaring others. Also, the focus is on the teacher: the level of the teacher's knowledge is the limit to the things the students can learn (Schunk, 2014, p. 129). By using a social constructivist learning theory, the focus turns to the interpersonal relations, such as student-student and teacher-student relations, and to their background, which in return gives a fuller picture of the learning situation (Hoëm, 2010, p. 30; Vygotsky, 1978, p. 102). During our empirical work, we found that there are several layers of culture and context in which students at a university belong to that also affect the choice of technological learning tool, as presented in Section 1.4.

Our target group are students at the very beginning of their journey into the world of HCI, and as they become more submerged into the HCI community, their preferences and values in regards of technology changes. Our findings indicate that social relationships and individual goals influence both inner and outer motivational forces. Therefore, we argue that when implementing technology, one should take

into consideration the social and cultural background of the students, and the interpersonal relations which exist in a classroom. Moreno and Mayer (2005) argue that agent-based computer games have the potential to offer a valuable venue for education, but inexperienced learn to need structured guidance in combination with reflective techniques to help them achieve deep understanding. Our findings support this argument.

When designing for motivation, as with learning opportunities, choosing a platform that enables learning in a setting other than the traditional educational context improves the student's knowledge. These platforms can be virtual worlds, simulations, cloud-based applications and mobile applications. There is much research done on game-based learning and the use of gamification to improve 21st-century skills (Barak, 2017; Chen et al., 2008; Ke et al., 2016; Mørch et al., 2018; Thomas & Seely Brown, 2011a). However, as mentioned, we found that students are more motivated to use the technology if it helped them prepare for the final exam. Our findings suggest that gamification motivates the student to use the skills of the 21st-century, as such we argue that gamification does not only motivate the students to engage with their learning but also to use these skills in order to find information.

Virtual worlds and simulations can promote a collaborative learning environment; nevertheless, we found in our user tests that in order to engage the students to use these as a means of additional learning it must be mandatory. As they will not use a mobile application that supports them alongside the study, we argue that larger applications such as virtual worlds and simulations will probably be used either as they will require more time to set up and a larger, more powerful, such as a PC. This will also make the students reliant on a PC, which in return will make the learning less accessible in non-educational contexts. However, virtual worlds, simulations, cloud-based applications, and mobile applications do enable a new way for teachers to reach their students which is also a place most of them are familiar with from their hobbies and such.

All the studies we have addressed in regard to gamification have a cognitivist and more measurable approach than we do. With our social constructivist framework, we were able to see a more culturally and socially nuanced image of gamification. Therefore, we met challenges stemming from the cultural context in which the literature with the cognitivist approach did not address.

8.3 Designing for Feedback

We found that when designing for feedback that there were two formats to consider; (1) automated feedback which is from the application itself; and (2) dialogue-based feedback which is from the group teachers and peers.

When designing automated feedback, the format needs to have the same format even though the task and the information are given might vary. Although we argued for multiple representations in Section 8.1, these representations must be well-organised and designed so that the format is consistent. Additionally, the presentation of information will either motivate or demotivate the user to interact further with the application; as such, the design and presentation of the feedback when using multiple representations are essential. When the representations are used correctly and effectively, the feedback becomes quick and easy to read. When regarding multiple representations in the design of feedbacks, we argue that one can both see it as Kluge (2019), Ainsworth (2006, 2008) and Furberg (2009) does; different ways of presenting information, i.e. use of graphs, tables and equations; and as the use of images and illustrations to support the conversion of theoretical to practical understanding. To support this argument, we refer to the work of Vygotsky (2001) and Wertch (1991, 1998) where a language is a tool. Images, illustrations, and other representation of information are tools that convey a message, just like a language. As such, having multiple representations of information in the design of feedback is a tool that will improve the students' language, hence making them become part of the knowledge community.

DomíNguez et al., (2013, p. 391) found that having tasks that required the teachers to evaluate and give feedback did not work well because the students did not get the instant feedback that games are good at and it gave extra work burden on the teachers. In our case, we used both types of feedback, automated instant feedback and feedback given individually by the teachers, and we saw that they gave different values. The instant feedback proved to be a vital part of the application because, in the prototype; if we did not provide instant feedback after they performed an action, the students immediately missed it. DomíNguez et al., (2013, p. 391) suggest for future work that the teacher's work concerning feedback should be automated and they then refer to two studies on how neural networks can help provide personalised feedback that suits the students current level of knowledge. We will not argue that the route of neural networks should not be taken. However, we would like to add that it might not be necessary to involve such advanced technology. We can argue this because we saw in our research that giving all students the same feedback did not matter because mostly, they are in the same context of being first years with little prior knowledge, and what they need is not tailored feedback, but being given learning opportunities and shown where to go if they want to learn more (main finding #4). The social constructivist framework allowed us to see beyond just what cognitive aspects that affected the students view on the feedback, but also the social value of having a lower threshold feedback system from the group teachers. We would argue that the work the group teachers would have to put into giving individual feedback on the tasks that required it is worth it because both group teachers and students highly valued this lower-threshold way of communicating with each other. Because the application facilitated that this feedback was dialogue-based by being in a chat format, they felt that it was also a

place they could use to ask questions they might have for the group teachers, that feels less formal than sending an e-mail.

Nicol (2010, p. 501) did a study on how to improve the often monologue-based written feedback that students receive in higher education. He argues that in order for written feedback to be effective, it must be embedded in a dialogical context, thus promoting adaptive, discursive, interactive and reflective feedback (Nicol, 2010, p. 504). Our findings support this argument as we could see that the students appreciated the ability to reply to the feedback they received with questions. We also saw in our research that another significant advantage dialogue-based feedback could give is a lower threshold way of communicating with your more capable peer. Therefore, we argue that dialogue-based feedback is not only important because it is more adaptive, discursive, interactive and reflective, but also because it facilitates a space where the students and the more capable peers can talk to each other in a way that is less formal than e-mail. When designing for dialogue-based feedback, the format of the dialogue should be well structured, and one that is familiar to the user. Our findings have shown that this creates a better communicative flow between the sender and the receiver of feedback. Nicol (2010, p. 514) also suggests that while peer feedback has received mixed reviews, if multiple students give feedback it can provide a richness and volume of feedback dialogue that could be difficult for a single teacher to achieve. However, there are difficulties that need to be overcome in order for peer review to work. We saw during our research that the students have little to no trust in receiving feedback from other students, which Nicol also agrees with (2010, p. 514); the students have a lack of confidence in their peers. Nicol (2010) mentions a study done by Bloxham and West (2004) where the teacher reinforced the feedback given by peers. In our application, we could perhaps have provided a function that allow the group teachers to approve peer feedback thus assisting them on actually having to write any textual feedback themselves, but still give the students the needed trust in the feedback given by their peer. This would also serve as an indicator to the peer who gave the feedback that they did a good job. As Nicol (2010) states, the tasks of giving feedback to a peer can give highly valuable learning to the student giving the feedback, therefore, the group teacher should also have been able to give feedback on the feedback to the person who wrote it. Thus, creating a dialogue-based feedback loop that maximises learning for both peers, but leaves a minimal amount of work on the group teachers. Another aspect the technology could help with is providing the person giving the feedback with a checklist they must fulfil before they can send the feedback. This checklist must not be too long so not to overwhelm the user, but enough that the receiver of the feedback gains more trust in the feedback given.

As mentioned in Section 8.1, our empirical work showed that feedback and guidance must come from a human more capable peer when the students have reached the reflective tasks. The topic of AI vs human feedbacks came up a lot of during our user test evaluations, where students showed hesitation

for non-human feedback tasks which required long and reflective questions. This was because the students trusted the way humans evaluate and guide these kinds of tasks, rather than AI. The integration of student-student feedback and teacher-student feedback was said by our participants to create a low threshold platform for them where both parties felt comfortable. Additionally, the chat format for feedbacks created a low threshold for students to seek out more information when they needed it.

8.4 Contributions

To summarise this chapter, we will now present our contributions. Our first contribution is design considerations for designing learning opportunities, feedback, and motivation in learning technology. Within these three themes, we presented 18 design considerations for designing a learning technology that will act as a more capable peer. The three themes represent the most important ways digital technology can act as a more capable peer, i.e. through giving the student different learning opportunities, how to motivate them and what type of feedback is useful. The 18 design considerations and their three themes answer our main research question:

What design considerations should be made, when designing technology that will act as a more capable peer?

We have also contributed with design considerations for game elements in learning technology as we found that gamification is motivating if used correctly. For instance, one is motivated to see that the work one is doing (solving tasks) is leading one closer to one's goal (being prepared for the exam). When designing for motivation, one must also consider the language of the application; formal or neutral feedbacks from the application does not motivate students to engage in their learning, nor with the application. When designing for feedback, enabling dialogue between students, their peers and teachers and creates a low-threshold knowledge source.

Through operationalising our theoretical framework, we gained new insight into what social constructivist concepts were suitable to implement in digital technology for scaffolding students. The theoretical analysis revealed that the concepts of collaborative learning, situated learning and learning by doing were not ideal in our context. However, our empirical context was very specific in terms of what the students needed to learn. We will, therefore, not argue that they are not suitable, but we did not operationalise them and cannot contribute any new insight on them to the literature. Even so, we have contributed with insights on which social constructivist concepts are best suitable to answer our secondary research question:

Which social constructivist learning concepts are best suited to implement in digital technology when scaffolding students?

Through making knowledge available and content exam relevant, using gamification and motivational language to motivate, and allowing dialogue between teachers, students and their peers, we promote social constructivist learning. The main social constructivist concepts that facilitate these are scaffolded learning, active learning, reflexive learner and dialogue-based learning. As there exists mostly research on how new complex ideas are presented to children and teens (Ainsworth, 2006, 2008; Furberg, 2009; Kluge, 2019), our findings enrich the research on implementing multiple representations of information as our research has been on students attending higher education and with a social constructivist perspective.

What mainly sets our contribution apart from others, is the combination of theory and practice where theoretical principles are operationalised and implemented in design considerations (Ainsworth, 2006; Ainsworth, 2008; Barak, 2017; Kluge, 2019; Moreno and Mayer, 2005). There is research on technology and learning, where they have operationalised their theoretical framework, but with the use of different theoretical frameworks. Our contributions are aimed towards the research community of HCI; nevertheless, they are also relevant for the researcher in the field of pedagogy as we also made contributions to their literature on learning with technology. The contributions we have made in this thesis are mostly relevant for the interdisciplinary fields between education and technology as they involve both works of literature.

9 Conclusion

This thesis investigated how we can design technology to that will act as a more capable peer using a design thinking approach. We conducted the investigation at the University of Oslo with students that attend or have attended an introductory design course. Group teachers, who were previously students in the course themselves, also participated. Through our empirical investigation we have found that technology can act as a more capable peer. However, we argue for a technology that itself is not a more capable peer, but rather a tool to enhance scaffolding by adopting the characteristics of a more capable peer mixed with the characteristics of technology, to become a useful tool. As interpretive researchers with a social constructivist foundation, we believe that the role of technology is to extend and support human ability; we do not support the idea of technology replacing humans.

The five phases of DT made it possible for us to get closer to the student's academic life, as well as their hopes and expectations for the course and the future. Additionally, through our theoretical framework and related work, we have seen that the social aspect of learning is essential for the student's understanding, i.e. the students need a more capable peer to become better practitioners. The design course we followed during the fall semester had the students highly focused on understanding the terms and concepts of HCI and had an exam-oriented structure, i.e. the lectures and assignments prepared the students for the upcoming exam. As such, the skills of the 21st-century student became secondary to the traditional skills; memorise and reproduce information. Therefore, we saw an opportunity to provide the students with another source for information which enabled the needed skills for both the digital age that they live in and to prepare them for the exam. We also found in our empirical work, that collaboration and discussions with fellow students were the preferred methods for understanding all the new information. Based on our insights, we presented 18 considerations one should follow when designing for learning opportunities, motivation and feedback in a learning technology that promotes the skills that are required in the 21st-century and acts as a more capable peer.

The last phases of our DT process, which were affected by COVID-19 regulations, has shown how important technology is for collaboration and communication to keep a society going, and the importance of 21st-century skills in today's society. However, being able to socialise and interpersonal relations is still of concern for one's health and well-being, which emphasises that technology is best when it enhances people's ability and not replaces them altogether.

9.1 Future Work

Based on what we have seen in this thesis, this section will suggest some directions for future research by researcher in the interdisciplinary field of pedagogy and technology. Our main goal for this thesis has

been to investigate how technology can become a more capable peer. However, we did not get to implement the concept and test it with students while they were attending the course. As such, we would argue additional in-depth empirical research with a social constructivist theoretical framework to investigate whether our considerations are still valid and to identify issues that may occur if the concept is implemented in the design course.

Finally, we have approached this problem area using social constructivist learning theory, and our findings has shown the importance of interpersonal relations and constructing knowledge through social interactions. However, we did also find evidence that suggested an alternative focus, namely cognitive processes and internal mental processes. As such, we argue for additional research done with social cognitivism. We believe this will enrich our contribution, as there are useful and essential findings regarding active learning.

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Appendix A – Learning Tools

Clickers

A clicker is a type of Audience Response System (ARS) intended to make passive lectures more active by engaging the students in the lecture (Caldwell, 2007, p. 9). Clickers are mostly intended to promote active learning and student-instructor interaction in large classes (Mayer et al., 2009, p. 51). It has also shown to work well in group learning to help the instructor monitor the progress of the different groups (e.g. if they are confused or ready to move on to the next subject) (Caldwell, 2007, p. 18). Clickers are a type of digital technology that mediates active learning and social interaction in a large, previously passive lecture.

Collaborative design tools

Figma[1] allows teams to design and prototype solutions in real time by addressing a colour to each member. This way each individual can follow a team members movement by seeing where their arrow is, or which element they have selected. Figma also allows members to leave comments on your work. You can assign owners to a file, give people editing rights or just viewing rights depending on the role the team member is going to play in the design process.

Mural [2] is a digital workspace for visual collaboration, inspiration and innovation, based on design thinking. Mural, like Figma, allows teams to collaborate online by addressing a colour to each member. But unlike Figma, Mural is better suited for facilitating workshops and organize team efforts. Mural has features like timer, "follow the facilitator", a chat, comments and voting possibilities, which enables you to facilitate workshops online. In addition to this, Mural has several templates to help your design process; templates for the design, ideate, empathy, define, evaluate and prototype phases.

Collaborative text editors

Google Docs[3] allows you to create, upload and share documents. Like the tools mentioned earlier, the platform allows for real-time collaboration. It allows users to create text documents, slide presentations, spreadsheets, drawings, and surveys. Google docs enables collaboration by allowing teams to comment,

[1] www.figma.com
[2] www.mural.com
[3] www.drive.google.com

suggest editing, directly edit and chat in each document they are invited to. Google Docs is free to use with a Google account and unlike the tools mentioned earlier, easy to use on both desktops and smartphones.

Notion[4] helps you with organising your life and is available as a web, desktop and mobile application. It provides building blocks for you to create your own layouts and toolkit to get work done. Notebooks in Notion can be shared with other, creating a collaborating document platform for the team. Notion is free for students and educators.

Conference tools

Students at the UiO have the opportunity to use Microsoft Teams[5] along with the rest of the Microsoft Office 365 package with their UiO e-mails. Teams enables students to collaborate across platforms through video chats, screen sharing, file sharing, collaborative writing, arrange meetings and schedule work assignments. With Lucid chart teams can create flowcharts, process maps, UML models, and other diagrams. Lucid chart is available as a Microsoft Teams plug-in.

Zoom[6] allows for video and audio conferences, as well as a chat, on all platforms, operative systems and web browsers. Zoom is the preferred tool for remote meetings and lectures at UiO. With Zoom, students can work remotely with peers, attending lectures and for instance user test prototype with external users.

Collaborative learning tools

Unlike the collaborative tools we mentioned above, these tools were created with an educational purpose.

Padlet[7] is an online bulletin board application meant to help users organize their life whether it be notes from lectures or ideas for a hobby. Using Padlet in the classroom can enable collaborative knowledge construction by letting the students share and explore each other's understanding of a concept.

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[4] www.notion.com
[5] https://www.uio.no/tjenester/it/lagring-samarbeid/o365/
[6] https://www.uio.no/tjenester/it/telefoni-sanntid/videokonf/zoom/
[7] https://no.padlet.com/

Talkwall[8] is a tool meant for sharing information and developing knowledge in the classroom. This tool is based on research done by the UiO in collaboration with the University of Cambridge. Talkwall is based constructing knowledge with others through dialog.

Quiz/flashcard tools

Quiz and flashcard tools such as Quizlet[9] allow the user to create flash cards, quizzes and games in order to learn anything. The content is governed by the user themselves as they can create flash cards, quizzes and games specifically for the test or exam they wish to prepare for.

[8] https://talkwall.uio.no/#/
[9] www.quizlet.com

Appendix B – Consent Form

Vil du delta i forskningsprosjektet "Studie av læring med digitale verktøy"?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å forstå hvordan læring i et stort klasserom ved høyere utdanning. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Formålet med prosjektet er som nevnt over å få en bedre forståelse av hvordan læring i et stort klasserom foregår. Vi er ute etter å finne ut av hvordan design av digitale læringsverktøy kan gi økt læringsutbytte, særlig ved å fasilitere samarbeid og god studieteknikk. Dette vil vi gjøre ved å følge et stort fag med varierte undervisningsformer for å få en økt forståelse av hvordan de ulike undervisningsformene påvirker studentenes læring. Vi ønsker å se på spørsmål som:

- Hvordan kan vi gjøre store klasserom mer interaktive ved bruk av digital teknologi?
- Hvordan samarbeider generasjon-z i store klasserom?
- Hvordan motivere studenter til å jobbe sammen for å lære ved hjelp av digital teknologi?
- Hvordan kan samarbeid med digitale verktøy gi bedre studieteknikk?

Dette prosjektet er masteroppgavene til to masterstudenter ved Institutt for Informatikk på Universitetet i Oslo. Prosjektet vil vare frem til masteroppgavene er levert. Ved videreføring av prosjektet etter levert master vil all data anonymiseres.

Hvem er ansvarlig for forskningsprosjektet?

Masterstudentene Citona Marie Rygg og Yas Taheranpour samt deres veileder Suhas Govind Joshi er ansvarlig for prosjektet.

Universitetet i Oslo er behandlingsansvarlig institusjon.

Hvorfor får du spørsmål om å delta?

Du får spørsmål om å delta i dette forskningsprosjektet fordi du møter ett eller flere av følgende kriterier: Du tar eller har tatt emnet IN1050-Introduksjon til design, bruk, interaksjon ved Institutt for Informatikk på Universitetet i Oslo.

Du er eller har vært underviser, gruppelærer, plenumsforeleser og/eller obligretter i emnet IN1050-Introduksjon til design, bruk, interaksjon ved Institutt for Informatikk på Universitetet i Oslo.

Hva innebærer det for deg å delta?

Hvis du tar emnet IN1050-Introduksjon til design, bruk, interaksjon nå innebærer det at du svarer på et spørreskjema. Det vil ta deg ca 15 minutter. Spørreskjemaet inneholder spørsmål om deg (alder, kjønn, studieerfaring), dine studier, hvilke studieverktøy du bruker og din erfaring med gruppearbeid. Dataen samles inn anonymt via Universitetet i Oslo sin tjeneste Nettskjema og blir registrert elektronisk.

Vi vil også samle inn data gjennom flere spørreundersøkelser, observasjoner av de ulike undervisningsformene, intervjuer og workshoper. Det er helt frivillig å delta i videre undersøkelser og du kan når som helst slutte å delta i prosjektet.

Hvis du har tatt emnet IN1050-Introduksjon til design, bruk, interaksjon tidligere eller møter noen av de andre ovennevnte kriteriene innebærer det å delta på intervjuer, workshoper og observasjoner. Du kan velge å delta på det du ønsker og du kan når som helst slutte å delta i prosjektet.
Ved samtykke vil det bli tatt bilder under workshoper og observasjoner og lydopptak under intervju.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg. Det vil heller ikke påvirke dine studier på noen måte.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

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

- Det er kun de to masterstudentene Citona Marie Rygg og Yas Taheranpour samt deres veileder Suhas Govind Joshi som vil ha tilgang til dine personopplysninger.
- Alle personopplysninger som blir samlet vil bli lagret offline.
- Det vil ikke publiseres noen personopplysninger om deg.
- Personopplysningene vi samler inn fra deg er e-post, alder, kjønn og lydopptak ved intervju.
- Det vil ikke samles inn noen sensitive personopplysninger.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Prosjektet skal etter planen avsluttes 4 mai 2020. Etter prosjektet er slutt vil all data anonymiseres, tilfelle videre bruk. Alle opptak vil bli slettet.

Dine rettigheter

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

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

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke. På oppdrag fra Institutt for Informatikk har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?

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

- Institutt for Informatikk ved Suhas Govind Joshi på joshi@ifi.no.
- Vårt personvernombud: Maren Magnus Voll hos personvernombudet ved Universitetet i Oslo. Personvernombudet kan nås på personvernombud@uio.no
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55582117.

Med vennlig hilsen

Suhas Govind Joshi,	Citona Marie Rygg og Yas Taheranpour
(Forsker/veileder)	(Studenter)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet «Studie av læring med digitale verktøy», og har fått anledning til å stille spørsmål. Jeg samtykker til (kryss av de relevante boksene):

☐ å delta i intervju

☐ å delta i spørreskjema

☐ å delta i workshop

☐ å delta i digital workshop

☐ å delta i digital brukertest

☐ å delta i observasjon

☐ at det blir tatt lydopptak

☐ at det blir tatt bilder som publiseres

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet, ca. 15 juni 2020.

(Signert av prosjektdeltaker, dato)

Appendix C – Nomenclature

Table 1 *Table of nomenclatures*

More capable peer	A more capable peer is a peer that is on a higher level of understanding than the students present level. The more capable peer can, therefore, help lift the student to a new level of learning they would not be able to achieve themselves with the help of the more capable peer. The student will, by observing and collaborating with a more capable peer, be able to reach a higher level of learning.
21st Century skills (Hagelia, 2017; T&SB)	There are 12 abilities the learners of today need in order to succeed: 1. Critical thinking: Finding solutions to problems 2. Creativity: Thinking outside the box 3. Collaboration: Working with others 4. Communication: Effectively convey ideas to others 5. Information literacy: Understanding facts, figures, statistics, and data 6. Media literacy: Understanding the methods and outlets in which information is published 7. Technology literacy: Understanding the machines involved in the Information Age 8. Flexibility: Deviating from plans as needed 9. Leadership: Motivating a team to accomplish a goal 10. Initiative: Starting projects, strategies, and plans on one's own 11. Productivity: Maintaining efficiency in an age of distractions 12. Social skills: Meeting and networking with others for mutual benefit