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MusiCT: a support system for teachers when integrating computational thinking in music education

Master's thesis in Computer Science
Supervisor: Monica Divitini
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Abstract

As programming and other computer skills become essential for an increasing number of jobs, schools are increasing their focus on integrating these skills into existing educational systems. The Norwegian school system is no exception, and through a revolutionary change in teaching plans in 2020, it has made computer skills one of its new areas of focus. These changes have clear benefits for students, but also challenges for teachers that might not be as clear. As the curriculum evolves, teachers need to keep up with the changes by learning new things, increasing their competence.

This thesis looks at how digital systems can be used to support teachers in dealing with changes related to an increased focus on computational thinking, a set of methods used to solve complex problems through computational means. The specific case explored in this thesis is the integration of computational thinking with music education in the Norwegian school system. To help explore this case, I designed and implemented a prototype system, MusiCT, based on findings from literature and by looking at existing systems that provide support to teachers. MusiCT is a template-based learning activity creation tool, meaning it assists teachers in creating learning activities to use in the classroom that integrate computational thinking with music. MusiCT was evaluated in two iterations, first with 4 experts and then with 9 teachers.

Through the evaluation of MusiCT, it was found that the fields in a template for such a system should include the following elements: Grade, learning objectives, equipment, CT-methods, an activity title, a description of the activity, information related to assessment of the activity and what potential learning outcomes there are for students. It was also found that the concept used when designing MusiCT laid the foundation for a system that when implemented provides great support for teachers when creating learning activities that integrate computational thinking with music. As such, designing a system with the same or a similar conceptual model to MusiCT will result in a system that supports teachers in other cases.

Sammendrag

Etterhvert som programmering og andre dataferdigheter blir essensielle for et økende antall jobber, øker skoler sitt fokus på å integrere disse ferdighetene inn i eksisterende undervisningssystemer. Det norske skolesystemet er intet unntak, og gjennom en revolusjonerende endring i læreplaner i 2020 har de gjort dataferdigheter til et av sine nye fokusområder. Disse endringene har klare fordeler for elevene, men også noen ulemper for lærerne som kanskje ikke er like åpenbare. Etterhvert som pensumet utvikler seg må lærere holde tempo ved å lære seg nye ting og øke kompetansen deres.

Denne oppgaven undersøker hvordan digitale systemer kan brukes for å støtte lærere i å håndtere endringer relatert til et økt fokus på algoritmisk tenkning, et sett med metoder som brukes for å løse komplekse problemer ved å bruke digitale verktøy. Tilfellet som utforskes i oppgaven er integreringen av algoritmisk tenkning i musikkundervisningen i det norske skolesystemet. For å utforske tilfellet designet jeg og implementerte et prototype-system, MusiCT, basert på resultater fra artikler og eksisterende støttesystemer for lærere. MusiCT er et mal-basert verktøy for generering av læringsaktiviteter til å bruke i klasserommet som integrerer algoritmisk tenkning og musikk. MusiCT ble evaluert i to iterasjoner, først med 4 eksperter og deretter med 9 lærere.

Gjennom evalueringen av MusiCT ble det fastslått at en mal i et slikt system burde inneholde de følgende elementene: Klassenivå, kompetansemål, utstyr, AT-metoder, tittel for aktiviteten, beskrivelse av aktiviteten, informasjon tilknyttet vurdering av aktiviteten, og hvilket potensielt læringsutbytte det er for elevene. Det ble også fastslått at konseptet brukt i designet av MusiCT tilrettelegger et system som, når implementert, gir god støtte til lærere når de lager læringsaktiviteter som integrerer algoritmisk tenkning med musikk. Dermed vil man kunne designe gode støttesystemer for andre tilfeller ved å bruke et konsept likt, eller tilnærmet likt, det som ble brukt i MusiCT.

Preface

This thesis was written as a master thesis for the Department of Computer Science at the Norwegian University of Science and Technology. It marks the end of my five years at NTNU, achieving a master's degree in computer science, and the end of my 18 year journey in education.

I want to give the biggest of thanks to my supervisor, Monica Divitini, for guiding me through the specialization project last semester, and this thesis. Without you, I would have been totally lost and incapable of achieving this degree. With your advice and support you have led me to the checkered flag in this project that truly felt like a race against the clock at times. Grazie mille!

Next, I want to thank everyone that participated in this project, experts, teachers, and acquaintances alike. Needless to say, this project would have been nothing if it was not for you and your valuable thoughts on MusiCT and the entire project. For the experts, I admire your passion and knowledge about your fields. For the teachers, I hope that the results from this thesis will come to benefit you one day.

Finally, I want to thank everyone I have met along the way, be it friend or foe. In some way, you have all led me to this point and for that, I am grateful. I would like to particularly thank those who have been closest to me: Family, close friends, teachers, and past and current relationships, as you have had the greatest impact on me.

Trondheim, June 2022
Kristoffer Hegge Østreim

Table of Contents

List of Figures

List of Tables

Abbreviations

UDIR = Utdanningsdirektoratet
LK20 = Kunnskapsløftet
CT = Computational Thinking
CPB = Competence Boost Package
CS = Computer Science
NTNU = The Norwegian University of Science and Technology
SUS = System Usability Scale
AT = Algoritmisk Tenkning
CTL = Computational Thinking Language
UI = User Interface
LACP = Learning Activity Creation Page
NSD = Norwegian center for research data

Glossary

Teaching plan: A teaching plan is a set of guidelines for teaching given to teachers by UDIR specific to a subject

Learning Objective: A learning objective describes something a student should learn over the course of a year concerning a subject

Learning Activity: A learning activity is something that students do during a lesson with the purpose of teaching the students something

Computational Thinking: Computational thinking denotes a set of terms and methods used to solve problems using computational tools

1 Introduction

In recent years there has been an increased focus on providing computing education to more students than ever before through the "computing for everyone" movement (Guzdial 2015). The movement is concerned not only with providing opportunities for computing education to more students, but also to encourage more students to try computing. In Norway, this movement is reflected in the recent revamp of teaching plans by Utdanningsdirektoratet (UDIR) known as "Kunnskapsløftet", or LK20 for short (UDIR 2021b), where an increased focus on programming and computational thinking (CT) is one of the major changes (UDIR 2021c).

Alongside the changes in LK20, UDIR offered a set of "kompetansepakker", or competence boost packages (CBPs), to in-service teachers (UDIR 2021d). A CBP is a set of definitions, and tasks and challenges to be completed by teachers. The teachers then reflect in groups after each task. The idea is that the CBPs will help teachers to keep up with changes in teaching plans related to LK20 as they need to gain new knowledge of their fields and other fields to be integrated with it. One of these CBPs concerns programming and CT and is made for teachers teaching students in year 1 through 10 in the Norwegian school system (primary and lower secondary schools).

For in-service teachers, it can be a challenge to adapt to changes related to new teaching plans (Rouhani et al. 2021). Studies indicate that teachers are not sufficiently prepared to teach computing through their teacher education (Yadav et al. 2021) and teaching computing can also mean using different methods than what teachers are used to from before (Guzdial 2015). As such, there could be challenges for teachers related to the new changes made by UDIR now, and possibly in the years to come. These challenges should be addressed and teachers supported, the question is how to do this?

For this thesis, I designed and implemented a prototype system to support music teachers with integrating CT with music in Norwegian primary and lower secondary schools. The system was tested in two iterations: Firstly with teacher educators, and secondly with in-service music teachers. The purpose of this thesis is to investigate the type of system created and design decisions within the system to see if they help support teachers and deal with the relevant challenges.

1.1 Motivation

This thesis is motivated both personally and professionally. Regarding personal motivation, I wanted to do this research as I wanted to become a teacher for many years before changing priorities to computer science (CS). As a result, I am interested in the habits and challenges of the teacher profession, and I want to improve the current situation. I have chosen to focus on the music course because I play guitar and have an interest in music. As a result, this project combines my interests in the teacher profession, music, and CS.

The choice of focusing on the music course also has some professional motivation factors. Not only is the music course included in the relevant changes from LK20, but it is also a subject that has received little attention compared to others when it comes to integration with CS. Typically, the STEM subjects are in focus in this field of research. STEM stands for "Science, Technology, Engineering and Mathematics" and is commonly used to group these subjects (Gonzalez and Kuenzi 2014). This is reflected in existing support systems and task databases as they often do not list music as a supported subject. It is also seen in professional development courses for programming. The Norwegian University of Science and Technology (NTNU) offers such a course, and a lot of the in-service teachers enrolled are teaching STEM-related subjects. In 2020, the NTNU-course had 173 teachers enrolled with more than 80 % teaching STEM-related subjects (Rouhani et al. 2021). In addition, The University of Bergen (UiB) provides a course for integrating programming and CT in math (UiB 2022), but there is no equivalent for music.

1.2 Context

This report describes the work done in a master thesis project executed by a student of Master of Science in Computer Science at the Department of Computer Science at NTNU. The supervisor for this project was Monica Divitini. The project aims to create and test a support system for music teachers that deal with challenges facing the teachers as found in a specialization project executed in a previous semester (Østreim 2021).

The specialization project investigated possible challenges among music teachers when integrating CT with music in lower secondary schools. Through a set of interviews, the identified challenges were: A lack of competence regarding CT, little time to obtain new knowledge about CT, low priority from the administration, and a lack of communities. In addition to these challenges, the project was unable to determine if personal motivation is a challenge or not as the participating teachers cited motivation/interest as a reason for participation. If the teachers who chose to not participate did so due to a lack of motivation, it is still a challenge. The project also found that equipment can be a challenge. The amount and variety of available equipment in schools can vary a lot and in some cases will not be a challenge. However, some teachers did think that equipment was an issue. The specialization project provides a lot of background for this thesis as it is a direct continuation of it. As such, parts of its literature review will be repeated in chapter 2 as they are also relevant for this project.

1.3 Research Questions

There are many ways to support teachers in dealing with changes to teaching plans, but this thesis is based on the hypothesis that a system can be used as a way of supporting teachers as proven by existing systems and other prototype systems. Existing and prototype systems will be explored further in section 3.2. The thesis is also using the Norwegian school system and the role of CT in it as a case. Hence, the answers to research questions will be valid for the case of the Norwegian school system, but not necessarily for other cases. As such, the research questions should also be constrained to the relevant case. This gives us our main research question:

> **RQ 1**: How can a system support music teachers in integrating computational thinking into music education in Norway?

After reviewing related work and existing systems, the concept for the system began to take shape. This led to a design that produced more detailed research questions, giving us the following breakdown of RQ 1:

> **RQ 1.1**: What are the relevant fields in a template-based learning activity creation tool for music education?

> **RQ 1.2**: Will a template-based learning activity creation tool provide teachers with useful information about integrating CT in the Norwegian classroom and assist them in doing so?

RQ 1.1 does not mention Norway explicitly as what fields are relevant in a template does not depend on the case. It may differ from teacher to teacher due to differences in how they like to plan, but there should not be any commonalities among teachers in Norway that are not relevant for teachers in other countries.

1.4   Research Method

As this thesis aims to contribute to the knowledge base through a digital system, it follows the methodology of design science research (Hevner and Chatterjee 2010), sometimes also called design & creation research (Oates 2006). Design science research projects create artifacts to answer questions related to the real world and create new knowledge. These artifacts are typically sorted into four categories, one of which is called Instantiations. In this category we find prototype systems such as the one created for this thesis.

As this thesis functions as a continuation of the specialization project, the thesis enters the method of design science in the middle stages. As seen in figure 1, there are 3 cycles to design science: relevance, design and rigor. In the specialization project one half of a iteration was concluded for both the relevance cycle and the rigor cycle. It investigated the current knowledge base on challenges facing teachers as well as computing education, and helped define acceptance criteria for the artifact created in this thesis by identifying challenges among teachers. This thesis continues by performing two iterations of the design cycle through creation and testing of the artifact. It also completes the relevance and rigor cycles began by the specialization project by testing with end users (field tests) and adding to the existing knowledge base through the artifact respectively.
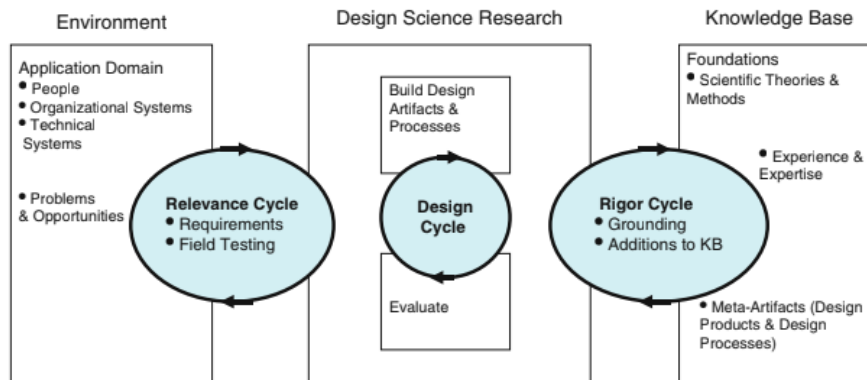
Figure 1: The cycles of Design Science Research (Hevner and Chatterjee 2010)

Because the thesis mainly focuses on designing and developing the artifact, the design cycle is in focus. Two iterations of this cycle are performed as the development is iterative, following an agile methodology for system development. Following the first iteration, interviews were done with experts in music education and computer science. These interviews consisted of a presentation of the conceptual model behind the system and questions referring to the system. The experts were asked to give their opinions on the design and functionality to further improve the system before testing with end-users, in this case in-service teachers. This brings us to iteration two, where the system was refined and finally tested with in-service teachers. These tests were more structured, following standards of user-tests. Data was collected through observations of the test-subject, an interview, and the use of System Usability Scale-forms (SUS-forms). As such, a combination of quantitative and qualitative data was analyzed. 2 pilot tests were done with people who are not teachers before the teachers tested the system in order to get feedback used to make some final improvements to the system. The pilot tests also provided some information on how well the tasks created for the user-test worked. The participants of the pilot tests completed the user-test and filled out a SUS-form. They did not participate in an interview after the test as the questions were designed for teachers with appropriate knowledge of a teacher's working processes.

1.5   Results

The project concluded by answering the research questions RQ 1.1 and RQ 1.2. The concept for the system created for the thesis (MusiCT) was found to provide the foundation for a system that teachers liked and thought would be helpful in supporting them when integrating CT with music. Additionally, the project concluded that a template-based design should include fields for grade, learning objectives, equipment, CT-methods, an activity title, a description of the activity, information related to assessment of the activity and what potential learning outcomes there are for students. A field that was missing, but was suggested was a field for multimedia content.

The results listed above were validated by also measuring the usability of the system. The usability was found to be good with an average score of 80,5 and a median score of 82,5 on the filled out SUS-forms alongside positive observations from user tests. As such, the usability was said to not affect the opinions of participants regarding the underlying concepts of the system in a negative way.

1.6   Outline

This thesis consists of 9 chapters in total and includes 7 appendices. Chapter 2 looks at CT, the case of the Norwegian school system and other pieces of background information. Chapter 3 provides theoretical background in the form of instructional design theory as well as related work in the form of existing support systems. The thesis then goes into the system created for it, MusiCT. Chapter 4 describes the design process before chapter 5 details the implementation of the design. Chapter 5 also discusses the technological solutions chosen to develop the system.

The system was evaluated twice, first with experts and then with teachers. Chapter 6 details the expert interviews that were done after the first iteration of development and discusses the outcomes of this evaluation. Chapter 7 describes changes made to the system during iteration 2 of development based on the results from the expert evaluation. Chapter 8 then details the final evaluation, done with teachers. Chapter 9 closes the thesis by providing a conclusion as well as discussing limitations for the project and future work building on this thesis.

2   Background Information

This chapter provides some background information related to the problem. As mentioned in chapter 1, the project aims to create a support system for music teachers in Norway, but in order to understand how the system should be designed one needs to look at the bigger picture. To do this, the chapter begins with looking at what computational thinking is, its history, and how UDIR views CT. This is important as it is related to the content within the system. Next, the environment relevant to the project will be discussed in order to identify the people that will be using the system and the user-context. The new teaching plans and the CPB for programming and CT are also discussed as these are relevant to the content within the system and provides motivation for the system. Finally, 2 sections copied from the Specialization project regarding CT and its use in education are included.

2.1   Computational Thinking

"What is computational thinking?" is not an easy question to answer. What can be said about it is that it has received a lot of attention since the term was introduced and has been important to the "computing for everyone" movement. This is reflected by UDIR's decision to adapt it for Norwegian schools and include it as a part of LK20.

2.1.1 The History of Computational Thinking

Computational thinking as it is known today was first introduced by Jeannette Wing in 2006 (Wing 2006). In her article, Wing proposes CT as a fundamental skill for everyone and not just computer scientists. As such, using CT in other disciplines such as music is central to Wing's reasoning of why CT is beneficial. In short, CT is a way of thinking which allows a human to solve complex problems in a structured way, using methods of computing as a tool. CT is therefore the knowledge of how to use those tools. Wing mentions that CT does not mean to think as a computer, but rather to know how to use them efficiently for problem solving.

When claiming that CT is a fundamental skill, Wing argues that everyone should know CT in order to function in modern society. She also suggests that it should be taught from an earlier age than what most computing education courses aim for now. Today, most computing education occurs in higher education (Guzdial 2015), but Wing claims that CT should be taught to pre-college students using the following messages to motivate these students:

1. Intellectually challenging and engaging scientific problems remain to be understood and solved

2. One can major in computer science and do anything

It is clear from Wing's article that it is not only meant to introduce CT as a term, but it also aims to promote computing to a broader audience, showcasing why it is useful and why people should enroll in computing education as motivated by the messages above. Attracting students to the computing field has been a long-standing issue despite the massive growth of the IT-industry in recent years (Lu and Fletcher 2009). By using CT as an introduction to computing, this issue could be resolved.

In her 2006 article, Wing discussed what CT is and what it is not, but she did not provide a concise definition of CT. In 2010, she wrote a follow-up article providing a more concise definition of the term: *'Computational Thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent.'*(Wing 2010)

As Wing's 2010 article is a follow-up to her introduction of CT in 2006, she discusses how CT has started to influence other disciplines and people's daily lives. These areas of influence were identified in her 2006-paper, but without many examples. In the follow-up paper, Wing mentions active areas of study such as algorithmic medicine and computational finance are mentioned as examples of CT influencing other disciplines (Wing 2010). It is clear from these examples that CT can indeed influence other disciplines. However, regarding CT influencing people's daily lives, the examples provided are not as clear-cut. They all come from stories provided to Wing by the CS department at Carnegie Mellon university and are at such a high level of competence that it goes beyond what CT can provide on its own.

From Wing's 2010 article, it seems that CT is more beneficial for influencing other disciplines than influencing people's daily lives. This has also been claimed by Mark Guzdial who is skeptical about applying computing ideas in daily life, partially due to how hard it is to prove and demonstrate knowledge transfer (Guzdial 2015). In his 2015 book, he initially listed CT as one of 6 reasons to teach computing to everyone, but by the end of the book this list had been reduced to 4 with CT being one of the 2 reasons removed. More recently, in 2020, Guzdial said that he had given up on CT entirely because the term lacks an accepted definition (Guzdial 2021). As such, CT is not without its fair share of criticism.

2.1.2 Computational thinking in Norway

As mentioned above, CT is hard to define and there is no commonly accepted definition. What is certain is that CT includes a lot of concepts and methods, and many researchers focus on identifying these rather than creating an ultimate definition (Juškevičienė and Dagienė 2018). A similar approach has been taken by UDIR who have translated the term to "Algoritmisk tenkning" (AT). Interestingly, "algorithmic thinking" is a term defined in 1967 that is closely related to CT, but focuses on what a computer scientist does rather than how they think (Guzdial 2015). Even though AT is a direct translation of this term, AT is more closely related to CT and must not be confused for the algorithmic thinking defined in 1967. UDIR have not provided a concise definition of AT, but instead focuses on the key terms and methods included in it and uses the poster seen in figure 2 to summarize them (UDIR 2021a). For the remaining part of this thesis, CT will be used as a term denoting both computational thinking and "algoritmisk tenkning" based on the assumption that we define CT in the way UDIR have defined AT.

Figure 2: Poster for AT by UDIR (UDIR 2021a; Adapted from Barefoot Computing)

2.2 The Environment

The environment is the setting in which the problem lies. As the project focuses on a system to be used by teachers, schools are a part of the environment as they are relevant to how the system will be used, and the output of the system functions as an input for the school system. For the specialization project, lower secondary schools in the Norwegian school system was chosen as the case. This was done to limit the scope of the project and because CT is used to solve complex problems and lower grades lack complexity (Østreim 2021). However, for this thesis the environment has been extended to also include primary schools. This means that the case is now grades 1 through 10 in the Norwegian school system. The choice to include primary schools was made for several reasons. Primarily, the change was made as teachers interviewed during the specialization project mentioned that music teachers in primary schools often had little to no knowledge about music theory, potentially making it even harder to integrate CT. Secondarily, the CPB for programming and CT is made for grades 1 through 10, meaning primary schools are included in the envisioned changes and should also be supported. Finally, a larger environment gives a larger set of potential participants.

In addition to the relevant grades, the music course is part of the environment as it is the relevant subject to the project. The music course is taught throughout grades 1-10 with UDIR providing explicit competence goals for second, fourth, seventh and tenth grade (UDIR 2021f). In lower secondary school the course is graded with an overall grade and no additional exam in the tenth grade. As students get older, the learning objectives become increasingly more complex beginning with basic musical elements such as rhythm and tempo through song and dance, and gradually incorporating more and more of musical history and its social values as well as ability to create and preform music through digital and analog means (UDIR 2021f).

2.3   The New Teaching Plans and Competence Boost Packages

As a part of LK20, there are new teaching plans for the music course. The previous plans had remained unchanged since 2006 and there are a lot of similarities between the old and new version. For example, grading remains unchanged and the number of hours allocated to music education is the same, and still the lowest of all subjects. However, the increased focus on interdisciplinary topics in LK20 can also be seen in the new teaching plans for music (UDIR 2021e).

As an increased focus on programming and CT is one of the major changes in LK20 it has led to changes in many courses. In mathematics, one of the learning objectives for the tenth grade is to be able to explore mathematical properties and contexts through programming (UDIR 2022a). In Science, tenth-graders should be able to use programming to explore natural phenomenons (UDIR 2022b). In music, programming can be integrated in a number of ways, but integrating CT on its own is more difficult. This is because CT is more abstract in nature as it is a way of thinking and as such it is not as explicitly coupled to a certain task. CT is also not mentioned in the learning objectives for music, making it more difficult for teachers to know what is expected of them. UDIR claims this is because CT is a way of working with complex problems and is not limited to music. Instead, by working with music through the methods included in CT in addition to using the same methods in other courses, students will be able to see that one can solve different kinds of problems by using CT (Farstad-Jensen 2021).

Along with the new teaching plans, UDIR created the CBPs mentioned in chapter 1. The CBP for programming and CT is created for grades 1 through 10 and includes a common part as well as specific parts for mathematics, science, arts and crafts, and music. Currently, this is the only support system provided by UDIR. In the music specific part, the CBP suggests that programming can be integrated through the use of synthesizers and sequencing of audio clips in a digital audio workstation (DAW) in addition to traditional programming. For CT, the CBP provides brief explanations of the terms and methods included in CT and some examples of how they appear in music. Still, the material provided in the CBP does not go in-depth and provides no examples of tasks that can be used in the classroom. The CBP is meant to be used in cooperation with other teachers at a school and does not facilitate communication between teachers from different schools, nor with experts in computing. This lack of communication with others was identified as a challenge in the specialization project (Østreim 2021).

For teachers, the changes can come with challenges as proven by the specialization project. From a theoretical point of view, there is an issue with the type of knowledge music teachers possess versus what they require. Lee Shulman claims teachers require two types of knowledge to teach: Knowledge of the content, and knowledge of the process (Shulman 1986). For music, this entails that a teacher not only needs to know music theory, but also have some pedagogical knowledge that informs the teacher of how to transfer their knowledge of music to the students. One can assume that music teachers today have the necessary content and process knowledge for the old teaching plans in music. With the introduction of CT however, new knowledge is required about what CT is (content knowledge) and how to teach it (process knowledge). The CBP supports teachers by providing some content knowledge, but very little process knowledge. Thus, a better support system is needed that also considers how to teach CT as discussed in section 2.4.

2.4   Teaching CT (From Specialization Project)

While a lot of research looks at teaching computing and programming, there is less research focusing on teaching CT. Teaching CT is different from teaching programming because programming is a task and CT is a way of thinking. One could argue that programming in computing is what proofs are in mathematics, meaning that it is not the first thing one should look at within the field (Lu and Fletcher 2009). Instead, CT can work as an introduction to CS before starting to learn programming. There are a number of articles that look at the pedagogical aspects of teaching CT and a lot of them focus on integrating CT into other subjects taught in schools as CT itself does not warrant a separate course.

One way of integrating CT in other subjects is through language and using what is known as a computational thinking language (CTL) (Lu and Fletcher 2009). CTL allows teachers to describe methods by using terms from CT. As an example, addition can be seen as an iteration in a multiplication. $3 \cdot 6$ is the same as adding 3 to itself 5 times, thus creating 5 iterations. Iteration is a method from CT and thus the student now has a way of thinking about this method related to mathematics in this case. In this way, students are introduced to the terms in a subtle yet efficient manner and by starting early and gradually increasing the usage and complexity of tasks and the CTL used to explain the methods used, students will have a deep understanding of CT when they get to the point where they encounter programming (Lu and Fletcher 2009).

While CTL is an approach that focuses on language, another paper focuses on CT as a way of solving problems and how different methods of problem solving utilizes methods from CT. Rather than incorporating CT into existing tasks, one redesigns existing tasks to increase the presence of CT by substituting more traditional problem solving methods with those found in CT (Kale et al. 2018). The authors argue for a strong connection between traditional methods and those found in CT summarized in figure 3 below. The paper provides some examples of how to use the methods in different courses. For instance, the "load reduce" method can be related to algorithms and automation from CT, and the paper provides an example of doing this while teaching Spanish.
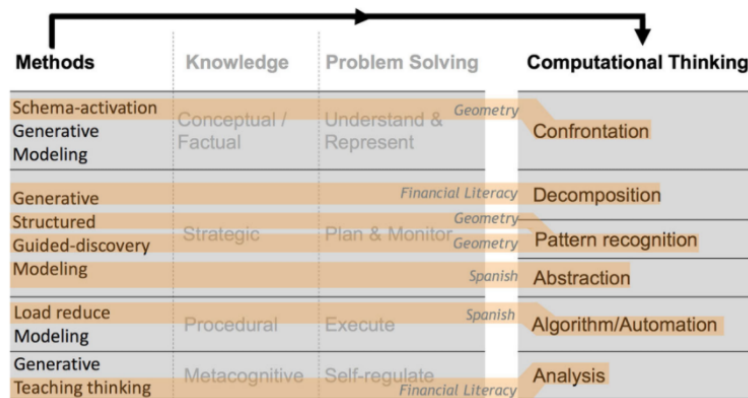
Figure 3: Methods for teaching problem solving and their connections to computational thinking (Kale et al. 2018)

2.5   Integration With Music (From Specialization Project)

While digital tools and instruments have been used in music for a while now, integrating CS into music education is an emerging field of research. Music education has received less attention than many other subjects. As an example, it was not mentioned in the report by Barr and Stephenson outlining the results of the efforts of the International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA) in identifying ideas of how to integrate CT in various content areas (Barr and Stephenson 2011). The same report did however address mathematics, science, social studies and language arts.

A lot of the work done with integrating CS in music education is done at the university level by designing courses for both groups of students to come together and learn from each others disciplines. One paper describes how students made games using instruments to play them (Silla et al. 2016). Another paper looks at the results of combining a class of music students with a class of CS students to create programs to write musical notations created by the music students (Heines et al. 2009). Both of these examples of integrating CS with music are at a much higher level than what is expected of lower secondary school students. They also do not focus on CT.

Regarding CT specifically, there have been some articles written on teaching the methods found in CT through music. The articles tend to focus on providing examples of tasks to use in classes and explaining how they teach CT. One paper looks at an interdisciplinary course at the university level and provides good examples of teaching CT by coding using Scratch (Ruthmann et al. 2010). Some of these tasks could work at a lower secondary level as well. Another paper focuses on much more simple tasks, and even some without the notion of coding at all (J. Bell and T. Bell 2018). The tasks described in this paper could be used at a lower secondary level and even in primary schools. Both of these papers present the tasks and explain how CT is integrated in a way where the teacher should be able to use the task in class after reading. However, they do not touch on pedagogical aspects of teaching CT.

2.6 Summary

To summarize: CT is difficult to define and should be viewed as a collection of terms and methods used for solving complex problems. This mindset does not mean to think like a computer, but rather gives one the ability to use computers as a tool. CT can be beneficial for everyone as computing surrounds us in an increasingly digital world. Despite some people having doubts about the usefulness of CT, UDIR have decided to create their own version of CT which is to be integrated in a number of subjects in Norwegian schools. The music course is on the list of subjects where CT could be integrated, and has its own part in the CBP for programming and CT. Despite this, the CBP does not support teachers in a way that considers content AND process knowledge, meaning a better system should be implemented that deals with the relevant challenges facing in-service teachers.

3 Theoretical Background and State Of The Art

This chapter will review theoretical background in the form of instructional design theory and the state of the art on developing support systems for teachers. Instructional design theory is reviewed to describe some models for working processes that teachers use when planning lessons. The artifact created for the thesis should fit into these working processes. Similar systems are reviewed to find inspiration for the artifact.

3.1 Instructional Design

Instructional design can be described as a systematic procedure in which educational programs are created to improve learning (Seel et al. 2017). It is also a scientific discipline concerned with educational planning, both long-term and short-term. The system created aims to support the procedure of instructional design as teachers make educational plans. Making such systems is often referred to as instructional systems development (ISD). It is worth noting that instructional design is historically an American tradition and can be seen as equivalent to the European tradition of didactics as there are a lot of similarities between models from both disciplines (Seel et al. 2017).

3.1.1 Decision Making in Instructional design

When developing educational plans, a number of decisions must be made by the instructional designer - which in this case is a teacher. Instructional design is in fact so closely related to decision making that some view it as a decision making process (Seel et al. 2017). As referred to in (Seel et al. 2017), Harris and Hofer (2009) claimed that any learning event can be described as the result of these five basic instructional decisions:

1. Choosing among instructional goals

2. Making practical decisions about the nature of the learning experience

3. Selecting and sequencing appropriate activity types to combine to form the learning experience

4. Selecting formative and summative assessment strategies that will reveal what and how well students are/were learning

5. Selecting tools and resources that will best help students to benefit from the learning experience being planned

As these decisions are crucial to the design of learning events and in turn, learning outcomes, it is important that they are made by knowledgeable people. One tends to look at two types of decision making in instructional design: rational and intuitive. While rational decision making is traditionally seen as the best, intuitive decision making has its place, and can even lead to the best results. This however depends on the competence and prior experiences of the individual making the decision. Baumert and Kunter (2006) argued that individuals with the necessary professional knowledge at their disposal can make good decisions intuitively (Seel et al. 2017). Professional knowledge has three core dimensions: content knowledge, general pedagogical knowledge and pedagogical knowledge. These relate to the PCK-framework described by Shulman (Shulman 1986). As mentioned in section 2.3, teachers might lack this knowledge when changes are made. Thus rational decision making is preferred for novices (Seel et al. 2017).

3.1.2 Models of Instructional Design

There are many theories within instructional design and educational research, but these theories tend to be very broad and complex. This makes it hard to use the theories for specific scenarios without additional support. This is where models of instructional design come in. The models act as a representation of a theory that simplifies it and makes it usable for simpler cases (Seel et al. 2017). In instructional design, models tend to be either procedural or conceptual. Procedural models are geared to systems theory and thus will be in focus for this thesis.

The Dick-Carey model is a classic in instructional design, and is maybe the most well-known model of the first generation. It is a procedural model containing nine steps of design before the final evaluation of the instruction. It is also a systems-oriented model meaning it is often used to create long-lasting instructions such as an entire course. The model is typically described using a flowchart as seen in figure 4. The model follows an iterative process where the instruction is improved after reflection. Often, some steps are predetermined and not chosen by teachers. As an example, instructional goals tend to be specified in teaching plans by UDIR in the form of learning objectives.
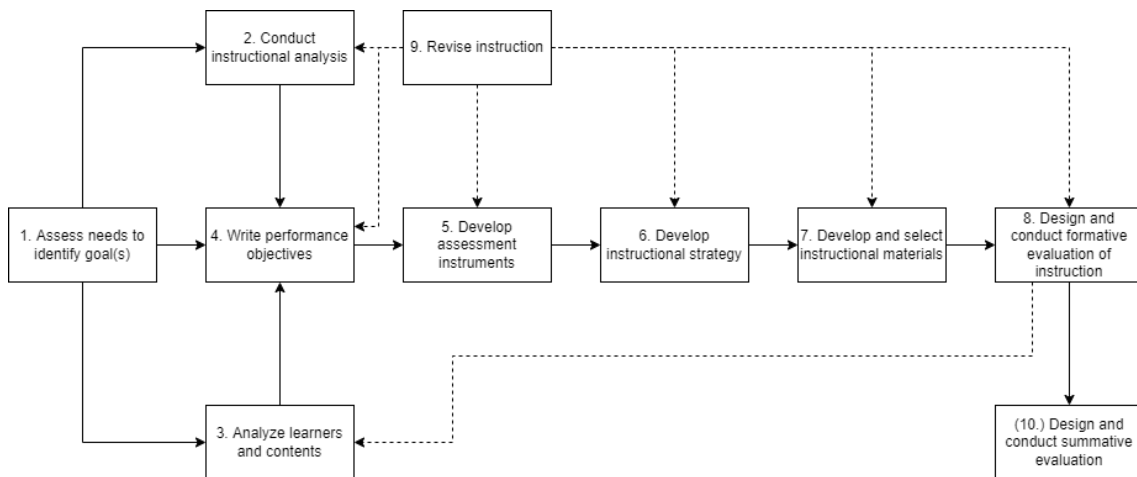
Figure 4: The Dick-Carey model

A model similar to the Dick-Carey model is the model made by Gerlach and Ely in 1971. It is a classroom-oriented model meaning it aims to support professional teachers in various classroom settings. Classroom-oriented models also tend to produce smaller instructions and are usually not very complex (Seel et al. 2017). The Gerlach-Ely model (see figure 5) is one of few models that considers content alongside learning objectives as a starting point for creation of instructions. As such it is usually suitable for instructional designers who have a high degree of competence within the relevant content domain for the instruction. Similar to the Dick-Carey model, it is procedural and iterative. A third category of models, product-oriented models, does exist, but will not be described in detail in this thesis.
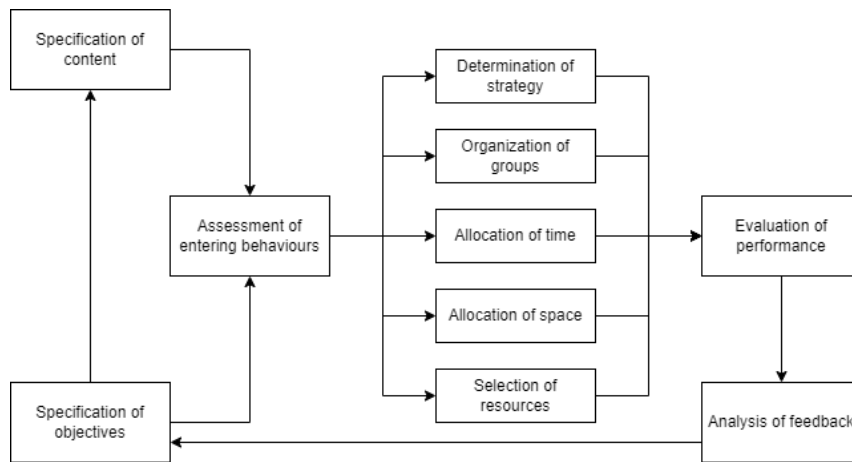
Figure 5: The Gerlach-Ely model

Both the Dick-Carey model, the Gerlach-Ely model and many other models are nowadays seen as examples of using the ADDIE framework. Similar to CT, ADDIE is a term that causes some discussion around what exactly it is, but it is commonly accepted that ADDIE is an umbrella term for most procedural models in instructional design (Seel et al. 2017). ADDIE is also referred to as a framework and is an acronym for Analysis, Design, Development, Implementation and Evaluation. These components and their interaction, as depicted in figure 6, try to explain the processes involved in developing an instructional system. Still, as seen with the Dick-Carey and Gerlach-Ely models above, the way in which the processes of ADDIE are done differs between models.
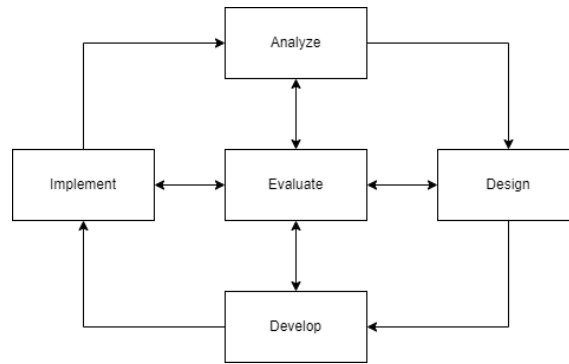
Figure 6: The ADDIE-framework

3.2 Existing Support Systems

As mentioned in section 3.1, making systems that are concerned with instructional design is often referred to as instructional systems design. In addition, instructional design experiments can be seen as research aiming at improving education in practice through the use of information and communication technology (Seel et al. 2017). From this it is clear that the field of instructional design is, among other things, concerned with the development of systems and using technology. As such, there are a number of existing systems that support teachers in some way. This section will present some existing systems, first from other research projects and then commercial systems used by end-users.

3.2.1 Planning Aids from Research

This section describes 4 systems. These systems are all lesson-planning tools developed for, and/or used in, research projects. While some may have been used for other purposes following the completion of the research projects, none of the systems are available to the public today. The articles associated with the systems were found through another master thesis (Kristiansen 2021).

SmartLP is a case-based system that supports lesson planning as described in (Saad et al. 2014). The system applies a case-based reasoning approach meaning that the system provides the user with existing lesson plans from similar cases to their own. This gives the user a starting point to create their own plan by modifying the existing one. Plans are described and modified following a template. The system also allows for sharing plans with others as this is needed for the case-based approach. The authors mention three main problems related to lesson planning that SmartLP attempts to solve: lack of time, lack of support for sharing plans, and isolation culture, citing one of the authors' doctoral thesis. The results of the study where SmartLP was used showed that plans were created much quicker through using the system without a significant drop in quality of plans (Saad et al. 2014).

Inquiry in Motion (IIM) is a system designed to support creation of inquiry-based lesson plans for mathematics. The system, as described in (Sloop et al. 2014), is template-based just like SmartLP. Overall, the system is very similar to SmartLP, but also includes functionality for teachers to collaborate on creation of plans. IIM also allows users to stream media from the site, making its sharing of content wider in scope than that of SmartLP. Another important part of this system is its target audience. The system is heavily specialized towards use in mathematics and for teachers located in the US. This is reflected in the fields found in the template used to create lesson plans as they include standards from the US educational system. Whereas SmartLP was tested, (Sloop et al. 2014) does not provide any results proving that the system is beneficial for teachers. The authors do mention that they hope the system will lead to a larger number of easily accessible plans.

Phoebe is a system made for professional development courses which helps to design effective and pedagogically sound learning activities (Masterman and Manton 2011). The system uses a wiki of reference materials in addition to a template-based lesson planning functionality. (Masterman and Manton 2011) tested the system with professional development educators to investigate, among other things, how the system can add value to teachers' individual practice. The combination of a database of reference materials along with a lesson planning tool was found to be one of Phoebe's key strengths, with novice teachers finding the reference materials particularly valuable.

The authors found that the template that was used received mixed reactions. Some teachers felt like the template was to restrictive and forced them to design their lesson plans a certain way that did not correspond with how they would normally do it. Others felt like it was helpful and matched their own style of planning. Just like the other systems mentioned above, Phoebe allows for sharing of lesson plans. This was found to be beneficial for most participants, but some argued that finding examples that were good enough was difficult due to a number of factors (Masterman and Manton 2011).

IPAS is another system that uses templates to allow teachers to design their instructional plans (Liu and Juang 2002). The system is made for plans larger than a single learning activity, but supports creating learning activities as a part of the larger plan. Templates are claimed to be beneficial as they simplify complicated tasks and support sharing of plans which the system also allows. Another method employed by the system is "quoting model plans". This means that teachers can find related plans based on some arguments passed by the user and use one of the related plans as the starting point for making their own plan by modifying it. Teachers also have a personal portfolio of their created plans.

To summarize the findings from these systems, the common denominator is the use of templates when planning. This is said to simplify the process of planning without losing quality of the created plans. Still, the design of a template probably will not fit all users, and some might find the template to inhibit their planning rather than support it. Outside of the template-based planning, the systems provide varying functionalities including sharing of plans, collaboration when planning, and use of existing plans. IIM is designed for a very specific case just like the system designed for this thesis. It connects plans to learning objectives, or standards as they are referred to in the article, from teaching plans designed by the governing organization in that environment: the US. The other systems do not include this as they are more general.

3.2.2 Commercial Resources and Planning Aids

This section describes a range of commercial systems available to teachers. These systems were found using the Google search engine. All of the systems mentioned were created to support teachers, but do so in different ways, either as a planning aid, resource or a combination of the two. While the systems in the previous section were rather similar, these ones differ more and a comparison of the systems is presented in table 1. This table details if systems are connected to the Norwegian curriculum in any way, if they explicitly mention and support CS as a subject, if they explicitly mention and support music as a subject, if the system allows users to create lesson plans, and finally, if the system supports communication between users. These properties are all desired properties for the system created for this thesis.

Lær Kidsa Koding is a voluntary group that aim to create better learning opportunities for children related to the digital society we live in (LærKidsaKoding 2022). The website "KidsaKoder" provides a number of free tasks related to CS that can be used at home or in the classroom. The task database is viewable in student- and teacher mode, with teacher mode giving additional information about the task. Tasks can be filtered by subjects and the system supports tasks related to music. The website also provides a forum where tasks and methods are discussed. That being said, the forum is not very active with the most recent post being from March 2020 (LærKidsaKoding 2022). In general the system provides the opportunity to communicate with others, but does not promote it. The forum pages are hard to find, and there is no functionality for comments or reviews on the tasks themselves. As the organization is Norwegian, the tasks fit the Norwegian school system well and are often linked to one or several learning objectives from the teaching plans made by UDIR.

Musikkpedagogikk.no is a website created by Eldar Skjørten, a music teacher (Skjørten 2022). The website is ran by Eldar and includes links to his other projects, courses to enroll in, a blog and a podcast. In addition to this, the website also offers some sets of tasks that can be purchased. As Eldar is the only one providing content to the website, the amount of resources is limited. Despite this, the resources are created to be used by Norwegian teachers and hence take the Norwegian curriculum into account. Using the search functionality on the website, no resources were found that included CT. A couple of teachers interviewed in the specialization project did mention this site during their interviews, meaning this is one of the most relevant support systems that music teachers have today. With no mentions of CT it is clear that there is a need for better resources on CT in music.

Dybdeundervisning.no is a website created by Kent Kirkhaug and Kine Caspersen, two teachers (Kirkhaug and Caspersen 2022). The website provides a large number of learning activities, mostly relating to physical education and focused on "in depth learning", related to the Norwegian curriculum. The website uses a licensing strategy, meaning one must pay for a license to access the resources found on the website. The licenses they offer last for 1 year. Without a license it is hard to say anything about the quality of the learning activities, but from looking at the website it seems that at least some tasks are related to CS, but none are related to music education. The site also does not give users the opportunity to communicate in any way nor contribute to the resource pool.

ISTE stands for the International Society of Technology in Education. They are an organization that promote using technology to transform teaching and learning (ISTE 2022a). ISTE provides resources for professional development for teachers and among these resources is a course on integrating CT in other subject areas (ISTE 2022b). The course is made for educators of all subjects and requires about 15 hours of work. It is not specific to music as a subject and how to integrate CT with music, nor the Norwegian curriculum or school system. While this may be a great way to increase teachers' competence, the course does not allow for continuous development. Once a teacher has completed the course, there is nothing more to do. The other systems, that provide an ever-growing pool of resources, are able to evolve over time and where communication is available, create a community.

Common Curriculum is a website for lesson planning (Curriculum 2022). This system is meant to be used as a way to both plan lessons and organize them in a calendar-like fashion. As a user, you create one or several courses that you wish to plan for and subsequently create plans for lessons in those courses. The lesson plans follow a template and the system provides several templates to choose from. In addition, the system supports linking plans to educational standards from all 50 US states, but not standards from other countries such as Norway. While lesson plans are not shared in a site-wide database, you can choose to share your plans with other users. You can also collaborate with other users and register a school in the system as well as individual users. A strength of this system is time-organization of created plans.

Blendspace allows users to create lesson plans using their own content or content from other sources such as Google, Youtube and Tes (Blendspace 2022). Lesson plans are made up of a set of activities that can be placed in whichever order the user wants. The lesson planning interface has a search bar where the user can type what they are creating a lesson about. Blendspace will then search the resource pools it draws from to find relevant teaching materials that the user can review and use if relevant. Created plans can be shared in a site-wide database. The lesson plans available in the database can be copied and imported into the users personal portfolio of lesson plans to use or modify. Even though lesson plans made by other users are available, the site does not provide any functionality for users to interact aside from the option to "like" a lesson plan. Blendspace also does not support linking plans to learning objectives and is a resource not specific to any subject nor teaching plan. As a result it does not provide any explicit support for any subjects nor teaching plans.

	Nor. Curr.	Supports CS	Supports Music	Plan creation available	Supports Communication
Kidsakoder	X	X	X		X
Musikkpedagogikk	X		X		
Dybdeundervisning	X	X			
ISTE		X			
Common Curriculum				X	X
Blendspace				X	

Table 1: Properties of the investigated commercial systems

As seen in table 1, there is no system that ticks all of the boxes. While Common Curriculum and Blendspace could be used to plan for both music and CS, it does not have any specific support for these subjects. Perhaps more importantly, they do not support standards from the Norwegian school system. KidsaKoder ticks almost all of the boxes, but does not provide tools for teachers to create their own plans. They do provide a way for users to submit tasks to be added to the database, but beyond that there is little users can do to add to the contents of this system. The course provided by ISTE is a good way to give teachers an introduction to CT, but does not offer long-term support. While its contents should be general enough to be used in music, teachers interviewed for the specialization project felt like there should be a music-specific part regarding CT in teacher education (Østreim 2021). Assuming this goes for their own acquisition of knowledge about CT as well, the course from ISTE would not cover the needs of teachers. It also uses a definition of CT that differs from the definition by UDIR. Only KidsaKoder and Common Curriculum provide support for communication between users. It is possible to contact the people behind Musikkpedagogikk.no and Dybdeundervisning.no, but not other teachers using the same resources to compare experiences. Without being able to communicate with, or be aware of, other users, teachers will likely feel the same lack of communities that was identified in the specialization project when using these systems.

4   Design of MusiCT

In the previous chapters, the current situation has been described both in terms of the problem area and work done in this area previously. This all builds towards helping to design an artifact in the form of a support system for teachers, the process of which will be described in this chapter. The chapter discusses how the literature motivates the chosen design, presents a conceptual model for the artifact, and finally lists the requirements that were set for the artifact. When referring to "the artifact" in this chapter, I refer to MusiCT, the system designed and implemented for this thesis. The design described is for the initial artifact, created before any testing was done.

4.1   Motivation from Literature

The goal of reviewing the related work presented in chapter 3 was to answer some questions, mainly how one can design support systems to deal with the identified challenges from the specialization project: Low competence, lack of time, low prioritization from administration and lack of communities. Dealing with these challenges is the foundation for the artifact to be created and it will focus on solving these issues. The findings for dealing with each challenge will now be presented.

Low competence is a challenge that can be solved through acquiring new knowledge. The theory of andragogy gives some claims as to how this should be done for the relevant situation as teachers are adults. The most important thing andragogy claims is that learning among adults is directly connected to solving problems that learners already face (Knowles 1990). The artifact should therefore provide teachers with learning opportunities directly linked with how to teach CT in the classroom as this is their problem. This also means that the artifact does not need to provide a lengthy description of what CT is and its history as that is not relevant for teaching it in the classroom. However, learning environments should be designed for all levels of competence and curiosity (Baldwin and Krishnamurti 2021) so the option to get a more in-depth description should be present. This could be done by adding an additional resource bank to the system somewhat like how Phoebe described in section 3.2 uses a database of reference materials, or by adding more levels to a course-like structured learning environment. That being said, a course-like structure can inhibit adult learners' self-direction by forcing them to go through topics in a set order.

Lack of Time is a difficult challenge to solve and so closely related to low prioritization that both these challenges will be discussed here. Teachers feel like they do not have the time to obtain new knowledge through taking courses. Often, teachers want to keep up with changes to teaching plans and have the necessary motivation to enroll in further education, but the administration does not prioritize it. Also, the use of the CBP for CT and programming was low as found in the specialization project (Østreim 2021). As time is such a big issue, it is important that the artifact is designed to provide learning opportunities that do not take to much time away from teachers' existing tasks. Ideally, the artifact will embed the learning opportunities in existing tasks as to not add new tasks to teachers' already busy days. SmartLP is an example of such a system, which aims to decrease the time spent on lesson planning while keeping the quality of the plans the same. While SmartLP does not aim to teach, its method for planning lessons can be adapted by teachers even outside the system. Keeping the information simple and relevant to use in the classroom as mentioned in the previous paragraph will also help to mitigate time-issues connected with obtaining new knowledge.

Lack of communities is something that technological solutions can solve very well. This can be seen from most of the reviewed systems in section 3.2 providing some kind of communication between users and enabling users to share resources. As such, the artifact should also facilitate the creation of a community among the users on the platform. Existing communities among teachers are also mostly digital, but they exist as open spaces with little to no organization of the content. As found in the specialization project, most teachers only use Facebook groups to connect with music teachers from outside their own school (Østreim 2021). The artifact would probably benefit from providing more organized communication about relevant topics and experiences from the classroom that other users can learn from.

To summarize the paragraphs above, the artifact should provide learning opportunities that are closely related to real-life problems while still giving the user the choice to choose what they want to learn. The artifact should aim to fit into teachers existing tasks as much as possible as to not be to time-consuming to use. The artifact should also facilitate communication between users and the creation and maintenance of a community among the users of the artifact. With this in mind, as well as the systems reviewed, I had the idea of creating an artifact that focuses on assisted template-based lesson planning that over time creates a resource bank of plans. (Aspillaga 2016) provides additional motivation for using a template-based design.

4.2 Conceptual Model

Following the review of relevant work and other systems, an idea for the artifact was established. An assisted lesson planner, similar to many of the reviewed systems from literature, but customized for use in the Norwegian school system and focused on music education and CT. Next, this idea needed to be formed into a larger conceptual model that would further develop the design. In doing so, a couple of decisions were made regarding the artifact. Instead of planning entire lessons, the artifact focuses on creating plans for learning activities to be used in lessons, similar to those found at (LærKidsaKoding 2022). This is because music education often divides a class into groups that do different activities. By designing the activities rather than the lessons, teachers can mix and match activities as they see fit within their lessons. Similar to Phoebe, the artifact will also have a resource bank in the form of wiki pages. This means that the information will be editable by users. This way, one can be sure that the information found in the wiki pages is relevant to the users' needs. Both the wiki pages and the database of existing learning activities should assist users when creating their own tasks. With these decisions in mind, the conceptual model presented in figure 7 was created.
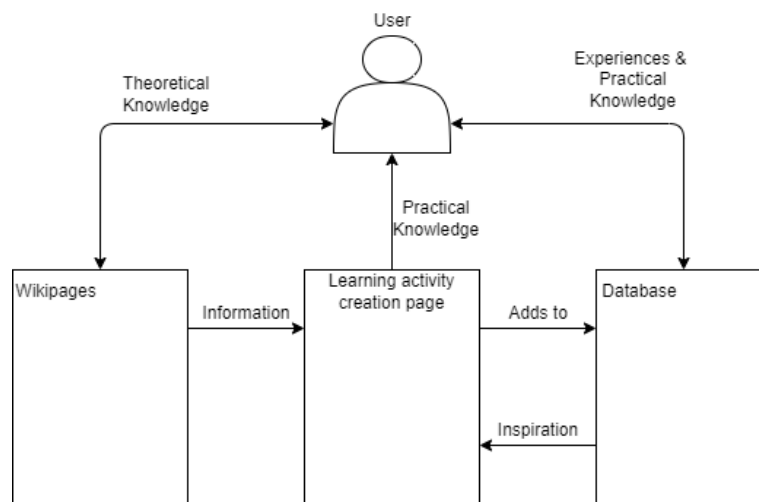
Figure 7: Conceptual model for the artifact

As seen in the figure above, there are 3 main parts of the system: Wiki pages, learning activity creation page, and the database of learning activities. The wiki pages will supply the learning activity creation page (LACP) with additional information, aiding teachers in creating learning activities that fit their needs. Additionally, the wiki pages will provide a pool of theoretical resources for teachers, giving them a chance to increase their competence of CT and other topics that might be covered. This also lets MusiCT provide in-depth learning experiences for those who desire them by citing articles and/or providing links to other, more high-level, resources. The database of learning activities will provide existing learning activities to the user given some preferences set by the user. This is similar to how SmartLP works. The existing activities can inspire the users to create a new variation of an activity or be used directly by the user in their own classroom. Additionally, the conceptual model mentions experiences being something users can gather in this part of the system. This is because every activity-page should allow for some sort of interaction between users, enabling users to ask questions and/or share their own experiences of using an activity in their own classroom.

The LACP is the central part of the system, which is reflected in figure 7, as the wiki pages and the database feed into the LACP providing theoretical information and inspiration through existing activities. This information is available in the respective parts of the system as well, but by providing the user with this information while they are looking to create an activity that suits their needs, the goal is to make the creation phase easier for the user in a user-friendly way. The user could have three tabs open, each with a different page, but feeding all of the available information into the LACP makes using all of the tools the system provides at once much easier.

The design of the wiki pages and the database page will not be in focus for this thesis. This is because they are both dependent on a community being present or under development. Building such a community is outside the scope of this thesis. As such, this thesis will focus on the LACP and how well it supports teachers in creating plans that are usable for their needs. The way the wiki pages and database supply the LACP will be a part of the thesis even though the design and content of these parts themselves are not important. Figure 8 shows the parts of the larger conceptual model from figure 7 that will be in focus for this thesis.
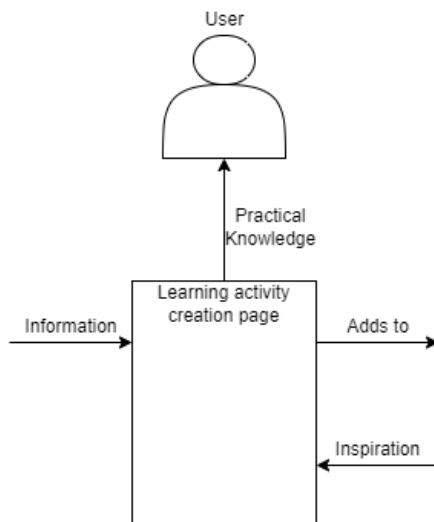
Figure 8: Parts of the conceptual model in focus for this thesis

4.3 Defining a learning activity

Besides the wiki pages, the content of the system is centered around the creation and sharing of learning activities. This posed the question "What is a learning activity within the system?". The first decision that was made was the scope of a learning activity, meaning how large of an instructional plan a learning activity is. As briefly mentioned in the previous section, an activity was determined to be some activity to be done by students in one lesson or less. It is comparable to a simple science experiment to be done in a lab over one lesson. Next, the structure of the learning activity needed to be defined. The conceptualization of the structure of a learning activity started by dividing the structure into two parts. The first part was a set of identifiers, used to distinguish activities from one another. Users should be able to search for and/or filter activities by these identifiers in the database-page. These identifiers had to be elements that determined how suitable an activity was for a user's case. For the initial concept of a learning activity, three identifiers were established: Grade, Learning Objective, and Equipment.

Grade describes the grades for which the activity is suitable. This is also needed to find the correct learning objective for an activity as learning objectives are different for different grades. Connecting a learning activity to a learning objective allows the users to clearly see what topics are included in the activity and is also seen in IIM which is specialized to a subject similar to the system created for this thesis. It also means that the contents of the system are explicitly linked to the Norwegian curriculum. Finally, a learning activity might require a piece of equipment and/or a platform to be executed by students. For instance, an activity that requires a student to play the guitar needs a guitar to be available. It is important to clearly describe the equipment necessary to execute a learning activity as the available equipment can differ a lot from school to school as found in the specialization project (Østreim 2021). By looking at all three identifiers the user can determine if an activity is suitable for their case. The second part of the structure of the learning activity concept is the textual description. The system aims to create and share learning activity plans among teachers. As such, each activity must include a description of how to execute the activity. In addition, each activity should have a title that gives an indication of what the activity consists of.

To summarize, a learning activity is an activity to be done by students in one full lesson or less. Each activity has three identifiers (grade, learning objective and equipment), a title and a textual description.

4.4   Design sketches

In addition to the conceptual model, some design sketches were created before implementation began. These were created to give a starting point for the user-interface (UI) once implementation started. The sketches were created using Figma.[1] During this process, the artifact also got its name: MusiCT, a portmanteau of Music and CT. Figures 9, 10, 11, and 12 show the design sketches created. While the sketches show the language of MusiCT to be English, the implemented artifact would use Norwegian as its language.
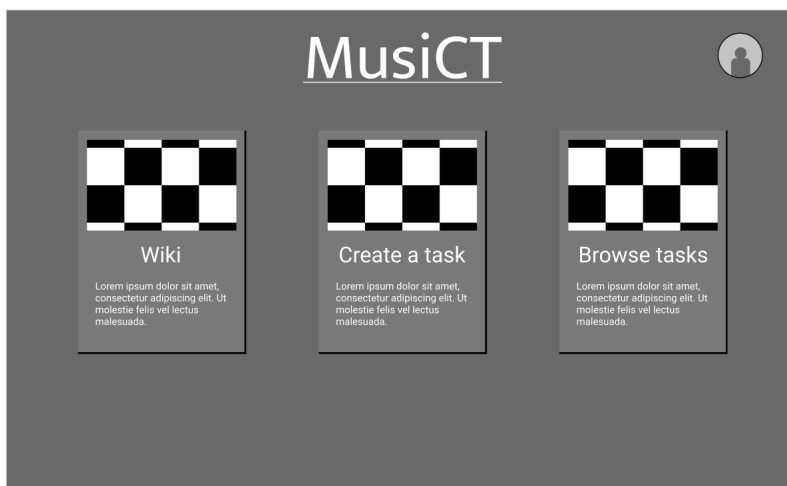
Figure 9: Design sketch for the front page of MusiCT

Figure 10: Design sketch for the wiki pages of MusiCT

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[1] https://www.figma.com/
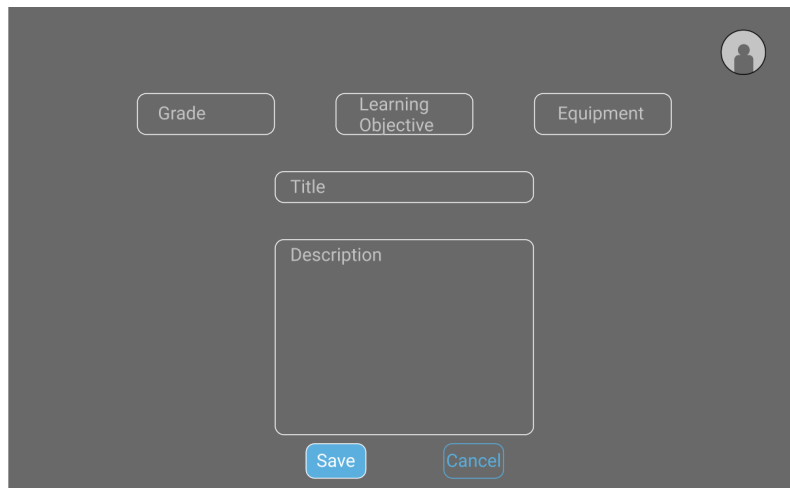
Figure 11: Design sketch for the learning activity creation page of MusiCT
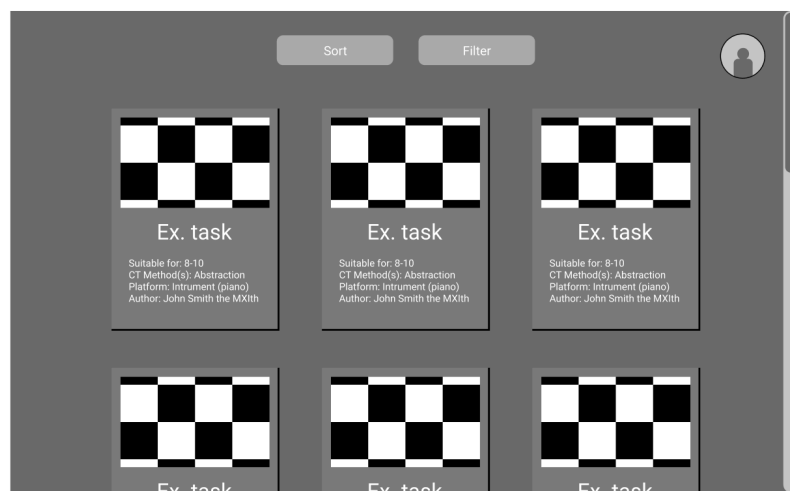
Figure 12: Design sketch for the learning activity database page of MusiCT

4.5 Requirements

With the conceptual model and design sketches created, the next step was to elicit some requirements to be met by the system. The requirements were described using statement-level templates, often called boilerplates, which are commonly used to create unambiguous and verifiable system requirements (Dick and Llorens 2012). The boilerplates used were:

The user shall be able to <action> when <action>
The user shall be able to <action> <entity>
The user shall be able to <action> from <entity>
The user shall be able to <action>
The <system> shall have <entity>

These boilerplates were used to formulate the requirements listed in table 2 below. These requirements are all functional requirements. Regarding non-functional requirements, these are often connected to quality attributes that the designer has chosen to focus on (Bass et al. 2013). "A quality attribute is a measurable or testable property of a system that is used to indicate how well the system satisfies the needs of its stakeholders."(Bass et al. 2013) As there is often a trade-off between quality attributes, some design choices have to be made that have implications for the system. As this artifact is only a prototype system, usability has received some focus, but without any specific non-functional requirements. Other common quality attributes such as performance and security have received no attention. Still, there are no non-functional requirements related to usability other than the general idea that the system should be easy to use.

ID	Requirement
FR1	The system shall have a front page
FR2	The system shall have a wiki page
FR3	The system shall have a learning activity creation page
FR4	The system shall have a database page
FR5	The system shall have a page where the user can view their own tasks
FR6	The system shall have a login/registration page
FR7	The user shall be able to register an account
FR8	The user shall be able to log in
FR9	The user shall be able to register an account
FR10	The user shall be able to log out
FR11	The user shall be able to create a learning activity
FR12	The user shall be able to see relevant learning activities from the database when creating a learning activity
FR13	The user shall be able to find information from the wiki on the learning activity creation page
FR14	The user shall be able to see all learning activities in the database
FR15	The user shall be able to view a learning activity
FR16	The user shall be able to view their own learning activities from the my activities page
FR17	The user shall be able to edit their own learning activities from the my activities page
FR18	The user shall be able to delete their own learning activities from the my activities page
FR19	The user shall be able to link a learning activity to their other learning activities
FR20	The user shall be able to choose what grades a learning activity is suitable for when creating a learning activity
FR21	The user shall be able to connect a learning objective to a learning activity when creating a learning activity
FR22	The user shall be able to connect a piece of equipment to a learning activity when creating a learning activity
FR23	The user shall be able to enter a title when creating a learning activity
FR24	The user shall be able to enter a description when creating a learning activity
FR25	The user shall be able to cancel creating a learning activity
FR26	The user shall be able to cancel editing a learning activity
FR27	The system shall be accessible online

Table 2: Requirements for MusiCT

4.5.1 Discussing the Requirements

Before looking at the technical description of the artifact, the requirements from table 2 will be elaborated on briefly to give some context to the requirements and their purpose.

FR1: The system shall have a front page
FR2: The system shall have a wiki page
FR3: The system shall have a learning activity creation page
FR4: The system shall have a database page
FR5: The system shall have a page where the user can view their own tasks

FR1 - FR4 correspond to the pages from the design sketches. In addition, requirement FR5 describes a page where the user can view their own tasks in order to perform actions on them. These pages make up the majority of the application's functionalities with the LACP being the most important part, particularly for this thesis.

FR6: The system shall have a login/registration page
FR7: The user shall be able to register an account
FR8: The user shall be able to log in
FR9: The user shall be able to register an account
FR10: The user shall be able to log out

With the wanted functionality of enabling interaction between users in a commercial version of the artifact, the need for having an account became apparent. As such, the artifact needs to have a page where users can register new accounts and log in to said accounts. It follows from this that a user should also be able to log back out again.

FR11: The user shall be able to create a learning activity
FR12: The user shall be able to see relevant learning activities from the database when creating a learning activity
FR13: The user shall be able to find information from the wiki on the learning activity creation page

These requirements cover the overall functionality of the LACP and the interaction between the wiki pages, database of learning activities and the creation page itself. These ways of assisting the user will be critical to ensuring that even teachers with little knowledge of CT can create learning activities that integrate CT to use in their classroom which gives them further knowledge by seeing how the activity works in practice.

FR14: The user shall be able to see all learning activities in the database
FR15: The user shall be able to view a learning activity
FR16: The user shall be able to view their own learning activities from the my activities page
FR17: The user shall be able to edit their own learning activities from the my activities page
FR18: The user shall be able to delete their own learning activities from the my activities page

The 5 requirements above describe the actions a user can do on the other pages aside from the LACP. As part of the learning experience for users is to use the learning activities in the classroom, it is crucial that they can be edited at a later time. This is also reflected in the models of instructional design covered in section 3.1.2. By assisting teachers in both creation and editing of learning activities, the system aids users in executing step 6, 7 and 9 of the Dick-Carey model. Step 8, which is concerned with assessing the success of the instruction will have to be done by the teacher outside the system.

FR19: The user shall be able to link a learning activity to their other learning activities

FR20: The user shall be able to choose what grades a learning activity is suitable for when creating a learning activity

FR21: The user shall be able to connect a learning objective to a learning activity when creating a learning activity

FR22: The user shall be able to connect a piece of equipment to a learning activity when creating a learning activity

FR23: The user shall be able to enter a title when creating a learning activity

FR24: The user shall be able to enter a description when creating a learning activity

This set of requirements cover the actions that the user performs when creating a learning activity. This means that these requirements describe the fields included in the template used on the creation page. These requirements are therefore also heavily linked to RQ 1.1: "What are the relevant fields in a template-based learning activity creation tool for music education?". Because the artifact should be usable by all teachers, the template cannot be so strict that it inhibits teachers from planning in their usual ways. Therefore, the template leaves a lot of room for interpretation of what should be included in the task description with the possibility of adding further guidance following the round of reviewing the system with experts as described in chapter 6. As some teachers prefer short plans of one lesson or less, and others prefer longer plans (Østreim 2021), the system should ideally facilitate both and thus the option to link activities together is included in FR19.

FR25: The user shall be able to cancel creating a learning activity

FR26: The user shall be able to cancel editing a learning activity

These requirements relate to the ability of canceling an operation within the system. This is a common tactic used to support user initiative and hence enhance usability (Bass et al. 2013). Aside from these requirements, all attention to usability is purely non-functional.

FR27: The system shall be accessible online

A major design decision that had to be made was how to make the system available to the end-users. Due to familiarity with technology and ease of accessibility, an online solution was chosen as reflected by the requirement above. This means that users should have access both at home and at school regardless of what computer they use. Normally, online solutions come with major considerations regarding security and accessibility. However, as neither of those quality attributes have been considered for this prototype system, these downsides are not relevant for MusiCT.

5 Technical Description of MusiCT

The design described in the previous chapter gives a good indication of how the initial system was intended to work. However, to give a better image of how the system actually worked, this chapter will present the system as it was implemented during the first iteration of implementation. This version (Version 1.0) of the system was used during expert interviews and a demo is running at https://musict-v1.netlify.app/ at the time of writing. The source code for this version of MusiCT is also available at https://github.com/KreizerHgz/MusiCT/tree/Version-1---used-for-expert-tests. The code for both versions of MusiCT is open source.[2] As well as presenting the implemented system, this chapter closes with a further discussion of the system's limitations and attention to quality attributes.

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[2]https://opensource.org/licenses/MIT

5.1 Technical Choices

At the beginning of the implementation phase, some choices had to be made regarding technologies to be used. From the beginning, the system was designed as a CRUD application. CRUD is an acronym for Create, Read, Update, Delete, and denotes the four basic operations executed by such a system. These operations are executed against a persistent storage, typically a database. With that in mind, the following technologies were chosen.

5.1.1 Web Technology

As requirement FR27 describes, MusiCT should be accessible online. As such, web technologies needed to be used for development, and the traditional technologies of Javascript, HTML, and CSS were used. In addition to these, Node.js[3] was used in order to quickly install packages using npm[4] and to enable the use of Express.js[5] for the backend of the application. Express.js is a useful framework for building light APIs, which is what the backend was essentially going to be; querying the database when required. Express.js is also very easy to work with which was important as I did not have any prior experience with it. The backend being based around Javascript was useful as it is a programming language I know quite well.

5.1.2 Deployment & Hosting

When building an application for the web, the code needs to be uploaded to a server which grants access to users wanting to use the system. Then, the system is available for users to access by going to the server hosting the system. For MusiCT, I used Heroku[6] and Netlify[7] for deployment and hosting. Heroku is a cloud-based platform that allows users to run their applications in the cloud. They offer a number of functionalities, but for MusiCT the important part is that it acts as a server hosting the backend and database for the system through ClearDB[8]. As MusiCT is a small system, I chose the options granting the least amount of resources as these options were free. The frontend is hosted using Netlify, a website that allows users to easily deploy web applications directly from Git repositories. Before the expert interviews described in chapter 6 the system was not deployed to these platforms as the interviewees did not have to use the system themselves. However, deployment was done before testing with teachers described in chapter 8 as interviewees needed to use the system themselves and deployment gave a larger pool of potential participants as testing could be done digitally.

5.1.3 User Interface Frameworks

On top of the web technologies already mentioned (Javascript, HTML and CSS), some frameworks were used for development of the frontend. React.js[9] is a commonly used framework for building web applications. It changes the way one creates a web application by introducing the concept of components, isolated pieces of code that make up parts of a website. These components are linked together in a tree structure to create a larger webpage that includes all of the components. Another advantage of using React.js is that it enables us to use Material-UI[10] (MUI). MUI is a library that includes a large number of ready-built components and is based around React.js. The components provided by MUI have a modern look to them, and are easy to use. As usability is an important quality attribute for the system, it was important that the system had a professional look to it despite only being a prototype. MUI helped to achieve this.

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[3]https://nodejs.org/en/
[4]https://www.npmjs.com/
[5]https://expressjs.com/
[6]https://www.heroku.com/
[7]https://www.netlify.com/
[8]https://www.cleardb.com/
[9]https://reactjs.org/
[10]https://mui.com/

5.1.4 Database

As MusiCT is a CRUD application, a database was required. While there are a lot of options for database technologies for web applications, I decided to go with MySQL[11] as my database management system. MySQL was chosen as I had prior experience using it and because it was supported by Heroku. MySQL is one of many variations of SQL which stands for structured query language and is used to manage relational databases. These databases are based on the notion of entities and the relations between them. Before a relational database is constructed, its entities and their relations are often modeled in a Entity-Relation diagram (ER-diagram). The ER-diagram for the initial version of MusiCT is presented in figure 13. As seen in the figure, MusiCT's database includes 3 entities: The user, a task, and a wiki page. The wiki page has no relations to the other entities, but there is a relation between a user and a task. This is because a task must be made by a user, and a user can make any number of tasks. Task refers to what is described as a learning activity in this thesis. As will be described later, both terms were used during the development phase of the system. The attributes of the task-entity correspond to the parts of the learning activity structure described in section 4.3.
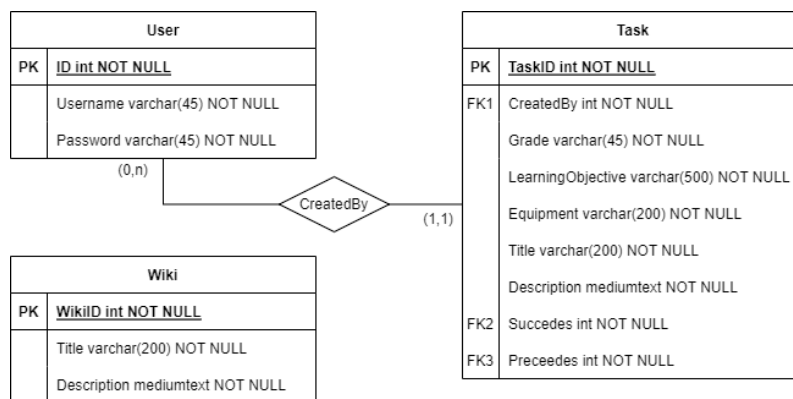
Figure 13: ER-Diagram for the database in version 1.0 of MusiCT

5.2 Learning Activity Creation Page UI

As mentioned in chapter 4, the focus area of this thesis is the LACP. The UI for this page is presented in figures 14 and 15 below. The page has 5 key areas referred to as "elements" highlighted in the figures which will be described further.

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[11]https://www.mysql.com/
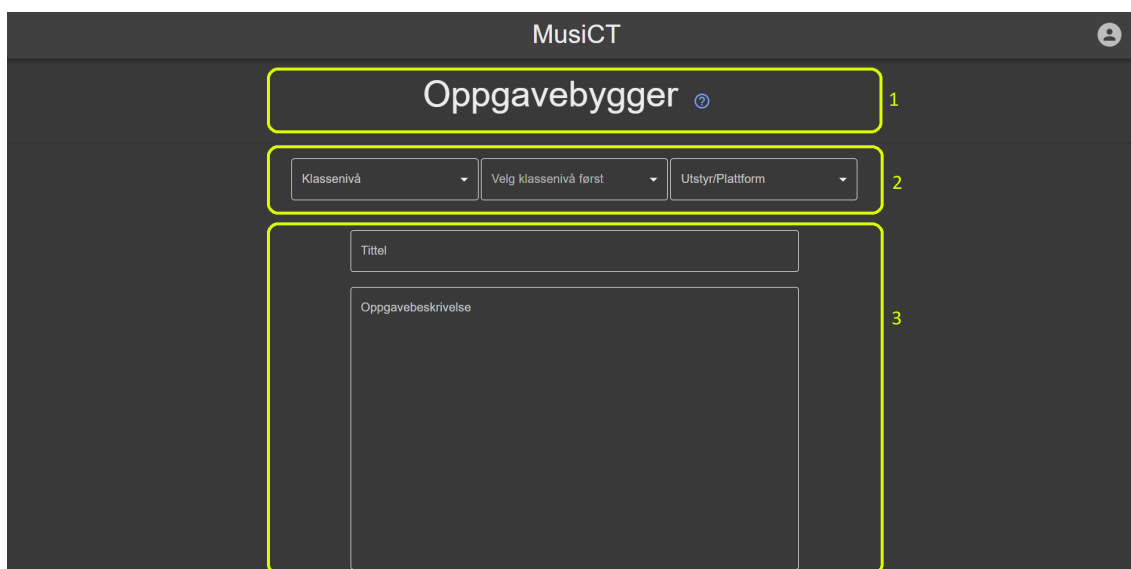
Figure 14: Learning activity creation page in version 1.0 of MusiCT (part 1)
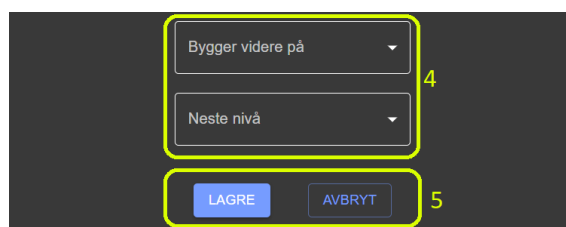
Figure 15: Learning activity creation page in version 1.0 of MusiCT (part 2)

Figure 14 shows the first 3 elements that the user encounters when loading the LACP. Element 1 is the headline as well as a little blue question mark. These question marks also appear in other areas of the application and indicates a link to more information, often in the form of a wiki page. In this instance, the question mark brings up a modal with more information about the page to assist the user in using the LACP as intended. Element 2 is a set of menus to select the grade-level of the learning activity, the learning objective that the learning activity works towards achieving, and the equipment and/or platform required that students need to use in order to perform the activity (The identifiers mentioned in section 4.3). Figure 16 shows the menu-options for the equipment/platform selector. Each item that has a corresponding wiki page has a question mark that brings up the wiki page in a modal (other than the currently selected item). This way, the wiki pages assist the user when creating learning activities as also described in the conceptual model.
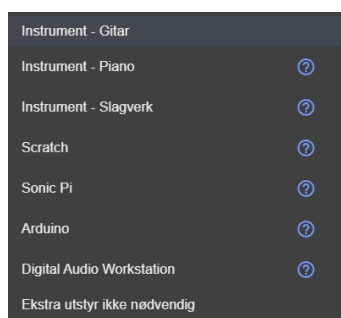
Figure 16: Menu options for the equipment/platform field

When the fields have some values selected, a new button appears between element 2 and 3. Clicking this button will bring up a modal showing all learning activities in the database that share the same values for the fields in element 2 as seen in figure 17. The user can open the activity page in a new tab or import the information directly to the LACP. This way, the existing tasks contribute towards assisting the user in creating their own learning activities as described by the conceptual model.
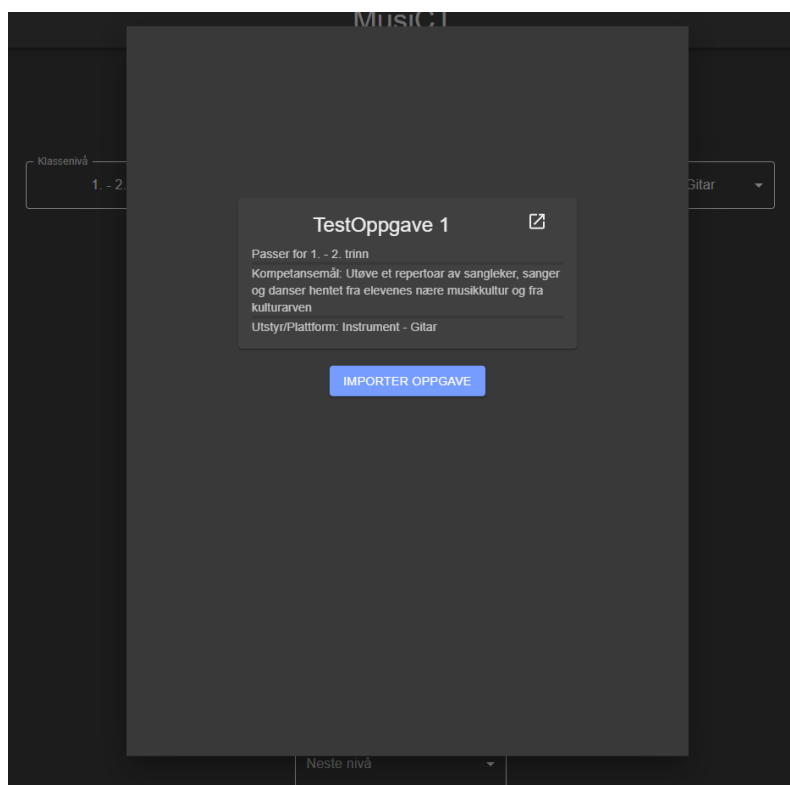
Figure 17: Modal showing similar tasks

Element 3 in figure 14 are the text fields. The template includes a field for a title, and a field for a description of the learning activity. Element 4, as seen in figure 15 is where the user can link an activity to their other activities as a previous and/or next level to create a progression of multiple levels of difficulty. Finally, element 5 is a set of buttons at the end of the page that allows the user to save the learning activity or cancel the creation of a new learning activity. Canceling redirects the user back to the front page.

5.3 UI of Other Pages

While the LACP is the focus area of this thesis, many other pages were also created for MusiCT in order to provide the required context for the LACP. On its own, the creation page is not a full-size system, and test subjects would have many questions regarding what happens to a learning activity when it is created and where all of the input to the LACP comes from. The other pages of the system will be presented briefly in this section. They were only implemented to give the minimal amount of required functionality without much consideration of usability or other quality attributes.

5.3.1 The Front Page

The front page is the first page the user sees when they enter MusiCT. Figure 18 shows the front page when the user is not logged in. The LACP is unavailable as the user must log in to create a learning activity. This is because a task must be created by a user who is logged in in order to save the learning activity in the database as seen in the ER-diagram in figure 13. The wiki pages and the database of existing learning activities are available to users who are not logged in. Because of this, existing resources within the system is available to everyone without the need to log in or create a user.
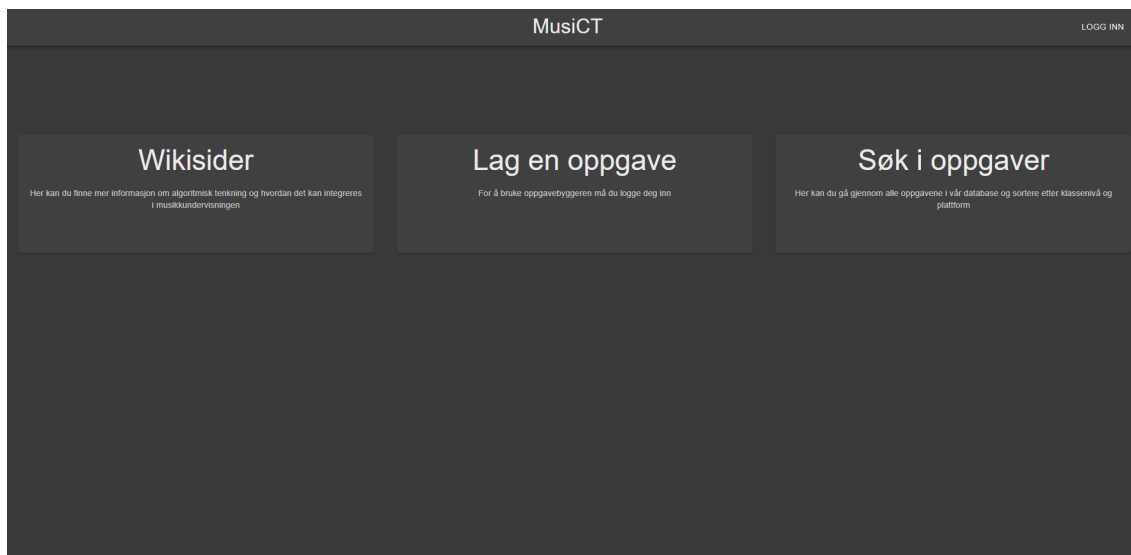
Figure 18: Front page when not signed in

When the user is logged in, the front page changes slightly and looks like the screenshot presented in figure 19. The LACP is now available and the log in-button is exchanged for an avatar which opens a menu with the option to go to the MyActivities page or log out when clicked.
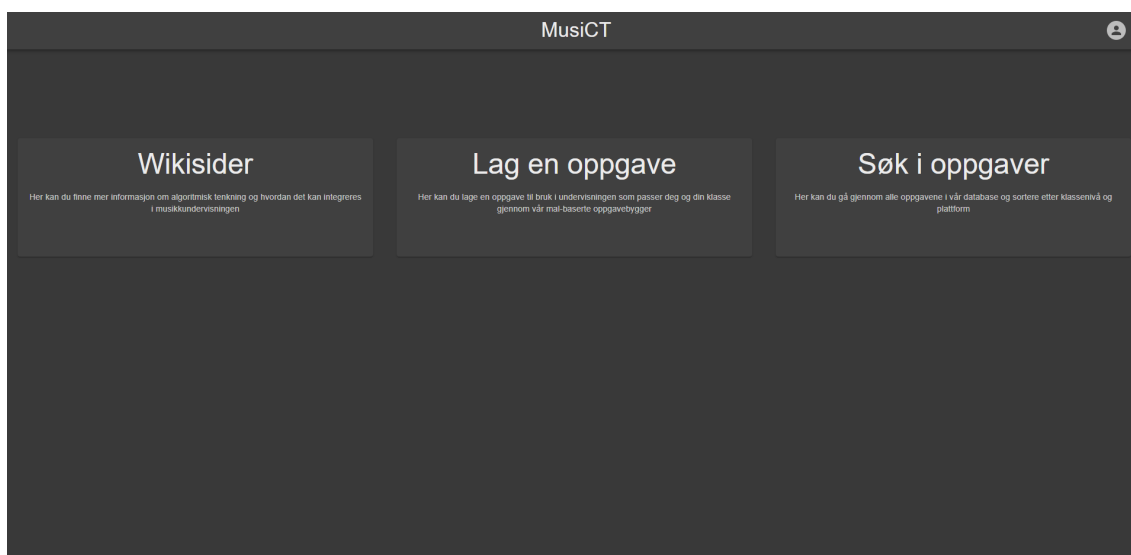
Figure 19: Front page when signed in

5.3.2 The Login Page

As the system requires users to log in to access the LACP, a login page was required. This page is seen in figure 20 below. This page also allows users to register a new account. When the user successfully logs in, they are redirected to the front page.
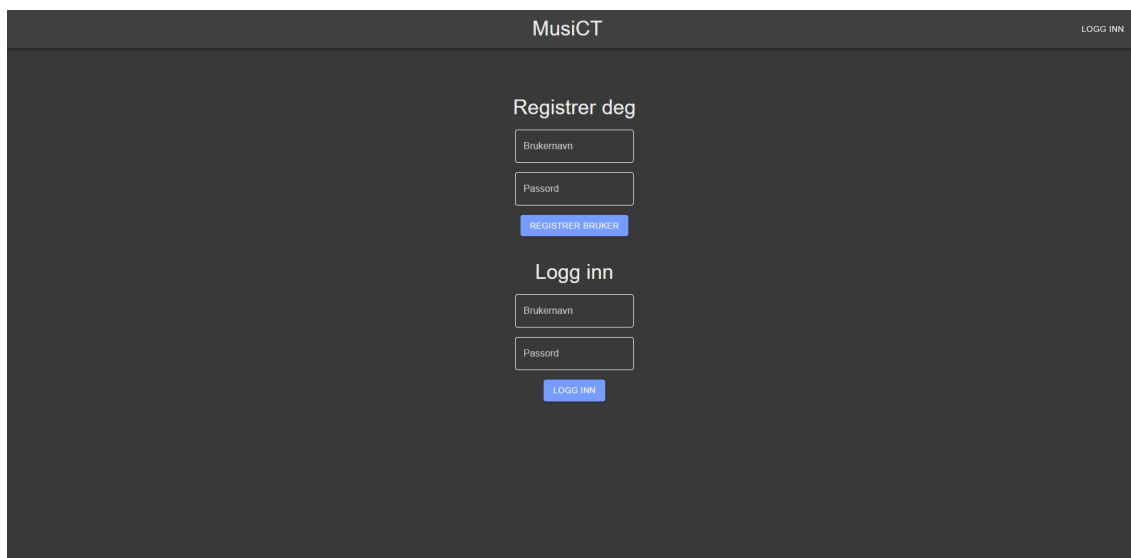
Figure 20: The login page for MusiCT

5.3.3 The Wiki Pages

As the design of the wiki pages is not important for this thesis, they have a very minimalist design. There is a menu on the left to select the wiki page to display, and the text for the selected wikipage shows up in the main window. Figure 21 shows the wiki page for Arduino, one of the supported pieces of equipment in MusiCT.

Figure 21: The wiki page for Arduino

5.3.4 The Database Page

The database page is the page showing all learning activities in the database, and is presented in figure 22. From here, the user can access the activity page for each learning activity. In a commercial version of MusiCT, this page would have options to search and filter learning activities, but as this thesis does not focus on this part of the system it has not been implemented.
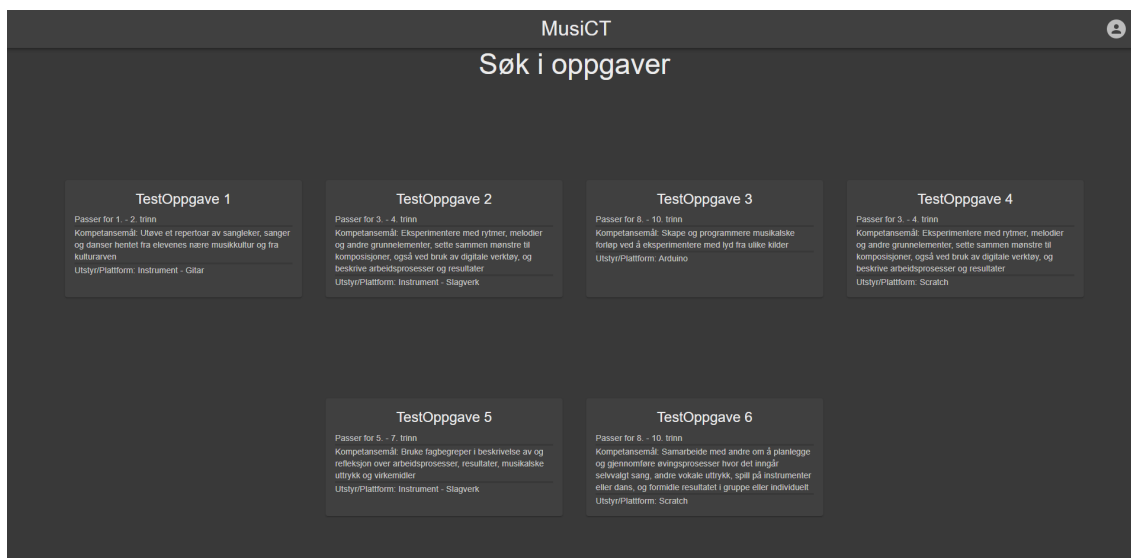
Figure 22: The database page of MusiCT

5.3.5 The Activity Page

When clicking a learning activity from any part of the system, the activity page is displayed. Figure 23 shows the activity page for "TestOppgave 2". Here, all details of a learning activity can be seen, including other activities linked to the main one.

Figure 23: The activity page of "TestOppgave 2"

5.3.6 The MyActivities Page

In order for a user to see their own learning activities, the MyActivities page was created. As seen in figure 24, this page displays the user's own learning activities with the option to open the activity page, edit the activity or delete it.
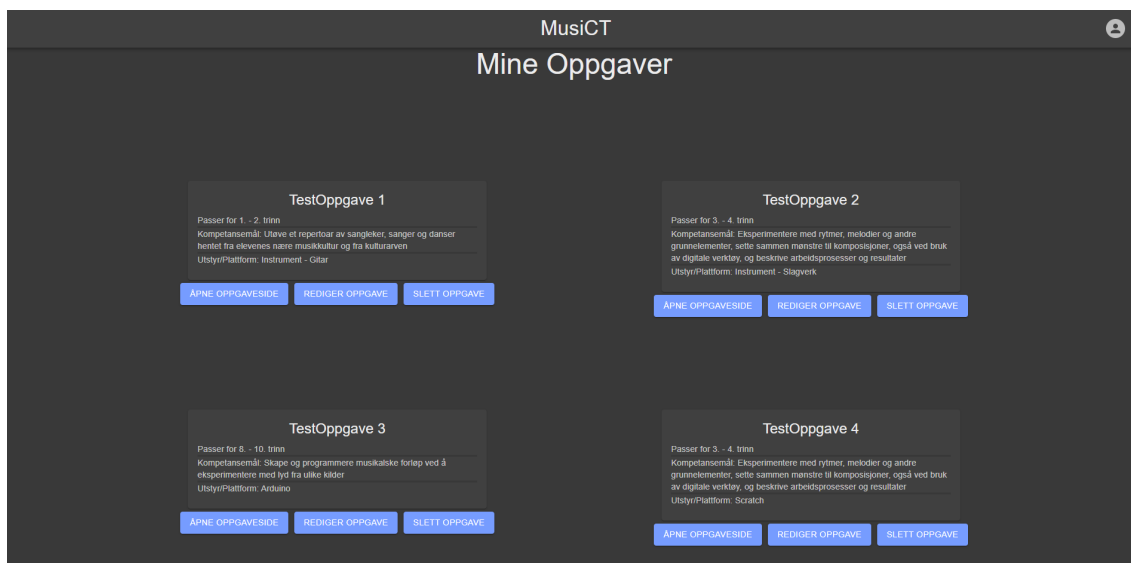
Figure 24: The MyActivities page of MusiCT version 1.0

5.3.7 The Edit Activity Page

The editing page is similar to the LACP and allows the user to edit an existing learning activity that they have created themselves. Upon loading the page, all fields are filled out with information from the database and upon clicking save, every field is updated. If the user cancels the procedure, the changes are not saved and the user is redirected to the front page.
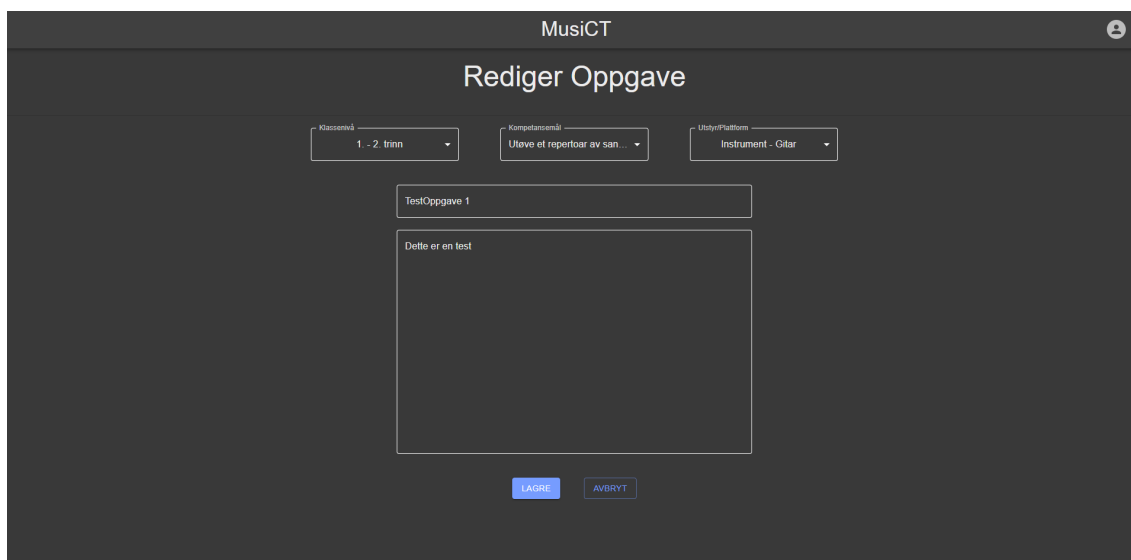
Figure 25: The editing page for a learning activity

5.4 Limitations

While the system does fulfill most the requirements previously set, it still has some limitations. Because the implemented system is only meant to be a prototype, some things were not considered that would cause huge problems if the system was to be used commercially. Generally, the system was developed focusing on the easiest solution rather than the best as this is only a prototype and the system had to be developed in a short amount of time. Security is becoming gradually more important in digital systems and MusiCT does not implement standard security measures such as hashing of passwords or protecting against SQL injection attacks. As such, sensitive information should not be stored in MusiCT and accounts created during testing should not include any information that can identify the users' identities.

Another limitation is authentication. While the system does allow a user to log in or log out, their authentication when logging in is only valid for that tab. If a user opens a new tab, they will not be logged in in the new tab. Similarly, if the user refreshes the tab while logged in, they will be logged out. This happens because the authenticated state is stored in a React context which does not persist across tabs or between sessions. In a commercial system this would obviously be a massive issue, but when testing the system for this thesis, it should not be an issue.

As mentioned before, usability is the only quality attribute that has been considered for the system. Despite this, version 1 of the system has been developed with the assumption that the user will only perform actions that are allowed. Because of this, there is a lack of constraints and user feedback within the system. As an example, a learning activity cannot be stored in the database without a title, but the system will try to save the activity anyway. When the action fails, the user does not receive any feedback indicating that the action failed. In a commercial version of MusiCT, the system should notify the user that the activity cannot be saved as soon as the user tries to save the activity without a title. Even when a learning activity is saved and stored in the database successfully, the user does not get any feedback indicating that the action succeeded.

Finally, as mentioned previously, the system was not deployed following the first iteration of development due to the fact that it did not need to be until testing with end-users following the second iteration of development. This limitation did not have any consequences for the expert interviews described in chapter 6, but because one of the requirements stated that the system should be accessible online it is a limitation of the system as not all requirements were met. Instead, deployment was added to the list of issues for the second iteration of development.

6   Expert Interviews

Following the first iteration of development, version 1.0 of MusiCT was ready to be discussed with experts. The idea was that experts in music education and CS would be able to give some comments on the design and how it could be improved before testing the system with end-users, in this case music teachers. With regards to the research questions, these interviews mostly focused on RQ 1.1: What are the relevant fields in a template-based learning activity creation tool for music education? As RQ 1.2 relates directly to the thoughts of teachers, asking experts about this would be irrelevant to answering the research question as their teaching and perspective is different. This chapter will describe the methods used for recruiting participants, collecting data and analyzing data before presenting the results and what implications they had for the second iteration of development.

6.1   Method

The methods used during all phases of conducting the expert interviews will be described in this section. There were 3 phases in total: Recruitment, data collection and data analysis. Note that data collection includes both the planning and execution of data collection. The methods chosen, particularly for data collection, were chosen with the aim of improving the functionalities of the system and potentially introducing new functionalities.

6.1.1 Recruitment

Before recruitment could begin, I had to determine what experts I wanted to interview. More precisely, I needed to determine which competences would be relevant for commenting on not only the design of a digital system, but also how well it supports the working processes of music teachers. The following groups of potential participants were identified:

1. Experts of music education working in teacher education for teacher students specializing in music. These experts should have some knowledge about the working processes of music teachers as well as how the system should be designed to support these processes. They will have a lot of knowledge about music, but maybe not much about CT.

2. Experts of CS with experience from working with systems for teachers in the past. These experts will be able to comment on the system from a CS perspective. They might have some knowledge about CT, but maybe not much about music.

The 2 groups complement each other well and together provide competences that touch on all parts of the system. Potential participants were recruited via email and were not offered any incentives to participate. The email that was sent included some information about the project and testing as well as the informational document seen in appendix A. To find relevant experts for the first group I looked through the staff list of several institutes for music education throughout Norway. For the second group I got a recommendation from my supervisor. As I did not have time for many interviews, I decided not to look for more participants from this group once the recommendation agreed to participate. In total, 10 potential participants across both groups were contacted. Table 3 shows the participants that contributed to this project.

Participant	Group	Position
1	1	Senior lecturer
2	1	Associate Professor of Music
3	1	Associate Professor of Music
4	2	Associate Professor of CS

Table 3: Participants for expert interviews

6.1.2 Data Collection

Interviews were chosen as the data collection method for this round of testing as it is a data generation method well suited for situations there one wants to obtain detailed information, ask open-ended questions and explore emotions/feelings that are difficult to observe (Oates 2006). Specifically, semi-structured interviews were used, meaning that questions allowed the interviewee to speak in detail and could be skipped if deemed unnecessary. This could happen in cases where the interviewee had answered a question in their answer to another question asked earlier in the interview.

An interview guide was made as seen in appendix B. The questions included all concern the LACP as it is the focus of the thesis. 2 types of questions were asked: Questions about the current functionalities of the system and questions about potential additions to the functionalities of the system. These are separated by the vertical line in the interview guide. Even though the questions asked refer to the UI of the LACP, the answers would be used to improve the concept of a learning activity as described in section 4.3 as fields in the template only represent parts of the structure of a learning activity. The first group of questions was important to assess the current usability of the system. If an existing part of the system was not working as intended it would need adjusting in the second iteration of development.

The second group of questions are related to specific things that came to mind while developing the first version of the system and through discussions with my supervisor. The LACP had 3 fields at the top used to distinguish learning activities and help find similar ones while creating a new one. Interviewees were asked about their thoughts on some suggestions for new fields that could be added. They were also asked for additional ideas if they had any. A similar approach was used in the next question about text-fields. Version 1.0 of MusiCT only had a text-field for a title and a description of the learning activity and it felt natural to add more. The final question concerned a totally new functionality that could be added to the system. My supervisor had suggested adding reflection questions that would help the user reflect on the quality and inclusiveness of their learning activity. Through discussions with my supervisor we came up with some suggestions for potential reflection questions. These were mentioned to the interviewee as examples of how this new functionality could be used. Interviewees were also asked about other ideas they might have for this functionality.

In the event that someone agreed to participate, I would work together with the participant to find a suitable time and place for the interview. Most interviews were conducted at the university where the participant worked, but one interview was done remotely through Zoom[12]. The audio from the interview was recorded and later transcribed as to not occupy me with taking notes during the interview. Participants were informed ahead of time that the interview would take around 45 minutes to complete.

The interviews consisted of 2 parts. First, I would show the interviewee a presentation of the conceptual model behind the system as well as the system itself, and go through all of the different pages of it. Even though the LACP was the focus, it felt natural to show the interviewee more of the workflow within the system to give the necessary user context. After the system had been presented, I asked questions from the interview guide with the LACP displayed on screen for reference. I attempted to create a relaxed and friendly tone during the interview.

6.1.3 Processing of Personal Data

As personal data was processed in this part of the thesis, the project was submitted to the Norwegian center for research data (NSD)[13] and approved by them. The acceptance letter is included in appendix G. Names and contact information of participants were collected during the recruitment process and NSD considers this processing of personal data even though this data was never processed further. The reason Zoom was used for the remote interviews instead of other similar services was that NTNU has a data processor agreement with them which is required by NSD. The sound recordings done during the interviews were done using an audio recorder loaned from NTNU. Audio files were directly uploaded to NTNU's Sharepoint[14] server before transcription. The transcribed interviews did not include any personal data as the participants were asked not to say anything during the interviews that could identify them in written form. All data was deleted by the deadline for the project (10th of June 2022). Throughout the entire process, I followed the ethical guidelines provided by NTNU (NTNU 2022). All participants signed the consent form which was part of a larger informational document found in appendix A.

6.1.4 Data Analysis

Following the interviews, the collected data had to be analyzed. With such a small amount of qualitative data to analyze, I decided to use the table method. This method consists of plotting the data in a table with columns corresponding to the questions from the interview guide and the rows correspond to the participants. Using matrix coordinates, the cell with coordinates (2,6) would represent the answer of participant 1 to question number 5 as the initial row is the table header and the initial column indicate the ID of the participant whose answers are displayed in that row.

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[12]https://zoom.us/
[13]https://www.nsd.no/
[14]https://www.microsoft.com/nb-no/microsoft-365/sharepoint/collaboration

Table 4 below shows an example table with cell (2,6) marked with an X. When the data is plotted in such a table it is easy to compare answers from different participants, at least when the number of participants is quite small. The data from interviews with experts of music and the expert of CS were analyzed together despite slightly different perspectives. In addition to the table of answers to questions from the interview guide, additional notes from all interviews were inserted into a different table. These notes were mostly about other systems or the community of music teachers and their current working methods.

Participant ID	Question 1	Question 2	Question 3	Question 4	Question 5
1					X
2					
3					
4					

Table 4: Example of the use of the table method for data analysis

To help distinguish the tone of answers, I colored the cells in the table. A green cell would indicate a positive answer and a red cell would indicate a negative answer. For uncertain or neutral answers, yellow was used. An an example, when asking about the layout of the page, a positive answer would be an answer that is only positive to the layout. A neutral answer is an answer that is mostly positive to the layout, but has some comments regarding specific parts. A negative answer would be an answer that claimed the layout was poor and needed major changes. In short, positive is only positive, neutral is mostly positive, but with some criticism, and negative is mostly negative to the chosen design, possibly while being positive to some parts. Despite this color coding, each response was analyzed in detail and compared to the other responses to the same question by other participants.

6.2 Results

The data analysis provided some results in terms of guiding the further development of the system. The results will be listed in this section before the next section discusses what implications the results had for further development of MusiCT.

6.2.1 Existing Functionalities

Regarding existing functionalities, the experts were generally very positive. 3 out of 4 had positive answers to the first question regarding the layout of the LACP. 1 expert found it difficult to understand that grade had to be selected before a learning objective could be selected, but thought that the layout was otherwise logical and nice-looking. 2 experts talked about how the LACP was very simple, perhaps too simple for a commercial system, but very nice for a prototype highlighting the concepts behind the system. The connections to wiki pages for the available equipment choices had similar responses by 3 experts, being positive towards the functionality existing as well as the way in which it was implemented. 1 expert gave a negative reply to this question as they misunderstood how the equipment field worked. They attempted to find the wiki page for the equipment by selecting the menu-item rather than the question-mark leading to the wiki page being displayed.

Another thing that was mentioned during this part of the interview was the limitation of only being able to select one learning objective or one platform/piece of equipment. All experts agreed that being able to select several options for these fields would be an improvement. This was something I had thought of during the first iteration of implementation as well. In total, one could conclude that the existing functionalities of the LACP were designed well with most experts being positive in their answers. The simplicity of the page payout allows the underlying concept to come through and the concept is promising.

6.2.2 New Functionalities

Regarding the possible additions to the LACP, experts were first asked about additional fields that would be used to search for similar tasks. The most obvious result from these questions is that all 4 experts agreed that adding a field for methods from CT would be beneficial. This was also something I had thought about for the second iteration of development while developing version 1 of the system. The issue of keywords had mixed replies with one expert saying:

"Keywords are good for searching in the database, but at the same time there is an issue regarding differences in how terms are used and interpreted".

When asked about other ideas that the experts had, 2 of them mentioned "setting" as something that could be included. Setting refers to one of 6 elements included in the Didactical Relationship Model as described by (Hiim and Hippe 2003) and includes elements such as the number of teachers available during a lesson, the number of students present, and the amount of time required to finish a learning activity. These are important to teachers when they plan their lessons, and supporting them in the system could be a good idea. Expert number 3 took a very pedagogical point of view and mentioned that in music education, there are a lot of "pedagogical directions". Because of this, they proposed adding a field for selecting the pedagogical direction that the learning activity was designed for when creating an activity.

Version 1.0 of the LACP only had text-fields for title and description. It quickly became apparent that more text-fields would be beneficial, and when asked about adding a field for assessment, all experts agreed this was a good idea. As mentioned above, one expert suggested a selection field at the top part of the LACP for choosing a pedagogical method. This expert mentioned that assessment is something that differs a lot between pedagogical methods. As such, they suggested that the field for selecting a pedagogical method would partially fill inn the text-field for assessment, like a template. This would make it easier for teachers to write about assessment.

The other question asking about a specific idea for a new text-field had mixed replies. In education, students are often expected to meet certain goals of having learned a particular skill or obtained knowledge about something specific. As such, expected learning outcomes is something that is often talked about, and adding a text-field for this could be useful for help other teachers understand what a learning activity works towards teaching students more specifically. 2 of the expert specializing in music were asked about such a text-field. One agreed that it was a good idea, but the other had some issues with the mindset that goes with this text-field. The issue with expected learning outcomes in music education is that it is hard to predict what the student will learn. The expert who disagreed with adding the text-field for expected learning outcomes said the following about this:

"Expected learning outcomes becomes inappropriate for music and exploratory tasks. When you explore you cannot always know what the learning outcomes will be, and that is fine! We use the term "potential learning outcome" instead with reflection to figure out what the learning outcomes were".

The final question, and its sub-questions, was the only question not referring to something that was already implemented or something similar to existing functionalities. As such, the experts mostly discussed their opinions on adding reflection questions as a whole rather than what those questions should be. The answers were also quite mixed. One expert did not think reflection questions were needed saying the following:

"This does not seem like a good idea to me. Teachers are supposed to be competent enough to not have to reflect over the learning activity. It could be good for inexperienced teachers, but one would have to assume that teachers know enough to not need this. These questions would also have to change over time as focus on inclusion changes".

On the other hand, another expert was very positive towards the reflection questions and gave many suggestions to questions that could be used. They also referred to a university which had a policy where all educational material must receive reflection regarding inclusivity. The CS expert had a more system-oriented perspective on the reflection questions. While they thought the reflection questions was a good idea, they were not sure about the presentation of the reflection questions. They felt it was important that the reflection questions were available during creation of the learning activity, and not just afterwards. Having the questions visible at the same time as being able to edit what you have written was also highlighted as important. Similar to the expert who was critical to the reflection questions, the CS expert also felt like these questions would not be necessary for everyone. Hence, it would be best if the reflection questions were voluntary with the option to see/remove them as requested.

6.2.3   Other Things Mentioned

One expert was concerned that learning activities being published once they are created would prevent some teachers from creating learning activities. If a teacher is using the system, then it is likely that they are not very comfortable with CT and publishing their activity for all users to see might be intimidating. Because of this, the expert proposed making publishing of an activity voluntary. That way, a learning activity can be created without being visible to other users and can be published at a later time when the user feels more comfortable with sharing the activity.

Despite giving an overview of the system before asking questions, 2 of the experts felt like they needed more information about the system. As an example, one expert asked about what is meant by an "oppgave" within MusiCT as it can be interpreted in many ways. In both instances, the conclusion was that an about-page for the system could be a good idea. That way the user would be able to get more information about the system in order to use it correctly. The questioning about the definition of an "oppgave" also led to a change of translation of the term. Before, I used "task" as the English translation, but this was changed to "learning activity" as I felt it was more appropriate following the reflection i did after the interviews.

6.3   Implications For Further Development

The results from the expert interviews were used to create a list of issues to be completed during the second iteration of development. The issues were submitted to the Github repository of the system for organizational reasons. Ten issues were created, which are all presented in table 5. The ID refers to the ID the issue had in Github and the priority, given on a scale of high (H), medium (M) and low (L), refers to how important it was to resolve the issue. The issues will be discussed further in the following sections similar to the requirements discussion in section 4.5.1. It is also worth noting that the issues will refer to "tasks" rather than "learning activities" as the English translation of the term "oppgave" changed as a result of the expert interviews. Because the code referred to tasks (as development started before the change of term) it felt most natural to keep referring to tasks rather than learning activities during development. In terms of this thesis, task as referred to in the issues is equivalent to how the term learning activity has been used so far, and will continue to be used, in this thesis.

ID	Issue	Priority
#1	Test deployment to Heroku & Netlify	H
#2	Add multiselect CT-field to task builder	H
#3	Make other fields multiselect	H
#4	Add textbox for evaluation & potential learning outcome	H
#5	Implement review questions	M
#6	Make similar task-search more adaptive	M
#7	About-page	M
#8	Voluntary publishing	L
#9	Add pedagogical method-field	L
#10	MyTasks layout change	L

Table 5: Issues created before iteration 2 of development

6.3.1 Discussion of Issues Related to the Expert Interviews

This subsection will provide further reasoning for the issues with a connection to the results from the expert interviews.

#2: Add multiselect CT-field to task builder

Adding a field to the LACP for selecting methods from CT covered by the activity being created was one of the potential additions where all 4 experts had the same opinion. It was clear that this was heavily supported by all of them, hence the high priority. It was natural to make this field multiselect, meaning that several methods can be selected for one activity, because when using CT to solve a problem the solution often requires a combination of multiple methods. This field was to be inserted at the top of the LACP along with the existing fields for grade, learning objectives and equipment. As such, the CT methods will also be used when finding similar learning activities from the database.

#3: Make other fields multiselect

When discussing the existing fields for learning objectives and equipment, it became clear that these fields should also be multiselect. An activity can aim towards achieving multiple learning objectives, and multiple pieces of equipment and/or platforms are often used together in the classroom. An example would be using an instrument with a DAW to manipulate recorded audio from the instrument. While this issue also had a high priority, I planned to finish issue #2 first as that issue concerns creating a new field that is multiselect. In doing so, I would have a better understanding of how to modify the existing code for the existing fields for learning objectives and equipment to make them multiselect as well.

#4: Add textbox for evaluation & potential learning outcome

Issue #4 concerns the text-fields, or "textbox" as it is referred to in the issue. As all 4 experts were in favor of adding a text-field for assessment, this was included (referred to as evaluation in the issue). As mentioned in the results section above, the initial idea was to add a text-field for expected learning outcomes, but following the interview with one of the experts, this was changed to potential learning outcome. Other experts did not discuss the issues of expectations in music education, and were in favor of a text-field for expected learning outcomes. I concluded that a field about learning outcomes could be useful, and decided to go with the wording of "potential learning outcome" rather than "expected learning outcome".

#5: Implement review questions

While reflection questions, referred to as review questions in the issue, received mixed responses, the conclusion I drew was that it could be useful for some users, but not all. As such, the reflection questions could be included if they did not have to be used by all users. Another important thing about the implementation of the reflection questions was that they needed to be visible while the user is able to look through their learning activity and edit it.

#7: About-page

Issue #7 is creating an about-page for the system. This was motivated by what 2 experts said about desiring more information about the system itself. The contents of the about-page should include the purpose of the system, the context of the system (being used for this thesis), inform the user that personal information should not be stored in the system for security reasons, and the definition of an "oppgave" within the system. I gave this issue a medium prioritization as it was mentioned by more experts than the issues with low prioritization.

#8: Voluntary publishing

As mentioned by one of the experts, voluntary publishing could be a good idea. Despite only one expert mentioning this, I felt it was important to include voluntary publishing in the list of issues. The reason is that the situation the expert described, with a teacher unable to save their activity due to insecurities concerning their competence of CT, is the type of situations the system is developed to solve. The system is aimed at inexperienced teachers, and their feelings towards all activities being public should be considered as a part of the user-context. Despite the low priority, this issue was the highest prioritized issue of the ones with low priority in table 5.

#9: Add pedagogical method-field

Only one of the experts talked about differences in pedagogical methods and the possibility of adding a field at the top of the LACP for selecting the pedagogical method the learning activity was designed for. As I thought it was an interesting idea, I added it to the list of issues, but with a low priority. Despite this, I chose not to add an issue for creating a similar field for selecting setting-factors from the Didactical Relationship Model even though 2 experts mentioned it as a possible addition. The reason was that there are many different setting factors and I could not think of a good way to select them. Either there would be different fields for different types of setting factors, creating a lot of complexity in the LACP, or there would be one field with way too many menu-items and or very different types. Issue #9, along with issues #2, #3, #4 and #8, all affect the structure of the task entity within the database.

6.3.2   Discussion of Issues Not Related to the Expert Interviews

Some of the issues from table 5 did not have any connection to the results from the expert interviews. These will be discussed in this section.

#1: Test deployment to Heroku & Netlify

Issue #1 concerns deployment of the system. As mentioned in section 5.4, the system was not deployed during the first iteration of development and requirement FR27 was not met. Because of this, I felt like it was important to see if I could deploy version 1 of the system as a test of the deployment process. I had no prior experience using Heroku or Netlify and was unsure of how long the process would take. By deploying version 1.0, and going through the process of deployment once, I would have a better idea of how to deploy version 2.0 and ensure that I would be able to do so without unexpected problems. Deploying the system to the internet provides opportunities for remote testing with users for the second round of tests, which provides a larger pool of potential participants. As recruitment was proven to be challenging in the specialization project, this issue received a high priority because of its consequences for recruitment of teachers. This issue had no connection to the expert interviews as deployment was not discussed with experts, nor was the choice to develop the system as a web-application.

#6: Make similar task-search more adaptive

With the addition of a field for selecting methods from CT covered by the learning activity, I felt the functionality for finding similar learning activities needed improvement. For example, having to select values for all fields before being able to search is an issue when users are likely to try to find tasks only based on methods from CT and/or the equipment they have available to them. Because of this, I wanted to improve the functionality for finding similar activities by making it more adaptive as mentioned in the issue. By adaptive, I meant to enable the user to search for activities with the same value(s) for any combination of the fields at the top of the LACP. As this was only a usability-related issue, and not discussed with experts, it did not receive a high prioritization, but I felt the improvement in usability was high enough to warrant a medium prioritization.

#10: MyTasks layout change

With the addition of voluntary publishing from issue #8, the MyActivities page (referred to as the MyTasks page in the issue) became very busy. As seen in figure 24, the MyActivities page in version 1.0 uses 3 buttons under each activity to allow the user to execute some actions regarding their tasks. With the addition of changing the visibility of a task, there would be 4 buttons under each activity. An improvement on this, to create a less busy UI, would be a good idea, but not strictly necessary. This is only a matter of improving the usability of a page of the system that is not critical to testing, thus the low priority of this issue.

7   Implemented Changes to the System

The second iteration of development lasted for 4 weeks and concluded with version 2.0 of MusiCT being created and deployed. The source code for version 2.0 is located at https://github.com/KreizerHgz/MusiCT/tree/Version-2 and the prototype is running and available at https://musict.netlify.app/. This chapter will present the changes made during iteration 2 of development similar to how version 1.0 was presented in chapter 5.

The changes made are based on the issues from table 5 and 9 out of the 10 issues were resolved with a full list of the implemented changes included below. Issue #9 was not resolved due to a lack of knowledge about pedagogical methods in music education as well as time constraints. This was a low priority issue and only 1 expert mentioned this during the expert interviews. Even then, it was only a suggestion and not a critical functionality for the system. Issue #1 was resolved, but will not be mentioned further as it did not directly impact the structure of the system.

Changes made to the system following the expert interviews:

- Added multiselect CT-methods field to the LACP and updated database structure

- Changed existing fields for learning objective and equipment to be multiselect and updated database structure

- Added new text-fields for assessment and potential learning outcome and updated database structure

- Added reflection questions to the LACP with 4 example questions

- Added an interface when searching for similar activities allowing the user to choose the identifiers to use in the search

- Added an about-page with a text-link on the bottom of the front page

- Added interface allowing user to save as public or private and updated database structure

- Changed the layout of the MyActivities page

7.1 Changes Made to the Database

Due to resolving issues #2, #3, #4, and #8 some changes had to be made to the task entity in the database. As a result, the structure of the concept of a learning activity within the sytem also changed accordingly. Issue #8, concerning voluntary publishing of learning activities, led to a new attribute being added to the task-entity named "isPrivate" in order to distinguish private and public activities. Private activities will have the value 1 for isPrivate and public ones have the value 0. Similarly, resolving issue #2, #3 and #4 added new fields and modified the number of characters for the existing fields for learning objectives and equipment. The ER-Diagram for the database belonging to version 2.0 of MusiCT is presented in figure 26.
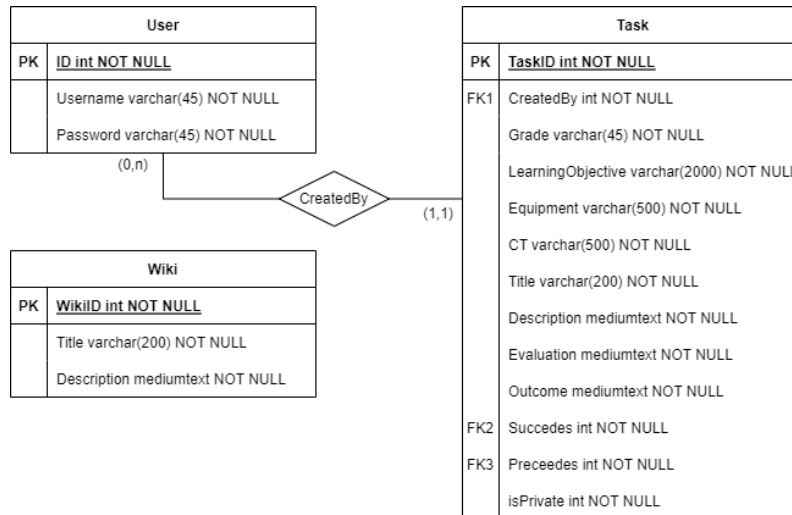
Figure 26: Final ER-Diagram for the database in version 2.0 of MusiCT

Before ending up with the structure presented in figure 26, another structure was considered. The fields for learning objectives, equipment and CT-methods were all multiselect following the resolution of the issues concerning them. Being able to select multiple values for an attribute leads to some issues as MySQL can only hold 1 value for each attribute in an entry in a database table. A solution is to create separate entities for the fields and connect them to the task entity through a relation. As the selection fields have lists of possible choices in the form of menu items, the tables for the new entities can be filled out during development. When creating an activity, the backend only needs to connect the entities by filling out one or several rows in a joining table, holding the ID for both entities to be connected. Such a design is described by the ER-Diagram in figure 27 and was considered for the system. This is also a design which is more robust and should be implemented for commercial versions of similar systems. The reason why I chose not to go with this design was because it would cause a lot of changes to existing code and create more complex queries. With the time constraints, and the necessary functionality required to execute user tests of the system, I found it unnecessary to go with this more complicated structure. At this scale, the functionality of the system would not be impacted by using the simpler structure. When multiple values are selected in MusiCT version 2.0, a string is stored for the respective field in the database with the different values separated by a comma in the case of CT methods and equipment. As some learning objectives have commas in them, a | was used to separate multiple selected values for learning objectives.
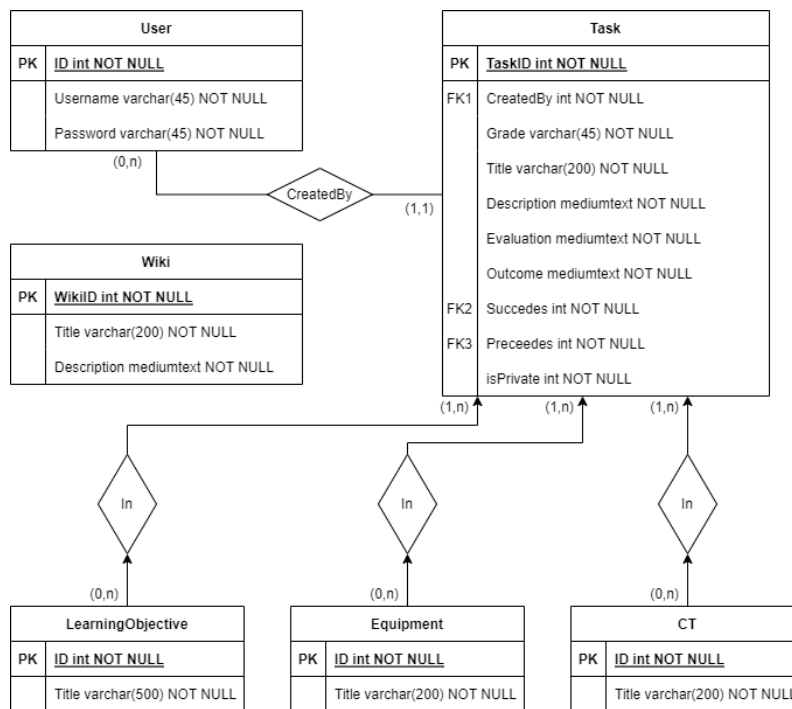
Figure 27: Possible ER-Diagram for the database in version 2.0 of MusiCT

7.2 Changes Made to the Learning Activity Creation Page UI

The LACP received a lot of changes during the second iteration of development, and this section will highlight those changes starting with the field for selecting CT methods. This field was added to the top of the LACP, and the editing page, along with the other selection fields and is highlighted in figure 28. The methods listed in the menu are the same ones that are mentioned by UDIR in their definition of AT. The menu-items of the CT-methods selection field are presented in figure 29.
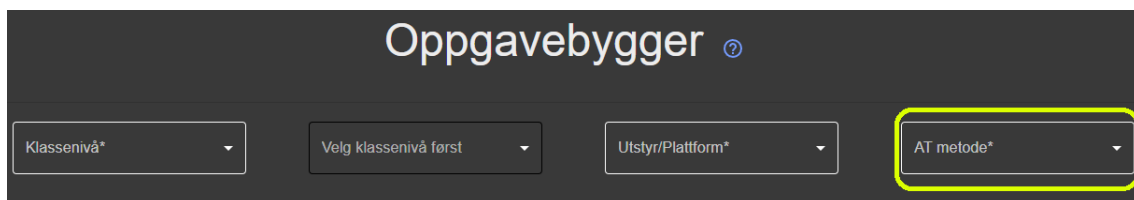
Figure 28: The fields at the top of the LACP in MusiCT version 2.0

The menu in figure 29 also shows how the multiselect menus were different from the single-select menus in MusiCT version 1.0 as seen in figure 16. The squares on the left are checkboxes which are checked when items are selected. Similar to the menu for equipment, links to the wiki-pages were implemented in the menu for CT-methods as these methods also have entries in the wiki. For the prototype, the contents of those wiki-pages was copied from the music-specific part of UDIRs CPB for CT and programming.
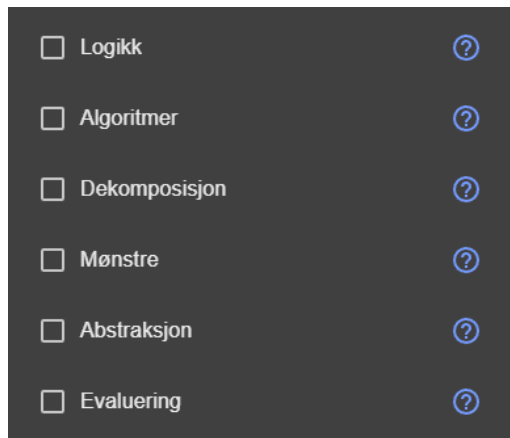
Figure 29: Menu-items for the selection menu for CT-methods

Two text-fields were added to the LACP and editing page during iteration 2 of development. These are displayed in figure 30 and are identical to the description text-field implemented for version 1.0 apart from the name of the text-fields. Another small change that was done to all fields and text-fields was that they were marked with an asterisk indicating that they must be filled out for the activity to be saved. This is explained in the information about the LACP accessible through the question mark at the top of the page. Marking fields with asterisks is also standard for indicating mandatory fields in online forms.

Figure 30: Text-fields added to the LACP for version 2.0

The implementation of the reflection questions consisted of two parts: A button to open the sidebar showing the questions and the sidebar itself. The button was placed at the end of the LACP, just over the save- and cancel-buttons. It is highlighted in the lower left of figure 31. This was done as it is likely that reflection will occur after a first draft of the activity has been written. Clicking the button opens a sidebar on the right-hand side of the screen displaying a reflection question with buttons to navigate through the available reflection questions. The sidebar is highlighted on the right-hand side of figure 31. While scrolling up and down on the LACP, the sidebar remains visible, meaning that the user is able to see the questions while editing their activity. The sidebar can be closed by clicking the white arrow in the top right.
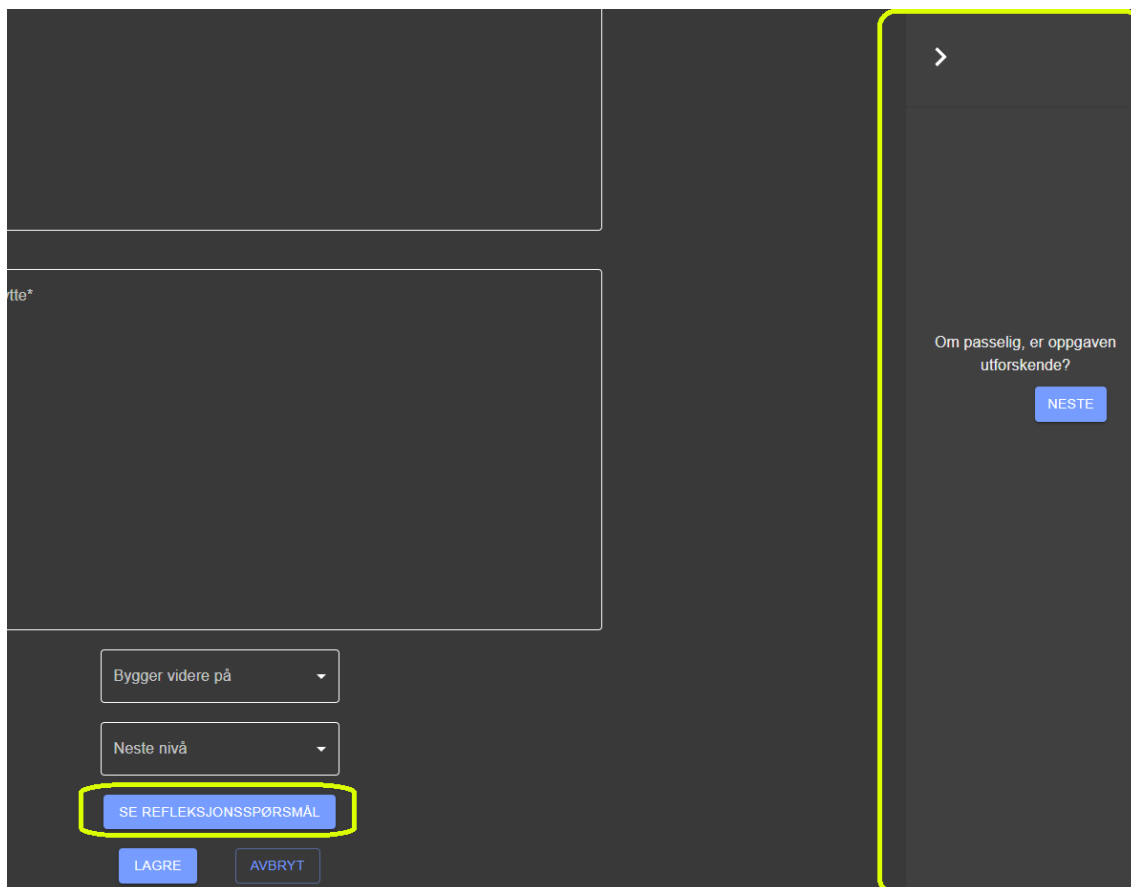
Figure 31: Reflection questions in the LACP in MusiCT version 2.0

As was discovered in the expert interviews, the reflection questions would probably not be used by all users, and as such making it voluntary to go through the reflection questions was important. This was considered when implementing the functionality and is the reason a button is required to display the sidebar. I also decided that it would be better for one question to be visible at a time to keep the user focused on reflecting over one thing at a time. There are buttons to navigate between questions and in version 2.0 of the prototype, 4 questions were included. These questions were examples of reflection questions that were discussed with experts and received the most positive feedback.

Issue #6, concerning changes to the search for similar learning activities was resolved by making several changes. In version 1.0, all of the then three available fields had to be filled out before the button to search appeared. One of the changes made to this functionality was that in version 2.0 the button would appear once one of the fields has a value selected. When clicking the search-button the system does not search as it did in version 1.0. In version 2.0, the interface presented in figure 32 is opened in a modal. This interface allows the user to select the what fields the are interested in finding similar activities for. Any combination of fields is accepted. In figure 32 only three of the fields are selectable, with learning objectives missing. The reason is that the figure displays the interface that shows up when all fields except the field for learning objectives has a selected value. The text at the bottom of the interface explains that field(s) not present must have values selected before they will show up and the user can search for similar activities based on the value for that, or those, field(s). When all fields have values selected, the text will not be rendered.

Figure 32: New interface for finding similar learning activities

The final change to the LACP is connected to the implementation of voluntary publishing. In version 1.0, clicking the save-button would save the learning activity and redirect the user to the front page. In version 2.0, the interface presented in figure 33 is opened in a modal instead. This interface allows the user to either save the activity as private or public, with only public activities being visible in the database-page and when searching for similar activities. In addition, a simple alert was added when saving the activity to confirm to the user that the activity was saved before the user is redirected to the front page.

Figure 33: New interface for selecting visibility when saving a learning activity

7.3   Changes Made to the UI of Other Pages

The LACP was not the only part of the system that had changes made to it for version 2.0. As already mentioned, the CT-methods field and the new text-fields were also added to the page for editing a learning activity. The other changes to the system were not as many, and not as large, but would still help increase the usability of the system and inform the user about the system itself through the about-page presented in figure 34. The topics of this page were described in section 6.3.1 and the written text covering these topics is visible in the figure. The user can navigate to this page by clicking on the text "Om MusiCT" which was added to the bottom of the front page as a footer. As this is only a slight change to the front page from version 1.0, a figure of the new front page is not included.
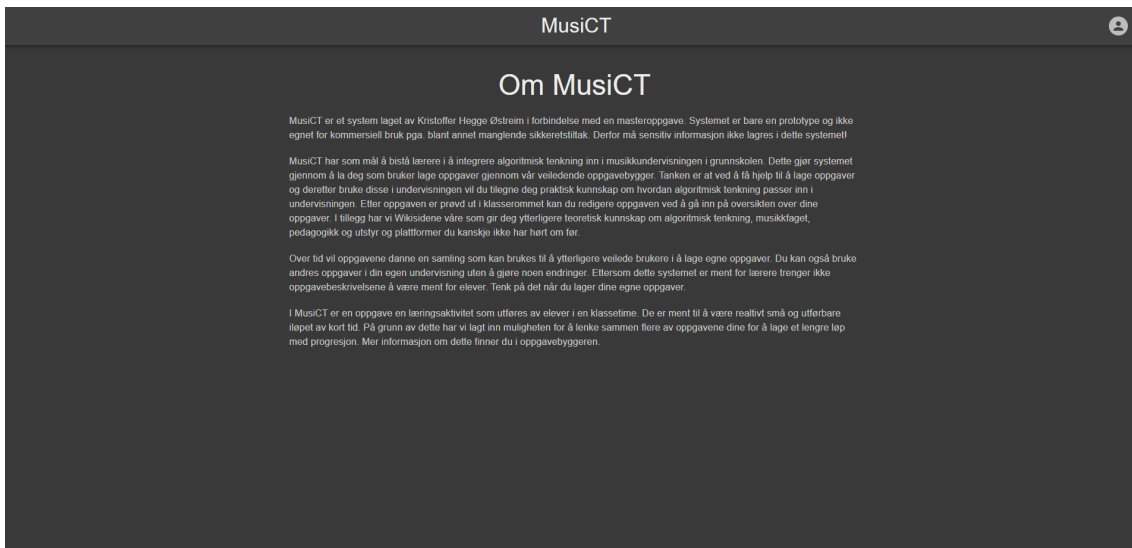
Figure 34: The About-page in MusiCT version 2

As described in the discussion of issue #10, the MyActivities-page started to become very busy once a fourth action had to be added to each activity on the page. Adding a fourth button would make the buttons take up more space on the page than the cards with information about the activities. To improve the layout of the page, I implemented a drop-down menu for each activity which was accessible through the three dots highlighted in figure 35 showing the new layout for the MyActivities-page. Figure 36 shows the drop-down menu that appears once the user clicks the three dots. User feedback was also added in the form of alerts when changing the visibility of an activity or deleting it.
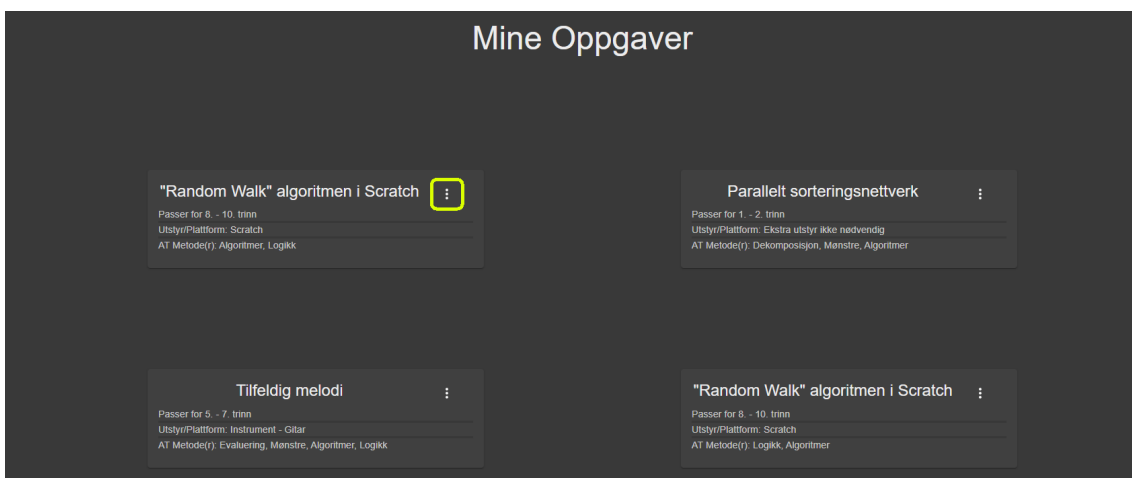
Figure 35: The MyActivties-page in MusiCT version 2
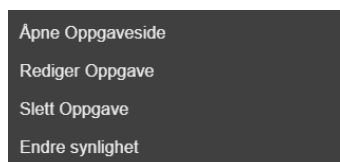
Figure 36: Menu showing the available actions for each activity on the MyActivities-page

8 Evaluation

After the second iteration of development, a final evaluation of the system was made. This evaluation, or testing as it will also be referred to as, provides the final results for this thesis and focuses on two areas of the developed prototype: Usability and the attitudes of teachers concerning the concepts used within the system. The evaluation will attempt to answer both RQ 1.1 and RQ 1.2. This chapter will describe the evaluation similar to how chapter 6 described the expert interviews, explaining the methods used, the results, and discuss the results before a final conclusion is drawn in the next, and final, chapter.

8.1 Method

Similar to the expert interviews, the final evaluation consisted of the three phases: Recruitment, data collection and data analysis. Once again, data collection includes both the planning and execution of data collection. In addition to these phases, preparations made before tests will be described as this evaluation required more preparations than the expert interviews. Processing of personal data was approved as described in section 6.1.3, but some considerations had to be made that were not made for the expert interviews. These will also be described in this section.

8.1.1 Recruitment

As the final evaluation also relied on participants, a new recruitment phase began. This phase began during the final week of development by identifying the desired groups of participants and beginning to contact potential participants. Two groups of desired participants were identified, namely:

1. Non-teachers. As will be further detailed later in this chapter, the usability of the system was tested to validate the results regarding the concepts behind the system. As such, some pilot tests with non-teachers, looking only at the usability of the system, could help improve the usability before testing with teachers.

2. Music teachers in primary and lower secondary school. This is the target audience for the system and the relevant participants to help answer the research questions. They know the working processes of teachers and will be able to provide thoughts on how useful the system is in supporting these working processes.

Because the non-teacher user tests were going to be done first, these participants were recruited first. As there were no requirements for these participants other than that they should have no prior knowledge of the system, I asked people I knew personally to partake in the user tests. I did not need many participants from this group as they would only provide feedback on the usability aspect of the system. Two participants were selected from this group, identified using U1 and U2 in table 6. They did not receive an informational document regarding the project, but I answered all the questions they had regarding it. They did sign a consent form just like all other participants.

Recruitment for the main group of participants, music teachers, was done in several ways. I began by contacting the teachers who participated in the specialization project via email, four in total. In the email, I wrote about the project and attached the informational document included in appendix C. They had all expressed desire to participate in my thesis project after I interviewed them for the specialization project. Out of the four, three agreed to participate in this project. Next, I approached the administrators of two Facebook-groups for music teachers about posting in the groups. As identified in the specialization project, such groups are the most used communities among music teachers (Østreim 2021). The groups had 4.9k and 6.2k members at the time of contacting the administrators. I was allowed to post about the project in both groups and asked if anyone wanted to participate. In the end, only one teacher replied asking for more information about the system, but no participants were found by posting in these Facebook-groups. As these groups are busy and have several posts each day, it is likely that many of the members in each group missed my post as it was lost among other posts.

After failing to find participants through Facebook, I resorted to contacting schools via email. I started by contacting schools in Trondheim as I could execute these evaluations physically and not online. Unfortunately, Trondheim municipality had recently changed their policy on accepting research projects. Some schools replied saying I had to register the project using the municipality's website and others said I had to contact the person responsible for masters theses at my institute. I ended up contacting the person responsible for theses at my institute, but we were unable to figure out how to deal with this issue. This forced me to look outside of Trondheim, and I started contacting schools in other municipalities. I started by contacting random municipalities from memory, some small and some large, before using a list of the biggest cities in Norway[15] to find more municipalities to contact. This way, I contacted schools of various sizes ranging from 100 to 1000 students at the school. In total, over 400 schools were contacted across 25 municipalities. I also sent a follow-up email to schools in five municipalities around two weeks after I sent the initial email. Each email included information about the project and had the informational document attached. From this part of the recruitment, an additional four participants were found.

At this stage, I had seven teachers who had agreed to participate and I felt like it was too late to start contacting more schools as the end of the evaluation phase was approaching. Despite this, I wanted more participants. So after every test I asked the participating teacher if they could mention the project to colleagues. In doing so, another two participants were found, for a total of nine participating teachers. These are listed in table 6 as "TX" where the number replacing X represents the order in which the participants participated.

Participant ID	Group	School level
U1	1	N/A
U2	1	N/A
T1	2	Primary and lower secondary
T2	2	Primary and lower secondary
T3	2	Primary and lower secondary
T4	2	Primary
T5	2	Primary and lower secondary
T6	2	Primary and lower secondary
T7	2	Lower secondary
T8	2	Lower secondary
T9	2	Primary and lower secondary

Table 6: Participants for the final evaluation

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[15] https://snl.no/de_st%C3%B8rste_byene_i_Norge

8.1.2 Preparations for Testing

Before testing could begin, some preparations had to be made. As some tests would be done remotely, the system was deployed to Heroku and Netlify. Following the deployment, the database needed to be populated with wiki pages and some example activities. The wiki pages were simply copied over from the local database used during expert interviews and development. Regarding example activities, three were added in total. I created one myself and added one activity described in (J. Bell and T. Bell 2018), and one activity from (Ruthmann et al. 2010). The contents of these activities was not important as the content in the system was not part of the assessment. Still, I wanted the example activities to be similar to those the system is intended for to not confuse participants during testing. To create these activities within MusiCT, I created an admin user. I also created a test-user used during tests.

The preparations mentioned above were all done before any tests were done and were not modified afterwards. However, one preparation needed to be made before each test. The tasks that participants completed using the system during the user test as a part of the evaluation required them to create and save a new learning activity. As such, a new learning activity was created during each test that needed to be removed before the next test. I would remove these activities between tests by logging in to the test-user and deleting the activity from the MyActivities-page. Aside from this, I would occasionally double-check that the system was still running, especially after an issue with the database provider during testing with participant T6.

8.1.3 Data Collection

For data collection during this evaluation, three methods were used: Observation, a questionnaire, and an interview. Participants from group 1 only participated in observation and filling out the questionnaire whereas participants from group 2 participated in all three. This section will further describe the three methods used for data collection and why they were included.

User Tests
Observation was used through doing user tests with participants. User tests are a way to assess usability of a system through observing a test subject perform tasks given to them using the system (Moran 2022). In addition to observing the actions of the test subject, it is common to ask them to think out loud and explain their actions as they use the system. This allows the observer to understand the reasoning behind the choices the user makes as they navigate through the system. Ideally, one would have two researchers administrating the test with one observing the test subject and one giving them tasks. As I worked on this thesis alone, I did both roles during user tests.

The reason I included user testing in the final evaluation was to assess the usability of the system. As the project explores the perception of teachers regarding the concepts used within the system, it is important that their perception is not affected by bad usability. This could lead to participants having a negative view of the system and its concepts despite actually having a positive view of the concepts used. Essentially, usability is assessed in this evaluation to validate the results regarding the concepts of the system. Proving that MusiCT's usability is good will show that bad usability did not affect the perception of participants regarding the concepts that I want to address.

During the user tests I administered during the evaluation phase, I used the list of tasks included in appendix E. The list of tasks is also included in table 7. This document also includes some preliminary information given to the user before the test began. This information is seen as standard for user testing and originates from a ten-point checklist created by K. Gommoll og A. Nicole, as also mentioned in (Tognazzini 1991), which is listed below. After each point I list what was done with regards to the point in question. A scenario is also described in appendix E. This is used to set the scene for the test and the tasks to come.

Checklist for user-tests:

1. Introduce yourself - I naturally did this at the start of each test so it was not included in the preliminary information.

2. Describe why the test is being done - This information is included in the first paragraph of the preliminary information.

3. Tell the participant that they can abort the test at any time - This information is included in the second paragraph of the preliminary information. I also explain that the participant does not need to provide reasoning for aborting the test.

4. Describe the equipment in the room and the limitations of the system - Limitations of the system are briefly mentioned in the fourth paragraph of the preliminary information. As there were many limitations, I simply mention that I will assist the participant in the event that they encounter a limitation. I do not describe any additional equipment in the room as there was none.

5. Explain how to think out loud - As thinking out loud is something that people rarely do, it can be quite foreign to participants. As such, one should explain how it is done to the participant before the test begins and provide an example. I do this in paragraph three of the preliminary information.

6. Explain that you cannot assist the participant during the test - This is mentioned alongside limitations in paragraph four of the preliminary information.

7. Describe the tasks and introduce the product - This point is addressed as the product (in this case MusiCT) was introduced briefly in the email I sent to the participants during recruitment. The task list was available to the participant during the test. I also explained that the participant should not use the system between tasks.

8. Ask if there are any further questions - I would to this before describing the scenario for each test. As with introduction of myself, this was a natural thing to do and I did not need to be reminded by writing it down.

9. Finish the test by letting the participant explain themselves - In the event that a participant would get stuck while doing a task, I would ask what the issue was. I would typically ask these questions after the relevant tasks instead of after all tasks were done.

10. Use the results as input for improving the design - In the case of U1 and U2, their results were used to improve the design before testing with teachers. As for teachers, their results were used to assess the usability of the system.

The tasks given to participants were designed to take the participant through most of the functionalities of the system in a way that mimics how the system would be used in a real-life setting. The tasks are linked to the scenario which mentions that the user is to use the system for the first time after a recommendation by a colleague. For the participants from group 1, the scenario also puts them in the position of a music teacher. The tasks mostly concern the LACP as it is the focus of this thesis, but also includes other parts of the system. This was done for the participants to get the full user-context and enable them to comment on the concepts behind the system and their usefulness for teachers even better. For instance, creating a learning activity might not seem useful if one does not know what happens to that activity after it has been created.

Task number	Task description
1	Din kollega sa ikke mye om hva systemet brukes til og du er interessert i å finne ut mer om MusiCT. Hvordan går du frem for å finne mer informasjon?
2	Logg inn med brukeren din (Gi innloggingsinfo) og gå til oppgavebyggeren.
3	Du ønsker å lage en oppgave som benytter metodene "Algoritmer" og "Logikk" fra algoritmisk tenkning, men ønsker mer informasjon om metoden "Logikk". Hvordan går du fram for å finne mer informasjon om denne metoden?
4	Du ønsker å finne inspirasjon til oppgaven din gjennom oppgaver som allerede ligger i systemet. Søk etter eksisterende oppgaver som også benytter de samme metodene fra AT. Importer en oppgave funnet av søket ditt.
5	Gi oppgaven din en ny tittel (kan være hva som helst)
6	Før du lagrer oppgaven din ønsker du å bruke oppgavebyggerens refleksjonsspørsmål til å vurdere kvaliteten på oppgaven din. Hvordan går du fram? (Du trenger ikke vurdere oppgaven, kun navigere gjennom de tilgjengelige refleksjonsspørsmålene)
7	Lagre oppgaven din som privat slik at den ikke er synlig for andre
8	Etter å ha brukt oppgaven i en time fant du ut at oppgaven fungerte svært godt og du ønsker nå å endre slik at oppgaven er synlig for andre. Hvordan går du fram for å endre synlighet på oppgaven din?

Table 7: Tasks used during user tests

SUS-Forms

In addition to collecting data in the form of observations, I wanted a quantitative measure of the system's usability. To do this, I used the System Usability Scale as first described by (Brooke 1995). This article describes a questionnaire consisting of 10 claims used to measure usability of digital systems. When filling in the questionnaire, or form as it is also referred to as in this thesis, the participant will check one of 5 boxes describing if they agree or disagree with the claim regarding the system. As such, the SUS-form uses a 5-point Likert scale. A filled out SUS-form is scored by adding the scores for each claim and multiplying the number by 2,5. Claims 1, 3, 5, 7 and 9 are scored by taking the value of the answer by the participant and subtracting 1. Claims 2, 4, 6 and 8 are scored by subtracting the value of the answer by the participant from 5. Overall scores of SUS-forms range from 0-100.

For this evaluation, I used a Norwegian version of the SUS-form created by Dag Svanæs, a professor at NTNU. This version of the SUS-form is included in appendix F. For tests that were done physically, I brought a printed out version of the form. For the remote tests I used an online service to host the form and gave a link to the participants following their user tests. Before the participant would answer the questionnaire I made it clear to them that the claims in the form were concerned with the usability of the system and not the contents of the system. For instance, claim 10 could be interpreted as needing to learn a lot about CT before using the system which is not the intended interpretation. I added that I could clarify any of the claims and give examples in the case that the participant did not fully understand the claim and what it was referring to in the case of MusiCT.

Interviews

As mentioned above, usability was assessed to validate the results regarding the concepts within the system using user tests and SUS-forms. For teachers, who were the only relevant group to comment on the usefulness of the system as a tool for teachers, an interview was also included in the evaluation. This interview was designed to collect data regarding the concepts within the system and the thoughts of teachers regarding the system as a whole. In short, I wanted to know if this type of system is something that would be helpful and if yes, if it should be designed in the same way as MusiCT or not. Semi-structured interviews were chosen for the final evaluation for the same reasons as listed before in section 6.1.2. The interview guide used is included in appendix D.

The first question asks for the participant's general impression of the system after having used it during the user test. This question is very open and can lead to a lot of different answers. The idea was that whatever the participant answered would likely be what they emphasized about the system. It also opens the door to discuss things further depending on what the participant answers. The subsequent questions are more specific and question 2 asks about access to parts of the system, specifically the wiki pages and the database-page, without being logged in. Often, a user will view creating a user to access parts of the system to be a lot of bother. This question is also indirectly asking about teachers' motivation towards using such systems. Are they motivated enough to create a user to explore the system or would that be to much effort? This is useful information for both the pages I ask about and also the LACP.

Looking back to the conceptual model presented in figure 7, the LACP is supposed to interact with the other parts of the system. The wiki pages should feed information into the LACP by allowing its contents to be accessible directly from the LACP. The database of existing learning activities should support creation of new activities by providing relevant inspiration. Question 3 asks for thoughts on the ways connections between the different parts of the system are implemented in MusiCT. As this is a key feature of the LACP, it is important to assess if these connections are useful and if they can be improved.

Question 4 asks about the functionality that allows the user to link activities together to create a longer progression of activities. This functionality is not included in the user test and as such I would provide an additional explanation of the idea behind this functionality when asking the question. As such, this question is more of a discussion with the participant about the possibilities of this functionality as well as if it is a good idea or not.

During the expert interviews, the concept of a learning activity and the fields in the LACP template were in focus, related to RQ 1.1. This was looked at again during the final evaluation and question 5 asks about the fields that are present in the LACP of MusiCT version 2.0. In addition to asking about the fields that are present, I also ask if the participant feels like something is missing that they usually include when they plan themselves. As the system should be usable by everyone, the template cannot be too specific, but there is still room to add new fields if a large portion of participants feels like a particular field is missing.

A functionality that was added after the expert interviews was the reflection questions. These questions were implemented with the results from the expert interviews in mind, but they did not receive any testing before the final evaluation. Question 6 queries the participant about the usefulness of the functionality itself before question 7 asks about the topics that such questions should cover. It should be noted that question 7 was added following the first two tests done with teachers (T1 and T2). As such, T1 and T2 were not asked about the topics that reflection questions should cover.

Question 8 relates to the overall impression of the system and asks the participant about the system's potential to affect their motivation and/or confidence with respect to integrating CT with music. One of the aims of the system is to give teachers a way of integrating CT in their classrooms when teaching music without needing to spend a lot of time to learn about CT, hence dealing with two of the three identified challenges from the specialization project. The LACP does this through empowering teachers to create activities to use in the classroom and gain practical knowledge from using the activities. If this works as intended, then teachers should feel like using the system would make it easier for them to integrate CT with music and positively affect their motivation and/or confidence depending on how they felt about CT before. Finally, I ask the participants for any other comments they might have regarding the system.

8.1.4 Processing of Personal Data

With regards to processing of personal data, there were some things to consider. While contact information was processed in the same way is with the expert interviews, no audio recordings were made during the interviews for the final evaluation. This was done because I felt like I would be able to take notes during the interview and to not discourage potential participants from participating as some might feel like audio recording is a privacy concern. All participants signed the consent form included in appendix C. For the remote tests, I needed to use some data processing services to host the test and the SUS-form. To host the test itself, I used Zoom like with the expert interviews. To host the SUS-form, I used Nettskjema[16] who, like Zoom, have a data processor agreement with NTNU.

8.1.5 Data Analysis

During the final evaluation, both qualitative and quantitative data were collected. Qualitative data, meaning observations from user tests and the interviews, was analyzed using the table method as explained in section 6.1.4. The quantitative data from the SUS-forms was analysed by inputting the replies for each answer into a table and computing the average score of the forms. As the average can be affected by outliers in the data, the median was also calculated as it is not affected by this and can be a better representation of the central tendency. This analysis also allowed me to see the replies to each individual answer alongside one another to identify if there were any particular claims that received a lot of negative opinions.

8.2 Results

This section will present the findings from the data analysis. Between the observation results from pilot tests and tests with teachers, the changes made to the system following the pilot tests will be presented. As these changes were few and only minor changes, I have chosen to include them in this section because they do not alter the user experience, only improve it. No changes were made to the system between tests with teachers other than the deletion of activities as mentioned in section 8.1.2.

8.2.1 Observations

Observation data was analyzed using the table method as mentioned above with color coding of notes. In this case, colors would correspond to how well the participant executed the tasks. Green would represent an execution of a task that went flawlessly and with very little to no hesitation. Yellow was used for task-executions where the participant voiced some confusion or insecurity, but ended up finding the correct functionalities without making mistakes or me intervening. Red was used in cases where the participant did not manage to complete the task without mistaking another functionality for the correct one or me intervening. In some cases, the participant would simply say that they did not know where to go after trying everything they could think of and I needed to intervene. The results from the observations will be presented in the following order: Observation data from the pilot tests, a brief description of changes made to the system following the pilot tests, and observation data from tests with teachers.

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[16]https://nettskjema.no/

Pilot tests

Overall, the results from the pilot tests were positive. Tasks 2 and 6 were completed by both U1 and U2 without issues. Tasks 3, 4, 5, 7 and 8 were also completed by both participants, but in some cases there was some hesitation. For instance, U2 thought there might be a button to change the title rather than just writing a new title in the title-field. Other reasons for hesitation included opening information about the LACP before finding information about logic in task 3 and considering the database-page as a place to find your own, privately saved, activities in task 8. As both participants seemed positive to the functionalities despite their hesitation, the functionalities involved with these tasks did not change. Task 1 was not completed by either of the participants as they did not see the text-link to the about-page. U1 suggested increasing the font-size of the link to the about-page on the front-page. U2 also said that they did not see the text without explicitly suggesting a change.

System improvements

The main improvement that needed to be made following the pilot tests were the text-link to the about-page. Both U1 and U2 had missed this when testing the system. The chosen solution was to increase the font-size as suggested by U1. During the pilot tests, some other issues were also identified. There was a typo in the wiki pages that was resolved, and the activity used for importing in task 4 had to be remade with its CT-methods in the opposite order. The selection fields proved to be sensitive to the order in which the user selected the menu-items and to be sure that the correct activity was found, I made two copies with the CT-methods in both possible orders ("Logic, Algorithms" and "Algorithms, Logic").

Teacher tests

During all of the user tests executed with participants from group two (teachers), tasks 2, 5 and 6 were executed without issues. From this, it seems like logging in, inputting text in the text-fields of the LACP and accessing the reflection questions were all intuitively designed functionalities. 3 teachers even closed the sidebar with the reflection questions after reading though them despite this not being part of the task. For the remaining 6, the sidebar did not cover any of the other elements of the LACP and did not hinder them in any way so there was no need to close it.

Task 7 was executed flawlessly by 7 out of the 9 participating teachers with T5 and T7 hesitating slightly. They mentioned how they felt like it was risky to click save and were looking for some sort of checkbox to ensure that the activity was saved privately. In the end, they both clicked save and received the option to save privately and did so. Task 8 also had some participants hesitating. 5 of the participants felt like there were two possible ways to find the privately saved activity: Through the profile, or in the database-page. Most of them tried the database-page first before quickly navigating to the MyActivities-page and changing the visibility with 1 of the hesitating participants going straight to the MyActivities-page. The remaining 4 participants found the MyActivities-page and changed the visibility without hesitation. All 9 managed to change the visibility without issues and credited the intuitive design of the menu attached to each activity.

The results reviewed thus far shows a lot of positive results, but there were some tasks where multiple participants had major problems. Task 1 proved to be difficult for many, but in some cases not necessarily due to the design of the system. T1 and T6 executed task 1 flawlessly, with T2 and T3 going to the wiki pages first before going back to the front page and quickly clicking the text-link with T2 saying:

"I saw about early, but assumed that it was not finished in this prototype and therefore chose to ignore it afterwards. I like to get straight to business and was more interested in exploring the contents of the system".

This attitude of just looking around the system was found among other participants as well. T4, T7, T8 and T9 all had a similar attitude and deliberately chose not to click the text-link as they thought the information they would find there would not be interesting. In hindsight, they understood that they should have clicked it as that kind of information was what the task was asking them to find. T5 was the only participant who did not notice the text-link and never clicked it without me intervening. As they also navigated to the wiki pages first it seems like it would have been better to include the about-page as an entry in the wiki.

There were also issues with task 3, as T1 and T6 were not able to complete the task without me intervening. T6 also noted that they did not see the question marks in the menus earlier without understanding why. T1 only selected Logic from the menu without ever clicking the question mark next to it. T3 did something similar, but clicked the question mark shortly after selecting Logic as they realized that selecting the method did not bring up more information about it. In the case of T2, I forgot to add that they had to stay in the LACP and they went to the wiki pages first. After I clarified they found the correct functionality. The remaining participants, 5 in total, completed the task without problems.

Finally, task 4 also had mixed results despite 5 participants completing the task without problems. T6 only hesitated by searching for a search-button before selecting the methods and then completed the task. T1 completed the task correctly, but wanted to read more about the activity before importing it. As this would be natural in a real-life setting, this is seen as a positive result. They did however note that the list of similar activities could become crowded and not very user-friendly with a lot of activities in the database. T4 and T5 were not able to complete the task without me intervening. In both instances it seemed like the participant wanted to first select search and then select parameters for the search. Because of this, they got stuck looking for a search-button and did not select the methods from the correct field. T5 also noted that they felt like the design promoted filling out all of the fields at the top of the LACP (the identifiers for a learning activity) before searching. If the search button was visible, but disabled from the beginning, they might have been able to complete the task.

Overall, all of the tasks except task 1 had the majority of participants complete the task without issues. In total, all 8 tasks were completed by all 9 teacher participants (with or without my help) for a total of 72 observations of task executions. Following the distinction described earlier, 49 observations were marked as green, 14 were marked as yellow and 5 were marked as red. In addition, 4 observations were marked with the color blue. These observations corresponded to the instances where a participant had ignored the text link for the about page due to their own attitude rather than the design of the system.

8.2.2 SUS-forms

SUS forms provided a quantitative way of measuring usability alongside the qualitative observation data. The scores of the SUS-forms are presented in table 8. The ID corresponds to the participant IDs from table 6 and C#X corresponds to claim number X from the SUS-form. The score in the rightmost column is the overall score for the SUS-form of that participant. The average score was calculated to be 80,5 and the median score was 82,5, which indicates that the usability of the system was good, but could have been better.

ID	C#1	C#2	C#3	C#4	C#5	C#6	C#7	C#8	C#9	C#10	Score
U1	4	2	4	1	4	2	4	1	4	1	82,5
U2	4	2	5	1	4	1	5	2	3	2	82,5
T1	3	1	4	1	4	2	4	1	5	1	85
T2	4	1	4	2	5	1	3	2	4	5	72,5
T3	3	1	5	1	5	1	5	1	3	2	87,5
T4	3	1	4	1	4	1	3	1	4	1	82,5
T5	3	2	4	3	4	1	5	2	3	2	72,5
T6	4	2	4	2	4	2	5	1	4	1	82,5
T7	4	3	3	1	3	3	4	2	2	2	62,5
T8	2	2	5	1	3	2	3	1	5	1	77,5
T9	4	1	5	1	5	1	5	1	5	1	97,5

Table 8: Results from SUS-forms

8.2.3 Interviews

Starting with the first question from the interview guide, the results from the interviews were positive. There were many general impressions of the system, but the most common ones were that the system was easy to use, exciting, and a good idea/concept. As T1, T4, T6 and T8 noted, it is important that such a system has a decent amount of learning activities in the database already before it becomes usable. T4 and T8 mentioned how there was a lot of text in the descriptions of learning activities and wanted more multimedia functionalities, which was echoed in their responses to question 5 as well. T8 was rather skeptical to the entire system and mentioned that they were skeptical to these kinds of systems in general. Still, they liked the initiative that was shown through creating MusiCT and evaluating it, and thought the concept was a good idea. T7 had the following to say about their general impression of the system:

"It is different from other systems I have seen be used in the school in the way that there are few options in most of the systems we use for education. There is a set path one must take. Here (referring to MusiCT) it is more open and you can choose what you want to use and that is positive. I like to pick and choose what I like myself."

When asked about parts of the system being accessible without logging in, all participants were positive to some degree. However, there were differences in how strongly they felt about this. For instance, T1 said that being able to explore the system without creating an account was very important as registering an account was too much bother in order to just have a look. They said that a lot of intrigue could be enough to convince them to register an account before exploring a system, but that was not the case with MusiCT. On the other hand, T7 said that it would depend on the cost of registering an account. If the system is free to use even with an account, then it is no problem creating one. Given that all participants felt like it would be good to have parts of the system be accessible without logging in, this should probably be the case for similar systems made in the future.

As questions moved to specific parts of the LACP, the results were still very positive. All participants liked the way in which existing activities were used in the LACP. T1, T2 and T6 used the idiom "There is no need to reinvent the wheel" to describe their feelings towards this functionality referring to using existing activities to figure out how CT can be integrated rather than figuring it out themselves from scratch. T8 even called this functionality decisive for whether or not the system would be usable. T8 was also critical to the connections to the wiki pages within the LACP, despite having no problems with this functionality during the user test, saying quote:

"The wiki page connections need to be more "in your face" ... Like, what kind of problem does this solve?"

Regarding connecting learning activities to one another to create a progression, all of the participants were positive in their answers. T3 said this functionality made it easier to plan, and T1 and T2 mentioned differences in competence among students, wanting to use this functionality to create multiple variants of a task with increasing levels of difficulty. T9 considered the time-perspective saying:

"Yes. I also think that you could like ... with Scratch, if 15 minutes of coding is enough, you can do a little all throughout the year."

As such, participants saw multiple ways in which this functionality could be used. Some were positive given certain conditions. T8 thought it was a good idea as long as it is not mandatory, which was not the case with MusiCT, and T6 was concerned with losing the copy of the learning activity that was not connected to other activities. After some discussion around the intended use of the functionality, their concerns were reduced.

Question 5, regarding fields in the LACP and ultimately the structure of a learning activity, was a very important question due to its relevance for RQ 1.1. 7 participants were happy with the existing fields and did not feel as if any they needed were missing. T6 asked about printing the activity in their reply, but this related to other functionalities within the system. As mentioned earlier, T4 was missing a way of uploading photos, videos or other files attached to the activity. T9 had some comments regarding the equipment-field, wanting an option named "other" in the menu for equipment not supported by the system, but was otherwise content with the available fields of the LACP.

Similar to the experts, the teacher participants had mixed feelings about the reflection questions. 6 participants (T2, T3, T4, T5, T7, and T9) were positive to the reflection questions with T4 and T9 mentioning that it was nice that using the reflection questions to evaluate the activity was optional. T8 thought the idea was good, but would have implemented it differently, using a different verbiage as they associated reflection with something that students do rather than teachers. T1 felt like they did not need this functionality themselves, but saw how it could be useful to others, giving a rather neutral answer:

"Could be useful enough, but I think ... why not, it doesn't harm to include them, but ... what should I say? If I had made a plan I would have thought about these points thoroughly myself. So I don't know if it is necessary, but it does not hurt to include them."

T6 felt like the reflection questions would have worked better in a different format. As the reflection questions were implemented in MusiCT, they felt like the system encouraged reflection after creating the activity as opposed to while creating it. They suggested adding a section to the wiki pages discussing what users should consider when creating their tasks, almost like a set of system-wide guidelines for activity-creation.

In addition to asking about the usefulness of the reflection questions, I also asked the participants about topics that such questions should cover. As mentioned previously, this question was added following the evaluations with T1 and T2. As such, only 7 participants were asked this question. Those that were asked listed several topics in their replies and a overview is presented in table 9 below. From this table, one can see that participants were mostly concerned with activities being created with differing levels of competence among students in mind in addition to good readability of the activity description.

Topic	Mentioned By
Competence levels among students	T3, T4, T7
Activity description	T3, T7
Accessibility	T5
Cultural background	T5
Formal things about CT	T6
Music related	T8
Practical execution	T9

Table 9: Topics that should be covered by reflection questions according to the participants

All but one participant agreed that using the system would affect their ability to integrate CT with music in a positive way. T1 said they did not have issues with motivation nor confidence, but that it was clear that other teachers who struggle with this could get a lot of help from using the system. T3 agreed that using the system would have a positive impact on them, but noted that they were not able to claim this with a lot of certainty as MusiCT is only a prototype and due to their limited use of the system. Both T4 and T5 agreed that the system motivated them to try new things. T9 agreed that using the system would affect their ability to integrate CT with music positively, but rather than affecting their motivation or confidence, they felt like it would affect their self-awareness. This was because the system helped to make them aware of the correct terms to use. The one participant who disagreed that using the system would have a positive impact on them was T8. They said that the system as it was would not change their motivation nor confidence, but they did add that a later, more complete, version of the system could.

Throughout the interviews, many comparisons were made between MusiCT and other systems the participants had used before. T6 said that the system reminded them of how UDIR's own planning tool for year-long plans works. This meant that the participant recognized elements from UDIR's system and was able to understand MusiCT easily. After looking at this tool myself, I see that certain elements are the same, but UDIR's planning tool uses a modular template, meaning the user can add whichever fields they want (UDIR 2022c). T7 mentioned a database for learning activities for mathematics that they had used before. As that site was no longer in use, the participant said that they had missed "something like this". T9 made a comparison to how Google Drive works in the sense that you can create something and share it with others through a url. They said that this is often how educational material is shared among teachers today, but having everything in one place would be better.

8.3 Discussion

The results presented in the previous section will be discussed further here. The discussion is split into two sections: One on usability based on findings from observation results and results from the SUS-forms, and one on the concepts used in MusiCT based on the results from the interviews.

8.3.1 Usability

From the observation data it is clear that large portions of the system holds a high level of usability as most of the tasks were performed without difficulties from a lot of the participants. The functionality that would certainly need improvement is the about-page as a lot of participants had trouble and/or hesitated when completing task 1. Additionally, the button for finding similar tasks should probably be visible before any values are selected for the identifier-fields, and the functionality for saving should be redesigned to avoid the fear of automatically saving as public as seen with some participants.

The positive results from the observation data is echoed by the data from the SUS-forms. An average score of 80,5 and a median score of 82,5 proves that the usability of the system was good. Looking at the data, it seems like there is little correlation between positive results from user tests and the SUS-form for some participants. For instance, T7 gave the lowest SUS-score of 62,5, but they only had issues with task 1 and a slight hesitation when completing task 7. Other participants had more issues when using the system, but still gave a higher SUS-score. Looking at T7's scoring of the SUS-form, it seems like their low score is due to them scoring 4 of the 10 claims as 3, meaning they do not agree nor disagree. The cause of this could be that they did not have enough impressions from just using the system for 15 minutes before filling out the form. Another interesting result is that of T2, particularly their scoring of claim 10. While all other participants gave a score of 1 or 2, T2 gave a score of 5. This could be because they interpreted the claim as concerning the contents of the system instead of the functionalities of the system. Finally, claim 1 received a lot of 3s and 4s which is natural as this is not necessarily a system one would use very often so it is hard to give a strong opinion on this.

As mentioned before, usability was assessed to validate the results concerning the concepts behind the system. After reviewing the results from the observations and SUS-forms, I would say that the usability of the system was satisfactory enough as to not affect the opinions of participants regarding the underlying concepts of the system in a negative way. As such, participants should not disregard the underlying concepts due to the way in which they are implemented.

8.3.2 Concept for the System

The overall concept for MusiCT received a lot of positive feedback as participants had good general impressions of the system and compared it to other systems they had used before. It is clear from the results that participants saw the potential of the concept despite MusiCT being a prototype. Some participants did voice concerns about the lack of existing activities, but in a fully-functional system, this would not be an issue. It does however beg the question of how to establish an initial database of learning activities and what its size should be for users to be content.

The replies to question 2, regarding parts of the system being accessible without an account, indicate that it is a good idea to have parts of the system be open for everyone. In MusiCT, the LACP was not one of the parts accessible without an account, but one could argue that it should have been to allow users to test this page as well without committing to creating an account. The problem with this is that an activity needs to be connected to an account, but this problem could be solved by letting these activities be registered in the system as being created by "guest" or a similar proxy account.

As mentioned in chapter 4, MusiCT took a lot of inspiration from systems described in section 3.2. The elements that had proven to work in those systems, such as interactions with a resource pool and the ability to find existing resources relevant to your own case, proved to be useful in MusiCT as well. Participants were positive to wiki pages and existing activities being utilized in the LACP despite the wiki page connections needing to be redesigned based on the response from participant T8 in the interview as well as the observations of T1 and T6.

As the LACP is of focus for this thesis, its structure received a lot of attention during the evaluation. When asked about the fields of the LACP, the results were mostly positive with some participants missing the ability to link multimedia to the activity. Technically, a url to a video hosted on a different platform could be included in the activity description, but providing a dedicated functionality for this is certainly something to consider for future iterations of this kind of system. Apart from this, the concept of a learning activity used within MusiCT and its structure seemed to cover all the needs of the participants.

When presenting the results, I mentioned that participants saw multiple ways to use the functionality enabling users to link activities together to form some sort of progression. While T7 praised the system for giving the user a lot of freedom, allowing users to link activities for multiple reasons might not be a good idea. This is because free use of this functionality would lead to users not knowing what they would find when seeing that there are multiple connected activities. For instance, the participants mentioned using this functionality to cover both long-term planning and facilitating all levels of competence among students. If both are allowed, a user would never know which of these are used in a specific case. On the other hand, one could argue that this is okay as long as the creator makes it clear what kind of progression is being used. That way, both ways of using the functionality can be used, covering a larger set of use cases. In either case, participants were very positive to this functionality being included in the LACP. This can also be said for the reflection questions which also received some criticism, but only relating to their implementation.

To summarize, the concepts used in MusiCT received a lot of positive feedback. Aside from the comments regarding multimedia functionalities, all criticism of the system related to implementation rather than conceptualization. The participants uttered excitement about this kind of system possibly becoming a reality at a later time, further proving that the underlying concepts were positively received.

9 Conclusion

This chapter finalizes the thesis by describing the outcomes of this research project as it relates to the research questions. These outcomes are based on the final evaluation described in the previous chapter. Additionally, limitations for the project will be explored and suggestions for future work building on the work done will be listed.

9.1 Answering the Research Questions

Before discussing how the research questions were answered as a result of the final evaluation, recall that the research questions were:

RQ 1.1: What are the relevant fields in a template-based learning activity creation tool for music education?

RQ 1.2: Will an assisted learning activity creation tool provide teachers with useful information about integrating CT in the Norwegian classroom and assist them in doing so?

Looking at each of these there are two areas to be looked at: Did the overall concept describe a system that teachers would find helpful in integrating CT with music? Did the structure of the concept of a learning activity, and therefore the fields of the template, provide teachers with relevant elements for planning? Each of these corresponds to one of the research questions and will thus be explored in subsequent sections relating the relevant research question. As mentioned previously, usability was assessed to validate the results related to the research questions and not in order to answer them. As 8.3.1 already concluded that the usability was satisfactory to validate the results relevant for the research questions, the conclusions drawn here relate to the data gathered during the interviews.

9.1.1 Answering RQ 1.1

All of the fields in the LACP were found to be relevant, meaning a template-based system such as MusiCT should include grade, learning objectives, equipment, CT-methods, an activity title, a description of the activity, information related to assessment of the activity and what potential learning outcomes there are for students. In addition to these fields, participants suggested including multimedia elements in the LACP, and thus the structure of a learning activity.

This thesis has thus answered RQ 1.1 for the case of the Norwegian school system. Despite this, and different models of instructional design, these fields could provide an outline for other cases as well. Some things would obviously need to change such as the learning objectives not relating to those set by UDIR, but other institutions in other areas. The list of supported equipment should also be customized for each individual case as the curriculum might require different types of equipment (e.g. instruments) in different cases. Software that schools use is typically licensed by governing bodies and thus this also changes from case to case.

9.1.2 Answering RQ 1.2

Through the evaluation of MusiCT, one can conclude that an assisted learning activity creation tool can provide teachers with useful information and assist them in integrating CT with music. The concept received a lot of praise, even when the implementation was less than satisfactory. As several participants were quoted saying that they missed "something like this" it is clear that a system similar to MusiCT is desired among teachers. Through the connections to the wiki pages and the database of existing activities, MusiCT provides teachers with useful information about how to integrate CT with music, and through the LACP, enables teachers to use this information when creating their own learning activities. With the addition of other tools such as linking activities and the reflection questions, the LACP creates an interface that assists teachers in all aspects of creating activities for the classroom.

Once again, this conclusion is restricted to the case of the Norwegian School system. However, a lot of the concept should be transferable to other cases as well. This has already been proven in some cases through systems like Phoebe (Masterman and Manton 2011) and SmartLP (Saad et al. 2014) employing some of the same concepts found in MusiCT to different cases.

9.2 Limitations

There were some limitations in this project, most obviously a lack of participants. Ideally, I would have interviewed more experts and included more teachers in the final evaluation, but finding people willing to participate proved to be very difficult. The low number of participants is especially a weakness for the SUS-forms as they produce quantitative data which is require a larger amount of data than qualitative analysis to produce valid results. As such, the results from the SUS-forms might not be enough to draw generalized conclusions, but the data from observations support that the system had a high level of usability.

Another limitation was the system itself as only parts of it were fully developed as they were prioritized. This prioritization comes from focusing on certain parts of the conceptual model due to the scope of the thesis. Ideally, all parts of the system would have been fully developed to give a more accurate impression of the capabilities of a system using the same conceptual model as MusiCT. The fact that the results found regarding the concept were still positive despite this limitation is however very promising.

The final limitation that will be discussed is the amount of time participants had to use and reflect over the system. This thesis presents results regarding the system and its usefulness to teachers, but this is based on first impressions from teachers having used the system for around 15 minutes completing predetermined tasks. It is clear that the system should be tested while being used over a longer time frame by multiple teachers actually using the system to create learning activities that they then use in the classroom. Then, the usefulness of the system in the working lives of teachers could be fully assessed. As such, this thesis is more of a proof of concept rather than a confirmation that MusiCT as it is is a beneficial tool for teachers.

9.3 Future work

Due to the positive feedback that MusiCT received, it would be wise to continue work with the system, further developing it and executing more tests. I have eluded to some of the future work that can be done already, and below is a full list of suggestions for future work that can be done that builds on this thesis.

- Research structure of other parts of the system - In this thesis, the LACP was of focus, meaning that other parts of the system such as the wiki pages and the database-page were not fully developed. How these pages should be implemented is something that could be researched in the future. Things to look at include the categories included in the wiki pages, what the contents of the wiki should focus on, the different ways to sort and filter activities.

- Test the system with long-term use - This thesis has provided results based on short-term use, but the system should also be tested while being used over a longer period of time with teachers using the activities they create in their classrooms. This would require more research to be done to the other parts of the system first in order to present a fully developed prototype for this kind of testing.

- Explore options for multimedia content in learning activities - As some participants suggested, adding non-text elements to the learning activity structure could help make the activities in the database more interesting and accessible to users.

- Investigate different possibilities for facilitating communities on the platform - In chapter 4 I listed 3 challenges identified in the specialization project that the system should address. The third challenge, a lack of communities, is not solved by MusiCT as it does not facilitate communities in any way. Researching how to facilitate communities in a system similar to MusiCT is also something that can be done as future work.

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Appendix

A Informational Document - Experts

Vil du delta i forskningsprosjektet

MusiCT, a support system for teachers when integrating computational thinking in music education?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å designe et digitalt system for å hjelpe musikklærere i grunnskolen med å integrere algoritmisk tenkning i musikkundervisningen. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
Dette prosjektet er en masteroppgave og en fortsettelse av et fordypningsprosjekt gjennomført høsten 2021. I fordypningsprosjektet ble utfordringer blant lærere utforsket for å identifisere problemer som må håndteres. Formålet med denne oppgaven er å designe en digital løsning for disse problemene og teste systemet i 2 iterasjoner. Prosjektet vil forsøke å besvare følgende forskningsspørsmål:

1. What are the relevant fields in a template-based learning activity creation tool for music education?

2. Will a template-based learning activity creation tool provide teachers with useful information about integrating CT in the Norwegian classroom and assist them in doing so?

Hvem er ansvarlig for forskningsprosjektet?
Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Du blir spurt om å delta i testing av systemet etter første iterasjon med utvikling. Til denne testingen ønsker vi eksperter innenfor musikk, didaktikk og/eller læringssystemer som kan gi kommentarer til designet som blir vurdert under andre iterasjon med utvikling. I utgangspunktet ønsker vi opp til 5 deltagere fra denne gruppen

Hva innebærer det for deg å delta?
Du vil delta i testing av systemet. Denne testingen vil bli gjennomført i form av en dialog mellom deg og student hvor vi ser på systemet sammen og snakker om de beslutningene som er tatt og hvordan designet kan forbedres funksjonelt og estetisk. Det vil bli gjort lydopptak av samtalen som senere transkriberes og slettes for å ivareta personvern (mer om det lenger ned i skjemaet). Samtalen vil ta rundt 45 minutter.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

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. Kun student (Kristoffer H. Østreim) og veileder for prosjektet (Monica Divitini) vil ha tilgang til dine personlige data og all data behandles gjennom utstyr tilhørende institutt for datateknologi og informatikk. I masteroppgaven vil alle deltagere være anonyme. Navn og kontaktinformasjon vil kun brukes til å avtale tid/sted for intervju og ikke lagres sammen med annen data. Forsker og veileder forholder seg også til de etiske retningslinjene ved NTNU som innebærer taushetsplikt om din deltagelse.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Opplysningene anonymiseres når lydopptak transkriberes og all data slettes når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 3. juni 2022.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:
- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til 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 Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og 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:
Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk ved
Kristoffer Hegge Østreim,
Monica Divitini,
Vårt personvernombud: Thomas Helgesen,

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:
- NSD – Norsk senter for forskningsdata AS

Med vennlig hilsen

Monica Divitini   Kristoffer Hegge Østreim
(Forsker/veileder)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *MusiCT, a support system for teachers when integrating computational thinking in music education*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i samtale
- ☐ at Kristoffer Hegge Østreim kan gi opplysninger om meg til prosjektet
- ☐ at opplysninger om meg publiseres slik at jeg **ikke** kan gjenkjennes
- ☐ at mine personopplysninger slettes etter prosjektslutt

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

----
(Signert av prosjektdeltaker, dato)

B   Interview Guide for Expert Tests

Oppgavebygger

Gjør sidens layout det enkelt å lage en oppgave?

Er koblingen til wiki-sidene designet på en god måte slik at det er enkelt å finne relevant informasjon?

Øverst på siden er det noen felter, hva tenker du om å legge til de følgende feltene:
- Tagger/nøkkelord
- Metode/begrep fra algoritmisk tenkning som dekkes
- Andre?

For øyeblikket har oppgavebyggeren bare mulighet for å legge inn en tittel og beskrivelse for oppgaven. Er det disse feltene gunstige å ha her:
- Vurdering
- Forventet læringsutbytte
- Andre?

Vi ønsker å legge inn noen spørsmål som får læreren til å reflektere over kvaliteten på oppgaven de skal lage/har lagd. Kan det være gunstig å få læreren til å reflektere over:
- Kulturell bakgrunn
- Vurderingsform
- Tilpasning for alle kompetansenivåer
- Andre?

C   Informational Document - Teachers

Vil du delta i forskningsprosjektet

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1. What are the relevant fields in a template-based learning activity creation tool for music education?

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Hvem er ansvarlig for forskningsprosjektet?
Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Du blir spurt om å delta i testing av systemet etter andre iterasjon med utvikling. Til denne testingen ønsker vi musikklærere som kan teste systemet og si noe om løsningen er god for å hjelpe med integrering av algoritmisk tenkning i musikkundervisningen. I utgangspunktet ønsker vi opp til 20 deltagere fra denne gruppen

Hva innebærer det for deg å delta?
Du vil delta i testing av systemet. Denne testingen vil bli gjennomført i form av brukertest hvor du får noen oppgaver du skal utføre i systemet. Når du utfører oppgavene skal du tenke høyt slik at studenten kan forstå tankegangen din når du bruker systemet. Etter du har fullført oppgavene skal du fylle ut et kort spørreskjema som brukes for å måle brukbarhet i digitale systemer og svare på noen spørsmål om systemet. Dersom testen gjennomføres digitalt vil skjemaet fylles ut digitalt og selve testen gjennomføres over Zoom.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

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. Kun student (Kristoffer H. Østreim) og veileder for prosjektet (Monica Divitini) vil ha tilgang til dine personlige data og all data behandles gjennom utstyr tilhørende institutt for datateknologi og informatikk. I masteroppgaven vil alle deltagere være anonyme. Navn og kontaktinformasjon vil kun brukes til å avtale tid/sted for intervju og ikke lagres sammen med annen data. Forsker og veileder forholder seg også til de etiske retningslinjene ved NTNU som innebærer taushetsplikt om din deltagelse.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Opplysningene som lagres vil være anonyme og all data slettes når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 10. juni 2022.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:
- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til 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 Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og 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:
Norges teknisk-naturvitenskapelige universitet Fakultet for informasjonsteknologi og elektroteknikk (IE) / Institutt for datateknologi og informatikk ved
Kristoffer Hegge Østreim,
Monica Divitini,
Vårt personvernombud: Thomas Helgesen,

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:
- NSD – Norsk senter for forskningsdata AS

Med vennlig hilsen

Monica Divitini   Kristoffer Hegge Østreim
(Forsker/veileder)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *MusiCT, a support system for teachers when integrating computational thinking in music education*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ☐ å delta i brukertest
- ☐ at Kristoffer Hegge Østreim kan gi opplysninger om meg til prosjektet
- ☐ at opplysninger om meg publiseres slik at jeg **ikke** kan gjenkjennes
- ☐ at mine personopplysninger slettes etter prosjektslutt

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

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(Signert av prosjektdeltaker, dato)

D Interview Guide for User Tests

Intervjuguide

Hva er ditt generelle inntrykk av systemet?

Svar:

Synes du det er bra at eksisterende oppgaver og wikisidene er tilgjengelige uten å være logget inn?

Svar:

Hva tenker du om måten wikisidene og eksisterende oppgaver i databasen brukes på i oppgavebyggeren?

Svar:

Synes du det er bra at en oppgave kan kobles til andre oppgaver du har lagd i oppgavebyggeren?

Svar:

Er det noen felter du føler mangler i oppgavebyggeren eller noen felter som er der nå som er unødvendige?

Svar:

Hva er dine tanker rundt bruken av refleksjonsspørsmål i oppgavebyggeren?

Svar:

> Hvis positiv: Hvilke områder føler du refleksjonsspørsmålene bør dekke?
>
> Svar:

Føler du at bruk av dette systemet kan gi deg større motivasjon/selvsikkerhet når det kommer til å integrere algoritmisk tenkning i musikktimene når du underviser?

Svar:

Andre kommentarer?

Svar:

E Task List

Info

Denne testen gjennomføres for å undersøke om konseptene som brukes i MusiCT er utformet på en god måte og om de danner en prosess som virker veiledende og motiverende for brukere, i tillegg til å produsere oppgavebeskrivelser av god kvalitet til bruk i undervisning i klasserommet.

Du kan avbryte testen når du vil om du ønsker uten å måtte forklare hvorfor.

Under testen er det ønskelig at du tenker høyt og forklarer tankegangen din. Et eksempel kan være "Jeg tenker det er naturlig at jeg finner X ved å trykke på knappen merket Y og gjør dermed det".

Jeg kan ikke hjelpe deg underveis med mindre du treffer på en teknisk begrensning i systemet da det er utviklet uten begrensninger for valg som ikke skal være tillatt.

Vennligst ikke utfør handlinger i systemet mellom oppgaver

Scenario

Du er interessert i å integrere algoritmisk tenkning inn i musikkfaget når du underviser, men du er usikker på hvordan du skal gå fram for å gjøre dette. En kollega har nevnt systemet MusiCT til deg og du skal nå prøve det.

Oppgaveliste

1. Din kollega sa ikke mye om hva systemet brukes til og du er interessert i å finne ut mer om MusiCT. Hvordan går du frem for å finne mer informasjon?

2. Logg inn med brukeren din (Gi innloggingsinfo) og gå til oppgavebyggeren.

3. Du ønsker å lage en oppgave som benytter metodene "Algoritmer" og "Logikk" fra algoritmisk tenkning, men ønsker mer informasjon om metoden "Logikk". Hvordan går du fram for å finne mer informasjon om denne metoden?

4. Du ønsker å finne inspirasjon til oppgaven din gjennom oppgaver som allerede ligger i systemet. Søk etter eksisterende oppgaver som også benytter de samme metodene fra AT. Importer en oppgave funnet av søket ditt.

5. Gi oppgaven din en ny tittel (kan være hva som helst)

6. Før du lagrer oppgaven din ønsker du å bruke oppgavebyggerens refleksjonsspørsmål til å vurdere kvaliteten på oppgaven din. Hvordan går du fram? (Du trenger ikke vurdere oppgaven, kun navigere gjennom de tilgjengelige refleksjonsspørsmålene)

7. Lagre oppgaven din som privat slik at den ikke er synlig for andre

8. Etter å ha brukt oppgaven i en time fant du ut at oppgaven fungerte svært godt og du ønsker nå å endre slik at oppgaven er synlig for andre. Hvordan går du fram for å endre synlighet på oppgaven din?

F   SUS-Form

Noen spørsmål om systemet du har brukt.

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig

1. Jeg kunne tenke meg å bruke dette systemet ofte.

1	2	3	4	5

2. Jeg synes systemet var unødvendig komplisert.

1	2	3	4	5

3. Jeg synes systemet var lett å bruke.

1	2	3	4	5

4. Jeg tror jeg vil måtte trenge hjelp fra en person med teknisk kunnskap for å kunne bruke dette systemet.

1	2	3	4	5

5. Jeg syntes at de forskjellige delene av systemet hang godt sammen.

1	2	3	4	5

6. Jeg syntes det var for mye inkonsistens i systemet. (Det virket "ulogisk")

1	2	3	4	5

7. Jeg vil anta at folk flest kan lære seg dette systemet veldig raskt.

1	2	3	4	5

8. Jeg synes systemet var veldig vanskelig å bruke

1	2	3	4	5

9. Jeg følte meg sikker da jeg brukte systemet.

1	2	3	4	5

10. Jeg trenger å lære meg mye før jeg kan komme i gang med å bruke dette systemet på egen hånd.

1	2	3	4	5

|

G   NSD Acceptance Letter

Dato
03.03.2022

Type
Standard

Kommentar
Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg, og eventuelt i meldingsdialogen mellom innmelder og Personverntjenester. Behandlingen kan starte.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til den datoen som er oppgitt i meldeskjemaet.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake.

Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
Personverntjenester vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:
· lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
· formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke behandles til nye, uforenlige formål
· dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
· lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lenger enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), og dataportabilitet (art. 20).

Personverntjenester vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
Personverntjenester legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

Nettskjema er databehandler i prosjektet. Personverntjenester legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og/eller rådføre dere med behandlingsansvarlig institusjon.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til oss ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde:
https://www.nsd.no/personverntjenester/fylle-ut-meldeskjema-for-personopplysning er/melde-endringer-i-meldeskjema

Du må vente på svar fra oss før endringen gjennomføres.

OPPFØLGING AV PROSJEKTET
Personverntjenester vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.
Lykke til med prosjektet!