# Programming for Developing Mathematics Competencies

Collaborative Project to Meet Societal and Industry-related Challenges
Thematic area: Education and competence

### Relevance to the call

The competences and skills required by industry and society are constantly changing, and many of the tasks and problems that were solved manually a few years ago, are now solved by computers. At the same time, the demand for human computers, that is professionals who know a range of computational algorithms and can execute them correctly, has perished (Schaathun, 2022). Nonetheless, mathematical competence is necessary to understand the meaning of mathematical problems and interpret their solutions. Since its implementation in 2020, the mathematics curriculum in Norway focuses on five core competencies (referred to as core elements in the curriculum): (1) Exploration and problem solving, (2) Modelling and applications, (3) Reasoning and argumentation, (4) Representation and communication, (5) Abstraction and generalisation. The curriculum offers an additional core element that summarizes the mathematical fields of knowledge that the students shall meet through working with the first five (Ministry of Education and Research, 2018, 2019). The new mathematics curriculum in Norway, as in many other countries, offers an increased focus on programming. Many argue that programming can be helpful in developing mathematical competencies, including the competencies mentioned above (Balanskat & Engelhardt, 2015; Kaufmann & Stenseth, 2021; Berland & Wilensky, 2015; Weintrop et al., 2016; Brandsæter, 2021). But for various reasons, many teachers in primary, secondary, and upper secondary education find it difficult to successfully implement programming in their teaching,

This strategic research project investigates how **programming can successfully become an integral part of mathematics education, utilized to support learners’ development of mathematical competencies.** In close collaboration between teachers, pre-service teachers, teacher educators, school management, school owners and researchers, we develop teaching practices targeting specific mathematical competencies. To ensure relevance to the teaching profession, the activities are thoroughly tested and evaluated in practice. The scope of the project includes different types of programming and algorithms, including text-based programming (writing code as text in an editor), block-based programming (draggable shapes in a canvas work area), and programming in spreadsheets (with or without macros). We develop teaching practices relevant to all the core competencies of the Norwegian curriculum. Additionally, we explore new topics relevant to Artificial Intelligence (AI) and Machine Learning (ML), reaching beyond what is currently included and considered within reach for pupils in primary and secondary education.

The project refers to areas A and D in the Research Council of Norway’s plan for Education and Competence. We investigate how programming can affect learning of mathematics (A: learning processes, assessment forms and learning outcomes), and develop teaching practices that explore how and if programming can be useful to support learning (D: education, society and working life). Based on our findings we provide recommendations to a broad audience, including teachers, school owners, teacher educators, the academic community, and policymakers.

### Excellence

## State of the art, knowledge needs and project objectives

Skills and knowledge about digital tools, computational thinking, and programming are recognized as vital in many subjects, including science, technology, engineering, and mathematics (Grover & Pea, 2013). Computational thinking is a set of skills that is often used when tackling difficult problems. It includes decomposition (breaking a problem into smaller parts), pattern recognition (analyse and find connections in data), abstraction (identify relevant information and eliminate the extraneous details), and algorithmic thinking (develop step-by-step processes). Programming is introduced in the Norwegian school curricula with the aim of developing the students’ analytical abilities and problem-solving skills necessary to learn, work, and live in the society of the future (Kaufmann & Stenseth, 2021), helping the students to approach problems with a computational perspective, and adapting their thinking processes to align with the algorithms of a computer (Berland & Wilensky, 2015).

Many topics of mathematics are largely related to programming, and many mathematical problems cannot be solved effectively without the help of computers, such as, applying numerical methods for computing quantities like the derivative and the integral. Programming in mathematics has often been used to solve difficult problems or for the purpose of increasing the programming skills of the student. In this project our focus is different. We focus on programming as a measure for developing all core mathematics competencies in the Norwegian curriculum and experiment using programming in all mathematical fields of knowledge including for example calculus, geometry, and number theory.

Since its implementation in 2020, the mathematics curriculum in Norway focuses on six core competencies (referred to as core elements in the curriculum), which to a large extent overlap with the mathematical competencies of Niss & Højgaard, (2011) and the mathematical competencies used to predict item difficulty in PISA (Turner et al., 2013), see Figure 1. This follows a trend of recent reforms in mathematics that stresses a curriculum that emphasizes *the potential for learning* and doing mathematics rather than providing specific content (Fried & Amit, 2016, p. 259).

|  |  |  |
| --- | --- | --- |
| * Mathematical thinking
* Reasoning
* Representation
* Communication
* Problem handling
* Modelling
* Symbols and formalism
* Aids and tools
 | * Reasoning and argumentation
* Representation
* Communication
* Solving problems mathematically
* Modelling
* Symbols and formalism
 | * Abstraction and generalisation
* Reasoning and argumentation
* Representation and communication
* Exploration and problem solving
* Modelling and applications
* Mathematical fields of knowledge
 |
| *The eight mathematical competencies of the Danish KOM-project (Niss & Højgaard, 2011)* | *Mathematical competencies used to predict item difficulty in PISA (Turner et al., 2013)* | *Curriculum for Mathematics 1-10 in Norway (Ministry of Education and Research, 2019)* |

**Figure 1:** The eight mathematics competencies of the Danish KOM project (left), the competencies categories used to predict item difficulty in PISA (middle) and the core competencies of the mathematics curriculum in Norway (right) overlap to a large extent.

This project aims to demonstrate how learners can develop their mathematical competence through working with programming activities. Developing an algorithm, such as for example sorting an alphanumeric list, can potentially comprise all the core mathematical competencies mentioned above or none of them, depending on the assignment design and its implementation. It is currently an open research question on which teaching practices will enhance the focus on specific mathematical competences for a given task.

Several projects, networks and initiatives, both international and Norwegian, have the ambition of promoting and teaching programming for children at different ages. This includes voluntary movements like Lær Kidsa koding[[1]](#footnote-2) [Teach kids coding], teaching labs for programming in STEM education like the Newton room[[2]](#footnote-3), and research projects and centres for excellence in education like the ExcITed[[3]](#footnote-4), and DiCoTe[[4]](#footnote-5). Many of these initiatives focus on programming, without emphasizing the connection to mathematics education or how the use of programming can increase the understanding of mathematics. This connection is, however, made clear by the research centre CCSE[[5]](#footnote-6) as well as our proposed project. An important difference between the CCSE and the project in this proposal is the target group; CCSE targets “students from the first semester of their undergraduate studies”4, whereas we are targeting primary and secondary education, see Fig. 2. Furthermore, an ongoing collaboration between University of Copenhagen and Volda University College seeks to coordinate relevant mathematical competencies and computational thinking practices, and articulate the relevant mathematical competencies best suited in supporting students in engaging in computational (Tamborg and Refvik, 2023).



**Figure 2:** Overview of some currently ongoing related initiatives and research projects.

*Knowledge needs:*There has been an increasing effort at teaching students programming, both internationally and in Norway. Several previous studies indicate that programming and computer game activities lead to positive effects on the students’ attitudes, including self-confidence, value, enjoyment, and motivation, towards mathematics (Ke, 2014; Forsström & Kaufmann, 2018). However, the introduction of programming in the mathematics curriculum creates a need to better understand the challenges teachers meet when teaching mathematics through programming. While there is a vast amount of teaching material on programming available, material that focus on learning mathematical competencies is under researched. Some of the findings of Hoyles and Noss (1992) and Benton et al. (2018) suggested that there are possibilities to implement programming activities into mathematics teaching, but there is not much research of how to reach this potential. Further it is unknown how programming can be used to enhance the core competencies of the students.

Project objective: to create, implement and evaluate new teaching practices that support teachers and educators in Norway and abroad to **successfully utilise programming as an integral part of mathematics education to develop the learners’ mathematical core competencies**. The main target group comprises teachers, school owners and students in primary and secondary education, as well as teacher educators and teacher education programmes.

## Research questions and hypotheses, theoretical approach and methodology

*Overall Research Questions:* **How can programming facilitate and support learners’ development of mathematical core competencies?**

*Secondary Research Questions (associated with the two PhD projects):*

* *RQ1: How does integrating programming in education affect teaching and learning interactions?*Programming can affect learning in different contexts and interact with learning processes on many different arenas.
* *RQ2: Which competences are necessary for future citizens and society to exploit the opportunities and manage the challenges that programming and AI brings?* We focus on interpreting predictions and models, assessing uncertainty, assumptions, transparency and explainability, as well as making ethical considerations.

*Hypothesis:* We believe the introduction of programming in mathematics curriculums *can* lead to increased focus on mathematical competencies. This may increase the students’ understanding, facilitating new connections between formal mathematics and the real world (Brandsæter, 2021). However, programming can also be a distraction in the classroom, and lack of programming competence among the teachers is a known challenge. Furthermore, Hadjerrouit and Hansen (2020) emphasize that learners may encounter challenges in integrating mathematical and computational thinking skills to a coherent whole. Our hypothesis is that by supplying teachers with teaching practices that are well documented and focused on how to achieve specific mathematical competencies, the learners will develop these competencies.

Therefore, when we investigate the current situation in Norwegian schools, we expect to find both success stories and discouragement. We expect the focus on mathematical competencies to be difficult to spot in a regular teaching situation, and the awareness of the core competencies as introduced in the curriculum is assumably low both among teachers and students. However, we do expect teachers to be somewhat enthusiastic about the core competencies, although many will find it challenging to adjust their teaching to reflect them.

*Approach and methodology:* To answer the research questions, teaching practices will be developed through active collaboration between teachers, pre-service teachers, teacher educators, and researchers. The project is structured in 5 Work Packages (WPs), see Figure 3, where WP 1 is responsible for the development of new teaching practices. The practices are tested, analysed and documented with three different perspectives: teacher perspective (WP 2), learner perspective (WP 3) and societal perspective (WP 4).

**WP 1**Teaching Practices Development

**WP 2**Teacher Perspective

**WP 3**Learner Perspective

**WP 4**Societal Perspective

**WP 5**Consolidation and dissemination

**Figure 3:** Work package structure

The teaching practices developed in **WP 1** will target specific mathematical competencies (core elements). The development will follow a cycle of expansive learning (Engström, 2001) as shown in Figure 4. The methodology is derived from activity theory and propose a structure for how to work systematically with innovation and development. Stokke et.al. (2022) conclude that the methodology is well suited in projects that have a close collaboration between researchers and stakeholders. The three first steps in the expansive learning cycle consist of choosing which mathematical competency and grade level the teaching practice should target; research scientific literature, governmental documents, textbooks, task databases etc. relevant to the teaching practice; and finally creating the teaching practice with supplementary material. The fourth step is an evaluation of the teaching practice before it is implemented in the classrooms. Here, the teaching practice is possible adapted based on evaluation of pre- and in-service teachers and researchers in WP 2-4. The implementation of the practices in classrooms (step 5) is carried out by WP 2 and WP 3, and the feedback from the analysis of the teacher and student perspectives in these two WPs is used as input in the 6’th step. Based on the evaluation, the teaching practice may be adapted and retested in a classroom. An important deliverable of WP1 is to document the implementation of the tasks in classrooms.



**Figure 4:** Cycle of expansive learning shows how WP 1 will work when developing new teaching practices targeting the combination of programming and a specific mathematical competence. After Engström (2001).

In **WP 2** the focus is on how the teacher enact and carry out the teaching practices, developed in WP 1, in classrooms. The development team in WP 1 may have specific goals for a teaching practice, however, the supplied teaching material may fail to convey this goal clearly to the teacher. Further, even if the goal is clear, the teacher may find it unreachable for a variety of reasons. The teacher perspective on the developed tasks will therefore be important feedback to WP 1 to ensure high quality of the teaching practices. **WP 3** focuses on the student’s perspective when the teaching practices are implemented in the classrooms. The WP leaders of WP 2 and WP 3 will discuss when it is appropriate to analyse the same classroom situation. Both WP 2 and 3 investigate their respective perspective using an exploratory sequential mixed methods design (Fetters et al., 2013; Schoonenboom & Johnson, 2017), by observing, interviewing, and videorecording before, during and after the implementation of the activities in classrooms. The video recordings will be systematically analysed using CLASS K-3 (Pianta et al., 2008), a measurement tool to perform coding from multiple perspectives (Vattøy & Gamlem, 2020). Mixed research methods will ideally combine quantitative and qualitative approaches that have complementary strengths and nonoverlapping weaknesses (Onwuegbuzie & Johnson, 2008), and integrating the findings of WP 2 and 3 will therefore assist a thorough discussion, reflection, and adaption of the developed tasks by WP 1.

**WP 4** is responsible for analyzing the societal perspective of the teaching practices implemented. One of the activities in this WP is to carry out a document analysis to evaluate the activities with respect to the intended purpose of the new Norwegian curriculum. The work package will also interview educators at higher education to research what they expect and require of students.

**WP 5** is responsible for consolidation of the new practice both for schools and teacher education. The practices will be made available in various channels, e.g., the WP will create a web-page where the teaching activities will be posted. What is unique about the activities developed in this project compared to the many other task-databases on programming is that the implementation of the tasks is thoroughly documented and targets specific mathematical competences. An important part of the teaching practice is the supplementary material that will be provided with each teaching practice. This material can include video-instructions or examples, explanation of key goals of the task, or possible pitfalls or best practices that we have documented in WP 2 and WP 3.

*Risks:* Experience shows that schools and school owners will sometimes struggle to prioritize research projects, as research is not their main purpose. To reduce this risk, we have chosen to work with schools and school owners with whom we have an already established collaboration. The WPs are separate subprojects, to mitigate the risk that the whole project collapses if one of them face obstacles. As the schools will take active part in the data collection and testing activities, we will be able to collect data from active teaching even if teaching change character in case of for example new Covid outbreaks.

Stakeholder/user knowledge: The project will be carried out in active collaboration between the researchers and representatives from the schools, including teachers. We believe that the teachers are essential to focus our research and ensure its relevance. Throughout the project period, each of the partner schools will have dedicated teachers allocated to the project.

Gender perspectives: Women are underrepresented in most ICT disciplines and jobs (Corneliussen, 2021), and this pattern is particularly noticeable for disciplines focusing on programming and more technical aspects of computing (Corneliussen, 2011). We seek to identify and document potential gender differences that may be visible in the data material collected in the project. We also seek to identify underlying causes, such as investigating whether introducing programming in early-ages can contribute to decrease gender differences.

Potentially undesirable effects: We foresee no negative effects on human and animal health, climate and the environment and society at large from carrying out the project.

Ethics: The project will be conducted in accordance with recognized ethical norms and guidelines[[6]](#footnote-7) and internal guidelines. In accordance with Norway’s “National strategy on access to and sharing of research data” (Norwegian Ministry of Education and Research, 2018) research data will be made available to researchers in Norway and abroad through Norwegian Centre for Research Data’s (NSD) archive for research data[[7]](#footnote-8), ensuring transparency in all publications and presentations of project results.

Data collection and storage: Data will be collected in the work packages and used and shared throughout the project. Personal data will be processed in accordance with the provisions of relevant legislation, including the EU General Data Protection Regulation (GDPR). We will make such datasets available to other researchers after anonymization. Following the Research Council of Norway’s “Policy for open access to research data” (2017), a data management plan will be made for the project to ensure improved quality assurance, storage, accessibility to and sharing of data. The following list provides an overview of data which will be collected in the project:

* Systematic video observation of teachers planning, implementing, and evaluating teaching practices
* Semi-structured interviews of teachers implementing and evaluating teaching practices
* Survey regarding mathematical modelling, AI and ML.
* Teacher–student interactions in activities with programming
* Semi-structured interviews exploring teacher beliefs regarding programming for academic and social learning.
* Focus group interviews exploring student perceptions (programming in relation to motivation, perceived competence, self-efficacy, autonomy etc.)
* Survey exploring student perceptions (programming in relation to motivation, perceived competence, self-efficacy, autonomy etc.)

## Novelty and ambition

When the revised school curriculum was introduced in 2020 in Norway, comprehensive changes were made to the mathematics curriculum by 1) including the core competencies and 2) introducing programming. This project will be a first of its kind to study how these changes define the interaction of programming and the understanding of mathematics. The novelty comes from the project’s focus on programming and mathematics from primary and secondary school. If successful, the project will be the first of its kind to present documented teaching practices that can be used to develop the core mathematical competencies defined in the Norwegian mathematical curriculum through programming. The project has an extensive outreach plan to consolidate the findings of the project in schools. By focusing on the three perspectives - teacher, learner, societal - the project aims at becoming the leading knowledge centre on programming in mathematics education in Norway, and it will be a bridge between practice in schools, teacher education and academic research. The bridge shall not be one-way, and transition of knowledge and experience will take part between all participants and increase the quality of teaching in schools, teacher educator programmes and research.

### Impact

## Potential impact of the proposed research

The project aims at becoming a leading knowledge hub and competence centre for programming in mathematics in primary and secondary education, contributing to increase education quality worldwide (goal number 4 of United Nations Sustainable Development Goals). We foresee a continued focus and emphasis on programming in education in the years to come. This is happening despite a great knowledge gap concerning the effect of introducing programming in school curriculums. More research is needed to gain knowledge about the effects of introducing programming in education, and how it can be implemented to support learners’ development of core mathematics competence. The results and evaluations of this project will be published in scientific articles, and hence impact the academic community. Gradually, this will impact teacher education in Norway and abroad.

Furthermore, the project will develop new teaching practices for mathematical competence development supported by programming. In close collaboration between teachers, researchers, and experts in science communication (Dept. of Communication, Volda University College), the project will make these practices easily available to a wide audience. Through a step-by-step guide, we aim to make it easy to implement the teaching practices in classrooms, also for teachers with little programming experience and competence. Additional information regarding evaluation, purpose, didactical choices made during development should also be easily accessible. All relevant information will be published open access online, available to teachers and other users in Norway and abroad. The activities, including the development process, its evaluation and testing will in addition be published in academic channels.

According to the Norwegian Ministry of Local Government and Modernisation (2020) “Artificial intelligence (AI) represents vast opportunities for us as individuals and for society at large”. If the predictions become true, a basic understanding of AI will be vital for citizens in the future society. The project will generate knowledge and insight about how AI and related topics can be introduced and taught to students, which will be valuable input to the development of future curricula in Norway and abroad.

If successful, the project:

* develops teaching practices that are frequently used in Norwegian schools and abroad,
* publishes multiple peer reviewed articles (at least 6 papers submitted at project end),
* successfully graduates 2 PhD candidates,
* identifies practices that effectively increases learners’ mathematical competence development,
* identifies how teacher-student interactions change when programming is intruded in a classroom,
* identifies how different learning environments (classrooms, learning labs, home, etc.) affects teaching practices,
* contributes to knowledge- and experience transfer between the teacher education institutions in Norway and abroad,
* contributes to professional practice and competence- development for teachers and school management in Ålesund municipality and Møre og Romsdal County, and makes this geographical region a frontrunner within technological innovation, programming, science, and mathematics.

## Measures for communication and exploitation

The target audiences and stakeholders/users of the project outputs include the scientific community in, particularly within teacher education. Another important target audience comprises school owners, school management, teachers, and policymakers responsible for future curriculum development.

**Table 1:** Planned dissemination, communication, and engagement activities that will contribute to the realisation of the potential impacts of the project outputs

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| --- | --- | --- | --- |
| **Type** | **#** | **Target audience** | **Description** |
| Article | 11 | researchers | Scientific articles (including the articles of the PhDs) |
| Workshop/ conference | 1 | teachers, researchers | At the end of year two we will host an international workshop discussing topics from the project, targeting both 1) teachers and school management, and 2) researchers |
| Online documentation | 1 | teachers | Through a step-by-step guide and documentation of the teaching practices, we aim to make it easy to implement the teaching practices in schools  |
| Video | 2 | teachers, general public | Short videos that present the highlights of the project and its results |
| Seminar  | 2 | students in teacher education | Full-day student workshops at the universities presenting topics related to the project, project results and research questions.  |
| Seminars  | 6 | teachers | Project results and research questions will be presented to teachers locally at the partners’ schools  |
| Phd thesis | 2 (2) | academia | The project will supervise and fund two PhDs. (Additionally, two PhDs will be associated with the project; Arve Fiskerstrand (2019-2024) and Martyna Katarzyna Fojcik (2021-2025)).  |
| Master thesis | 4 | academia | The project will supervise 4 master’s theses  |

To ensure that the project and its results remain relevant, teachers from the partner schools will actively contribute to all types of dissemination activities in the project, including scientific publications.

### Implementation

## Project manager and project group

The project manager, Assoc. Prof. Andreas Brandsæter, has broad experience from collaborative research projects in industry and academia. He has taken the role as project leader, work package leader, supervisor, and researcher in several projects, including Knowledge Building Projects for Industry, Centre for Research-based Innovation, Industry PhDs, Innovation Projects for the Industrial Sector, and Joint Industry Projects. With a PhD in statistics and data science, and a master’s degree in Computational Science from the Faculty of Educational Sciences, Brandsæter’s background and experience fits well with the scope of this collaboration project, comprising key topics of the project: programming, mathematics, and educational sciences. The project will organize a mentor-mentee arrangement ensuring close support and collaboration between the project manager and senior project members. Similar mentor-mentee arrangements will be set up for the work package leaders.

The project partners comprise three research institutions, Volda University College (VUC), NTNU and the University of Agder (UiA); two school owners, Møre og Romsdal County and Ålesundmunicipality, owners of 20 upper secondary schools 35 primary and secondary schools respectively; and Skaparhuset, which brings valuable knowledge and facilities for a hands-on teaching of programming to students. The project team comprises senior and junior researchers, programming experts, mathematicians, teachers, pre-service teachers, teacher-educators, and representatives from school management.

## Project organisation and management

The following table displays the work plan and allocation of tasks to the work packages, per project month, and project year:

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 2:** Work plan and allocation of tasks and deliverables to the work packagesYear | 1 | 2 | 3 |
| Month | 1-3 | 4-6 | 7-9 | 10-12 | 13-15 | 16-18 | 19-21 | 22-24 | 25-27 | 28-30 | 31-33 | 34-36 |
| WP 1 | T1.1 |  |  |  |  |  |  |  |  |  |  |  |
| Deliverables |  |  | D1.1 |  |  |  |  | D1.2 |  |  |  |  |
| WP2 |  | T1 |  | T2 |  | T3 |  |  |  |  |  |  |
| Deliverables |  |  |  | D1 |  | D2 |  | D3 |  |  |  |  |
| WP 3 |  |  | T1 |  | T2 |  | T3 |  |  |  |  |  |
| Deliverables |  |  |  |  | D1 |  | D2 |  | D3 |  |  |  |
| WP4 |  | T1 |  | T2 |  | T3 |  |  |  |  |  |  |
| Deliverables |  |  |  | D1 |  | D2 |  | D3 |  |  |  |  |
| WP 5 |  |  |  | T1 |  | T2 |  | T3 |  |  |  |  |
| Deliverables |  |  |  |  |  | D1 |  | D2 |  | D3 |  |  |

|  |  |
| --- | --- |
|  | **Description** |
| T1.1 | Teaching practices development |
| D1.1 | Establish an open access web service to share teaching practices and project results |
| D1.2 | Documenting the development process (scientific article) |
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 **Table 3:** Tasks and deliverables description

The project will fund and supervise two PhD candidates. The candidates will take active part in the testing, evaluation and documentation of the teaching practices developed and analysis, and thereby contributing to the deliverables of the WPs. In addition, the two PhD candidates will focus on (1) how programming affects learning interactions, and (2) how the teaching practices can impact society in the future, particularly regarding AI-related skills and competencies . The candidates will develop their own detailed project plan.

#### Overview of research infrastructure:

* The research institutions will make necessary research infrastructure available to the project, including library and IT services, as well as facilitating robust and secure data storage.
* The Newton-room Møre, a teaching lab for programming in STEM education equipped with robots and other programming equipment, is also an important resource to the project. The lab is owned by Ålesund municipality and will be made available to the project providing a unique opportunity to perform observational studies and comparative experiments.
* The facilities of Skaparhuset will also be utilized by the project, including robots, 3D printer, laser burner, virtual reality equipment, electronics (BOLT, microBit, Arduino, Raspberry Pi, drones), sewing machines, and workshops. The hardware in Skaparhuset will be made available to the project, and the project will utilize the facilities as an arena to meet students, schools, and industry.
* The study programmes for teacher education at UiA and VUC will be an arena for disseminating results of the project, ensuring that the future teachers in Norwegian schools obtain relevant skills and competence in programming. Students, especially at master level, will also take active part in conducting experiments and comparative studies, both in collecting data and in analysis.

Organisation and management structure: A project steering committee, comprising senior members from all collaboration partners will be established at project start. The steering committee will be the governing body of the project, providing oversight, guidance, and support from project start to finish, ensuring that the project stays relevant to all partners and stakeholders. Decisions and prioritizations concerning the project progress and its focus will be made in collaboration between the school owners and the researchers. All project partners will appoint dedicated personnel with specific responsibilities within the work packages and the overall project.

**Table 4:** Project owner and partner description

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Contribution** |
| Volda University College | The dept. of mathematics and natural science offers … |  |
| NTNU | The Dept. of ICT and Natural Sciences offers engineering programs at Bachelor´s and Master´s level. | * Actively contribute to the research tasks and deliverables of the project
* Head of Department will participate in the project steering committee.
* be the degree-conferring university and supervise one of the PhD candidates.
 |
| University of Agder | The Dept. of Mathematical Science provides mathematics teaching in all the University’s teacher education programs | * Actively contribute to the research tasks and deliverables of the project
* Head of Department will participate in the project steering committee.
* Be the degree-conferring university and supervise one of the PhD candidates.
 |
| Ålesund Municipality | Responsible for 24 primary schools and 11 lower secondary schools. | * Will allocate a teacher in 20% position to the project throughout the project period.
* Actively contribute to the development and testing of new teaching practices.
* The Newton room will be available for research purposes in the project.
* Provide access to perform classroom experiments and observational studies in their schools
 |
| Møre og Romsdal County | Responsible for 22 upper secondary schools, including the STEM network – a network of teachers working to increase quality in STEM-subjects | * Will allocate a teacher in 20% position to the project throughout the project period.
* Organize workshops/seminars to disseminate project results and facilitate discussions
* Provide access to perform classroom experiments and observational studies in their schools
 |
| Skaparhuset | is a “markerspace” established to “help enable” the new curriculum (LK20) | * Serve as an arena to test, observe and evaluate the teaching practices developed in the project
* Dedicate at a “makers guide” (10% position) to the project
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***Table 5:*** *Roles and participation requirement*

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| --- | --- |
| **Roles** | **Costs (NOK)** |
| The costs of the Project Owner and other research organisations participating as partners (VUC, NTNU, UiA) | 12 893 724 |
| The costs of Norwegian partners from the business sector or other parts of society (Ålesund Municipality, Møre og Romsdal County, Skaparhuset) | 2 250 449 |
| Total project cost | 15 144 172 |
| Participation (percent) | 15 % |

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1. <https://www.kidsakoder.no/om-lkk/> [↑](#footnote-ref-2)
2. <https://newtonroom.com/the-newton-concept> [↑](#footnote-ref-3)
3. <https://www.ntnu.edu/excited> [↑](#footnote-ref-4)
4. <https://www.uis.no/nb/barnehage/millioner-til-forskning-pa-digital-kompetanseheving-for-barnehagelaerere> [↑](#footnote-ref-5)
5. [↑](#footnote-ref-6)
6. https://www.forskningsetikk.no/en/about-us/our-committees-and-commission/nesh/statements/2018-255/ [↑](#footnote-ref-7)
7. https://www.nsd.no/ [↑](#footnote-ref-8)