2021

Center for Computing in Science Education

ANNUAL REPORT

CCSE

Center for Computing
in Science Education

Graphic design Maria Hammerstrøm
Photos Line Schibstad Foto

Contents

Summary

The Center for Computing in Science Education (CCSE) aims to become an international hub for the research-based integration of computing in science education. Computing – using computers to solve problems – has changed research and industry. And the use of digital technologies is expected to impact all of society. However, computing is not yet fully integrated in the contents of educations – neither in the sciences nor in other disciplines. CCSE wants to change that. Computing and programming should be an essential skill in all science educations, and the contents and form of the educations should be changed accordingly. This requires new learning materials and new teaching methods and approaches. These materials and methods should be based on research on how students learn computational modeling and how computational modeling affects learning of the specific discipline.

IMPACT OF THE PANDEMIC

The activity of CCSE in 2021 has been strongly affected by the pandemic. We have made changes to our original plans to adapt to the new situation, but also used the situation to promote research-based redesign of teaching practices. For example, many courses have had to rethink their learning design, and this is an excellent opportunity to align courses more with research-based pedagogy and active learning designs. In addition, transitions to digital learning also opens for new types of assessments in home exam situations. One example is the use of computational essays to support student epistemic agency. Initial results indicate that other assessment forms may open for more support of diversity – allowing students that do not succeed in ordinary exam situations to find other ways to demonstrate their competence. CCSE, and in particular KURT, has taken a leading role to help teachers adapt their materials, approaches and assessments to digital teaching using pedagogically sound principles.

IMPACT OF THE MIDTERM EVALUATION

CCSE passed its midterm evaluation with excellent scores, and has used 2021 to plan and prepare for the second five-year period. For example, we have introduced new approaches to support student epistemic agency that we have indications are important for diversity. Similar types of learning approaches will be used in the new first year of the physics bachelor program, which we expect both will foster improved computational literacy and support diversity. We are also introducing new initiatives for the second five-year program, including a wider dissemination strategy, focus on how computing may support diversity, a new education research program, and focus on statistical thinking and artificial intelligence in addition to computational literacy and computational skills.

EDUCATION RESEARCH

In 2021 CCSE saw its second PhD student graduate – Odd Petter Sand. In addition, the first permanent faculty position in the field of CCSE was hired at the Department of Physics – Associate Professor Tor Ole Odden. We have prioritized to wait for this appointment before planning the education research program for the second five-year period. With Associate professor Odden in place, CCSE is ready to build a strong education research activity to support and develop a research basis for the curricular change program. We plan to hire 4 new PhD students and one postdoc or researcher in 2022 using a combination of funding from CCSE's grant, university resources, and grants from the Research Council of Norway. The focus of the education research program will be on computational literacy, programming in schools, teacher education and in-service training of teachers, and assessment methods to measure to what degree students are building computational skills.

CULTURE OF TEACHING AND LEARNING

CCSE personnel and KURT has contributed to workshops and meetings focusing on digital teaching and

Computing and programming should be an essential skill in all science educations, and the contents and form of the educations should be changed accordingly.

assessments. We found that it has been important to share teaching experiences from the pandemic, and have taken the initiative to biweekly seminars to share experiences and develop strategies. We have continued to develop, support and expand the Learning Assistants program, which now is integrated both across several departments at the Faculty of Mathematics and Natural Sciences and with the Center for Teaching and Learning (LINK) at the University of Oslo.

DIGITAL LEARNING MATERIAL

CCSE has continued to support and develop digital learning materials and digital assessment tools. Learning progressions for flipped classrooms with integrated videos, examples, and quizzes have been developed in several courses. New learning materials have been developed in chemistry with excellent integration of videos, quizzes, programming problems, and a new textbook in the making. In addition, we have been involved in developing courses for school and university teachers using both the doconce environment developed at CCSE and Canvas.

COMPUTATIONAL LITERACY IN SCHOOLS

CCSE and KURT has continued its effort to help teachers prepare for integrating programming in various school courses. From 2020, programming is integrated in mathematics, the sciences, and other subjects at schools. We have continued our effort to train teachers in programming through our nationally recognized brand, ProFag. Andreas Haraldsrud and Cathrine W. Tellefsen rolled out the first MOOC for teachers that focus on how programming can support domain learning. This MOOC also serves to provide an excellent example of how to teach digitally.

COMPUTATIONAL LITERACY IN THE HONOURS-PROGRAM

In fall 2020 the humanities students at the interdisciplinary Honours bachelor program at UiO piloted a course in programming for humanities students. This course was developed by Dag Haug and Øystein Linnebo in collaboration with Henrik Sveinsson from CCSE and students Eline P. Andersen and Karl Henrik Fredly. In 2021 this pilot course was expanded to a complete 10 ECTS course in programing open for all humanities students. This provides an excellent example of how we can test development in small groups before expanding to full-scale courses. In addition, the course provides an excellent example of how programming can be introduced in non-science disciplines.

COMPUTATIONAL SKILLS FOR PHD-STUDENTS

In 2021 we hired 15 new PhD students on the CompSci MSCA COFUND program. The vision is to train a new generation of computationally proficient researchers to renew research and industry across Europe. We are in the process of developing a new training program for these students, consisting of new and advanced courses in computational science and in machine learning and artificial intelligence. The courses will be piloted with the 15 CompSci students in 2021–2022, before being rolled out as full courses for 100–150 students in 2022.

DISSEMINATION

CCSE has continued its dissemination efforts both nationally, in collaboration with the University of Southeastern Norway, and internationally through the Circle-U university network and our international partnership for computing in science education, which is a collaboration between the University of Oslo, Michigan State University, Oregon State University and the University of Colorado – Boulder. CCSE have given several talks across the Circle-U network in 2021 in particular through the Innoved4TS Erasmus+ KA3 program. However, both national and international dissemination have been restricted in 2021 due to the pandemic.

Mission and goals

VISION
CCSE will become an international hub for research-based integration of computational methods in education.

GOALS
- Develop research-based learning materials with deep integration of computing
- Develop research-based methods and approaches for integrating computing in curriculums
- Transform student learning and teaching culture
- Engage students through student-driven projects and practices
- Disseminate and adapt practices across disciplines nationally and internationally

REALIZING THE VISION: FROM THE PRESENT STATE TO THE TEN-YEAR GOAL

Present state (2016)

Existing interdepartmental culture for CSE with some excellent teaching practices and strong student engagement. Math and programming integrated in first semester. Full CSE integration in 2 of 6 basic physic courses and partial integration in other courses. Two textbooks have been published internationally. The research basis for methods and approaches is sparse.

Five-year goal (2021)

The center has initiated a research-based approach to curriculum change and teaching and learning methods in partnership with students. Full integration of CSE in 4 of 6 basic physics courses, with two new textbooks, 2 of 4 math courses, and 1 astronomy course. A pilot extension of CSE into biology; a pilot adaptation by an external partner; a pilot school interaction program; and pilot studies of learning outcomes and teaching methods in 3 courses.

Ten-year goal (2026)

The center is an internationally leading hub for research-based approaches to CSE, with a strong educational research activity; an international repository for methods and materials; and strong student partnership. Full integration of CSE into 6 of 6 basic and 2 advanced physics courses, 4 of 4 math courses, and 2 astronomy courses. Extensions of CSE to 3 other disciplines at UiO. Adaptation of CSE at 2 external partners. A well-running school interaction program.

Perspectives on digital competence

Digital competence has become an important skill in society, industry and education. However, what actually constitutes digital competence in often unclear. At the Center for Computing in Science Education we have a clear vision for how to reform education to ensure students are prepared to face tomorrows challenges: We need to integrate the use of computers to solve problems – computing and programming – into all aspects of education across disciplines and across the entire educational ladder. Students need to learn how to work effectively with machines – computers – that are becoming gradually more intelligent. We all need to become literate in the use of computing – to obtain computational literacy. We need to learn to think, argue, analyze and be creative using computing and programming. This does not mean that everyone should become computer scientists. Instead, students should learn to use computers in their disciplinary context.

The focus on digital competence will increase in the years to come, with good reason. The advent of new technologies, represented by breakthroughs in machine learning and AI, and the rapid growth of new industries that require competence in computing and data science, will change all of society, including education. The Ministry of education introduced its strategy for digitization in higher education in 2017 and a new strategy for AI in 2020.

These strategies point to the importance of digital competence at all levels in higher education – for researchers, students, teachers, and administration – and CCSE is used as a case example in the strategies.

We need to learn to think, argue, analyze and be creative using computing and programming.

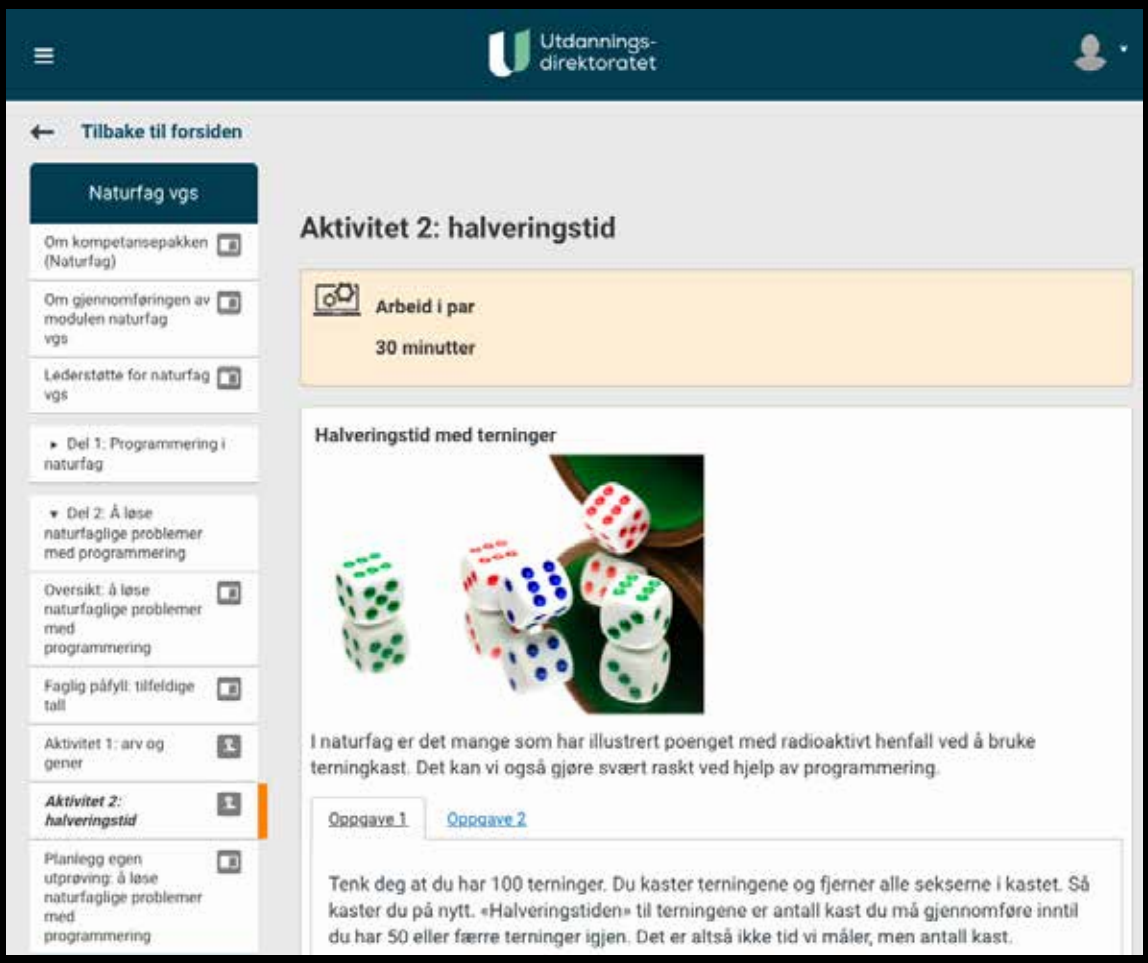
Similarly, EU's strategy for the digital single market points to the need for all professionals to master digital skills in their respective fields. CCSE is in a unique position to lead the digital transformation in education because we already have worked twenty years with a vision of how to integrate computing into education. We have experience with how digitization can and will change the content of education, the practice of teaching, and the methods of research.

Higher education institutions should provide their students with a research-based education. If all educations integrate computing, this means that a university needs to have research activities and research-based competence in three related fields: (1) In the specific disciplinary field: For example, a bioscience education must build on high quality bioscience research; (2) In the computational field: An education with a computational element must build on a strong research activity in this area; and (3) In education research. Only the largest institutions are able to build top research activities in all these areas and provide high quality, research-based education that integrates the computational and digital perspectives.

We are convinced that the approach and strategy of CCSE will become more important as more and more stakeholders, institutions and students realize the importance of an up-to-date education with a modernized curriculum. The growing digital divide – between parts of the population that have digital access and master the digital technologies and the rest will only widen. The only realistic solution is to address this challenge through education. We need to include digital skills – deep, non-trivial skills – throughout the education. However, this requires a new generation of teachers and researchers who can build computational curriculums and educate tomorrows teachers. CCSE's ambition is to take a lead role in training these researchers and teachers.

Highlights 2021

CCSE CONTRIBUTED TO DEVELOP CONTENT FOR UDIR LEARNING PORTAL



Cathrine W. Tellefsen and Andreas Haraldsrud have developed digital learning material on how to integrate programming into natural science in high schools. The material is part of the learning platform for teachers provided by UDIR (The Norwegian Directorate for Education and Training) and is available for teachers in Norway. The material also provides a starting point for developing similar learning material for university teachers who want to learn about programming in a disciplinary context.

ILLUSTRATIVE FILMS AND PODCASTS ABOUT CCSE AND INTEGRATION OF COMPUTING

Two films that illustrate how computing is integrated into the bachelor educations at UiO have been published. The target audience is prospective students and the general public.

Film:
Computational science at the University of Oslo: https://youtu.be/OvLutIsrgIo (English)

Computational methods in study programs at UiO: https://youtu.be/T6Wa59E7S-Y (Norwegian)

Podcast:
Research projects for bachelor-students: https://soundcloud.com/nokutpodden/den-om-forskende-bachelorgradsstudenter (Norwegian)

Bachelor-students who teach: https://soundcloud.com/nokutpodden/den-om-studenter-som-underviser (Norwegian)

Computational essays at University of Oslo: https://www.it-vest.dk/aktiviteter/podcast-om-computational-thinking/episode-14-penduler-tornadoer-og-omvendt-tyngdekraft-fysikuddannelse-med-computationelle-faerdigheder (English)

ASSOCIATE PROFESSOR TOR OLE ODDEN HIRED AT CCSE

Tor Ole Odden has joined us in a permanent position at the Department of Physics. He will build up and head the education research activity at CCSE. He has a background in science education research and physics education research and his focus the last years have been on computational literacy and the impact of computing on physics education. We are excited to have Tor Ole Odden with us. Congratulations Tor Ole!

Plans and Priorities

The main activities of the center will in 2022 and onwards follow the new action plan for the center developed for the midterm evaluations. We have decided to reorganize the activity into four work-packages from 2022. In addition, the newly hired associate professor Tor Ole Odden will develop the new research plan for the center in 2022, which also will form the basis for the new hirings in 2022.

THEME 1: EDUCATIONAL DEVELOPMENT (2022-2026)

Integration of computing and experimental methods: Experimental data collection and analysis will be integrated into the teaching workflow in introductory courses starting with the first year of the physics bachelor program in 2022.

Instructional methods: The Learning Assistants program will be extended across the natural sciences and also beyond the natural sciences. Students who develop learning material will be enrolled in the LA program, integrated into the teaching team, and closely supervised by pedagogically experienced faculty. New approaches to researcher training in cross-disciplinary cohorts with common training in computing skills will be piloted and evaluated on 32 PhD-students in the CompSci Cofund project. In 2022, we will also develop and test new learning approaches to student innovation with student teams from the Honours bachelor program.

Learning material: We will expand development and support of docOnce as an infrastructure for modular learning material; we will build a community for authors through regular meetings, workshops and retreats; and adapt and develop textbooks and digital learning material to various domains in collaboration with domain specialists. New learning material will be developed for the new course in computational thinking for the humanities.

Assessment and evaluation: Standardized assessments will be developed and applied across study programs. Student evaluations will be reformed to be based on research-based principles. New digital assessment

Future plans: Original five- and ten-year plans for CCSE with indications of successes. The ten-year goals will be changed to reflect experiences, new development and new priorities in the new center plan.

Present state (2016)	Five-year goals (2021)		Three-year results (2019)	Ten-year goals (2026)
Existing culture for CSE with some excellent teaching practices and strong student engagement.	The center has initiated a reseearch-based approach to curriculum change and methods in partnership with students.	→	Successful initiation of a research-based approach to curriculum change, methods and materials in partnership with students.	The center is an internationalle leading hub for research-based approaches to CSE, with a strong educational research activity; an international repository for methods and materials; and strong student parnership.
Full CSE integration in 2 of 6 basic physics courses and partical integration in other courses with the textbooks published internationally.	Full integration of CSE: in 4 of 6 basic physics courses, with two new textbooks, 2 of 4 math courses, and 1 astronomy course.	→	Successful integration of CSE: in 4 of 6 basic physics courses, with one new textbook, in 1 of 4 math courses, and 1 astronomy course.	Full integration of CSE into 6 of 6 basic and 2 advancded physics courses, 4 of 4 math courses, and 2 astronomy courses.
	A pilot extension of CSE into biology.	→	Successful integration of CSE in biology with new textbooks.	Extensions of CSE to 3 other disciplines at UiO.
	A pilot adaption by an external partner.	→	Successfull adapation at Univ. Southeastern Norway.	Adaption of CSE to 2 external partners.
	A pilot school interaction program.	→	An amibitious school reform program.	A well-running school interaction program.
The research basis for methods and approaches is sparse.	Pilot studies of learning outcomes and teaching methods in 3 courses.	→	Published studies of learning outcomes and teaching methods in 3 courses.	

approaches for computational literacy will be developed, tested and disseminated.

THEME 2: EDUCATION RESEARCH (2022-2026)

The education research activity will continue the work initiated in the first period. The center resources will be used to (i) extend studies of computational literacy, design-based studies in physics and the use of assessments, and address student evaluation studies, (ii) initiate studies of the impact of computing in chemistry with PhD-students Andreas Haraldsrud, and (iii) initiate studies of teacher training and professional development and impact of computing in school education. Three new PhD-students (one in ProFag, one in collaboration with the ProTed center, and one at CCSE), one postdoc (focusing on computational literacy) and one researcher (on the S-ASSESS project) will be hired in 2022. This will form the basis of the education research activity at CCSE.

THEME 3: CULTURE FOR TEACHING AND LEARNING (2022-2026)

We will continue with teacher and student activities that have been effective: biannual workshops for teachers and LAs; education seminars at all involved departments; teaching teams in large courses, continue and extend the teacher training initiated by KURT, continue with Summer Institutes for both internal and external participants.

To increase the computational proficiency of the teaching faculty, we will develop courses inspired by ProFag for university teachers. However, due to the pandemic, the first summer institute will be hosted in 2023 Instead, we will focus on developing digital learning progressions and digital portals for university teachers. We will continue to develop CCSE into a meeting place for students and teachers interested in educational development through talks, workshops, hackathons and social activities. We will organize bi-weekly meetings at CCSE throughout 2022 focusing on challenges and opportunities in educational development projects.

THEME 4: DISSEMINATION(2022-2026)

Dissemination will follow and expand on the activity from the first period. We will build on our success in disseminating practices to bioscience, teacher education, and through select international partnerships. We will widen the focus with an ambition to reach: (i) across levels from 1–13 through BSc, MSc, PhD, and post-graduate education; (ii) across contexts, from science to humanities, social sciences and beyond, (iii) across institutions nationally and internationally; and (iv) across sectors to impact education, research institutes, government, industry, business and startups. We will in 2022 focus on disseminating results from the introduction of programming into the humanities and on student epistemic agency and computational essays as a driver for more diversity in assessment methods.

ACTION PLAN

The activity in the center will from 2022 be organized into four themes according to the following plan:

Action	Description	2022	2023	2024	2025	2026
Theme 0: Management (A. Malthe-Sørenssen)						
A0.1	Annual progress reports	D	D	D	D	D
A0.2	Advisory board meeting	M		M		M
Theme 1: Educational development (L. Nederbragt)						
A1.1	Integration with experiments		D		D	
A1.2	Instructional methods					
A1.3	Learning material		M	M	M	
A1.4	Repository		M	M	D	
A1.4	Assessments and evaluations	M		M		
WP2: Education research (T.O. Odden)						
A2.1	Computational literacy (Res)	D	M	D	M	D
A2.2	Computing in math (PhD)		M		D	
A2.3	Computing in schools (PhD)		D	D		

Action	Description	2022	2023	2024	2025	2026
WP3: Culture for teaching and learning (C.W. Tellefsen)						
A3.1	Workshops and seminars	M	M	M	M	M
A3.2	Summer institutes	M		M		M
A3.3	Student projects					
A3.4	Teacher courses		M	M	M	M
WP4: Dissemination (K. Mørken)						
A4.1	TraCS PhD training				M	
A4.2	ProFag		M	M	M	M
A4.3	Cross-sector programs			M	M	M
A4.4	Non-science applications					

M = Milestone, D = Deliverable, Color intensity indicate stages

CCSE is in a unique position to lead the digital transformation in education.

WP1: Research-based development of learning material

Leader: Hjorth-Jensen

GOAL (2016-2021)

Develop flexible learning material that deeply integrates the use of computing based on research-based pedagogy. Hereunder,
(1) Develop a repository of teaching material and evaluation methods;
(2) Develop textbooks and interactive and modularized material with integration of computational methods and programming examples;
(3) Study usage and effects using big data approaches, interviews, and observation;
(4) Provide writer support including writing groups and use of students to improve texts;
Develop CSE publishing tools; Build partnership with Springer on CSE book series.

ACTIVITIES IN 2021

Textbooks

The center has continued to develop high quality textbooks, interactive learning material and examples and exercises for courses. The textbook in Bios1100 is still under development. The textbook is the first to provide an introduction to programming in a biological context. A textbook in Elementary electromagnetism using Python was used as the main textbook in 2021 and is under preparation for publication with Springer. A textbook on Thermal and statistical physics using Python is under preparation for publication with Springer and was used as the main textbook in 2021.

Electronic learning material

Several courses with integrated programming have developed digital learning progressions. A new set of learning materials for Computational methods in chemistry was developed and used in 2021. The material is jupyter-book based with small video lectures integrated with exercises, quizzes, and examples. A set of learning materials for Data driven projects for honours-students in jupyter-book format was developed and used in 2021.

Writer support

The center aims to support the development of learning material by developing a community for writers, by developing and supporting the essential infrastructure and tools for writing, publishing and use, and by distributing and publishing the results. The main tool for textbook development is docOnce, which is developed and supported by CCSE. The development of docOnce is now taken over by CCSE leadership member Lex Nederbragt.

Student participation

Students play an important role in the development of learning material. CCSE financed 25 summer student scholarships in 2021. We are gradually transition to ensuring that all students that develop learning material have taken the Learning Assistant courses, and we are developing courses in material design based on sound pedagogical principles. Teachers and departments can apply for resources that they use to hire a student to develop new learning material that integrates computing in a course. In 2021, these resources were also used to develop new learning material for the new first year in the physics program.

STUDENT-DRIVEN DEVELOPMENT OF LEARNING MATERIAL

CCSE decided to let the 75.000 kr provided previously by Nokut be used for a project determined by the students. Student representatives in CCSE decided to use the funding to develop interactive animations and illustrations to be used for teaching since several students have argued that such illustrations and animations are useful for their learning process. The student representatives designed a call for summer jobs for students to design such materials, participated in the hiring process and supervised the hired students in during the project.

The two summer students who were hired for the project, produced educational material focused around interactive physics animations. As part of the process, the summer students were introduced to pedagogical principles of learning material design and applied these principles when creating texts and exercises around the physics animations that they developed. The animations were used by students in the fall semester 2021.

PLANS AND PRIORITIES FOR 2022

- Extend support to develop pedagogically sound digital learning progressions and develop guides and courses for students and teachers who are developing learning materials
- Extend use of Jupyter books and Jupyter notebooks to develop interactive learning materials that combine videos, quizzes, examples and runnable computer code
- Improve learning materials for programming courses in chemistry and in the humanities
- Engage students in testing and validation of learning materials

ACTION PLAN

Action	Description	2017		2018		2019		2020		2021		Milestones and Deliverables
A1.1	**Repository for material and evalution methods**											
	Establish repository				D							Working repository
	Enable stakeholder feedback						D		D		D	Yearly usage reports in AO.4
A1.2	**Develop and test textbooks and interactive and modularized material**											
	Publish textbook 1: Fys216O: Thermal Physics (D = editions)						D				D	Published book
	Test and evaluate textbook 1 (teacher, students, PhD1, Postdoc)						M				M	Reports for A1.1; Adjusted material
	Publish textbook 2: Fys112O: Electromagnetism (D=editions)								D			Published book
	Test and evaluate textbook 2 (teachers, students, PhD1, Postdoc)										M	Reports for A1.1; Adjusted material
	Develop textbooks 3-6: Continuous development		o	o	o	o	o	o	o	o	o	Preliminary books
	Develop material for two math courses. Publish in repository						M				M	Material in repository
	Develop material for AST2000: Astrophysics. Publish in repository										M	Material in repository
A1.3	**Support research on effects of material using data, interviews & observations**									M		
	PhD1 Project		o	o	o	o	o	o	o	o		Research project of PhD1
	Postdoc Project			o	o	o	o	o	o	o	o	Research project of Postdoc
	Publish research articles on results						M		M		M	Publish 1 article/yr
A1.4	**Writer support**											
	Establish writer groups and organize yearly meetings		M		M		M		M		M	Yearly meetings
	Support writing escapes for textbook and material authors		M		M		M		M		M	Support 2-4/yr; Report through AO.4
	Systematic use of student evaluation to improve texts		M		M		M		M		M	Support 1-2/yr; Improved texts
	Develop and support 'doconce' - a writing tool for cross-platform publ.		D		D		D		D		D	Yearly releases
(New)	**Develop and support Jupyter and JypyterHub at UiO**		D									**Established JupyterHub@UiO**
	Establish partnership with Springer to publish book series				M							Initiated partnership

M: Milestone, D: Deliverable, o: Ongoing
Colors indicate progress. : according to plan, : adjustment, : delayed

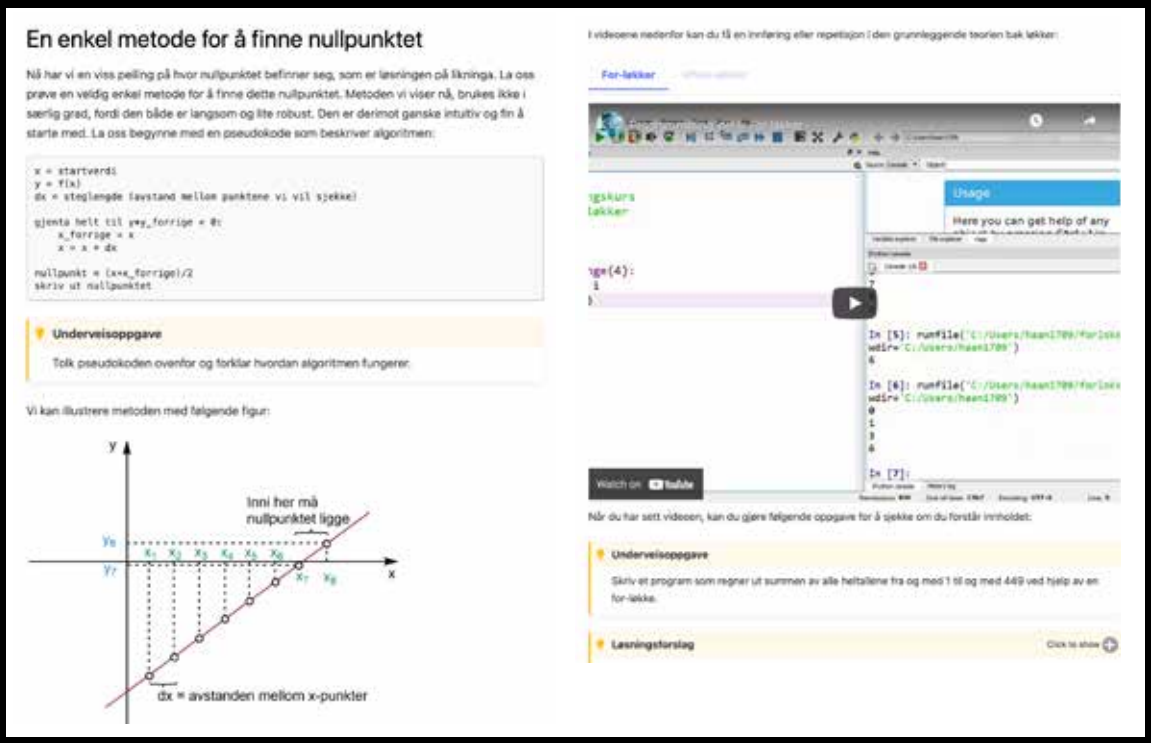
Comments

A1.1: The repository will in the first 5-year period be integrated with the PICUP project.
A1.2: Textbook development is progressing in Fys216O – Thermal Physics. A first draft has been developed in Fys112O – Electromagnetism. Texts in mathematics are continuously updated. New texts in computational physics and machine learning under development for the CompSci PhD-students.
A1.3: PhD-student 1 has addressed learning in Fys1001 – Introductory physics and BIOS1100 – Introduction to Computational Modeling for Bioscience. The results are published in his PhD thesis and is under publication as journal articles. The post-doc is focusing on learning progressions, computational essays in Fys112O, and learning assistants.
A1.4: Most of the actions are proceeding according to plan. However, the activities that support writers have been postponed to ordinary meetings can occur after the pandemic.

DIGITAL LEARNING MATERIAL IN CHEMISTRY

A digital learning progression has been developed in the courses In-kjm1900 "Introduction to programming for chemists" by Andreas Haraldsrud. The progression has been developed as a Jupyter book, which combines integrated video presentations, narrative text, examples, exercises, quizzes and computer code. Exercises may contain computer code that the students need to complete and run. The Jupyter notebook format also allows the students to download a copy of the learning material and update and comment the material on their own – creating their own version of the dynamic and digital textbook. This format is now the preferred formation for digital learning material developed at CCSE.

Learning material: Illustration from the Jupyter-book learning material in In-kjm1900 "Introduction to programming for chemists".



WP2: Research-based development of methods and approaches

Leader: Malthe-Sørenssen

GOAL (2016-2021)
Develop research-based methods and approaches for the integration of computing in a disciplinary context. Hereunder,
(1) Student-active learning: Develop, apply and evaluate traditional and new learning methods in CSE courses;
(2) Develop and test research- and industry-near CSE cases in collaboration with stakeholders;
(3) Develop and study methods for assessing student work and collecting data for CSE courses;
(4) Develop and test methods that use innovative digital and physical learning environments;
(5) Develop, test and evaluate study programs and courses

ACTIVITIES IN 2021

Student-active learning and learning assistants

CCSE and KURT (The Center for Teaching and Learning in Science) work in concert to promote the use of student-focused learning in general. In 2021, focus has been to develop pedagogically sound digital learning approaches and well-aligned assessment methods. We continue the development and adaptation of the Learning Assistant project to a Norwegian context. In this project, learning assistants in selected courses are offered a pedagogical training program that runs in parallel with their teaching activities. This year, the program has been extended to courses in mathematics. In addition, a pilot adaptation was made to the learning assistants from humanities in the new programming course for the humanities.

Assessment

The pandemic has called for new assessment forms to be tried out, in particular, variations of home exams. This requires careful pedagogical considerations, in particular in mathematics and the natural sciences, where it can be difficult to design exam problems that cannot be solved by simply looking up the answer, but still are not too difficult for the average student. We have focused on developing examples of exam problems that address the higher levels in Blooms taxonomy. However, this required developing new types of home exams as well as developing learning progressions that prepare students for this type of exams – ensuring good alignment between modes of instruction and assessments. KURT and CCSE has organized meetings to discuss and share experiences on home exams and to provide the background pedagogical perspectives needed to design good exam questions.

Computational Essays and student epistemic agency in Fys1120

Following the pilot introduction of computational essays in UiOs introductory course in electromagnetism (Fys1120), we have studied the impact of computational essays on student learning and developed reliable assessment tools to address student epistemic agency. We have developed an assessment rubric that has been used to assess both epistemic agency and computational skills in computational essay. The rubric has been applied in courses both at UiO and at Michigan State University with over 300 students and has been demonstrated to be a valid and reliable measurement tool. (See publications by Odden in 2020 and 2021).

In 2021 the computational essay was used as a home exam in Fys1120 Electromagnetism using a scoring rubric based on the rubric developed to measure epistemic agency. A computational essay is a report that uses text, pictures, and computer code in order to explain a topic or present an argument. However, the student is expected to formulate their own problem and pursue this problem using a combination of theoretical and computational arguments. Students were provided with an opportunity to get feedback on their problem formulation as well as practical help on solving the computational problems. The work requirements leading up to the home exam helped students prepare by asking students to define their own problem and study the problem using a complex, numerical model and a simplified theoretical model, following principles and workflows similar to that found in

Requirement	Point Value	Lacking Competence	Novice Competence (examples)	Developing Competence (examples)	Mastering Competence
Investigation Question	3	Student has not defined an investigation question, or the question is so trivial it could be answered using the example code as given (without modification).	Investigation question is **clearly defined** but it is not physical and/or is answerable by only tweaking variables in the example code.	Investigation question is **clearly defined** and **physically meaningful**, but it does not require significant changes in the simulation to answer it.	Investigation question is **clearly defined**, it is **physically meaningful**, and it requires **significant additions** to the example simulation to answer.
		0 points			3 points
Physics theory	3	Student has not written anything about the physics theory they are using from Fys1120.	Student has briefly **explained the physics theory** they are using from Fys1120, but only in text (without any equations). It is unclear how this theory contributes to the analysis.	Student has **explained the physics theory** from Fys1120 that they are using in their project through both **text and equations**. However, it is unclear how this theory contributes to their analysis.	Student has **explained the physics theory** from Fys1120 that they are using in their project through both **text and equations**. It is clear how the **theory connects to their investigation question** and contributes to their analysis.
		0 points			3 points
Code Quality	3	The code either doesn't work or student has not added any new code.	The **code works**, but it is poorly commented and inefficient.	The **code works**, and it is **well commented/documented**. However, it is inefficient and shows evidence of much copy-pasting.	The **code works**, it is **well commented and documented**, and an effort has been made to use **functions to structure the code** and avoid copy-pasting.
		0 points			3 points
Numerical Model	3	Student has re-used an existing model, without significant modifications.	Student has either **built a new model from scratch** or **significantly added** to an existing model (either by adding new physics or using it in a novel context). However, model results are not visualized, and the model is only developed to the point of providing initial results.	Student has either **built a new model from scratch or significantly added** to an existing model (either by adding new physics or using it in a novel context). **Results of the model are visualized in graphs, plots, and charts.** However, the model is only developed to the point of providing initial results.	**Student has either built a new model from scratch or significantly added to an existing model** (either by adding new physics or using it in a novel context). **Results of the model are visualized in graphs, plots, and charts** and their implications are explained. Model is developed in **multiple steps**, so that they first create a basic model then make additions to it.
		0 points			3 points
Physics in the Model	3	Student has not used any physics learned in Fys1120 in their model.	Students have used **1 or more principles from Fys1120** in their model to answer the investigation question or interpret model results. However, it is unclear how these principles are used or what they add to the project. Only basic principles have been used (e.g., Coulomb's law, electric fields).	Students have used **1 or more principles from Fys1120** within their model to answer the question they defined OR within the analysis/discussion to interpret model results. **It is clear how these principles are used** within the project and what they add to the analysis. However, only basic principles have been used (e.g., Coulomb's law, electric fields).	Students have used **1 or more principles from Fys1120** within their model to answer the question they defined OR within the analysis/discussion to interpret model results. **It is clear how these principles are used** within the project and what they add to the analysis. Students have used **more advanced analysis techniques** (e.g., symmetry, conservation laws, or Maxwell's equations) in their analysis.
		0 points			3 points
Conclusion	3	There is no conclusion.	**There is a conclusion**, but it only states the results and does not justify their meaning or reasonability. No discussion of limitations with the analysis.	**There is a conclusion** which describes the results, **interprets their meaning, uses them to answer the original question, and justifies their reasonability.** However, there is no discussion of limitations with the analysis.	**There is a conclusion** which describes the results, **interprets their meaning, uses them to answer the original question, and justifies their reasonability.** There is also a **discussion of the limitations** of the analysis.
		0 points			3 points
Written Report	4	There is no report, or the student has not changed the example code, or the report is so hard to read that it cannot be graded.	**There is a report** but it is poorly structured and does not adequately explain the code or steps of the investigation. Student has not cited any external sources.	Student has **written a report that explains the entire analysis.** Report is readable and **describes what was done, why it was done, and what was found out in a well-structured manner**. However, student has not cited any external sources.	Students have **written a report that explains the entire analysis.** Report is readable and **describes what was done, why it was done, and what was found out in a well-structured manner**. Students have **included references** to any sources used throughout the text and in a separate reference section at the end.
		0 points			3 points

Grading: The grading rubric used for the computational essay home exam in 2021.

research and development. In addition to the computational essay home exam, students also had a traditional school exam. Results from the computational essays and school exam shows that the school exam score is a good predictor for the computational essay score, but not the other way round. This implies that students that scored high on the traditional exams also scored high on the computational essays, but students that scored high on the computational essays were distributed across all scores in the school exam. This may indicate that the computational essays provide students who do not succeed in high-stakes school exams an opportunity to demonstrate their competence.

Research seminar series

In 2020 CCSE the seminar series on instructional design and education research was continued, but adapted to a digital platform. The full list of talks can be found in the list of products. The seminar series have been well attended with participants from physics, chemistry, mathematics, computer science, biosciences, and education. The seminar series is providing an avenue to focus on research-based instructional design at the Faculty.

PLANS AND PRIORITIES FOR 2022

- Initiate development of computational essay type problems for the new introductory courses in physics.
- Extend the Learning Assistant project to more courses and publish results from UiO
- Extend research activity to chemistry education research
- Extend the research seminar series and consolidate research group meetings

ACTION PLAN

Action	Description	2017	2018	2019	2020	2021	Milestones and Deliverables
A2.1	**Student-active teaching using CSE**						
	Evaluate traditional learning methods for CSE courses (PhD1, students)		M	M	M	M	Reports for courses
	Develop student-active methods: project-based, tutorials, collaborative	o	o D	o o	D o	o D	Methods for 3 courses in repository
	Investigte and Evaluate effect of methods		M		M	M	Reseach articles; Repository entries
	Publish research articles on results				M	M	Published 1 article/yr
A2.2	**Research-near and work-life relevant education by integration of computing**						
	Develop and test cases in collaboration with stakeholders			M		M	Cases in repository; Research articles
	Develop and test data-based exposition and examples			M		M	Examples in repository; Research art.
	Develop and test research-near projects with stakeholders		M		M		Projects in repository; Research art.
	Publish research articles on results		M	M	M	M	Published 1 article/yr
A2.3	**Methods for assessing student work and collecting data**						
	Develop and test assessment methods: Digital exams			M		M	Exams from 2 courses in repository
	Develop and test assessment methods: Project-based courses			M		M	Projects from 2 courses in repository
	Pilot study of effect of new approaches in Fys-mek1110: Mechanics (PhD2)		o	o o	o M		Research article from study
	Pilot study of effect of new approaches in INF1100: Programming (Postdoc)			o	o o	o M	Research article from study
	Pilot study of effect of new approaches in Fys3150: Comp. Phys (PhD2)				o o	o o	Research article from study
	Use 'devilry.org/canvas' to collect, categorize and study student work				M		Data from 2 courses analyzed
(New)	**S-ASSESS Project**		o	o o	o o	o o	**Research project of Postdoc**
	Publish research articles on results				M	M	Published 1 article/yr
A2.4	**Methods using innovative digital and physical approaches**						
	Develop and test innovative digital collaboration using github			M			Use in 1 course, results in repository
	Support and test innovative use of 400 m^2 learning center				M		Use in 1 course, results in repository
A2.5	**Develop, test, and evaluate study programs and courses**						
	Evaluate effect of study program change 2016 to 2017 (PhD2)			M		M	Research (M1: physics; M2: biology)
	Establish semester committees for course coordination		M	M	M	M	Established; Reports for AO.4
	Establish impact evaluation committees with regular meetings		M	M	M	M	Established; Reports for AO.4
A2.6	**Appoint senior researcher to build and coordinate educational research**		M				Appointed

M: Milestone, D: Deliverable, o: Ongoing
Colors indicate progress. : according to plan, : adjustment, : delayed

Comments

A2.1: Student active methods are developed for Fys-mek1110, BIOS1100 and Fys2130. PhD-student 1 has focused primarily on BIOS1100 – Introduction to computational modeling for bioscience, and Fys1001 – Physics for applications as shown in list of publications.
A2.2: Data-based methods have been developed in the course Fys2160 – Thermal physics and Fys 1120 – Electromagnetism.
A2.3: This project has been financed with three new positions from the Norwegian Research Council (S-ASSESS) and started in 2019.
A2.4: The new learning center is used in BIOS1100 and git and github is used in Fys3150 – Computational Physics, and Fys-stk3155 – Data science and machine learning.
A2.5: This activity was not initiated in 2021 due to the pandemic.
A2.6: An associate professor was hired in 2021 and will be central in developing the education research strategy at CCSE for the next center period (2022–2026).

WP3: Development of a culture for teaching and learning

Leader: Henriksen

GOAL (2016-2021)

Develop a culture for teaching and learning across the science departments. Hereunder,
(1) Develop school-university transition program and investigate effects on recruitment, retention, and results;
(2) Improve student culture through student spaces, mentor programs and startup seminars;
(3) Develop teacher culture through annual teacher retreat, teaching in teams, workshops and seminars with focus on teaching, and learning and curriculum development;
(4) Develop quality systems and student evaluation methods to enhance constructive alignment and ensure quality development through systematic feedback and improvement;
(5) Promote teaching skills renewal through pedagogical courses, educational sabbaticals, and career goals for teaching proficiency and excellence.

ACTIVITIES IN 2021

Developing teacher culture

The development of a strong teaching and teacher culture is important to improve the quality of the education and eventually also for student learning. In 2021 we have focused on developing digital meeting places for teaching faculty and teaching assistants to address and share experience on teaching under the pandemic. Together with the Faculty and the Departments, we organize day-long seminars every semester where we focus on teaching and learning, called "Real Utdanning" (aimed mainly at faculty) and "Real undervisning" (aimed mainly at teaching assistants).

Renewing first-year physics education

The bachelor program in physics has for a long time not had any physics courses in the first semester. Based on an initiative from among others Morten Hjorth-Jensen, the Department of Physics has initiated a process to redesign the first year of the physics program to integrate computing, experiments with real-time data collection, and statistics so that the complete scientific workflow can be introduced from day one. This is only possible with a simultaneous integration of computing in the experimental data collection and analysis. Three new courses are being developed for the new physics program, two of which will have a significant computational aspect: An introductory course in mechanics and an introductory course in statistics and data analysis and Tor Ole Odden is playing a key role in developing these courses. The new program will start in 2022.

Seminars

CCSE is working systematically to build a culture for teaching and learning by establishing meeting-places to exchange experiences on teaching practice and be inspired and informed on education research. In 2021 we arranged regular seminars with invited national and international speakers that were open for all teaching faculty and students (see Box). In addition, we organize a yearly Christmas seminar focusing on Computing in Science Education, which in 2021 was fully digital, but still had strong participation from teaching and research faculty.

Teaching assistant workshop

We consider the professional development of teaching assistant to be important and have developed biannual teaching assistant workshops that are compulsory. The workshops are designed to provide teaching assistant with basic pedagogical tools and skills needed to effectively teach smaller groups. The workshop is compulsory for teaching assistants. The workshop was from 2017 extended to include teaching faculty with great success – opening for sessions where teaching faculty and teaching assistants coordinate their activities at the beginning of the semester. Focus in 2021 has been on effective assessment strategies under the pandemic.

Center for Teaching and Learning in Science (KURT)

In order to support the Faculty's activities to promote professional development in teaching, the Faculty has

NETWORK FOR INTRODUCTORY PROGRAMMING TEACHERS

Programming has become part of the education for an increasing range of fields, including the school system down to elementary school. This means that a variety of programming courses have been developed, catering to different student characteristics, and organized by different departments. To improve sharing of experiences across these courses, we established in autumn 2021 a network for teachers of introductory programming courses across UiO. We are aiming to mainly establish contacts and initiate discussions between as broad a group as possible, and have thus planned for having a single meeting each semester (as well as sharing a few relevant events on email). The first meeting in autumn 2021 was a great success, with broad attendance and lively discussions, and we look forward to continuing these network meetings in 2022.

established a Center for Teaching and Learning in Science (KURT). KURT is directed by CCSE member by Cathrine W. Tellefsen and includes participants from all the departments at the Faculty for mathematics and natural sciences. The center aims to be the hub for professional teacher development at the Faculty. The activities organized by KURT range from speaking at seminars on the use of student active methods to publishing hands-on tips on teaching on the website. KURT also arranges a "journal club" where participants read, present and discuss international research concerning student-active learning, professional development of teaching assistants, and other topics of relevance for developing the teaching and learning culture – and skills – among UiO science teaching staff.

PLANS AND PRIORITIES FOR 2022

- Develop and provide online and physical in Python programming for teaching faculty
- Prepare summer institute on computational methods for bioscience teachers in 2023
- Continue to provide and improve teaching workshops for teaching faculty and teaching assistants.

ACTION PLAN

Action	Description	2017		2018		2019		2020		2021		Milestones and Deliverables
A3.1	**School-university transition program**											
	Establish school-university transition base study				M							Report (PhD2)
	Develop and test adapted transition practices							M				Practices in repository; Research art.
	Study effects on motivation, retention and results										M	Research articles
	Publish research articles on results						M		M		M	Publish 1 articles/yr
A3.2	**Student-spaces, mentor programs and startup seminars**											
	Study student self-organization in student spaces							M				Research report
	Develop student-teacher off-curriculuar activities in student spaces			M								Initialize; Regular acticities
	Support and extend student-student mentor program	o	o	o	o	o	o	o	o	o	o	Report from mentoring programs
	Support startup seminars focusing on learning-to-learn, study strategies	o	o	o	o	o	o	o	o	o	o	Reports from seminars
A3.3	**Teacher culture development**											
	Establish annual teacher retreat to focus on sharing and development		M		M		M		M		M	Yearly retreats; Reports
	Organize regular educational workshops and seminars	o	o	o	o	o	o	o	o	o	o	Reported workshops and seminars
	Develop teaching teams for main introductory courses						M				M	Teams in 2 courses; Report
	Study effects on learning environment and student evaluations						o	o	o	o	o	Research (PhD2, Postdoc)
A3.4	**Quality systems and student evaluation methods**											
	Develop and test efficient web-based student evaluation system				M		D		D		D	M: Implement system; D: Reports
	Present and discuss student evaluations at teacher retreats				M		M		M		M	
	Develop effective group-based evaluation systems for courses								M		D	M: Implement; D: Reports
A3.5	**Promote teaching skill renewal**											
	Develop pedagogical courses and workshops for CSE skills				M		M		M		M	M: Reported courses
	Support educational sabbaticals for course development				D							Implemented at Faculty
	Establish career goals for teaching proficiency and excellence										M	Develop; Implement pilot
	Establish teaching academy of excellent teachers at Faculty									M		Established pilot

M: Milestone, D: Deliverable, o: Ongoing
Colors indicate progress. : according to plan, : adjustment, : delayed

Comments

A3.1: The school-university transition program has been replaced with ProFag (See WP5).
A3.2: Startup seminars are well functioning and will continue to be developed in 2022. Student-student mentor programs have been postponed. The need for such programs will be reevaluated after the pandemic.
A3.3: Teaching days are running at several departments, including the Department of Physics. Teaching teams will gradually be introduced in 2022 with the new physics program.
A3.4: A group-based evaluation system is in use at the Department of Physics. A redesign of the student evaluation system awaits a central revamping of the system at UiO.
A3.5: A summer institute on the integration of computational methods into bioscience courses will be organized after the pandemic, possibly in 2023.

WP4: Student-driven activities

Leader: Tellefsen

GOAL (2016-2021)

Develop a set of student-driven activities to engage students deeply in educational development. Hereunder,
(1) Establish student partnership board;
(2) Support educational research projects where students collaborate with pedagogical researchers;
(3) Support student development of material, exercises and case studies;
(4) Support that student teaching assistants develop, share and document expertise through mentoring, courses, and workshops;
(5) Support student-developed instruction initiatives such as short courses, seminar series and science competitions;
(6) Support student innovation projects;
(7) Support research activities for bachelor students;
(8) Support student internships in research and industry.

ACTIVITIES IN 2021

Student development of curriculum

Bachelor- and master-level students contribute to curriculum development and the development of teaching practices through (1) direct development of learning material, (2) participation in teaching activities as teaching assistants, and (3) through student research activities. Bachelor- and master-students are hired to develop new learning material. In 2021 we received applications for and rewarded 900kkr for projects. However, in view of the pandemic situation there were additional needs to develop and adapt learning material to digital platforms. We therefore invested more than originally budgeted in student projects.

Student research projects

Introducing students to research already in the bachelor program is a goal of CCSE. We provide students with relevant skills – computational methods – that make them attractive as research assistants already from the first year. We have therefore developed student research projects that hired 2 bachelor summer students in 2021. In addition, we have initiated several research and development projects where students are involved.

Student innovation projects

Exposing students to innovation practices early in their education is important to spark their interest in innovation. Innovation projects also open for students to apply their computational skills in an authentic setting and to gain experience from real world problems. We have therefore initiated a collaboration project with Young Entrepreneurship Oslo and Oslo Science City. A pilot project was run in 2021 with a five-day project for six students addressing energy saving strategies for the energy company Hafslund. (See news article and movies from the project here: https://oslosciencecity.no/vellykket-innovasjonspilot/).

PLANS AND PRIORITIES FOR 2022

- Establish a student innovation project model
- Extend student research projects to 6 students/yr
- Apply for additional funding for further summer student projects.

ACTION PLAN

Action	Description	2017		2018		2019		2020		2021		Milestones and Deliverables
A4.1	**Establish student partnership board**											
	Establish board, organize regular meetings and reports to leadership				M		M		M		M	Established; Meetings
A4.2	**Support educational research project using students**											
	Support use of students for in-class observation and reporting			o	o	o	o	o	o	o	o	Reports on use
	Support student-driven data collection and evaluation projects											Reports on use
A4.3	**Support student development of material**											
	Support 3-6 summer students/yr to develop exercises and cases	o	o	o	o	o	o	o	o	o	o	Reports on use; Results in repository
	Support 2-4 student blog/web projects/yr	o	o	o	o	o	o	o	o	o	o	Reports on use; Results in repository
A4.4	**Develop and document students' pedagogical expertise**											
	Organize biannual teaching assistant workshop		D	D	D	D	D	D	D	D	D	Workshops organized
	Support student-organized teaching retreats					M			M			Reported retreats
	Support student-driven pedagogical mentors									M		
	Implement qualification system for teaching assistants										M	Pilot implementation
A4.5	**Support student-organized courses, seminars and competitions**											
	Support student-developed instruction through scholarships	o	o	o	o	o	o	o	o	o	o	Report on use
	Establish and support student science competitions	o	o	o	o	o	o	o	o	o	o	Report on use
A4.6	**Support student innovation projects**											
	Support 2-4 student innovation projects/yr	o	o	o	o	o	o	o	o	o	o	Report on use
	Organize yearly student innovation meeting				M		M		M		M	Yearly meetings arranged
A4.7	**Support research activities for bachelor students**											
	Organize research projects for 2nd, 4th, 6th semester students	o	o	o	o	o	o	o	o	o	o	Yearly reports
	Support 1-3 student teams working on summer research projects	o	o	o	o	o	o	o	o	o	o	Yearly reports
A4.8	**Support 2-5 student summer internships in research or industry**	o	o	o	o	o	o	o	o	o	o	Yearly reports

M: Milestone, D: Deliverable, o: Ongoing
Colors indicate progress. : according to plan, : adjustment, : delayed

Comments

A4.1: The student partnership board has not yet been established. Priority has been given to build the school activity instead from 2018.
A4.2: Education research projects started in 2018 according to plan. First paper from student researcher published in 2018, 2 student papers were published in 2019, and 1 in 2020. This project has been postponed due to the pandemic, and will continue in 2022 or 2023.
A4.3: Student development of material is proceeding according to plan.
A4.4: Teaching assistant workshops are organized. Student-driven activities in educational development will be postponed until good models have been found.
A4.5: Student-organized courses have not been prioritized in 2017-2019. Focus has been on education research and international student exchange. These elements were implemented in the honours-program in 2020.
A4.6 Student innovation has not been prioritized in 2017-2019. The first student innovation project was piloted in 2021. Full scale student innovation projects will be initiated in 2022 if possible due to the pandemic.
A4.7: Research activities have been significantly extended through external funding.
A4.8: Summer internships have been financed through external financing from Thon foundation. However, no funding was provided by the Thon Foundation in 2020, limiting the extent of such projects in 2020 and 2021. In addition, the pandemic reduced these activities in 2020 and 2021. We will increase such projects from 2022 and up to full scale in 2023.

WP5: Dissemination, dialogue and communication

Leader: Mørken

GOAL (2016-2021)

Develop and apply a research-based approach to dissemination locally, nationally and internationally. Hereunder,
(1) Disseminate learning material;
(2) Disseminate internally at UiO;
(3) Extend to other programs at UiO;
(4) Extend horizontally to other institutions nationally and internationally;
(5) Extend vertically to the school system.

ACTIVITIES IN 2021

Extension beyond science

CCSE has played a central role in supporting and developing courses that integrate programming in the new honours program at UiO. In 2020 Dag Haug and Øystein Linnebo developed an introductory course in programming for students from the humanities. This course was piloted for the honours-students. In 2021 this course was extended to a full course in Python programming for the humanities. The course includes relevant examples and exercises taken from the domain of philosophy and linguistics. Henrik Sveinsson has successfully developed a course on data-driven projects for honours students that integrate basic data-science and machine learning methods and teach them to interdisciplinary teams of students and will be expanded to a full course for all students in the humanities from 2021. We will use experience from developing these courses in our further dissemination to other disciplines.

Partnership through Circle-U

CCSE is part of an Erasmus+ KA3 program (Innoved4TS) that focuses on mapping out training in transferrable skills across the Circle-U university network. As part of that process, a group of experts from other Circle-U universities evaluated the flagship programs at each of the partner universities. CCSE was selected as the flagship project from the University of Oslo. In 2022, CCSE is organizing a two-day workshop for all Circle-U institutions, which will result in the final recommendations from the project to university leadership across all Cirlce-U institutions. Our long-time goal is to develop courses in computing that span across all or most of the Circle-U partners.

International disseminiation

CCSE has an INTPART on partnership for computing in science education with Michigan State University, University of Colorado – Boulder, and Oregon State University. However, international exchange has been negligible in 2021 due to the pandemic. This activity will be expanded again after the pandemic.

School partnership

The school activity has continued to expand in 2021. (See box).

PLANS AND PRIORITIES FOR 2022

- Confirm CCSE as the national resource on computing in education and digital competence from schools to higher education and research
- Consolidate extension to the humanities and expand extension to the humanities beyond UiO
- Become recognized as the national leader for computing in school education

ACTION PLAN

Action	Description	2017		2018		2019		2020		2021		Milestones and Deliverables
A5.1	**Internal dissemination at UiO**											
	CSE workshop for UiO leadership at various levels	o	o	o	o	o	o	o	o	o	o	Workshops arranged
	CSE workshops on computational methods and practices for faculty				M		M		M		M	Workshops arranged
	CSE workshops on computational methods for teaching assistants			M		M		M		M		Workshops arranged
A5.2	**Extension to new programs at UiO**											
	Extension to bioscience program											
	Develop plans and study programs with department leadership		M									Plans developed
	Develop new introductory CSE course for biology students		o	o	M							Course implemented
	Develop new textbook for introductory courses		o	o	D					D		Preliminary textbook; Published text
	Integrate CSE into other biology courses						M		D		D	Initiate; Implemented in 2 courses
	Test pilot courses on biology student groups, evaluate and improve		M						M			Reports
	Evaluate and adjust CSE approaches in new courses								M			Reports
	Evaluate and review approach and study program design									M		Reports
	Extension to other programs (chemistry, geoscience)							o	o	o	M	Materials and texts in repository
A5.3	**Extension to other institutions**											
	Extension to University College of Southeast Norway											
	Develop introductory course and material for programming		o	o	o	D						Course developed
	Adapt material from UiO to local courses				o	o	o	D				Adapted material and texts
	Research and evaluate adaption, iterative improvement					o	o	o	M	o	o	Research (PhD1, Postdoc)
	Develop material for other University Colleges								o	o	M	Material (if applicable)
	Extension to other Universities											
	Support adaptation and extension through workshops and support			o	o	o	o	o	o	o	o	Reports on workshops arranged
	International extensions											
	Study application of material at Michigan State University		o	o	o	o	o	D	o	o	o	Research articles
A5.4	**School partnership**											
	Develop school visit program		o	o	o	o	o	M				Material developed
	Pilot school visit program with partner school						D		D		D	School program initiated
	Evaluate and improve visit program								o	o	M	Report from evaluation
	Extend program to other schools									o	M	Other schools included in program
	Research effect on recruitment, retention and exam results									o	D	Research (Postdoc)
	Research effect on school teachers									o	D	Research (Postdoc)

M: Milestone, D: Deliverable, o: Ongoing
Colors indicate progress. : according to plan, : adjustment, : delayed

Comments

A5.1: CCSE has developed workshops for leaders, teachers and students. This work is well on track. See product list for details.
A5.2: Extension to bioscience is progressing according to plan. Extension to chemistry and geoscience is gradually extended through student projects.
A5.3: A collaboration agreement between UiO and University College of Southeastern Norway (USN) is signed, and the progress at USN has been exceptional (see box). CCSE has initiated collaborations with most other universities in Norway, and have also actively communicated our results to possible international partners.
A5.4: The school exchange program has been postponed in order to coordinate with new developments in the school curriculum

PROFAG – PROGRAMMERING I FAGENE (PROGRAMMING IN CONTEXT)

From 2020 programming and computing is integrated in all school subjects (1-13), and mathematics is given the main responsibility of introducing student to programming and computational thinking. This has proved a significant challenge, because most teachers in mathematics, of which there are 30.000 in Norway, do not know either how to program or even more importantly, how to use programming and computing to improve their teaching practice in their domain. At KURT and CCSE we seized this opportunity and introduced the ProFag project, where we address how programming can be used to improve learning in the various subjects taught in school.

CONTINUING EDUCATION FOR TEACHERS IN SCHOOLS

KURT is now working to support for teachers that need to learn how to use programming in their domain teaching through continuing education. This occurs either through courses or network meetings, with or without credits.

RESEARCH RELATED TO PRE-SERVICE TEACHERS' PROGRAMMING COMPETENCE

In 2021, KURT conducted a survey aimed at pre service teacher students, where we investigated the students' programming competence and whether they felt confident to teach programming in school. The survey raised a number of interesting questions, and Hannah Sabo – post doc employed at CCSE – conducted several interviews with some of the students.

The results from the interviews are being analysed and will be presented in a short paper and sent to Physical Review Physics Education Research.

PROGRAMMING IN SCIENCE COURSES FOR TEACHERS (PROFAG, WITHOUT CREDITS)

We have found that many school teachers found programming to be challenging and that they were worried about how to address the new requirements in the curriculum. We have introduced basic courses for upper secondary school and high school teachers that emphasize giving teachers a basic approach to programming, teaching them how to make simple programs and showing them how to integrate programming into the subjects.

From the autumn of 2020, we also established the course "Profag: high school level 2", where high school teachers are introduced to more advanced programming practices. Here, most of the programming is related to the subject being taught, and we have emphasized didactic reflections in connection with the teaching of programming. The goal of this course is to give teachers an improved confidence in how they can use programming in their subjects to facilitate in-depth learning and the opportunity for differentiated teaching.

DEVELOPMENT OF TEACHERS' PROGRAMMING SKILLS AND COMPETENCE IN COLLABORATION WITH THE NORWEGIAN DIRECTORATE FOR EDUCATION AND TRAINING

We have found that it is challenging for teachers to collaborate with collegues on course assignments between sessions. In 2021, we therefore developed network meetings where a leader and two teachers from the same school participate, and where they discuss how they can integrate programming in their local environments. The network meetings are based on a competence package for programming and algorithmic thinking (MOOC), which has been developed by KURT on behalf of the Norwegian Directorate of Education. The network meetings are based on two four-hour sessions and gives the leader and the teachers support in how to work with programming in their local environments.

PROGRAMMING IN SCIENCE COURSES FOR TEACHERS

Based on the Profag courses, KURT established NAT3000, science programming in schools, starting fall 2021. The course is open to all teachers in Norway, in contrast to Profag, which is developed specifically for the teachers in the specific school districts. NAT3000 also gives the students 15 credits after final exam. The course is based on two-days seminars, over six sessions and support students in how to teach programming in the natural sciences.

CHANGE IN CURRICULUM AND CONTINUING EDUCATION FOR TEACHERS

When changes in curricula are to be implemented, it requires continuous development work from several parties that have a good dialogue. Competence development through a decentralized support system gives the partnership the opportunity to maintain a developing dialogue and a close connection to the teachers' needs. Although we apply for funding every year, we see the work in a long-term perspective, and where the competence development measures over the years, are seen in context. In addition, it is closely linked to research and development work, which means that we are able to deliver competence development measures that are directly relevant to teachers.

The experiences we gain through the competence development measure also benefit the associate professor education and contribute to us being able to facilitate a more practical education where programming didactics is to be integrated into the education.

University of South-Eastern Norway

Report from the CSE activity at USN

Ole Marius Lysaker and Randi T. Holta, USN

The previous study year has been strongly impacted by the pandemic with closed-down campuses, digital lectures, home exams and many absences. Despite these challenges, we have succeeded in providing good educational programs for the students and a range of new courses have been introduced.

Python is the preferred programming tool in the natural sciences at USN. Already in the first semester, students get a general introduction in programming through the courses "Python for computations". In the second semester students are required to follow Mathematics 1 and Physics 1, in which Python programming is an integrated part. Mathematics 2 in the third semester and Statistics 1 in the fourth semester also integrate computing. During 2021, the study programs have been digitized both in the form of digital lectures and new, digital learning materials. To provide students with opportunities to meet, share experience and collaborate, we have strived to keep all group sessions physical in 2021.

ACTIVITES

In 2021 we developed and taught several professional training courses (EVU kurs) in Python programming:.

- Applied Python programming for mathematics and science high-school teachers. Zoom-based, 7.5 ECTS. Target group: Science teaching in high schools. Spring 2021.
- PY1010 – Python programming for computations. Zoom-based, 5 ECTS: Target group: Unemployed with technological background who work with various computations. Financed by Kompetanse Norge. 1 time spring 2021 and 2 times fall 2021.
- PY1000 – Python programming for STEM. Zoom-based, 15 ECTS. Target group: Teachers in science in high schools. Fall 2021 and spring 2022.
- Lightning course in Python-programming. Zoom-based, no ECTS. Target group: STEM teachers in high schools. Financed by Vestfold and Telemark fylkeskommune.

In 2021 USN has placed significant emphasis on increasing the university teachers' competence in Python programming. The goal is to help faculty include programming and computational thinking also in courses beyond the sciences. Faculty have been given the opportunity to participate in PY1000. During 2021 19 teaching faculty participated in this course, and they have also spent considerable of their own time in coursework.

We planned to developed 4 texts focusing on programming in Mathematics 1, 2, 3 and Physics, but due to changes in the teaching due to the pandemic, this work has been postponed to 2022.

Organization and management

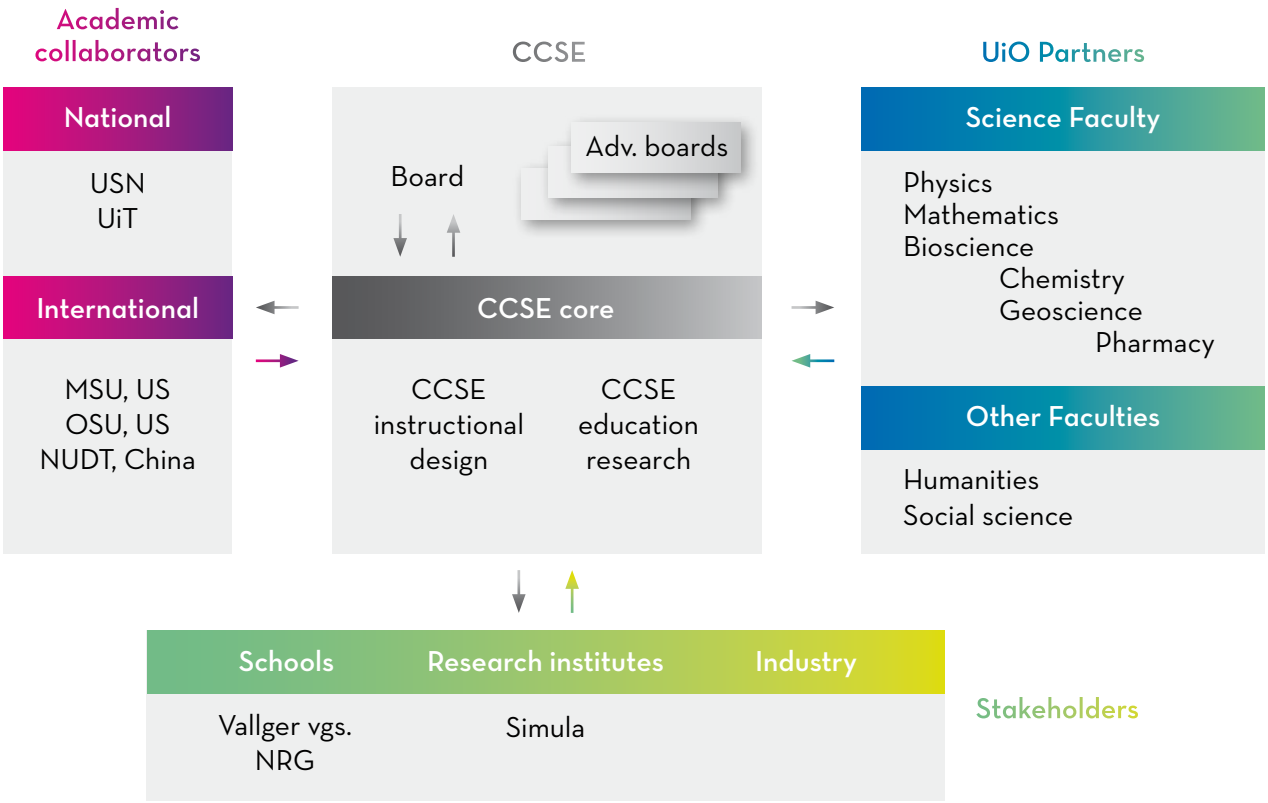
CCSE is directed by Professor Anders Malthe-Sørenssen and supported by an administrative leader, Tone Skramstad. The director is supported by a working group, with an advisory and coordinating function, consisting of the five work-package leaders, the administrative head, director of studies at the Faculty, and a student representative.

The center has a board with representatives from the four main departments, Departments of Physics, Mathematics, Computer Science and Bioscience, a student representative, and two ex-ternal representatives. The board will have two meetings a year.

The various departments provide contributions to the center in the form of in-kind contributions. For example, the Department of Physics provides a 20% in-kind resource for each of the teachers in the six main courses in physics. This in-kind contribution represents the time teachers use for educational development. In addition, the Department of Physics provides an in-kind contribution in the form of compulsory work for PhD-students that is used for educational development. Two students have contributed to BIOS1100, one student contributes to BIOS1120 – Physiology, and one student contributes by the integration of computational exercises in FYS1001 – Introduction to physics.

The center has an education research group directed by associate professor Tor Ole Odden and associate professor Marcos D. Caballero. The group has regular group meetings, and organize invited seminars and researcher visits to CCSE.

Additional advisory boards will be established to support the education research activity, evaluation, and input from stakeholders and students.



Leadership group

TONE SKRAMSTAD
Administrative head
Tone comes from a position as manager for the Observatory and has extensive experience from administrative positions at the University of Oslo. She is also an author of a book about the history of the Observatory. In CCSE she is in charge of outreach and communications as well as being the head administrative officer.

MORTEN HJORTH-JENSEN
Professor of physics, WP1 leader, 20%
Morten is a computational physicist focusing on applied quantum mechanics, quantum computing, and machine learning. He has developed the computational science master program, courses in computational physics (FYS3150) and machine learning (FYS-STK3155). He is a Fellow of the American Physical Society, Member of the Norwegian Academy of Science, winner of the Thon award, and has been awarded UiO's education award 3 times.

ANDERS MALTHE-SØRENSSEN
Professor of physics, director CCSE, 35%
Anders has extensive cross-disciplinary research, educational and innovation leadership experience. He has developed two master programs, UiO's honours program, courses and textbooks in mechanics, thermal physics, percolation theory, and electromagnetism. He is a member of the Norwegian Academy of Science, winner of the Thon award and winner of UiOs education award 2 times.

CATHRINE WAHLSTRØM TELLEFSEN
Senior lecturer, WP4 leader, 20%
Cathrine is the director of KURT – The Center for Teaching and Learning and Science. She has built up the ProFag activity – programming for disciplinary understanding in basic (school) education, the Summer Institutes, and promotes active learning at the Faculty. She is an experienced high-school teacher, author of a science textbook series for high-school, and winner of the Thon award.

KNUT MØRKEN
Professor of mathematics, WP5 leader, 20%
Knut is a founder of CSE and developed and wrote a textbook for the course in numerical calculus (MAT-INF1100). He is the leader of the InterAct project to reform the study programs at the Faculty using a backward-design approach, and the leader of the bachelor program in mathematics. He is the dean of education (since 2019) and winner of the Thon Award.

HANNE SØLNA

Leader of the study section, MN Faculty, 20%

Hanne is the leader of the study section at the Faculty and have been a key driver for the CSE project since 2003. She has broad experience from organizing and developing education transformations and strategy processes. She is also a key driver for the InterAct reform.

GEIR-KJETIL SANDVE

Associate professor of informatics, 20%

Geir-Kjetil has a background in statistics and leads a bioinformatics group at the Department of Informatics. He has for several years been responsible for the introductory course in programming for computer science students, IN1000. He introduced Python programming in this course and developed methods to use assessments to systematically improve teaching.

LEX NEDERBRAGT

Senior lecturer in bioscience, 20%

Lex is a Senior Lecturer at the Department of Biosciences, and head of education and training for the Center for Bioinformatics. He leads the implementation of CSE in the bachelor degree at the Department of Biosciences and is responsible for BIOS1100, the introductory course in programming for biology students. He has extensive experience as a Software Carpentry instructor. He leads the Advisory Council for eInfrastructure at UiO.

GULLA TORVUND

Bachelor student,

Honours program, UiO

Gulla is a student representative in the leadership group (2020-2021).

KARL HENRIK FREDLY

Master student,

CS program, UiO

Karl Henrik is a student representative in the leadership (2020-2021).

Education research

DANNY CABALLERO

Adjunct professor of physics education research, 20%

Danny is the Lappan-Phillips Associate Professor of Physics Education, Michigan State University, Leadership Faculty, CREATE for STEM Institute, Michigan State University, and Associate Professor at CCSE. He is PI of several large NSF-funded projects on the integration of computing into high-school and university educations. He is the leading international re-searcher on the effects of computational modeling on physics education outcomes.

TOR OLE ODDEN

Associate professor in physics education research

Tor Ole finished his PhD in Science Education Research at the University of Wisconsin – Madison. The topic of his PhD-research was on sensemaking. He is heading the Learning Assistant project at CCSE, studies computational literacy and the effects of computational essays, and develops a data-driven study of the historical development of education research.

JOHN MARK AIKEN

PhD-student/researcher

John defended his PhD dissertation in 2020 and continued at CCSE as a researcher into 2021. He has long experience and a solid track record in physics education research. He has taught physics classes that integrate computing at several US and European institutions. He has published 15 papers on physics education research in international research journals. His work focuses the use of machine learning methods to develop a quantitative basis for physics education research studies.

ODD PETTER SAND

PhD-student

Odd Petter has a background in computer science and astronomy. He thesis project addressed how students learn from making mistakes with a particular focus on mistakes and how to learn from them in computational problem solving across contexts.

HANNAH SABO

Researcher, S-ASSESS project

Hannah started as a postdoc researcher at CCSE on the S-ASSESS project in 2021. She has been hired in a two-year position from 2022-2023.

Other scientific staff

ANDREAS HARALDSRUD
Senior lecturer
Andreas has a background as a teacher at Valler high school where he has developed the course "Modellering og programmering X". He has written a textbook for this course and taken the initiate to get the course approved nationally. He is also teaching the introductory course in programming for chemistry students, is teaching in the ProFag contextual programming classes for teachers, and has recently written a textbook on programming for school teachers.

HENRIK A. SVEINSSON
Tenure-track post-doc, 20%
Henrik has a background in computational physics. He is the project leader for UiO's new honours-program, for which he is also developing and teaching courses in programming for humanists (HON2110) and data-science projects for honours-students (HON2200). He has developed computational content and taught oscillations and waves (FYS2130) and electromagnetism (FYS1120). He is a teacher in the ProFag project and has recently co-authored a textbook in programming for school teachers.

ALESSANDRO MARIN
Software engineer, S-ASSES project
Alessandro has a background as a data scientist, scientific programmer, and has a PhD in bioinformatics. He has long experience with managing scientific software projects with both back-end and front-end experience. He is responsible for developing the software tools necessary for the S-ASSESS project, for developing and maintaining local software such as docOnce, and contributes with data-science expertise in research projects.

Personnel

Name	Function	Position	Unit
Center personnel			
Anders Malthe-Sørenssen	Center leader	Professor	Physics, UiO
Tone Skramstad	Head of administration	Office manager	CCSE
Knut Mørken	WP leader, 20%	Professor	Math, UiO
Morten Hjorth-Jensen	WP leader, 20% Course development, 20%	Professor	Physics, UiO
Cathrine W. Tellefsen	WP leader, 20% Teacher education	Leader teacher education program	KURT, UiO
Lex Nederbragt	WP leader, 20%	Senior lecturer	Biosciences, UiO
Geir Kjetil Sandve	Course development	Professor	Informatics, UiO
Hanne Sølna	Administrative mentor	Director of studies	Faculty Adm, UiO
Education research group			
Danny Caballero	Education research (20%)	Adjunct Professor	MSU/CCSE
Elise Lockwood	Education research (20%)	Adjunct Professor	OSU/CCSE
Tor Ole Odden	Education research	Associate Professor	CCSE
John Aiken	PhD-student/Researcher		CCSE
Hannah Sabo	Education research	Post-doc	CCSE
Odd Petter Sand	PhD-student		CCSE
Andreas D. Haraldsrud	Educational devel/research	Lecturer	KURT, CCSE
Alessandro Marin	Technical support	Senior engineer	CCSE
Instructional development			
Øyvind Ryan	Course development, 20%	Ass. Prof.	Math, UiO
Andreas Görgen	Course development, 20%	Professor	Physics, UiO
Dag Kristian Dysthe	Course development, 20%	Professor	Physics, UiO
Henrik Sveinsson	Course development, 10%	PhD-student	Physics, UiO
Mikkel Lepperød	Course development, 20%	PhD-student	Comp Sci, UiO

Name *(continued)*	Function	Position	Unit
Student representatives			
Gulla Torvund	Student representative		UiO
Karl Henrik Fredly	Student representative		UiO
Iris Bore	Student representative		UiO

External projects

Granting body	Project title	Project period	Funding	PI/partners
Intpart/NRC	US-Norwegian collaboration on fluid-consuming processes	2017-2021	4500 kkr	PI: Anders Malthe-Sørenssen
Thon stiftelsen	Student-driven research for improved science education	2018-2021	1500 kkr	PI: Danny Caballero
FinnUT/NRC	Structured assessment method for improved student learning	2018-2023	6000 kkr	PI: Anders Malthe-Sørenssen
Intpart/NRC	International partnership for Computing in Science Education	2019-2022	4500 kkr	PI: Morten Hjorth-Jensen
EU Erasmus+ KA3	Innovating STE(A)M in Higher Education with Transdisciplinary Talent Programs	2020-2022	667 kEUR	Hanze University, University of Oslo (CCSE), 16 other partners including CCSE
EU Erasmus+ KA203 Strategic partnerships for higher education	Exploring how to build a joint European Campus based on innovative education for transferable skills	2020-2022	239 kEUR	PI:Aarshus University, Circle-U university alliance, UiO node: CCSE

Accounting 2021

Budget and Expenditures – HK-Dir Funding 2021

Budget HK-Dir funds	Expenditure 2021	Budget 2021
Personnel and indirect costs	3 560 605	2 346 514
Purchase of services	400 000	600 000
Equipment	200 000	200 000
Other operating expenses	-2 425 486	870 000
Total	**1 735 119**	**4 016 514**

Budget and expenditure – 2022 to 2026

Budget	2022	2023	2024	2025	2026	Sum
Personnel costs incl. indirect costs (Hkdir)	4 591 014	4 890 675	4 963 280	4 069 133	3 802 292	22 316 395
Personnel costs incl. indirect costs (UiO in-kind)	3 743 456	4 607 779	4 699 633	4 505 038	3 711 309	21 267 214
Partner USN (Hkdir)	800 000	600 000	600 000	600 000	600 000	3 200 000
Equipment (Hkdir)	200 000	200 000	200 000	200 000	200 000	1 000 000
Running costs (Hkdir)						0
Running costs (UiO in-kind)	1 000 162	1 172 260	1 148 867	1 148 867	1 104 712	5 574 868
Educational innovation project (UiO in-kind)	1 100 000	1 100 000	1 100 000	1 032 200	1 000 000	5 332 200
Total	**73 625**	**15 647**	**11 973**	**12 011**	**11 605**	**11 809**
DIKU	5 591 014	5 690 675	5 763 280	4 869 133	4 602 292	26 516 395
UiO	5 843 618	6 880 039	6 948 500	6 686 105	5 816 021	32 174 282
Total	**11 434 632**	**12 570 714**	**12 711 780**	**11 555 238**	**10 418 313**	**58 690 677**

List of products

AWARDS

Prize	Name	When
Excellent Teaching Practitioner and member of the Pedagogic academy at UiO	Tone Fredsvik Gregers (KURT)	2021
College of Natural Science, Norman L and Olga K. Fritz Excellence in Teaching Award, Michigan State Universit	Morten Hjorth-Jensen	2021

Visitors

Who	Topic	When
Associate Professor David Stroupe, Associate director of STEM Teacher Education at the CREATE for STEM Institute, and the Director of Science and Society at State at Michigan State University	Presentation of STEM educational research	15.11-19.11.2021
Professor Sehoya Harris Cotner, director BioCEED	Presentation of STEM educational research	12.11.2021

Graduated PhD-students

Who	Topic	When
Odd Petter Sand	Thesis title: Integrating Computing with Mathematics and Science Education: Case Studies of Student Understanding and Teaching design	08.10.2021

Dissemination – external events

THE ROLE OF CCSE

Topic	Where, for whom	Who	When
Computational literacy as a driver for disciplinary renewal	IT-Vest, Aarhus, Denmark	Malthe-Sørenssen	01.02.2021
Computational literacy as a driver for disciplinary renewal	Aarhus University, Denmark	Malthe-Sørenssen	02.03.2021
Introduction of computing in bachelor programs across the natural sciences – experiences from a coordinated effort at the University of Oslo	CMSE Brown Bag Seminar, Michigan State University, USA	Malthe-Sørenssen	12.02.2021
Computational literacy as a driver for disciplinary renewal	University College Dublin, Ireland	Malthe-Sørenssen	20.04.2021

CONTRIBUTIONS TO SEMINARS, WORKSHOPS AND CONFERENCES

Topic	Where, for whom	Who	When
Using topic modeling to analyze massive amounts of science education research literature	Hub for Learning Analytics Research (HuLAR)	T.O.B. Odden and A. Marin	Dec. 2021
Læringsassistenter – hvorfor er det så lurt?	University of Oslo Utdanningskonferanse	E. Fremstad, C. Kjekshus, T.O.B. Odden, I.C. Borge, S. Sæther, og N.M. Rud	Nov. 2021
Using Computational Essays to Support Student Creativity and Agency in Science	GeoHyd Lunch Seminar	T.O.B. Odden	Nov. 2021
Hvordan kan de gi mening å lære om bevegelsesmengde i fysikk 1?	Fysikklærerforeningens Årsmøte	T.O.B. Odden	Oct. 2021
What does it mean to make sense of science?	Homi Bhabha Centre for Science Education Research Seminar	T.O.B. Odden	Sept. 2021
Using Computational Essays to Support Student Creativity and Agency in Physics	Partnership for Integration of Computation into Undergraduate Physics Capstone Conference, virtual	T.O.B. Odden	Aug. 2021
Experiences from establishing a cross-disciplinary honours program at the University of Oslo	Invited talk, World of Talent, 2021	Malthe-Sørenssen	15.06.2021
Experiences from establishing a cross-disciplinary honours program at the University of Oslo	Steam+ workshop, Hanze University (online)	Malthe-Sørenssen	23.04.2021
Experiences from establishing a cross-disciplinary honours program at the University of Oslo	Workshop on transdisciplinary education	Malthe-Sørenssen	20.09.2021

WORKSHOPS AND CONFERENCES ORGANIZED BY CCSE

Topic	Where, for whom	Who	When
ProFag-U (middle school)	Course for middle school teachers	Tellefsen, Haraldsrud, Løvold, Gregers	05.10.2020–11.03.2021
ProFag-U (middle school)	Course for middle school teachers	Tellefsen, Haraldsrud, Løvold, Gregers	14.01.2021–10.05.2021
ProFag vgs 1 (high schools)	Course for high school teachers	Tellefsen, Haraldsrud, Løvold, Gregers	24.09.2020–17.12.2021
ProFag vgs 1 (high schools)	Course for high school teachers	Tellefsen, Haraldsrud, Løvold, Gregers	09.11.2020–15.02.2021
ProFag vgs 2 (high schools)	Course for high school teachers	Tellefsen, Haraldsrud, Løvold, Gregers	21.01.2020–22.04.2021

WORKSHOPS AND CONFERENCES ORGANIZED BY CCSE PERSONNEL

Topic	Where, for whom	Who	When
Nuclear Talent Course on Machine Learning in Nuclear Physics for the Erasmus+ program	European Master in Nuclear Physics, University of Basse-Normandie and GANIL, France 30 lectures and 30 exercise sessions	Hjorth-Jensen	15.09.2021–24.01.2022
Online Nuclear Talent course on Machine Learning Applied to Nuclear Physics	European Center for Theoretical Nuclear Physics and Related Areas, Trento, Italy	Hjort-Jensen	19.07–30.07.2021
CHPC Introductory Programming Summer School	South Africa, five lectures	Hjorth-Jensen	01.02–28.02.2021
Nuclear Talent Course on Machine Learning in Nuclear Physics for the Erasmus+ program	European Master in Nuclear Physics, University of Basse-Normandie and GANIL, France	Hjorth-Jensen	18.01–29.01.2021
Workshop om transdisiplinær utdanning	Seminar for Norwegian higher education institutions, DIKU, KD	Idsøe, Malthe-Sørenssen	20.09.2021

CONTRIBUTIONS TO POLICY AND THE PUBLIC DEBATE

Topic	Where, for whom	Who	When
Utvikling av et tverrfaglig honours-program på UiO	Seminar arranger av Kunnskapsdepartmentet og UiO	Malthe-Sørenssen	07.06.2021

Dissemination – internal events

CCSE SEMINAR SERIES

Title	Who	When
Exploring chemistry with programming and numerical experiments	Senior Lecturer Audun Sand, Department of Chemistry, UiO and lecturer Andreas Haraldsrud, CCSE, UiO	15.06.2021
Teaching a Computationally Integrated Quantum Physics Course	Associate Professor Marcos D. "Danny" Caballero, Department of Physics and Astronomy, Michigan State University	15.06.2021
Learning assistant approaches to teaching computational physics problems in a problem-based learning course	Dr Alanna Pawlak, Center for STEM Learning, University of Colorado	15.06.2021
Envisioning more equitable Higher Education	Professor and director Sehoya Harris Cotner, BioCEED, UiB	12.11.2021
Preparing science teachers for equitable instruction	Associate Professor David Stroupe, associate director of STEM Teacher Education at the CREATE for STEM Institute, and the Director of Science and Society at State at Michigan State University	16.11.2021
Disrupting epistemic injustice in classrooms	Associate Professor David Stroupe, associate director of STEM Teacher Education at the CREATE for STEM Institute, and the Director of Science and Society at State at Michigan State University	17.11.2021
What does this picture have to do with learning physics?	Senior lecturer Urban Ericson, National Resource Centre for Physics Education, Head of department, Department of Educational Sciences	15.12.2021
Programming to learn physics	Doctoral student Kim Svensson, National Resource Centre for Physics Education, Lund University	15.12.2021

THE BI-WEEKLY ODD SEMINAR SERIES AT CCSE

We have in 2021 continued the Open Discussions on Didactics (ODD) seminar series that were established in 2020. The seminars are on Tuesdays at 14.00 every other week (odd week numbers) and have been a mix of virtual-only and hybrid meetings. It is an informal arena to present and discuss learning theory, educational research and teaching experiences within computational science. To cater to the highly heterogeneous back-grounds and interests of students, teachers and researchers connected to the CCSE environment, we have aimed for highly varied seminars within a broad spectrum of aspects, in a form that invites reflection and discussion.

The series has been well attended, with typically 10-30 attendants per meeting and a good variation in who has attended the different meetings. Seminars have been given both by local researchers in the CCSE environment and external speakers.

Title	Who	When
The bi-weekly ODD seminar series at CCSE: Discussion: Does "algorithmic thinking" have a cousin "statistical thinking"?	Professor Geir Kjetil Sandve, Department of Informatics, UiO	16.02.2021
Interactive teaching material for learning programming	Lecturer Andreas Haraldsrud, CCSE, UiO	02.03.2021
Design of teaching for understanding in a mathematical-computational context, examples from our research in MAT-INF1100	PhD student Odd Petter Sand, CCSE, UiO	16.03.2021
Formative assessment and Peer Instruction in learning programming: examples from BIOS1100	Senior Lecturer Lex Nederbragt, Department of Biosciences, UiO	13.04.2021
Computational and data science as part of PhD education at MN faculty	Professor Anders Matlhe-Sørensssen, CCSE, UiO	27.04.2021
Some observations about the benefit of computing in mathematics	Professor Knut Mørken, Department of Mathematics	11.05.2021
Ways to materialize constructive alignment: using lectures to model learning activities, using exam tasks to discuss learning aims and weaving together weekly activities!?	Professor Geir Kjetil Sandve, Department of Informatics, UiO	25.05.2021
What does it mean to learn scientific computing? Perspectives from the literature	Associate Professor Tor Ole Odden, CCSE, UiO	14.09.2021
A simulation-based approach to learning statistics?	Professor Geir Kjetil Sandve, Department of Informatics, UiO	28.09.2021
Integrating computation in American high schools - a tale of resourcing, federalism, and equity	Associate Professor Marcos Caballero, Michigan State University	12.10.2021
Everything can be a vector! An approach to teaching machine learning to early physics students?	Associate Professor Tor Ole Odden, CCSE, UiO	12.10.2021
BraketLab - teaching quantum theory in a tangible way	Senior Lecturer Audun Skau Hansen, Department of Chemistry, UiO	09.11.2021
Mathematical programming problems in upper secondary school – Design, possibilities, and obstacles	Assistant Professor Morten Munthe, Faculty of Science and Technology, NMBU	23.11.2021
Challenges of preparing secondary subject pre-service teachers to integrate computational thinking into their teaching	Researcher Hannah Sabo, CCSE	07.12.2021

CCSE EDUCATIONAL DEVELOPMENT ACTIVITIES (POLICY AND TEACHING)

Topic	Where, for whom	Who	When
REAL education, seminar (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Mørken, Raaheim, Govid Joshi, Gregers and Tellefsen	07.01.2021
REAL education seminar (English)	REAL education, seminar for teachers and faculty of Mathematics and Natural Sciences, UiO	Mørken and Haynes	08.01.2021
REAL Prat (talk)	Everyone at MN: reflections after homeexames	Mørken, Tellefsen, Gregers and Haynes	08.01.2021
Group teacher education IFI, how to ask the right questions	Group teachers IFI	Haynes	04.03.2021
REAL Prat (talk)	Everyone at MN: Students with high learning potential	Idsø, Tellefsen and Haynes	23.03.2021
Teaching portfolio workshop	Phd-students at MN	Gregers and Haynes	07.06.2021
REAL education, seminar (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Mørken, Gregers, Tellefsen and Haynes	19.08.2021
REAL education seminar (English)	REAL education, seminar for teachers and faculty of Mathematics and Natural Sciences, UiO	Mørken and Haynes	20.08.2021
REAL Group teacher start	A start seminar for groupteachers at MN	Odden, Westgaard Sørensen, Borge and Skau Hansen	26.08.2021
REAL Prat (talk)	Everyone at MN: Exam after the pandemic	Mørken, Gregers, Tellefsen and Haynes	13.10.2021
Teaching portfolio seminar	Department of Chemistry	Gregers and Haynes	07.12.2021
REAL Prat (talk)	Everyone at MN: Work and career focus in education	Buhaug Sollbakken, Gregers and Haynes	08.12.2021

WORKSHOPS AND CONFERENCES AT CCSE

Topic	Where	Attendance	When
Computing in Science Education Summer Seminar – When both the content and the teaching are changed	Webinar at Zoom	40	15.06.2021
CCSE internal seminar	Soria Moria, Oslo	10	1.-2.11 2021
Computing in Science Education Annual Christmas Seminar	Webinar at Zoom	50	15.12.2021

SEMINARS FOR MASTER STUDENTS IN COMPUTATIONAL SCIENCE

Topic	Who	Date
From Physics to Consultancy in Data and AI	Vala Valsdottir, Cap Gemini	03.09.2021
Quantum Computing and Quantum machine learning	PhD student Stian Dysthe Bilek, Physics Department, UiO	15.09.2021
Expert Analytics, Industrial Research and Development	Ola Skavhaug, founder of Expert Analytics	17.09.2021
Economics: The Unnatural Science?	Sebastian Gregorius Winther-Larsen, Menon Economics	24.09.2021
Supervised learning with parameterized quantum circuits	Philip Sørli Niane, master student	29.09.2021
How do we work with Artificial Intelligence in SINTEF	Anne Marthine Rustad and Signe Riemer-Sørensen from SINTEF and the Mathematics and Cybernetics department	01.10.2021
Ising Model and different ways of solving it and also different ways of obtaining thermodynamic information about it	Joao Inacio, master student	06.10.2021
The programming language Julia and exciting things which can be done with this programming language	Karll Henrik Fredly, master student	13.10.2021
What happens when you transition from physics to finance?	DNB	15.10.2021
Research directions at Simula/IFI	Xing Cai and Joakim Sundnes	29.10.2021
Computational Neuroscience	Gaute Einevoll	26.11.2021

LECTURES AND ORGANIZATION OF SCHOOLS

Topic	Who	Date
Morten Hjorth-Jensen, Nuclear Talent Course on Machine Learning in Nuclear Physics for the Erasmus+ program http://www.emm-nucphys.eu/, European Master in Nuclear Physics, University of Basse-Normandie and GANIL	Hjorth-Jensen (30 lectures and 30 exercises sessions, main teacher)	15.09.2021–24.01.2022
Online Nuclear Talent course on Machine Learning Applied to Nuclear Physics, European Center for Theoretical Nuclear Physics and Related Areas, Trento, Italy	Morten Hjorth-Jensen (Main organizer and teacher), Daniel Bazin, Sean Liddick, Michelle Kuchera, and R. Ramanujan	19.07.2021–30.07.2021
2021 CHPC Introductory Programming Summer School, South Africa	Hjorth-Jensen (five lectures on machine learning)	01.02.2021–28.02.2021
Nuclear Talent Course on Machine Learning in Nuclear Physics for the Erasmus+ program http://www.emm-nucphys.eu/, European Master in Nuclear Physics, University of Basse-Normandie and GANIL	Hjorth-Jensen (30 lectures and 30 exercise sessions, main teacher)	18.01.2021–29.01.2021

Publications

Scientifc publications

- Odden, Tor Ole Bigton (2021). What Does It Mean to "Make Sense" of Physics? *The Physics Teacher*. ISSN 0031-921X. 59, s. 596–598. doi: 10.1119/5.0024095.
- Odden, Tor Ole Bigton (2021). How conceptual blends support sensemaking: A case study from introductory physics. *Science Education*. ISSN 0036-8326. 105, s. 989–1012. doi: 10.1002/sce.21674.
- Odden, Tor Ole Bigton; Marin, Alessandro & Rudolph, John (2021). How has Science Education changed over the last 100 years? An analysis using natural language processing. *Science Education*. ISSN 0036-8326. 105, s. 653–680. doi: 10.1002/sce.21623
- Aiken, John Mark; De Bin, Riccardo; Lewandowski, Heather & Caballero, Marcos Daniel (2021). Framework for evaluating statistical models in physics education research. *Physical Review Physics Education Research*. ISSN 2469-9896. 17(2). doi: 10.1103/PhysRevPhysEducRes.17.020104.
- Mikkelsen, N. J., Young, N. T., & Caballero, M. D. Investigating institutional influence on graduate program admissions by modeling physics graduate record examination cutoff scores. *Phys. Rev. Phys. Educ. Res.*, 17:010109, Feb 2021
- Aiken, John & Lewandowski, H.J. (2021). Data sharing model for physics education research using the 70 000 response Colorado Learning Attitudes about Science Survey for Experimental Physics dataset. *Physical Review Physics Education Research*. ISSN 2469-9896. 17(2). doi: 10.1103/PhysRevPhysEducRes.17.020144.
- Lockwood, Elise & Mørken, Knut Martin (2021). A Call for Research that Explores Relationships between Computing and Mathematical Thinking and Activity in RUME. *International Journal of Research in Undergraduate Mathematics Education*. ISSN 2198-9745. 7, s. 404–416. doi: 10.1007/s40753-020-00129-2.
- Frågåt, Thomas; Henriksen, Ellen Karoline & Tellefsen, Cathrine Wahlstrøm (2021). Pre-service science teachers' and in-service physics teachers' views on the knowledge and skills of a good teacher. *Nordic Studies in Science Education*. ISSN 1504-4556. 17(3), s. 277–292. doi: 10.5617/NORDINA.7644.

Scientific talks and posters

- Odden, Tor Ole; Yadav, Aman; Tellefsen, Cathrine Wahlstrøm & Caeli, Elisa Nadire (2020). Integrating Computing into K-16 Education: Scaffolding Teacher and Student Learning in STEM Disciplines. Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE. ISSN 1942-647X. s. 517–518. doi: 10.1145/3341525.3393961

Books

- Haraldsrud, Andreas Drolsum; Sandtorv, Alexander Harald; Hushovd, Odd T. & Brandt, Harald (2021). *Kjemi 1*. Aschehoug & Co. ISBN 9788203317637. s. 440. (Textbook in chemistry for high schools).

Social media

- Facebook: www.facebook.com/CentreForCSE/
- Web: www.mn.uio.no/ccse/
- Blog: www.mn.uio.no/ccse/om/aktuelt/blogg/

Student activities

STUDENT DEVELOPMENT OF LEARNING MATERIAL

Course and topic	Student	Teacher	When
Developing programming course for humanities	Eline Prytz Andersen	Henrik Sveinsson	01.01-31.12.2021
Developing programming course for humanities	Karl Henrik Fredsly	Henrik Sveinsson	01.01-30.04.2021
Developing programming course for humanities	Erik Aashamar	Henrik Sveinsson	01.01-28.02.2021
Educational development work for the CCSE	Morten Tryti Berg	Tor Ole Odden	01.01-30.04.2021
Educational development work for the CCSE	Henrik Haugerud Carlsen	Tor Ole Odden	01.01-30.04.2021
Developing programming course for humanities	Simon Peder Halstensen	Henrik Sveinsson	01.01-28.02.2021
Developing programming course for humanities	Thomas Lønn Hammer	Henrik Sveinsson	01.01-28.02.2021
Developing programming course for humanities	Tiril Flatebø	Henrik Sveinsson	01.01-28.02.2021
Development in biosciences	Nicolai Haug	Lex Nederbragt	01.01-31.12.2021
PYTHON scripts to hardware interfaces FYS2150	Jacob Larsen Lie	Nina Edin	01.06-31.07.2021
Course development FYS2150	Maria Markova	Nina Edin	01.06-31.07.2021
Developing programming course for humanities	Henriette Johansen	Henrik Sveinsson	01.05-31.12.2021
Transcription research interviews	Katharina Kristoffersen	Tor Ole Odden	15.06-15.08.2021
Transcription research interviews	Astrid Johanne Sørnes	Tor Ole Odden	01.05-31.12.2021
Course development FYS-STK3155/4155 Applied Data Analysis and Machine Learning	Linus Ekstrøm	Morten Hjorth-Jensen	15.06.2021-31.12.2021
Course development physics	Ola Sten Baksaas	Kjetil Røed	01.06-30.06.2021
Course development biosciences	Tiril Gjerstad	Lex Nederbragt	01.05-31.12.2021
Cource development chemistry	Mathilde Verne	Sissel Jørgensen	01.06-30.09.2021
Cource development chemistry	Erlend Tiberg North	Sissel Jørgensen	01.06-16.08.2021
Course development informatics	Erlend Akre	Andreas Austeng	01.06-30.09.2021

Course and topic *(continued)*	Student	Teacher	When
Course development informatics	Helene Wold	Andreas Austeng	01.06–30.09.2021
Course development physics	René Aleksander Ask	Anders Kvellestad	01.08–30.09.2021
Course development in physics: utarbeide interaktive læremidler/forelesningsnotater basert på Jupyter Lab	Jørgen Brevik	Ørjan Martinsen	01.06–31.12.2021
Programmerings- og modelleringsoppgaver biologi og biokjemi, BIOS1130, BIOS3900, BIOS4020	Julia Kluwer	Per Eugen Kristiansen	01.06–30.09.2021
Programmerings- og modelleringsoppgaver biologi og biokjemi, BIOS1130, BIOS3900, BIOS4020	Laura Lage Segura	Per Eugen Kristiansen	01.06–30.09.2021
Utvikling av programmeringsoppgaver/ prosjekter i bacheloremner i kjemi, KJM2601	Ingeborg Braskerud Tangevold	Audun Skau Hansen	01.06–31.07.2021
Course development geosciences – Øke programmeringsmengden i GEO1100 Jordens utvikling	Are Frode Kvenum	Karianne Lilleøren	01.06–30.09.2021
Course development geosciences – Øke programmeringsmengden i GEO1100 Jordens utvikling	Stian Damman	Karianne Lilleøren	01.06–30.09.2021
Bidrag på STEAM(+) – digital konferanse 23. april	Henriette Johansen, Thomas Lønn Hammer, Tiril Flatebø, Srishti Misra, Markus Kreutze,	Anders Malth-Sørenssen	22.04, 23.04 and 07.06.2021
Course development with funding from NOKUT	Jørn-Marcus Høylo-Rosenberg	Karl Henrik Fredly	15.07–30.09.2021
Course development with funding from NOKUT	Nigar Abbasova	Karl Henrik Fredly	15.07–30.09.2021
Course development with funding from NOKUT, project leading	Karl Henrik Fredly	Anders Malthe-Sørenssen	15.07–31.12.2021

STUDENT RESEARCHERS

Theme	Students	Supervisors	When
Research project on artifical intelligence	Simran Sahajpal	Anders Malthe-Sørenssen	01.01–31.12.2021
Research project	Nils Johannes Mikkelsen	Marcos Caballero	01.06–31.12.2021

UNIVERSITY OF OSLO

CENTRE FOR EXCELLENCE IN EDUCATION

Center for Computing in Science Education
A Center for Excellence in Education from 2016–2021

Center leader
Anders Malthe-Sørenssen

Contact address
Center for Computing in Science Education
Department of Physics, University of Oslo, Norway
P.O. Box 1048 Blindern, NO-0316 Oslo

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