ANNUAL REPORT

2022

CCSE

Center for Computing
in Science Education

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Summary

The Center for Computing in Science Education (CCSE) is now becoming 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 2022 has still been affected by repercussions of the pandemic. Travel to and from the US was still limited in the spring of 2022, and this limited exchange programs and research visits. Teaching was also to some degree digital in the spring of 2022, but went back to physical from the fall of 2022. Some of our original plans were therefore adapted to fit both digital, hybrid and physical forms. In this period, CCSE – and in particular KURT - has been active in introducing and discussing alternative modes of instruction and assessments.

POST-PANDEMIC CONFERENCES AND WORKSHOPS

In 2022 we took advantage of the post-pandemic opening and resources we had saved up due to limited activities during the pandemic, to organize two major international events. We organized the Nordic Regional Learning Assistants Workshop with the help of facilitators from the Learning Assistant program at University of Colorado – Boulder. You can read more about this event on page XX. This workshop was a great success, with local, national and Nordica participants. We foresee that this workshop will initiate a wider use of learning assistants and the associated active learning pedagogy. In addition, CCSE hosted the Oslo Physics Education Research Summer Institute (OPSI) conference to connect with Physics and STEM education researchers from the University of Oslo, Michigan State University, Oregon State University, University of Colorado – Boulder, and other Norwegian and Scandinavian Universities. Tor Ole Odden did a magnificent job together with the other organizers to create a safe space to share and learning following the pandemic. This event contributed to put CCSE on the map, internationally, and establish us as an international hub.

EDUCATION RESEARCH

Education research at CCSE in 2022 was at a transition between the activity in the first five-year period and starting new activity for the second five-year period. Three new PhD project have been started. In addition to his other initiatives and responsibilities, Andreas Haraldsrud is pursuing a PhD in education research focusing on learning in chemistry. PhD-student Henning V. Myhrehagen is pursuing a PhD project at KURT and CCSE to address how teachers and students integrate computing in the various disciplines at schools. And Karl Henrik Fredly was hired as a new PhD-student to address aspects of the integration of computing in physics education. In addition, researchers Hannah Sabo is working on the sAssess project and a further post-doc will be hired in 2023 or 2024. The group was significantly strengthened in 2022 from the sabattical visit of Ben Zwickl, who spent the fall semester at UiO. The group now holds weekly or biweekly group meetings with focus on education research. 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 continued to contribute to workshops and meetings focusing on digital teaching and assessments. The CCSE biweekly seminar series continue to focus on issues in teaching and education research. We have also continued to develop, support and expand the Learning Assistants program, which now is growing to become integrated in study programs across the university through a collaboration between KURT and the Center for Teaching and Learning (LINK) at the University of Oslo.

LEARNING MATERIALS AND APPROACHES

CCSE has continued to support and develop new learning approaches and new learning materials. The bachelor program in physics has been renewed, with new courses starting fall 2022. Tor Ole Odden has been involved in the design of tutorials used in large-classroom activities hosted in the new active learning classroom (ALC) at the Department of Physics. Simillary, Anders Malthe-Sørenssen has designed new learning activities for the ALC for third semester students. Geir Kjetil Sandve has taken the initiative to design learning activities and materials for a course in statistics that deeply integrates aspects of computing and programming. Lex Nederbragt has developed materials and methods for introducing biology students to programming, and Andreas Haraldsrud has designed digital learning path and exercises for introductory programming for chemistry students. All these activities contribute to build a significant portfolio of examples that forms the basis for successful dissemination.

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. From 2022, we have also started associated education research activities in collaboration with KURT.

COMPUTATIONAL SKILLS FOR PHD-STUDENTS

The MSCA Cofund CompSci PhD program started in 2021. The vision is to train a new generation of computationally proficient researchers to renew research and industry across Europe. In total, 31 students have been hired for the program, and we have developed two new courses in advanced computational science and in advanced machine learning and artificial intelligence. The courses have been piloted on two cohorts of CompSci students and will become part of the regular contributed curriculum for PhD students across all disciplines.

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 2022 in particular through the Innoved4TS Erasmus+ KA3 program.

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

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 goals (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 goals (2026)
The center is an internationally leading hub for research-based approaches to CSE, with a strong educational research activity and student partnership; Full integration into 6 basic and 2 advanced physics courses, 4 math courses, 4 bioscience courses, 1 course in humanities; Extensions to 3 other disciplines at UiO; Adaptation at 2 external partners. A nationally leading role in the integration of computing in teacher training.

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 needs to increase in the years to come, in particular with the advent of the new transformer-based language models, such as Bard or GPT. Students need to be able to use these technologies to become effective workers, but also to understand their advantages and disadvantages. This need was clearly stated in the ministry's white paper on AI in higher education in 2020. CCSE is in a unique position to lead the digital transformation and integration of AI technologies 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. However, developing teaching and assessment methods that teach students to use AI models in effective ways – as tools for their practice as well as for their learning – is now becoming a field that needs urgent attention.

We all need to become literate in the use of computing.

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 is taking a leading role in training these researchers and teachers.

Highlights 2022

CCSE HOSTED THREE WORKSHOPS

CCSE seized a post-pandemic opportunity to organize and host three international workshops. Having spent five years building competence and expertise, the timing was right to give something back to the community at large. We organized a workshop on pedagogies and approaches for learning assistants, a workshop on physics education research with the impact of computing as one of its pillars, and a workshop on quantum computing.

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)

BEN ZWICKL VISITED CCSE AS AN INCOMING FULLBRIGHT FELLOW

We are very excited that Ben Zwickl from Rochester Institute of Technology decided to spend his sabbatical at CCSE in the fall of 2022. His planned topic for the stay was to investigate and support students' development of experimental skills and their development of computational literacy in physics laboratory environments. He has been a great support in establishing the education research activity at CCSE, and also at addressing exciting issues in our understanding of teaching in quantum technologies.

Plans and Priorities

The main activities of the center will from 2022 and onwards follow the action plan for 2022-2026 with four main work packages.

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 2023. In 2023, particular focus will be placed on developing pedagogies and material for teaching large classes in the Active Learning Classroom (ALC) in the Department of Physics.

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. In 2023, we will develop shorter one-week workshops for the CompSci PhD students focusing on computational and machine learning methods, as well as aspects of open science and the handling of large-scale programming projects. In 2023, we will continue to develop and test new learning approaches to student innovation with student teams from the Honours bachelor program in collaboration with the new Center for Interdisciplinary Education.

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 use in the AL classroom in the physics program. These methods and approaches will then be disseminated to other programs that want to develop active learning in large-class situations in a Norwegian context.

Assessment and evaluation: The initial assessments developed for assessing computational thinking in computational essays will be distributed and used in a broader context and in more courses that employ activities that are similar to computational essays. We will also expand on the use of jupyter-notebooks in school exam situations. We will continue to help reshape student evaluations to be based on research-based principles.

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 pro-

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.	

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	D01		D01		D01		D01		D01	
A0.2	Advisory board meeting				M02				M02		
Theme 1: Educational development (L. Nederbragt)											
A1.1	Integration with experiments				M11				D11		
A1.2	Instructional methods										
A1.3	Learning material				M13		M13		M13		
A1.4	Repository						M14		D14		
A1.5	Assessments and evaluations		M15				M15				
Theme 2: Education research (T. O. Odden)											
A2.1	Computational literacy (Res)				M21				D21		
A2.2	Computing in math (PhD)				M22				D22		
A2.3	Computing in schools (PhD)			M23			D23				
A2.4	Computing in chemistry (PhD)				M24				D24		
Theme 3: Culture for teaching and learning (T. Skramstad)											
A3.1	Workshops and seminars		M31		M31		M31		M31		M31
A3.2	Summer institutes		M32				M32				M32
A3.3	Student projects										
A3.4	Teacher courses				M34		M34		M34		M34
Theme 4: Dissemination (K. Mørken)											
A4.1	TraCS PhD training								M41		
A4.2	ProFag				M42		M42		M42		M42
A4.3	Cross-sector programs						M43				D43
A4.4	Non-science applications						M44				M44

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

DO1: Annual progress report;
MO2: Advisory board meetings
M11: Implementation in physics;
D11: Learning material published
M13: Textbooks and digital materials published (phys., bio., phys.)
M14: Repository structure assessed;
D14: Repository launched
M15: Assessments in intro courses (physics, chemistry)
M21: PER handbook entry;
D21: Comp. literacy workshop in Oslo
M22: Midway eval of PhD student;
D22: PhD project finished
M23: Midway eval of PhD student;
D23: PhD project finished
M24: Midway eval of PhD student;
D24: PhD project finished
M31: Annual workshops and bi-weekly invited seminars
M32: Biennial summer institutes (bio, chem., humanities)
M34: Annual pedagogical/computing courses (phys, bio, chem, humanities)
M41: First cohort finished.
M42: Reports on yearly activities in ProFag (teacher courses)
M43: Development of cross-sector program: D43: Launch of cross-sector program
M44: Semi-integration of computing in study programs (philosophy, economics)

We will continue to develop CCSE into a meeting place for students and teachers.

fessional development and impact of computing in school education with PhD-student Henning Myhrehagen. One new post-doc focusing on Natural Language Processing will be hired in 2023 or 2024. We will host two incoming sabbatical researchers focusing on active learning methods and mathematics education research.

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 together with KURT develop courses inspired by ProFag for university teachers. However, due to the pandemic, we have postponed summer institutes. 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 2023 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 start-ups. We will in 2023 focus on disseminating results on student epistemic agency and computational essays as a driver for more diversity in assessment methods and from our experiences from the new bachelor program in physics.

Theme 1: Educational development

Leader: Lex Nederbragt

GOALS (2022-2026)

Develop evidence-based instructional methods, learning materials and assessment and evaluation practices that support the integration of computing in courses and education programs. Hereunder,
(1) Develop methods for fully integrated courses that combine theory, computing, experiments and analysis,
(2) Initiate integration of statistics, data science and AI,
(3) Extend the learning assistants programs,
(4) Develop textbooks and interactive and modularized material with integration of computational methods and programming examples;
(5) Develop and introduce standardized assessment of computational literacy, assessment methods that integrate computational methods, and evidence-based student assessment tools;
(6) Strengthen our efforts to ensure that a diverse range of students have the opportunity to develop computational literacy.

ACTIVITIES IN 2022

Developing fully integrated courses

The bachelor program in physics has been redesigned starting from the fall semester of 2022. The physics students now start with a physics course in the first semester that combines traditional theory, computing and demonstration experiments that are integrated in the learning activities. Classes are taught by a combination of short lectures and active learning classroom activities in the preliminary active learning classroom in the Physics building. Large classroom activities have been developed for students to work together on theoretical, computational and experimental problems in small groups. The new curriculum and teaching practice were developed and introduced in 2022 and subsequently adjusted courses will be introduced in the spring 2023. Initial student evaluations indicate that students, as expected from education research evidence, find the new learning approaches challenging, but that it changes their learning habits for future semesters.

Integration in statistics courses

Geir Kjetil Sandve has taken the initiative to develop a new course in statistics for computer scientists, which closely integrates the use of computational methods to build fundamental concepts, motivate and understanding statistics (see box).

Textbooks

The center has continued to develop high quality textbooks, interactive learning material and examples and exercises for courses. The textbook in Elementary electromagnetism using Python was used as the main textbook in 2022 and is now accompanied by a full flipped classroom course with small video lectures interspaced by multiple choice and discussion questions and sets of exercises that combines conceptual, theoretical and computational approaches. A textbook on Thermal and statistical physics using Python is under preparation for publication with Springer and was used as the main textbook in 2022.

Electronic learning material

Several courses with integrated programming have developed digital learning progressions. The learning materials for Computational methods in chemistry was developed and used in 2022 (see box). Similarly, learning materials for Algorithmic thinking for the humanities and Data-driven projects for honours students are published as open access Jupyter books and were used as the main learning materials in 2022.

Learning assistants

The use of learning assistants – students who lead learning activities in smaller groups – have been gradually strengthened and broadened at the University of Oslo and is actively being extended to other institutions nationally and internationally. CCSE is gradually becoming a national hub for the development of learning assistant methods in Norway, and we are contributing to build a Nordic and European learning assistants activity.

Student participation

Students play an important role in the development of learning material. CCSE financed 31 summer student scholarships in 2022. 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 2022, these resources were also used to develop new learning material for the new first year in the physics program.

PILOTING AND NEW COURSE IN STATISTICS FOR STUDENTS WITH PROGRAMMING BACKGROUNDS

The derivation of analytical formulas has been central to probability theory and statistics since their inception, and still is. It allows to compute the exact probabilities of outcomes for a range of common processes, including many test statistic distributions in hypothesis testing. However, writing computer programs to directly simulate the underlying processes provides an alternative route. This route may be seen as lying closer to the fundamental underlying concepts, and could thus potentially allow students to more easily construct viable cognitive models for working with probabilities and statistical inference. This could be particularly advantageous for students at IFI, who often have limited background in mathematics, while developing a strong intuition on programming and computational processes through their studies. CCSE member Geir Kjetil Sandve has together with postdoc Milena Pavlovic at Department of Informatics, Tor Ole Odden at CCSE and Professor Geir Storvik at Department of Mathematics discussed and developed pilot material for what could become a new course and a new way of teaching probability and statistics to informatics students. They have through 2022 solicited feedback from peers and piloted selected lectures as an informal offering to master students.

PLANS AND PRIORITIES FOR 2023

- Extend support to develop learning approaches and activities to be used in the large active learning classrooms with experimental components in collaboration with visiting international experts
- Extend use of Jupyter books and Jupyter notebooks to develop interactive learning materials that combine videos, quizzes, examples and runnable computer code.
- Extend the learning assistants program beyond the natural sciences in collaboration with the university-wide center for teaching and learning
- Engage students in testing and validation of learning materials

ACTION PLAN

Action	Description	2022		2023		2024		2025		2026	
A1.1	Integration with experiments				M11				D11		
A1.2	Instructional methods										
A1.3	Learning material				M13		M13		M13		
A1.4	Repository						M14		D14		
A1.5	Assessments and evaluations		M15				M15				

M11: Implementation in physics;
D11: Learning material published
M13: Textbooks and digital materials published (phys., bio., phys.)
M14: Repository structure assessed;
D14: Repository launched
M15: Assessments in intro courses (physics, chemistry)

Comments

A1.1: Experimental integration piloted in Fys1100, Fys1120 and Fys2160 and will be evaluated and updated in 2023 in collaboration with international experts.
A1.2: Methods for large active learning classrooms developed and tested.
A1.3: Textbook development is progressing in Fys2160 – Thermal Physics., Fys1120 – Electromagnetism, Programming for chemistry as well as in statistics for computer scientists. New texts and group-based teaching approaches in computational physics and machine learning under development for the CompSci PhD-students.
A1.4: New material is added to the open international repository at compadre.org
A1.5: Assessments for computational literacy have been developed for computational essays and used across two institutions in Norway and the US.

LEARNING CHEMISTRY THROUGH PROGRAMMING

For several years, CCSE has contributed funds to summer students to develop teaching resources in various subjects at several different institutes. In the summer of 2022, four diligent chemistry students will sit at the Hylleraas center and work on chemistry-oriented programming tasks.

Here, creative work is done with everything from machine learning in the lab to visualization of atomic orbitals in VR. The students work on concrete tasks, but have enough freedom to use their own creativity and knowledge of how they and others learn best when working with the resources.

The schemes are based on the Python modules B-service, BubbleBox and BraketLab, which have been developed by Audun Skau Hansen at the Department of Chemistry. He organizes the work with the summer students, and works side by side with them to create holistic and pedagogically well-thought-out resources.

"We want to create a platform where students can have social learning experiences in microscopic reality. With interactivity, programming and VR, we make a complicated world perceptible and alive, and in this way, we create coherence between the

Fig. 1: There is no summer holiday at the Hylleraas centre. Four creative and committed students (back from left Ayla Coder, Elias Dalan, Hanan Gharayba and Andreas Alstad) are working to make the teaching of the chemistry students even better. At the very back sits first lecturer Audun Skau Hansen (back).

Fig. 2: With programming and the BraketLab module, students can easily visualize hybridization of atomic orbitals.

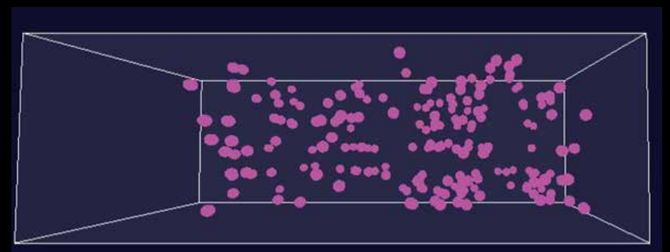


Fig. 3: The BubbleBox module supports the fact that everything we work with are models. A bubble is not an atom, but can be a model that represents part of the atom's properties. Students can build, simulate and visualize various systems directly in the notebook.

many different chemistry subjects," says Audun.

He goes on to point out that the goal of the students' summer job is "to create a learning environment where you can think a little outside the box. We try things out, and the path is made as we go. The students test out, get new ideas and test out again."

A large part of the project this summer has revolved around creating a machine learning module that uses gaussia n process regression (GPR) to draw inferences from composite experimental data.

"I've built a machine learning module with GPR," says Elias. "In addition, I have made notebooks that explain key concepts in quantum mechanics".

He has created Jupyter notebooks with a view to building bridges between the mathematics chemistry students know and the mathematics used in quantum chemistry, with programming as a link. In the notebooks, students can explore basic quantum chemical principles, with visual aids along the way.

"We want to offer specifics to visualize otherwise abstract things", explains Audun. Elias adds that "The modeling is very nice. You never get to see atoms and molecules in practice. Programming helps us build and visualize an invisible world. You can use formulas and theories to build models that make sense."

Active learning methods are central to the students' work. "I try to avoid SOPs (Standard Operating Procedures – detailed recipes for carrying out lab procedures) to create more interaction and active thinking in the learning process," Ayla says of the resources she has created.

She has concentrated on developing resources that can be used in laboratory teaching in analytical chemistry II. These resources are based on the GPR module that Elias has created.

Handling different types of experimental data is strong in chemistry, and it is not only Ayla who is working on this this summer. Andreas works under the guidance of Sissel Jørgensen with the analysis of XRD files (files from X-ray crystallography). "I'm trying to create a visual junction between nano-effects and spectroscopy," he says.

This is again an example of how programming can be used to visualize and explain connections between micro and macro levels.

Hanan is also concerned with connections between the observable macro level and the subtle micro level that no one has really seen. She has used the BubbleBox module to visualize and explore connections between micro and macro levels in thermodynamics. With BubbleBox, students can build models that can represent atoms or molecules.

A long-term goal of creating interdisciplinary, student-active resources is to create an interactive network for learning where the focus shifts from linear learning to exploration and interdisciplinary links. "We're well underway," Audun smiles enthusiastically.

The students all agree that they have had a lot of fun with the summer job.

"It's been a lot of fun, then!", points out Ayla. "Audun has shown us how code can be used creatively. Besides, I have also learned a lot. I learn an incredible amount from trying to teach and convey to others. I try to get the students to do something active and discuss with others or oneself".

At the very end, Elias exclaims: "If working life is similar, it's something to look forward to!"

THE LEARNING ASSISTANT PROGRAM AT UIO

Daring students to pose rich questions, engage in active learning, think computationally, and more – we reach for the best possible standards for our teaching.

Although the university has traditionally been envisioned as a place where crowds of students learn by taking notes while listening to a professor lecturing, research has shown that students learn more effectively through collaboration, discussion, and working on exercises.

In the mathematics and science courses at UiO, these activities often take place in group sessions, weekly seminars where students are given the opportunity to solve problems and discuss concepts previously covered in their lectures. At the heart of these seminars, you'll find the learning assistants– experienced students who take a teaching role in direct, often one-on-one, interaction with more junior students.

Fig. 4: From the left: Audun Skau Hansen, Lex Nederbragt, Christin Borge. (Photo: Ragnhild Olsby)

While group sessions have been an integral part of teaching at the University of Oslo for many years, over the last five years that the Faculty of Mathematics and Natural Sciences has been systematically developing a Learning Assistant (LA) program to support our learning assistants and provide them with essential training in top-quality research-based teaching methods.

The LA program was originally introduced to the faculty in 2018 by Tor Ole Odden, inspired by similar work developed by the University of Boulder in Colorado (USA). Initially brought to life at the Department of Physics, the program soon branched into Mathematics, Chemistry, Biosciences and Pharmacy. As of 2023, several dozen learning assistants have been through the workshops, and participation is at an all-time high.

Fig. 5: The students Frida Marie Engøy Westby and Even Werner (Photo: Ragnhild Olsby)

Throughout this period, the LA program at the University of Oslo has increasingly been used to improve student participation, variety in teaching methods, student-tutor interaction and even the course content itself, ultimately enhancing the learning outcome across disciplines and student groups.

The programme is currently being taught by a cross-faculty team with a passion for excellent science education, consisting of Tor Ole Odden (physics), Christin Borge (mathematics), Lex Nederbragt (biosciences) and Audun Skau Hansen (chemistry).

While the original LA-program has a transformative and holistic focus on higher education, the local adaptation has been focused on research-based teaching techniques. This includes the value of an engaging and inclusive learning environment, student-active learning, diversity in teaching methods, bite-size portions of learning theory, observation, computational thinking and sense-making. At its core, the training is designed to put the student into focus and allow for learning assistants to develop confidence in their proficiency as teachers.

The experience gained from extending the model to Scandinavian higher education can also provide valuable insight into how it might be adapted to other European universities, so the work has been carefully documented and evaluated. Initial results from research on the first three semesters of the program have been submitted to the European Journal for Physics for publication under the title "Implementing the Learning Assistant Model in European Higher Education", authored by Tor Ole Odden, Anders Lauvland, Maria Vetleseter Bøe and Ellen Karoline Henriksen. One central effect of the program, according to the authors, is that the learning assistants become better versed in active learning pedagogy as a result of their participation.

Participating in the LA-program

Each semester, participating learning assistants take part in six interactive workshops, where they discuss and analyze essential skills and techniques for group teaching.

The participants at the workshops are given tasks to try out in their own teaching, like giving minilectures, observation of the learning situations and questioning strategies. The workshops thus provide time and space for getting familiar with topics of higher learning, and the opportunity to collaborate with other learning assistants across the faculty.

Amongst the participants of autumn 2022 we find Frida Marie Engøy Westby and Even Werner, who both agree that the work as learning assistants can be challenging, and who value the opportunity to improve their teaching through the workshops.

"The seminars have helped me explain different teaching situations I have experienced", explains Frida. "They have given me a framework for reflecting around my own thoughts and pass them on to my colleagues. To me, they have been very important to gather an "educational toolbox" for my work. The seminars have made me sturdier as a Learning Assistant, and I believe it enhances everyone´s teaching for the better."

Even agrees, adding that:

"I have learned many different strategies and methods that I have incorporated into my own classes. The seminars really require us to evaluate ourselves and our work, which is great for further improvement.

We have also learned a lot about the different strategies that work for different types of subjects due to the many departments involved with the seminars. All in all, I think it have made me a better tutor".

Theme 2: Education research

Leader: Tor Ole Odden

GOAL (2022-2026)

Develop research-based methods and approaches for the integration of computing in a disciplinary context. Hereunder,
(1) extend studies of computational literacy across science disciplines,
(2) initiate studies of the impact of computing in mathematics in collaboration with Elise Lockwood at Oregon State University,
(3) initiate studies of teacher training and professional development and impact of computing in school education;
(4) establish education research studies of the impact of computing in chemistry, and
(5) extend the research portfolio through external funding to develop a foundation for computational science education research.

ACTIVITIES IN 2022

The foundations of computational literacy

CCSE associate professor Tor Ole Odden and adjunct professor Danny Caballero, who has his main position at Michigan State University, was invited to write the chapter on computational literacy in the Handbook of Physics Education Research by AIP Publishing. The book and the chapter will be published in 2023. The chapter collects and synthesizes most of the available research on computation in physics education and therefore serves as an overview of the published literature on the subject up to about 2021. The focus in the chapter has been on synthesizing and situating the research into different theoretical strands, which we hope will help bring some clarity to the various perspectives in the field. The educational program at UiO is featured as one of the three case studies of computational literacy in physics education, as an example of a curriculum that has a wholistic focus on producing computationally literate physics students.

Building an education research group for the second center period

Several new research directions were initiated in 2022, each headed by a PhD-student or a researcher. We hire a PhD-student, Karl Henrik Fredly, to further strengthen our activity on computational literacy. We will focus on addressing the impact and use of computing on teacher training and professional development in collaboration with the school laboratory at the Department of Physics. In 2022, PhD-student Henning Myhrehagen was hired to start these studies. For several years, we have introduced computing into the introductory courses in chemistry and Andreas Haraldsrud will develop his PhD-project in this direction. We are addressing the assessment of computational literacy and computational skills in physics in the externally funded S-Assess prosject, which is driven by researcher Dr. Hannah Sabo. In addition, we will be starting studies of the impact of computing in introductory mathematics courses from 2023 in collaboration with Jan-Fredrik Olsen at Lund University and Professor Elise Lockwood at Oregon State University who will resume her adjuct professorship at CCSE from 2023. The research group now has regular research group meetings and a visiting scientist program and provides an excellent foundation for developing an improved understanding of computational literacy and the impact of computational approaches across disciplines from 2023 to 2026. The high international standing of the education research activity was demonstrated by the highly successful OPSI workshop in June 2022 (see box).

Sabbatical research visit from Ben Zwickl

We are very excited that Ben Zwickl from Rochester Institute of Technology decided to spend his sabbatical at CCSE in the fall of 2022 as a Fulbright Fellow. His planned topic for the stay was to investigate and support students' development of experimental skills and their development of computational literacy in physics laboratory environments. He has been a great support in establishing the education research activity at CCSE, and also at addressing exciting issues in our understanding of teaching in quantum technologies.

PLANS AND PRIORITIES FOR 2023

- Initiate studies of the impact of computational approaches in mathematics courses in collaboration with Lund University and Oregon State University
- Extend international research collaborations through incoming and outgoing research visits following the success of the OPSI workshop in 2022
- Extend previous studies using Natural Language Processing methods in collaboration with international partners and recruit a PhD-student or a post-doc to support this research activity
- Develop and submit research grant proposals sketching new direction of research extending beyond the remaining four-year period of the center

ACTION PLAN

Action	Description	2022	2023	2024	2025	2026
A2.1	Computational literacy (Res)		M21		D21	
A2.2	Computing in math (PhD)		M22		D22	
A2.3	Computing in schools (PhD)		M23	D23		
A2.4	Computing in chemistry (PhD)		M24		D24	

M21: PER handbook entry;
D21: Comp. literacy workshop in Oslo
M22: Midway eval of PhD student;
D22: PhD project finished
M23: Midway eval of PhD student;
D23: PhD project finished
M24: Midway eval of PhD student;
D24: PhD project finished

Comments

A2.1: Published high-impact book chapter on computational literacy and hired a PhD-student
A2.2: Activity starting in 2023, but planned in 2022.
A2.3: Project started with new PhD student in 2021/2022.
A2.4: Project ongoing with PhD-student Andreas Haraldsrud.

OSLO PER SUMMER INSTITUE

This summer we hosted the Oslo PER Summer Institute (OPSI) conference to connect with Physics and STEM education researchers from the University of Oslo, Michigan State University, Oregon State University, University of Colorado - Boulder, and other Norwegian and Scandinavian Universities.

Goals for the Summer Institute

We had several goals for this summer institute:

1. First and foremost, we hoped to facilitate communication, connection, and collaboration between the different groups who was represented at the workshop. We are very excited that so many visitors participated from the PER groups at Oregon State University, Michigan State University, University of Colorado-Boulder, University of Oslo, the Norwegian University of Science and Technology, OsloMet, University of Helsinki and University of Jyväskylä!
2. However, we had a more specific goal with this workshop, which was to help our early-career researchers (graduate students, postdocs, undergraduates, and early-career faculty) help recover some of the travel and networking opportunities that were lost during the pandemic. For this reason, we built the workshop as follows:
   - ***Plenary sessions:*** An introduction to some of the work from four of the main attending PER groups (UiO, MSU, CU, and OSU)
   - ***Discussion sessions:*** A chance to discuss the plenary content with the speakers, and/or learn about other work going on in each respective group
   - ***Workshop strands:*** A chance to learn new skills in research and data analysis, writing, pedagogy, or professional skills
   - ***Long lunches, open collaboration time, and communal dinners:*** These will give you a chance to strike up conversations with folks from outside your group and build your professional network
   - ***Lightning talks and poster sessions:*** These will give you a chance to present some of your own work to your peers and fellow attendees
3. Of especial note here are the "lightning talks", short talks (up to 8 minutes in length) where early-career researchers, such as PhD students, postdocs, undergraduates or early-career faculty, presented a snapshot of their work and interests.

The overall purpose of this conference was to see what other universities were researching in terms of Physics and Stem Education, while also giving graduate and undergraduate researchers the opportunity to network, and discuss their research interests and ideas after the Pandemic.

This conference included discussions, workshops, lightening and plenary talks, and a poster session, as well as trips to Museums and chances to explore Oslo.

Each day had a specific theme, with a keynote talk on that topic from one of the research groups:

Fig. 6: Group photo (Photo: Tone Skramstad)

Monday:	Computation (UiO Keynote)
Tuesday:	Informal physics education (MSU Keynote)
Wednesday:	Physics education research beyond cognitivist theories of learning
Thursday:	Laboratory instruction (CU Keynote)
Friday:	Upper-division physics education (OSU Keynote)

The workshops were led by Tor Ole Odden, Danny Caballero and Rachel Henderson, Elizabeth Gire, Greg Mulder, Heather Lewandowski and Anders Lauland, and included topics in:

- Machine Learning in PER,
- Writing,
- Physical Computing for Beginning College Students,
- Professional Skills,
- Pedagogy in Upper-Division Courses Based on Paradigms, and
- Outreach with Block-Based Programmable Drones.

Lightening Talk Presenters and Topics:

- Victoria Borish, CU - Seeing Quantum Mechanics: The Role of Quantum Experiments
- Sarah Castle, MSU - Exploring the Impact of Computing on Students' Mathematical Creativity in Linear Algebra
- Giaco Corsiglia, CU - Is Quantum Physics Intuitive? A Case Study with Students in Upper Division Quantum Mechanics
- Tom Finzell, MSU - Sense-Making Tools in Computational Data Analysis
- Paul Hamerski, MSU - Computation-Integrated Education Research from Students' Perspectives
- KC Walsh, OSU - Searching for the Interconnected Web of Learning
- Daryl McPadden, MSU - Planning for in Participants' Varying Needs and Abilities in Qualitative Research
- Hannah Sabo, UiO - Mind the Gap: Challenges of Training Pre-Service Teachings in Computational Thinking

The poster session provided researchers to share project ideas and discuss education research with local and international education researchers in CCSEs facilities.

Participants had the opportunity to visit the Open Air Museum and Norwegian Folk History or the Norwegian Museum of Cultural History.

Theme 3:
Culture for teaching and learning

Leader: Cathrine Wahlstrøm Tellefsen/Tone Skramstad

GOAL (2022-2026)

Develop a culture for teaching and learning across the science departments. Hereunder,
(1) organize biannual workshops for teachers and LAs;
(2) organize education seminars at all involved departments;
(3) facilitate teaching teams in large courses,
(4) continue and extend student educational development project,
(5) continue and extend the teacher training initiated by KURT including Summer Institutes for both internal and external participants.

ACTIVITIES IN 2022

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 2022 we have focused on bringing teachers back into physical seminars focusing on both insights from education research and on sharing experiences from teaching practices. 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 been redesigned 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 have been developed for the new physics program, one of which will have a significant computational aspect: An introductory course in mechanics in which Tor Ole Odden has played a key role. The new program started 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 2022 we arranged regular seminars with invited national and international speakers that were open for all teaching faculty and students. In addition, we organized a network for introductory programming teachers to share experiences between teachers who are introducing programming to students in various education programs (see Box). In addition, we organize a yearly Christmas seminar focusing on Computing in Science Education, which in 2022 again was physical, for the first time since 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 established a Center for Teaching and Learning in Science (KURT). KURT 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 and is an integral part of the sustainability strategy for CCSE. 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.

PLANS AND PRIORITIES FOR 2023

- Continue seminar series for teaching staff
- Collaborate with teachers that use and plan to use active learning classrooms
- Continue to provide and improve teaching workshops for teaching faculty and teaching assistants.

NETWORK FOR INTRODUCTORY PROGRAMMING TEACHERS

Courses in introductory programming are among the ones that have the most distributed offering across UiO - being taught at several departments at the MatNat Faculty, and now also increasingly at other Faculties like the Faculty of Humanities and the Faculty of Law. To facilitate sharing of experiences we established a network of introductory programming teachers across departments under the CCSE umbrella in autumn 2021. This is set up as a long-term, low-intensity meeting point, where teachers involved in programming courses can meet consistently once per semester to keep communication lines open and gradually build common understanding on programming didactics. Meetings have both an open, informal component and a thematic discussion on a particular topic of broad relevance. The network had one meeting in spring 2022 where we discussed which best practices for programmering we lean on in our different courses,

Photo: Lin Stensrud

and one meeting in autumn 2022 where we discussed which development environments were used in different courses (editors, IDEs, virtual machines and more). Both meetings had good attendance and lively discussions, and we plan to continue in the same way throughout 2023.

ACTION PLAN

Action	Description	2022	2023	2024	2025	2026
A3.1	Workshops and seminars	M31	M31	M31	M31	M31
A3.2	Summer institutes	M32		M32		M32
A3.3	Student projects					
A3.4	Teacher courses		M34	M34	M34	M34

M31: Annual workshops and bi-weekly invited seminars
M32: Biennial summer institutes (bio, chem., humanities)
M34: Annual pedagogical/computing courses (phys, bio, chem, humanities)

Comments

A3.1: Workshops and seminars are listed in the tables at the end of the report.
A3.2: Summer institutes are planned for the period from 2023-2026, but not in 2022.
A3.3: Student projects are listed in the tables at the end of the report.
A3.4: Teacher courses are listed in the tables at the end of the report.

Theme 4: Dissemination

Leader: Knut Mørken

GOALS (2022-2026)
Develop and apply a research-based approach to dissemination locally, nationally and internationally. Hereunder, we aim 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.

ACTIVITIES IN 2022

Partnership through Circle-U

CCSE was in 2022 part of an Erasmus+ KA3 program (Innoved4TS) that focuses on mapping out training in transferrable skills across the Circle-U university network. CCSE was selected as the flagship project from the University of Oslo. In 2022, CCSE organized a two-day workshop for all Circle-U institutions, which resulted in the final recommendations from the project to university leadership across all Circle-U institutions. One of the recommendations of the project was to integrate computing in study programs and courses across the Circle-U network. These aspects were also integrated in the follow-up application from Circle-U to the second phase of the European Universities EU program.

International dissemination

CCSE has an INTPART on partnership for computing in science education with Michigan State University, University of Colorado – Boulder, and Oregon State University. In 2022 this partnership was used for three major activities, the OPSI Workshop in Oslo in June, the Nordic Learning Assistant Workshop in Oslo in June, and the Gemini Quantum Computing Workshop in Oslo in September.

Cross-sector dissemination and innovation

CCSE initiated a cross-sector dissemination project in collaboration with Young Entrepreneurship Oslo and the TechWell Gemini center for humane technology connecting the University of Oslo and SINTEF. The project introduced students to innovation practices and motivated them the develop entrepreneurial solutions to address societal problems by applying computational and entrepreneurial skills (see box).

Teacher education

In order to disseminate our practices widely, we work to disseminate practices to schools and school teachers. In particular, we are working to establish sustainable dissemination practices to reach the large number of teachers that need to update their computational skills and didactic competence to integrate the use of computing across school subjects (see box).

PLANS AND PRIORITIES FOR 2023

- Confirm CCSE's position as a national and international hub for the integration of computing in education through national and international partnerships
- Continue extension beyond the sciences at UiO and through Circle-U
- Contribute as partner in EU programs to disseminate practices widely across Europe

SUMMER STUDENTS DEVELOP CALM TECHNOLOGIES

How can we create technology that improve our lives, rather than drain them? In collaboration with Young Entrepreneurship Oslo, CCSE introduced 12 students to the concept of calm technologies and encouraged them to develop their own technological solutions to address a growing concern – how can we take back our attention from intrusive algorithms?

The students were introduced to an innovation methods based on design-thinking developed Young Entrepreneurship Oslo. Then, they used that model to address a societal problem that concerns experienced entreprenuer Tobias Dahl from SINTEF and the TechWell Gemini center – the challenge of interruptive technologies. The students developed their own ideas for technological solutions by applying the method and through discussions with selected experts from academia and industry. Instead of an exam, the students pitched their solutions to a panel of innovation experts. Two projects were selected – providing students with funding and support to consolidate and develop their ideas at the innovation hub StartupLab.

Fig. 8: Students at StartupLab. From the left: Aslak Hellevik, Line Horgen Thorstad, and Yasmine Kroknes-Gomez. (Photo: Magali Courtade)

The student teams have continued to develop their ideas and will continue to implement the ideas into full products in 2023 – applying their computational skills to adress real-world problems.

ACTION PLAN

Action	Description	2022	2023	2024	2025	2026
A4.1	TraCS PhD training				M41	
A4.2	ProFag		M42	M42	M42	M42
A4.3	Cross-sector programs			M43		D43
A4.4	Non-science applications			M44		M44

M41: First cohort finished.
M42: Reports on yearly activities in ProFag (teacher courses)
M43: Development of cross-sector program:
D43: Launch of cross-sector program
M44: Semi-integration of computing in study programs (philosophy, economics)

Comments

A4.1: The first cohort of CompSci PhD-students will enter secondments at cross-sector partners in 2023, forming a basis for collaborations with partners and stakeholders from other sectors
A4.2: We will continue dissemination through our professional development programs for teachers
A4.3: Cross-sector collaborations will be strengthened through entrepreneurship programs for students
A4.4: Extension to non-science subjects will be pursued partnership through summer student projects and student entrepreneurship opportunities.

THE DIDACTICS OF PROGRAMMING FOR SCHOOL TEACHERS

How can students who are going to become teachers learn to teach programming in the subjects? Today, programming didactics is not integrated into teacher training. We see a need to meet teacher students with a low-threshold offer where programming didactics is central.

With the national subject renewal (LK20), programming and algorithmic thinking entered the curricula for pupils in both primary and upper secondary schools. From autumn 2020, teachers who teach mathematics, science, arts and crafts and music, as well as the science program sub-jects, should therefore be able to teach both in and with programming.

Professional development for teachers in science programming

Through Decentralized Competence Development (DeKomp) and in collaboration with the Norwegian Education Agency in Oslo and Viken County, we at the Competence Center for Teaching Science and Technology (KURT) and the Center for Computational Oriented Education (CCSE) at the University of Oslo (UiO) have offered continuing education courses for teachers in science programming since 2018.

Over the past 5 years, several hundred teachers have followed the course package ProFag – Programming for the the subjects, and many teachers have eventually managed to integrate programming and algorithmic thinking into their science teaching.

At ProFag, we attach great importance to the fact that programming gives us the opportunity to teach, explore and learn science in a new way. We also show how we can use programming for deep learning and differentiation in the classroom.

Fig. 7: The picture shows teacher students having a group discussion.

What about the science teacher students?

The teacher's program in science at UiO is a 5-year integrated master's education where students take discipline subjects such as mathematics, chemistry or physics at the MN faculty, while they take professional subjects at the UV faculty. In the professional subjects, students are trained in both pedagogy, subject didactics and practice.

As a supplier of science teachers to the Norwegian school, we must ensure that the students are given the best conditions to meet the requirements of the current curricula. At the MN faculty, study programs in mathematics and physics have integrated programming and computing since 2003, and the other study programs followed suit from 2017. Our teacher students will therefore have good knowledge and skills in programming in the individual disciplines.

The challenge has nevertheless been to give the students training in integrating programming into their own teaching practice.

Surveying the teacher students

In the spring of 2022, we therefore carried out a survey among all teacher students in the field of science, regardless of which semester they were in. Here we asked, among other things, about:

- the extent to which they have had programming in their disciplinary subjects,
- whether they know how programming is integrated into the new curricula after 2020,
- how well prepared they feel they are to teach programming in school, and
- what will be the biggest challenges now that they have to teach programming.

All the students answered that they have had programming in the discipline subjects, but they feel that there is a large variation between the subjects in how well the programming is integrated into the subject. Some students also answer that they have programmed very little. When asked how well they know the introduction of programming in the new curricula, only 8% answer that they know this well.

Furthermore, the students answered four statements related to how safe and how well prepared they feel they are for what awaits them at school.

Although some students are early in their studies and the answers may be influenced by the fact that they feel unprepared for teaching in general, we see a tendency for the students to believe that they do not receive the programming didactic training they need to be able to use program-ming in an appropriate way in their own instruction.

Only 8% respond that they are well prepared to teach science programming, while 46% respond that they are not sufficiently prepared:

Claim	Strongly agree
I feel well prepared to teach science programming in school	8
I feel confident in programming	12
I don't feel sufficiently prepared to teach science programming in a good way	46
I know far too little programming to meet the requirements of the professional renewal	22

When we ask what challenges they think they will encounter in the classroom when they have to teach programming, it emerges that they particularly see challenges related to how they will teach - i.e. the didactics of programming:

"Didactic! I have learned very little about how to present this to the students in a good way, and my

teaching of programming so far has largely consisted of trial and error."

"Knowing how I can implement it in teaching in a good way. Don't know how to do teaching with programming."

"That I haven't received a good enough education in teaching programming in a good way."

As of today, programming didactics is not integrated into the professional subjects on the teacher's program in science, and there is no focus on this in the disciplinary subjects either. We at KURT and CCSE therefore see a need to meet the students with a low-threshold offer where pro-gramming didactics is central.

Teacher students at night-class

Based on the experiences we already had from ProFag, we knew very well what the teachers' needs are in the school and what the teacher students will face the day they graduate. We were therefore able to adapt the content of ProFag to the teacher students.

In the autumn of 2022, we set up a course series of four seminars that ran over four months with approximately one month between each session. The seminars took place in the evening. Before the seminar we served pizza. The students were therefore satisfied and motivated for two hours of discussions, reflections, programming, learning and exploration. More than 20 students, divided into different cohorts, voluntarily participated in this offer.

After the last day of the seminar, we carried out an evaluation. Although many students wished that this skills development was an integral part of the course, all were very satisfied with the course.

The seminar series has given the students a better understanding of how and why programming can both change the science subjects and contribute to in-depth learning. In particular, they ap-preciate that the seminars have given them more tools and methods for how to teach program-ming in school:

"I have learned how to think of programming as a natural part of mathematics, physics and sci-ence and not as an outside thing that students 'have' to go through. I have also learned about many good methods and strategies for teaching programming."

"I can directly implement the methods and strategies we have gone through and use them in the classroom. I can also use the resources to which we have been given access to create my own teaching plan."

"The scheme inspired me about how a programming session should be carried out."

"Yes, I came to believe that with effort on the part of the teacher, programming is something that can actually be done, where deep learning can happen."

"Incredibly pleasant, simple and nice course. Nice mix of both lectures and discussion in plena-ry and group. Learns good methods for varying teaching methods in programming"

In the long term, however, the goal must be for the teacher students to receive this training as an integrated part of their education.

CCSE Center for Computing in Science Education

University of South-Eastern Norway

Report from the CSE activity at USN

Ole Marius Lysaker and Randi T. Holta, USN

The previous years have been strongly impacted by the pandemic with closed-down campuses, but from 2022 campuses have been open and teaching could resume to its original forms.

Python is the preferred tool in the sciences at USN/TNM. In the first semester, students get a general introduction to programming through the subject "Programming for computing". In the second semester they follow Mathematics 1 and Physics, where Python now forms an integral part of the subjects. This is followed by Mathematics 2 in the third semester and statistics in the fourth semester.

In the year 2022, USN/TNM has carried out an investment in increasing the employees' competence in Python programming. The purpose of the initiative is to support employees in including programming and algorithmic thinking in subjects beyond the science subjects. Faculty has been encouraged and supported to participate in the course: PY1000 - Python programming for science. For autumn 2021 – spring 2022 and autumn 2022 – spring 2023, around 20 employees were registered in these courses. The participating faculty have made a significant personal effort in this work. As an indication: USN's norm for study effort is 27 hours per credit. Subjects comprising 7.5 credits then give $27 \times 7.5 = 202$ hours of work effort per participant.

- PY1000 - Python programming for science. The course is an intensive course consisting of several intensive periods where they all have to attend over zoom, 15 credits. Autumn 2021-spring 2022 and autumn 2022-spring 2023. Target group: Science teachers in upper secondary schools and internal competence enhancement for USN employees.
- PY1010 - Python programming for computing. The course is an intensive course consisting of several intensive periods where they all have to attend over zoom, 5 credits. Target group: maritime sector. The subject is financed by HK-Dir. The course was run once in spring 2022, 100 participants.

In the autumn of 2022, a pilot was carried out with a separate mandatory meeting for all student assistants associated with the subject "Python for computing", Campus Porsgrunn. The meeting had both academic and social content. We have received very positive feedback on the initiative and want to continue this next year. Python is now the preferred programming language in science. In this connection, a compendium of tasks has been prepared for the subject VE2010 Mathematics 3.

Furthermore, employees from USN have been represented at a number of CCSE events throughout the year:

- Nordic Regional Learning Assistant Workshop, 9–10 June
- Oslo PER Summer Institute, 13–17 June
- CCSE's Christmas seminar on 14 December

Organization and management

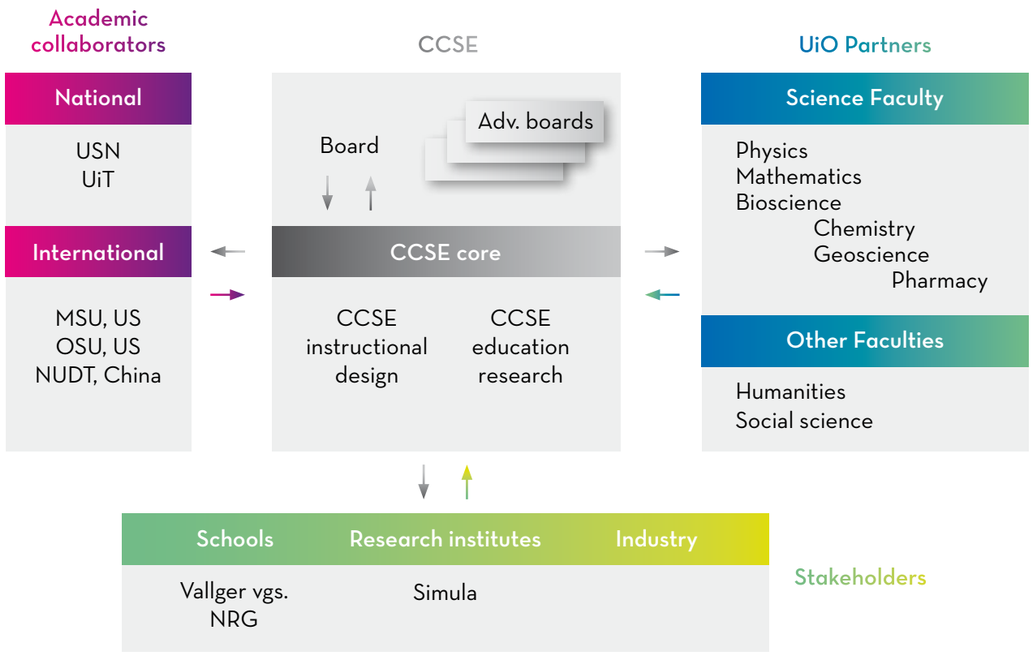
CCSE is directed by Professor Anders Malthe-Sørensen and supported by an administrative leader, Tone Skramstad. The director is supported by a working group, with an advisory and coordinating function, consisting of the five work-package leaders, the administrative head, director of studies at the Faculty,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

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 was 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 promote active learning at the Faculty. She was 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 (2018–2020) 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.

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 researcher 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.

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.

KARL HENRIK FREDLY
PhD-student
Karl Henrik is a PhD-student from 2022, addressing computational literacy. He has a master degree in Computational Science focusing on education research and computational literacy.

HENNING MYHREHAGEN
PhD-student
Henning is a PhD-student from 2022, addressing the impact of computational methods and programming on school teacher education programs.

Other scientific staff

ANDREAS HARALDSRUD
Senior lecturer / PhD candidate
Andreas has a background as a teacher at Valler high school where he has developed the course “Modellering og programmering X”. 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, as well as several textbooks in chemistry and programming. He is also pursuing a PhD addressing the impact of computing on students understanding of chemistry.

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.

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

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	Senior lecturer	Biosciences, UiO
Lex Nederbragt	WP leader, 20%	Senior lecturer	Biosciences, 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
Karl Henrik Fredly	PhD-student		CCSE
Hannah Sabo	Education research	Post-doc	CCSE
Henning V. Myhrehagen	PhD-student		KURT, CCSE
Andreas D. Haraldsrud	Educational devel/research	Lecturer	KURT, 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

Name *(continued)*	Function	Position	Unit
Student representatives			
Gulla Torvund	Student representative		UiO
Karl Henrik Fredly	Student representative		UiO
Håkon Olav Torvik	Student representative		UiO
Mads Saua Balto	Student representative		UiO
Sander Svartbekk	Student representative, CCSE board		UiO
Anne-Sophie Maria Reber	Substitute student representative, CCSE board		UiO

External projects

Granting body	Project title	Project period	Funding	PI/partners
Intpart/NRC	US-Norwegian collaboration on fluid-consuming processes	2017–2022	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 2022

Budget and Expenditures 2022

NOK Norwegian kroner	Budget 2022 HK-dir	Actual 2022 HK-dir	Actual 2022 UiO	Total
Personnel and indirect costs	4 140 879	2 611 288	3 685 351	6 296 639
Purchase of services	600 000	600 000		
Equipment	200 000	200 000		
Other operating expenses	165 400	851 323	2 135 004	2 986 327
Student projects			1 000 643	1 000 643
SUM	**5 106 279**	**4 262 611**	**6 820 998**	**10 283 609**

List of products

Visitors

Who	Topic	When
Amanda Bowerman, MSU	Participant Oslo PER Summer Institue, visiting researcher	May 16-July 30 2022
Sienna Frost, MSU	Participant Oslo PER Summer Institue, visiting researcher	May 16-July 30 2022
Marcos Caballero, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Jonathan W Alfson, Oregan State University (OSU), USA	Participant Oslo PER Summer Institue	June 13-17 2022
Trine Højberg Andersen, NTNU	Participant Oslo PER Summer Institue	June 13-17 2022
Akash Ram Bedi, Michigan State University (MSU), USA	Participant Oslo PER Summer Institue	June 13-17 2022
Mike Bennett, University of Boulder Colorado (UCB), USA	Participant Oslo PER Summer Institue	June 13-17 2022
Emily Bolger MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Tori Borish, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Julie Butler, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Sarah Castle, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Eleanor Close, Texas State University (TSU), USA	Participant Oslo PER Summer Institue	June 13-17 2022
Lucas Giaco Robert Corsiglia, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Adaline De Chenne, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Thomas Finzell, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Julian Gifford, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Elizabeth Gire, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Kelby T. Hahn, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Paul Hamerski, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Rachel Henderson, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Børge Irgens, UiT	Participant Oslo PER Summer Institue	June 13-17 2022
Paul Irving, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Dena Izadi, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Patrick Johns, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Magnus Strøm Kahrs, NTNU	Participant Oslo PER Summer Institue	June 13-17 2022
Niklas Karlsen, OsloMet	Participant Oslo PER Summer Institue	June 13-17 2022
Ronny Kjelsberg, NTNU	Participant Oslo PER Summer Institue	June 13-17 2022
Guri Sivertsen Korpås, NTNU	Participant Oslo PER Summer Institue	June 13-17 2022
Laurie Langdon, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Katja Anniina Lauri, University of Helsinki	Participant Oslo PER Summer Institue	June 13-17 2022
Antti Lehtinen, University of Jyväskylä	Participant Oslo PER Summer Institue	June 13-17 2022
Heather Lewandowski, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Elise Lockwood, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Marius Lysaker, USN	Participant Oslo PER Summer Institue	June 13-17 2022
Lillianna Mack, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Lenz MacKenzie, SUNY Korea (OSU)	Participant Oslo PER Summer Institue	June 13-17 2022
Betsy McIntosh, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Daryl McPadden, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Rachael Merritt, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Josephine Meyer, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Camila Monsalve, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Gregory Mulder, OSU	Participant Oslo PER Summer Institue	June 13-17 2022

Who *(continued)*	Topic	When
Carissa Myers, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Kristin Oliver, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Valerie K. Otero, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Ida Friestad Pedersen, UiT	Participant Oslo PER Summer Institue	June 13-17 2022
Brean Prefontaine, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Jacob Rodgers, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Knut Bjørkli Rolstad, NTNU	Participant Oslo PER Summer Institue	June 13-17 2022
Megan Schwartz, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Devin Silvia, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Christian Solorio, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Bryan Stanley, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Tyler Stump, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Evan Thatcher, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Dustin Treece, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Michael Vignal, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
KC Walsh, OSU	Participant Oslo PER Summer Institue	June 13-17 2022
Alyssa Waterson, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Bethany Wilcox, UCB	Participant Oslo PER Summer Institue	June 13-17 2022
Laura Wood, MSU	Participant Oslo PER Summer Institue	June 13-17 2022
Gerald Feldman, Department of Physics, Columbian College of Arts & Sciences, USA	Visiting researcher	August 15-19 2022
Ben Zwickl, School of Physics and Astronomy, Rochester Institute of Technology, USA	Visiting researcher	Aug. 15-Dec. 15 2022
Julie Butler, MSU	Visiting researcher	Sept. 20-Dec. 15 2022
Adam Christopher Hartley, MSU	Visiting researcher	Sept. 20-Dec. 15 2022
Danny Ibrahim Jammooa, MSU	Visiting researcher	Oct. 4-Nov. 30 2022
Heather Lewandowski, UCB	Visiting researcher	October 24-28 2022
Anne-Mieke Vandamme, KU Leuven	Honours seminar	November 7-14 2022
Jan-Peter Sandler, KU Leuven	Honours seminar	November 10-14 2022
Marharyta Shamshurina, KU Leuven	Honours seminar	November 10-14 2022
Yaylaci Nalan, KU Leuven	Honours seminar	November 10-14 2022

Who *(continued)*	Topic	When
Angelina Ohanjanyan, KU Leuven	Honours seminar	November 10-14 2022
Meng Wang, KU Leuven	Honours seminar	November 10-14 2022
Noyemi Sarko, KU Leuven	Honours seminar	November 10-14 2022
Kodjo Mawuelom N'blasso, KU Leuven	Honours seminar	November 10-14 2022
Andrea Jiménez Dalmaroni, School of Physics and Astronomy, Cardiff University	Visiting researcher	Nov. 11-Dec. 13 2022
Jane Mee Kim, MSU	Gemini Autumn School on Quantum Computation	November 14-22 2022
Aymeric McRae, MSU	Gemini Autumn School on Quantum Computation	November 10-20 2022
Gabriel Given, MSU	Gemini Autumn School on Quantum Computation	November 12-19 2022
Nicholas James Cariello, MSU	Gemini Autumn School on Quantum Computation	November 12-20 2022
Ryan La Rose, MSU	Gemini Autumn School on Quantum Computation	November 13-19 2022
Graeme Smith, UCB	Gemini Autumn School on Quantum Computation	November 14-19 2022
Patrick Dennis Cook, MSU	Gemini Autumn School on Quantum Computation	November 13-20 2022
Adrienne Traxler, Copenhagen University, Denmark	CCSE Christmas seminar	December 14-15 2022

Dissemination – external events

THE ROLE OF CCSE

Topic	Where, for whom	Who	When
Computational literacy as a driver for disciplinary renewal	Invited keynote talk, Aarhus University, Denmark	Malthe-Sørenssen	19.05.2022
Computational literacy as a driver for disciplinary renewal	DTU, Denmark	Malthe-Sørenssen	17.11.2022

CONTRIBUTIONS TO SEMINARS, WORKSHOPS AND CONFERENCES

Topic	Where, for whom	Who	When
Introduction to the Learning Assistant Model	UiO Læringsassistentdagen	T.O.B. Odden	13 January 2022
Introduksjon til LA Modellen	UV IDEA Lunsj	T.O.B. Odden	16 Februar 2022
Using Computational Essays to Support Epistemic Agency in Physics Education	Nordic Physics Education Research Consortium Lunch Webinar	T.O.B. Odden	28 February 2022
Introduksjon til LA-modellen	UiO Pedagogisk Innovasjonsnettverk Møte	T.O.B. Odden	17 March 2022
Implementering av beregninger i studieprogrammet Biovitenskap; med noen refleksjoner rundt farmasiutdanningen	Instituttseminar for Farmasøytisk institutt	L. Nederbragt	17 March 2022
Using computational essays as an alternative mode of assessment in physics education	American Physical Society April Meeting	T.O.B. Odden	10 April 2022
Using computational essays to support student agency in physics	2022 Physics Education Research Conference	T.O.B. Odden	14 July 2022
Using LDA to thematically analyze PER Literature	2022 Physics Education Research Conference	T.O.B. Odden	14 July 2022
Physics Education Research: What, Why, and How?	Invited talk at St. Olaf College, Northfield MN	T.O.B. Odden	21 July 2022
Programmering i fysikkfaget	Landskonferansen om Fysikkundervisning	A. Haraldsrud	9 August 2022
"Sensemaking i Fysikk" – Hvordan hjelpe elevene til forståelse?	Landskonferansen om Fysikkundervisning	T.O.B. Odden	9 August 2022
Lær å Lære (Fysikk!)	Fysikkinstituttets Programseminar	T.O.B. Odden	26 August 2022
Introduction to the Learning Assistant Model	E-PAL (LINK Seminar)	T.O.B. Odden	29 August 2022
LA Modellen på MATNAT	UiO LA Nettverkssamling	T.O.B. Odden	26 September 2022
Physics Learning Assistent Model at the University of Oslo, poster	2022 International Learning Assistent Conferance (ILAC)	H.C. Sabo, T. Skramstad	11-13 November 2022

WORKSHOPS AND CONFERENCES ORGANIZED BY CCSE PERSONELL

Topic	Where, for whom	Who	When
ProFag-U (middle schools)	Course for middle school teachers	Haraldsrud, Nordhagen, Paulsen, Gregers	06.09.21-07.03.22
ProFag-U (middle schools)	Course for middle school teachers	Haraldsrud, Sand	10.10.22-20.04.23
ProFag vgs2 (high schools)	Course for high school teachers	Haraldsrud, Nordhagen, Paulsen	20.01.22-07.04.22
ProFag vgs1 (high schools)	Course for high school teachers	Haraldsrud, Sand	15.09.22-12.12.22

Dissemination – internal events

CCSE SEMINAR SERIES

Title	Who	When
Integrating computation into undergraduate science education at University of Oslo: practice and research	Anders Malthe-Sørenssen and Tor Ole Odden, University of Oslo	13.06.2022
Informal Physics Education Research in a Nutshell	Brean Prefontaine, Michigan State University	14.06.2022
Engaging Students in Authentic Scientific Practices in Physics Lab Courses	Heather Lewandowski, University of Colorado Boulder	16.06.2022
Re-rethinking our Undergraduate Physics Major: Paradigms 2.0	Elizabeth Gire, Oregon State University	17.06.2022
Creativity, agency, and cognitive expertise: Mapping lessons from computational education back to theory	Ben Zwickl, Rochester Institute of Technology	14.12.2022
Characterizing Active Learning Environments in Physics: Networks and classroom observations	Adrienne Traxler, University of Copenhagen	14.12.2022
Tverrfaglige perspektiver i beregningsorientert utdanning Erfaringer med algoritmisk tenkning for humanister	Henrik Sveinsson, Fysisk institutt, UiO	14.12.2022
Programmering for jurister	Erik Winge, Juridisk fakultet, UiO	14.12.2022
Sidequests in Chemistry	Audun Skau Hansen, Kjemisk institutt	14.12.2022

THE BI-WEEKLY ODD SEMINAR SERIES AT CCSE

We have in 2022 continued the Open Discussions on Didactics (ODD) seminar series that were established in 2020. The seminars are on Mondays every other week (odd week numbers. 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 backgrounds 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. On demand we offer the possibility to participate via Zoom.

Title	Who	When
Computational essays and student agency: from work requirement to exam and back again	Professor Anders Malthe-Sørenssen, Department of Physics/CCSE, UiO	01.02.2022
Are quick and dirty programming habits sufficient in science - and do we at all need to consider code quality in science education?	Geir Kjetil Sandve, professor, Department of Informatics, UiO	01.03.2022
Teaching programming in a scientific context	Lecturer Andreas Haraldsrud, CCSE, UiO and senior lecturer Lex Nederbragt, Department of Biosciences, UiO	15.03.2022
What does computational literacy mean for disciplines outside of science?	Associate professor Tor Ole Odden, CCSE, UiO	29.03.2022
Programming for humanities students	Professor Dag Haug, Department of Philosophy, Classics, History of Art and Ideas, Faculty of Humanities, UiO	10.05.2022
Establishing a Collaborative Student-Centered Learning Environment using the SCALE-UP Pedagogy	Professor Gerald Feldman, Department of Physics, Columbian College of Arts & Sciences, USA	16.08.2022
Characterizing Lab Environments Using Activity Theory	Associate Professor Ben Zwickl, School of Physics and Astronomy, Rochester Institute of Technology, USA	12.09.2022
The TEAM-program at the Faculty of Medicine	Professor Jarle Breivik, Institute of Basic Medical Sciences, Faculty of Medicine, UiO	26.09.2022
Discussion on Computational Literacy Framework	Researcher Hannah Sabo and Master's student Fridtjof Gjengeset, CCSE, UiO	10.10.2022
Preparing for the quantum revolution: What is the role of higher education?	Professor Heather J. Lewandowski, Michigan State University, USA	24.10.2022
How the choice of programming language matters when learning programming - Python, Java, R and more	Professor Geir Kjetil Sandve, Department of Informatics, UiO	07.11.2022
Abstraction in computing education	Senior Lecturer Odd Petter Sand, Department of Informatics, UiO	21.11.2022
Towards a more equitable, diverse, and inclusive physics education: from collaborative exams to interactive lectures	Senior Lecturer Andrea Jiménez Dalmaroni, Cardiff University, UK	28.11.2022
Continuation of discussion of computational literacy	Researcher Hannah Sabo and Master's student Fridtjof Gjengeset, CCSE, UiO	05.12.2022

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	Odden, Gregers	25.08.2022
REAL education, seminar (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Odden, Gregers	20.01.2022
Introduksjon til Bloom's Taxonomy og Vurdering,	Fysisk institutt Utdanningsseminar	Odden	31.03.2022
Development of computational activities in Trinket.io/Glowscript	for introductory mechanics (FYS1100)	Odden	28.06.2022
Learning Assistant Pedagogical Training		Odden	Spring and Fall 2022

WORKSHOPS AND CONFERENCES AT CCSE

Topic	Where	Attendance	When
Nordic Regional Learning Assistant Workshop 2022	CCSE Oslo	55	9.6-10.6.2022
Oslo Physics Education Research Summer Institute (OPSI)	CCSE, UiO	85	13.6-17.6.2022
Computing in Science Education Annual Christmas Seminar	CCSE, UiO	60	14.12.2022

SEMINARS FOR MASTER STUDENTS IN COMPUTATIONAL SCIENCE

Topic	Who	Date
Computational neuroscience - modeling the brain	Gaute Einevoll, UiO/NMBU	02.09.2022
Research and job possibilities at SINTEF - including summer jobs	Helga Bodahl Holmestad, Sigurd Holmsen and Øystein Høistad from SINTEF	16.09.2022
Computational Science and the Spread of Harmful Conspiracy Theories in Online Social Networks	Daniel Schroeder, Simula and OsloMet and Kaspara Skovli Gåsvær, former master of science student at the CS program	30.09.2022
Current state and maturity of Quantum Computing technology	Lars Nordbryhn, IBM	14.10.2022
Using machine learning to boil water	John M. Aiken, Consultant and Expert Analytics Researcher at Njord Center for Physics of the Earth	28.10.2022
Economics needs Computational Scientists! Taking on finance as a Computational Scientist (DNB Markets Associate)	Sebastian Winther Larsen, Menon Economics and Vilde Flugsrud, DNB Markets Associate	09.11.2022

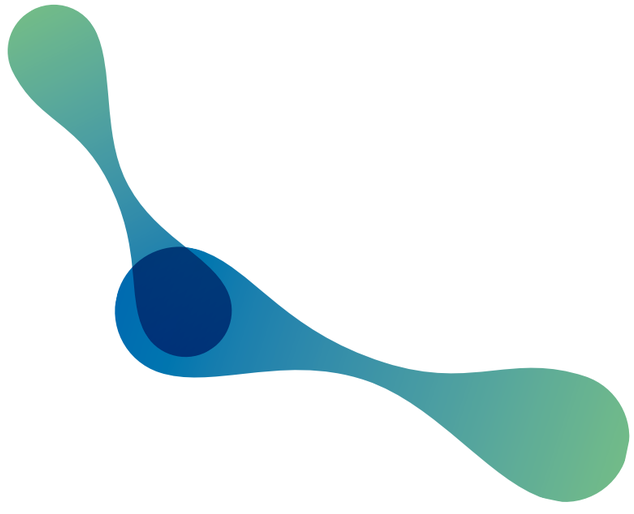
Publications

Scientifc publications

- Geiger, J. M., Goodhew, L. M., & Odden, T. O. B. (2022). Developing a natural language processing approach for analyzing student ideas in calculus-based introductory physics. 206–211. https://www.per-central.org/items/detail.cfm?ID=16233
- Haraldsrud, Andreas; Sandtorv, Alexander Harald & Odd T., Hushovd (2022). Kjemi 2. Aschehoug & Co. ISBN 9788203319495. 480 s.
- Odden, T. O. B., Silvia, D. W., & Malthe-Sørenssen, A. (2022). Using computational essays to foster disciplinary epistemic agency in undergraduate science. Journal of Research in Science Teaching, (in press). https://doi.org/10.1002/tea.21821
- Sabo, H. C., Odden, T. O. B., & Gregers, T. F. (2022). Challenges of preparing secondary STEM pre-service teachers in computational thinking. 395–400. https://www.per-central.org/items/detail.cfm?ID=16266

Social media

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



Student activities

STUDENT DEVELOPMENT OF LEARNING MATERIAL

Course and topic	Student	Teacher	When
Utvikling av beregningsbaserte oppgaver for FYS3120	Andrea Jensen Marthinussen	Anders Lauland og Are Raklev	20.06-15.09.2022
Utvikle og teste Python simulering- og programmeringsoppgaver til flere MENA kurs på 2000- og 3000-nivå	Andreas Alstad	Sissel Jørgensen	01.07-31.12.2022
Analysis of neural dynamics from Ca+ two-photon images	Anna Pauline Hjertvik Aasen, Gulla Louise Serville Torvund	Fredrik Rogge	08.06-23.08.2022
Innovation project in calm tech - the board	Aslak Hellevik, Line Horgen Thorstad, Martin Lars Gustaf Rydving, Sigrún Benjamínsdóttir	Anders Malthe-Sørenssen og Tobias Dahl, Sintef	09.06-31.12.2022
Exploring soft and hard constraints in artificial neural network	Aslak Hellevik, Mattis Dalsætra Østby	Vemund Sigmundson Schøyen	25.11.22-31.05.2023
Innovation project in calm tech - radiUs	Astrid Utheim Aune, Yasmine Kroknes-Gomez	Anders Malthe-Sørenssen og Tobias Dahl, Sintef (Tone)	10.06-31.12.2022
Labøvelser i KJM3400 – analytisk kjemi II	Ayla Steffensen Coder	Audun Skau Hansen	20.06-01.09.2022
Kartlegging av studentforståelse i FysMek	Bjørn Magnus Hoddevik	Tor Ole Odden	01.01.2022-28.02.2023
Emergent grid cell dynamics in clone-structured cognitive graphs	Carl Fredrik Nordbø Knutsen	Fredrik Rogge and Anders Malthe-Sørenssen	07.06-31.12.2022
Open World Learning-prosjektet	Christian Elias Anderssen Dalan	Audun Skau Hansen	20.06-01.09.2022
Open World Learning - en "ikke-lineær" og interaktiv læringsressurs	Hanan Gharayba	Audun Skau Hansen	20.06-01.09.2022
Samarbeid og faglig integrering mellom emnene FARM1130 og FARM2120 ved hjelp av Python	Helge Ørjan Kvello Stenstrøm	Trond Vidar Hansen	07.02-31.08.2022
Educational development work for the CCSE	Henrik Haugerud Carlsen	Tor Ole Odden	01.01-30.06.2022
Neural network models for causal learning	Herman Brunborg, Jakob Linnestad Sønstebø	Mikkel Lepperød	07.06-23.08.2022
Utvikling av nye eksperimentelle oppgaver og omlegning fra matlab. til Python i FYS2150	Jacob Larsen Lie	Nina Edin	01.01-30.06.2022
FYS3220 (lineær kretselektronikk) - utarbeide interaktive læremidler/forelesningsnotater basert på Jupyter Lab forlengelse kontrakt 0008429	Jørgen Brevik	Ørjan Grøttem Martinsen	01.01-30.06.2022

Course and topic *(continued)*	Student	Teacher	When
Transcribe research interviews	Linnea Møller Jess	Ben Zwickl	01.11-31.12.2022
B-tjenesten med maskinlæring på lab	Maren Helene Southwood Johnsen	Audun Skau Hansen	22.08-31.08.2022
Undervisningsutvikling HON2200	Marthe Grønlie Guren	Henrik Sveinsson	10.01.-31.03.2022
Undervisningsutvikling i FYS1100	Morten Tryti Berg	Tor Ole Odden	01.01-30.06.2022
forskningsprosjekte innenfor moderne Hopfield-nettverk og kontinuerlig læring	Simran Sahajpal	Anders Malthe-Sørenssen	01.01-30.06.2022
Utvikling av beregningsbaserte oppgaver for FYS3120	Øyvind Augdal Fløvig	Anders Lauland og Are Raklev	20.06-15.09.2022

STUDENT RESEARCHERS

Theme	Students	Supervisors	When
Creation of computational Fermi problem activities and scaffolded data analysis tutorials for physics course in statistics	Sienna Frost and Amanda Bowerman	Tor Ole Odden	16.05-30.07.2022
Evaluation of introductory mechanics courses at UiO using Energy and Momentum Conceptual Survey	Bjørn Magnus Hoddevik	Tor Ole Odden	03.01.2022-25.11.2022
Supervision of bachelor thesis: "Investigating Energy; The Impact of Language on Use of Ontological Metaphors for Energy"	Floris van Beurden, Bachelor student at Maastricht University (Netherlands)	Tor Ole Odden	05.01.2022-02.06.2022
Co-supervision of bachelor thesis/ honors project: "Developing a Natural Language Processing Approach for Analyzing Student Ideas in Calculus-Based Introductory Physics"	John M. Geiger, Bachelor student at Seattle Pacific University (USA)	Tor Ole Odden	21.02.2022-05.08.2022
Utvikling av en modell for robuste i nevrale nettverk basert på Krotov-Hopfield modellen	Mia Merlid (UiO)	Anders Malthe-Sørenssen	01.09-31.12.2022
Master's thesis: Shaping programming in physics education: A study on how teachers' conceptualization of computation in high school physics influences what is taught	Fridtjof Ronge Gjengset, UiO	Tor Ole Odden	2020-2022

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Center for Computing in Science Education
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