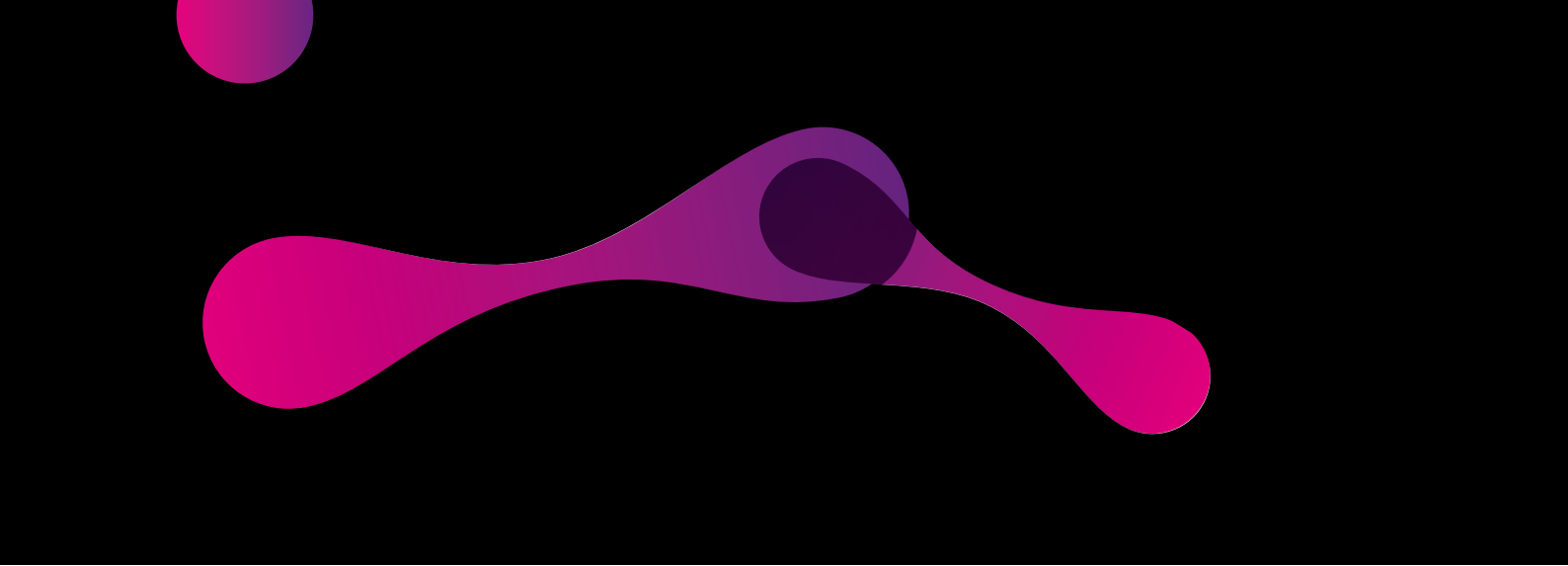




ANNUAL REPORT

2024



CCSE

Center for Computing
in Science Education



Graphic design
Photos

Maria Hammerstrøm
UiO, USN, Line Schibstad Foto, Oregon State University (OSU),
Rochester Institute of Technology (RIT)



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Summary

The Center for Computing in Science Education (CCSE) has established itself as 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.

EDUCATION RESEARCH

Education research at CCSE in 2024 has broadened to address the impact of computing across several disciplines and started to address the impact of AI on teaching and learning. PhD student Andreas Haraldsrud defended his PhD in 2024 with a focus on improved student understanding in chemistry from the integration of computing as well as from new AI-based learning methods. PhD student Karl Henrik Fredly is addressing student understanding and agency from computational essays, with a particular focus on students' use of AI tools. Jan Fredrik Olsen is a professor of mathematics

at Lund University and is broadening his competence by addressing how computing is impacting student understanding of mathematics at both the University of Oslo and Lund University. PhD student Henning V. Myhrhagen is pursuing a PhD project at KURT and CCSE to address how teachers and students integrate computing in the various disciplines at schools. A new PhD student, Helene Lane, was hired in 2024 and will focus on the use of text embedding models as a tool for physics education research. Ben Zwickl from Rochester Institute of Technology joined us as an adjunct professor in 2024, and we are also pleased that Elise Lockwood from Oregon State University again has joined us in an adjunct position. Together with adjunct professor Danny Caballero from Michigan State University, we are proud to have a strong team of affiliated faculty from the US to strengthen our education research activity. Our main focus from 2025 will be the impact of AI technologies on teaching, learning and assessment and the use of AI technologies in education research.

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



Education research at CCSE in 2024 has broadened to address the impact of computing across several disciplines and started to address the impact of AI on teaching and learning.

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. Similarly, Anders Malthe-Sørenssen has designed new learning activities for the ALC for third semester students. Lex Nederbragt has introduced new assessment methods for school exams using Jupyter notebooks. Andreas Haraldsrud has designed digital learning path and exercises for introductory programming for chemistry students. Vidar Skogvoll at KURT has continued to develop the LA program and has built an activity on the use of AI in teaching and learning. 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. In 2024 and 2025 these activities will focus on the integration of AI in teaching, with particular focus on mathematics and natural science in high schools.

COMPUTATIONAL SKILLS FOR PHD STUDENTS

The MSCA Cofund CompSci PhD program started in 2021. The vision has been 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. The first PhD students graduated from the program in 2024, and the successful candidates have already started postgraduate careers in both academia and outside.

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. We are also starting both Nordic and European networks that focus on AI in education and the use of AI for education research, that will be integral to our work over the coming years.

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 physics 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 is 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 tomorrow's 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. However, what it means to work with computers is dramatically changing with the advent of new AI models such as large language models and agent models. Therefore, we all need to become literate in the use of computing – to obtain computational literacy – as well as develop knowledge and skills needed to effectively use AI tools. We need to learn to think, argue, analyze and be creative using computing and AI approaches. This does not mean that everyone should become computer scientists and AI specialists. Instead, students should learn to use computers and AI in their disciplinary context.

The focus on digital and AI competence needs to increase in the years to come. 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 to support their learning based on fundamental insights and knowledge of how learn-

ing actually is supported – is now becoming a field that needs urgent attention. In particular, a research and evidence-based approach to the integration of AI into educational practices is urgently needed, and CCSE with its combination of education research, evidence-based practices and insights into what practices are important for student learning, is in prime position to take a lead in this field.

Higher education institutions should provide their students with a research-based education. If all educational institutions integrate computing and AI, 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 relevant 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 and AI curriculums and educate tomorrow's teachers. CCSE is taking a leading role in training these researchers and teachers.

Highlights 2024

CCSE RESEARCH HIGHLIGHT

CCSE researchers Danny Caballero and Tor Ole Odden were invited to write a comment on Computing in physics education in *Nature Physics* (March 2024, 339-341, 2024). They argue that computing now represents an opportunity to renew the physics curriculum and argue for the need for computational literacy in physics. Insights from CCSE's work over the past eight years provide background and examples in the article.

Editorial

Unlock the potential of a physics education

This month in *Nature Physics*, we publish a Focus issue that highlights the importance of physics education research.

Physics curricula and education systems have remained largely unchanged for decades, and much can be done to improve them. For example, the well-documented lack of diversity in physics starts at undergraduate level. As a result, much potential talent is missed and the under-representation of minoritized groups is amplified at each career stage. Additionally, the aim of many physics courses is still to train students to work in academia, thus making graduates less prepared for careers in industry.

A Focus in this month's issue of *Nature Physics* provides an overview of the current state of physics education research and offers recommendations on how to make learning environments more equitable and inclusive, diversify graduates' skillsets and enable them to tackle important societal issues and challenges.

With teaching sometimes perceived as being forced on researchers as one of the many additional tasks they must accomplish and with little departmental support, tackling inequality and updating curricula can feel overwhelming. However, a *Review* about equity and inclusion in physics learning environments by Chandrakala Singh and Alexander Maries stresses that a physics instructor's mindset and intentions can have a significant impact on the diversity in physics courses.

Unthinking comments about the 'triality' of an assignment or preconceptions about who can and cannot do physics will have hugely damaging effects on people from minoritized groups. Informing oneself of the effects of one's attitude during teaching can be the first step to prevent setting up



courses that widen existing gaps in achievement. These actions at the individual level must be supported by departments, Singh and Maries provide structural advice for physics departments as a whole and emphasize that simple interventions can empower all students.

In a similar vein, a *Comment* by Geraldine Cochran and coauthors analyses the specific example of racial equity in physics education research. They highlight that much research up until now has focused on elite universities with predominantly white student populations and advocate for an emphasis (both in focus and in funding) on intersectional research aimed at decolonizing physics research.

On a more practical level, the Focus issue includes two pieces about how to structure physics courses and how best to engage with the Gen Zers – often defined as those born between 1997 and 2012 – who make up the majority of today's undergraduate classes. In a *Comment* that discusses how to put together a physics curriculum for these so-called digital natives, Jenaro Guisasaola and Kristina Zuzadiscuss the benefits of a student-centred active learning approach in physics courses. They argue that traditional, lecture-based methods are insufficient to prepare students for the increasingly wider range of potential careers outside of academia. Such active teaching should be done in conjunction with diversity, equity and inclusion discussions, and students

should be encouraged to consider their identity as physicists and their role in society.

The benefits of active learning are further elaborated in a *Perspective* that places them in the context of the current generation of learners. Nam-thea Kang emphasizes the importance of considering the defining characteristics of the students currently going through the education system in order to set up an effective curriculum. Today's students are unlikely to be satisfied with traditional teaching styles and need an education structure that lets them take responsibility for their own learning with the help of digital technology. This approach will not only benefit students' understanding of physics but will also help them effect change in the world around them.

On the topic of digital technology, a *Comment* by Marcos D. Caballero and Tor Ole Odden describes how to effectively integrate scientific computing into undergraduate physics courses. As the reach and importance of computing grows, it is crucial that students understand its power and pitfalls. This is valuable transferable knowledge that will help regardless of whether the students continue into academia or take jobs elsewhere.

We at *Nature Physics* publish this Focus issue to highlight both the importance of physics education research and our interest in publishing primary research in this field. We would like to invite the physics education research community to consider submitting their work to our journal.

If physics research is to become more useful and physics groups more diverse, innovating in physics education systems is a good place to start. Physics departments should give more attention and resources to teaching to help all students feel like valued members of the physics community. Make teaching more equitable and relevant to that everyone can thrive.

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Comment

Computing in physics education

Marcos D. Caballero & Tor Ole Odden

Computing is central to the enterprise of physics but few undergraduate physics courses include it in their curricula. Here we discuss why and how to integrate computing into physics education.

Physicists use computing to control experiments, to model physical systems and to analyse data. Many recent breakthroughs in physics have been enabled by large-scale computational collaborations, including several Nobel prize-winning discoveries. And computing is not going away: computational hardware and software continues to improve, data science and machine learning methods continue to make their way into physics research, and quantum computing systems are gradually coming online for research use. Clearly, future physicists will need strong computational skills to be active members of the profession.

However, these innovative and important uses of computing are largely absent from the experiences of most physics students because those teaching computing in physics are few in number. We know that those teachers are already convinced of the utility of computing. So with the advent of widely available, cheap and open-source computing tools, along with several decades of research on how to integrate computing into physics education, there is now an opportunity to rethink how physics is taught.

An opportunity to renew the physics curriculum

At many universities, physics education has remained stable since the middle of the twentieth century. For example, in the USA the undergraduate physics curriculum – that is, the standard set of course work and activities in an accredited physics major – looks much the same as it did 60 years ago. A 1963 report on physics curricular standards published in the *American Journal of Physics* reads almost identically to a standard undergraduate curriculum at most major research universities.

Within this existing curricular structure, there have been numerous innovations in pedagogy. Over the past four decades, physics education researchers have systematically developed, studied and deployed research-based instructional strategies: for example, peer instruction, interactive lecture demonstrations, inquiry-based laboratory tasks and so on. The success of these strategies in science, technology, engineering and mathematics (STEM) classrooms is well documented: students taking these courses consistently demonstrate higher conceptual knowledge, often develop stronger social ties, and typically continue in STEM work.

There have also been some efforts to revisit and revise this curriculum, especially in introductory physics courses for non-major. For example, new courses on introductory physics for the life sciences have completely restructured the canonical two-semester sequence to focus on the important physics of biological systems. Innovative upper-level physics curricula have also adopted research-based instructional techniques and developed curriculum materials that improve students'

understanding of advanced undergraduate physics concepts'. However, large-scale curricular change is rare in physics.

The need for computational literacy in physics
A lack of computing education in physics curricula worked for a world in which computing was a necessary tool only for select physics majors. But going forward, it seems clear that all physics majors will need some degree of computational literacy to meet the needs of research, industry and education.

Students planning a career in academic research or teaching will need computational skills to construct experiments, to build models and to analyse data. Those who go straight to work after graduation will need computational skills to be competitive: indeed, recently employed bachelor's degree graduates often indicate that computing is usually a central part of their responsibilities. Students planning to become physics teachers will need computational skills to cover the computational thinking requirements that are making their way into national educational standards. And, regardless of career path, it is important that students are trained to critically evaluate models, statistics and data in a world increasingly populated with digitally generated misinformation.

Furthermore, research in physics education has shown that computation can substantially improve physics teaching and learning. Open-ended computational projects can help students to acquire early research skills, and can expose them to the creative side of physics work. Computational activities can develop skills in the construction and revision of physics models and facilitate access to more complex problems and systems earlier in students' physics careers. The visualization obtained from computational simulations can provide students with helpful physical insights and intuition about the dynamics of the systems they study.

The recent explosion of inexpensive hardware, open-source software and fast internet connections has made it easier for physics educators to bring computing experiences into their classrooms. Professional organizations for physics have acted on these needs by providing suggestions for those looking to integrate computing into their teaching; community recommendations for effective computing instructional practices and teaching development opportunities. Research into the impact of integrating computing into physics is also growing. So the time is ripe to think through how to help physics students to become computationally literate.

Helping physics students to become computationally literate

We see three essential elements of computational literacy. First, students need a basic familiarity with the computational tools used by physicists: for example, programming languages like Python or MATLAB, developer environments and a basic understanding of hardware and operating systems. Next, students should learn the most common computational physics techniques and practices: for instance, data plotting and visualization; numerical integration and differentiation; common algorithms like the method of relaxation and

nature physics

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KNUT MØRKEN RECEIVED NOKUT'S HONORARY PRIZE

Knut Mørken received this prestigious award at NOKUT's annual conference. This is a prize that have only been given to a very select group of recipients and is a great recognition for Knut's extensive and impactful work to improve education at the University of Oslo and in Norway. His focus has been to improve the underlying culture for teaching and learning, which requires a long-term commitment. We are proud that he has been a founding member for the work for integrating computing in science education at the University of Oslo. Knut is a member of CCSE's leadership group and serves at the Dean of Studies at the Faculty for Mathematics and Natural Sciences at the University of Oslo.

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/OvLutlsglo> (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)



Plans and Priorities

The main activities of the center 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 2025, particular focus will be placed on extending 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 2025, we will continue the development of direct instruction methods in introductory courses and project-based methods in advanced courses. In 2025, we will continue to develop and test new learning approaches that includes AI in various forms.

Learning material: We still support docOnce as an infrastructure for modular learning material, but will consider transitioning to other, more broadly supported tools that are in development internationally; we will build a community for authors through 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 active

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 research-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 international leading hub for research-based approaches to CSE, with a strong educational research activity; an international repository for methods and materials; and strong student partnership.
Full CSE integration in 2 of 6 basic physics courses and partial 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 advanced 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.	Successful adaptation at Univ. Southeastern Norway.	Adaption of CSE to 2 external partners.
	A pilot school interaction program.	An ambitious 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.	



learning 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 and develop new, alternative and more time-effective school exam approaches that assess the whole range of learning outcomes. AI-based assessment methods, with particular focus on forma-

tive assessment, will be developed and implemented. 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,
- (ii) continue studies of the impact of computing in across domains, and
- (iii) initiate studies of teacher training and professional development and impact of computing in school education.

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 (Leader: A. Malthe-Sørenssen)						
AO.1	Annual progress reports	DOI	DOI	DOI	DOI	DOI
AO.2	Advisory board meeting		MO2		MO2	
Theme 1: Educational development (Leader: 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 (Leader: 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		
A2.3	Computing in chemistry (PhD)		M24		D24	
Theme 3: Culture for teaching and learning (Leader: 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 (Leader: 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

DOI: 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 consider CCSE to be in a unique position to take a nationally leading role on how to integrate AI into domain educational programs.

The research activity will gradually shift to focus more on the impact of AI on teaching and learning and the development and application of AI-based text processing tools, such as the use of text embedding methods from large language models, in a joint effort between CCSE and INTED – Center for interdisciplinary education. We consider CCSE to be in a unique position to develop an internationally leading research activity in this field and to take a nationally leading role on how to integrate AI into domain educational programs. A PhD student focusing on Natural Language Processing, Helene Lane, was hired in 2024 and a PhD student focusing on the foundations of these methods will be hired in 2025.

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, the Center for teaching and learning in science and technology at the Faculty for mathematics and natural sciences, and consider organizing a final Summer Institute for both internal and external participants in 2026.

Together with KURT, CCSE will continue to develop a common meeting place for students and teachers interested in educational development through talks, workshops, hackathons and social activities. The goal

over the coming two-year period is to merge the activities from theme 3 into the regular activities of KURT in order to make the efforts from CCSE into a permanent part of the institution. We will organize bi-weekly meetings at CCSE throughout 2025 focusing on challenges and opportunities in educational development projects and the use of AI in both education research and educational development.

THEME 4: DISSEMINATION (2022-2026)

Dissemination will follow and expand on the activity from the first period. We will build on our success in disseminating practices to bioscience, teacher education, and through select international partnerships. We will widen the focus with an ambition to reach:

- (i) across levels from 1-13 through BSc, MSc, PhD, and post-graduate education;
- (ii) across contexts, from science to humanities, social sciences and beyond,
- (iii) across institutions nationally and internationally; and
- (iv) across sectors to impact education, research institutes, government, industry, business and startups.

We will in 2025 focus on disseminating results on the use AI in teaching and educational development and on the use of text embeddings from large language models for education research and build a strong Nordic and European partnership for these activities.



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 2024

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 in the newly opened 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. Subsequent courses in the spring and fall semester also use similar teaching practices. For example, the introductory course in electromagnetism in the third semester has switched to a fully flipped-classroom approach with only student seminars in the large active learning classroom. 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 and improve learning outcomes. Recording of student attendance shows that there is much less drop-out from classes in the active learning classrooms than from smaller group sessions.

Textbooks

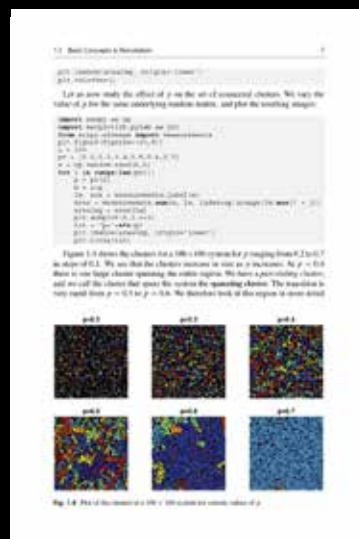
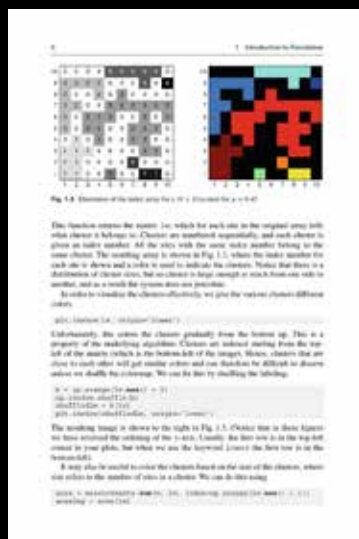
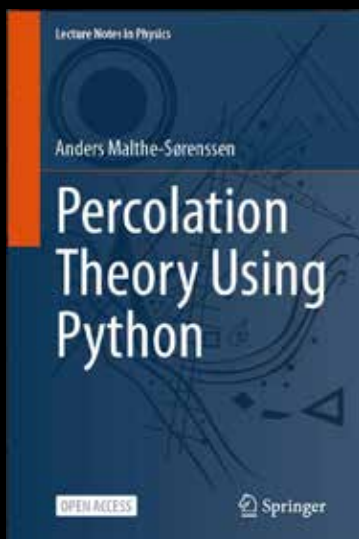
The center has continued to develop high quality textbooks, interactive learning material and examples and exercises for courses. The textbook in Elementary electromagnetism using Python was used as the main textbook in 2024 and is now accompanied by a full flipped classroom course with small video lectures 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 2024. A new textbook was developed and published this year, Percolation theory using Python (see box). A major effort has been made over several years to develop high-quality textbooks and learning



NEW TEXTBOOK ON PERCOLATION THEORY

A new textbook on percolation theory using Python was published as open access on Springer in 2024. The textbook is the result of a course that has been taught at the University of Oslo for the past twenty years. The book addresses a now classical field of percolation theory, which is the theory of connec-

tivity in sets, but starting from a computational perspective. All concepts are introduced using computational models, and the student is guided through the theory by developing short python programs, and learn to analyze real, noisy data from their own simulations.



materials in advanced courses. This material is open access and used in courses at the University of Oslo and internationally. This provides a lasting legacy for the high-quality learning materials developed at CCSE.

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 2024 and are being developed into a new textbook. 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 2024. These projects are unique internationally and contribute to build both legacy and a unique international brand for CCSE.

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 contribut-

ing to build a Nordic and European learning assistants activity. The use of learning assistants is developed in close collaboration with KURT and with the Center for interdisciplinary education, INTED, which are developing the learning assistant model into a model for interdisciplinary facilitators.

Partnership through Digiwind

CCSE has been a partner in the DIGITAL Europe DIGIWIND project coordinated by the Danish Technological University (DTU) with 11 international partners across Europe from universities, research institutes and industry. The goal of the program is to develop new master programs in wind energy that integrates computational competence. CCSE's contribution was primarily on the integration of computing in disciplinary programs and courses and with developing learning approaches and material for advanced courses that will be disseminated to partners in the program. However, changes in priorities in CCSE with a stronger focus on AI, has resulted in a scaled-down participation in DIGIWIND from CCSE in 2024.

Student participation

Students play an important role in the development of learning material. CCSE financed 36 student scholarships in 2024. 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 2024, these resources were used to develop new learning material for the new first year in the physics program as well as for courses in chemistry, pharmaceutical science and bioscience.

PLANS AND PRIORITIES FOR 2025

- Extend support to develop learning approaches and activities to be used in the large active learning classrooms and experiment on new methods of instruction.
- 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 and FYS1120 will be continued and extended in 2025.
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. A wide range of advanced texts are in development and are used as textbooks in advanced courses such as in FYS3150 and FYS-STK3155.
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.

NEW BACHELOR COURSES IN QUANTUM TECHNOLOGY



Fig. 1: Students in quantum technology learn to write algorithms for quantum computers, to use machines to “talk to” quantum systems, and gain experience from nanofabrication in clean rooms, as shown in the photo. (Photo: Jarli & Jordan/UiO)

Quantum technology is becoming an increasingly important trend in science, industry and society. The Physics Department at the University of Oslo has been involved with research and education in quantum science and technology for decades but is currently in the process of amping up its efforts in this rapidly developing field. UiO has identified three pillars that underscore all efforts related to QS&QT: Infrastructure, Research, and Education.

The Fall of 2024 saw the commencement of the first dedicated Study Programme Option in Quantum Technology in Norway, as part of the Physics and Astronomy Bachelor programme at UiO. Subsequently, two study options are scheduled to start in the Fall of 2025 at the master level: Quantum Science and Technology in the Physics master programme, and Quantum Information Science and Technology as part of the Computational Science master programme.

The quantum technology option deviates from the existing physics bachelor programme by the development of key courses. These include a third-semester course called Introduction to quantum technology, a fourth-semester course on Solid state physics and quantum materials, and a sixth-semester course in quantum computation (from a physics viewpoint).

At the time of writing, the first bachelor students are in the process of choosing whether they will pursue the Quantum Technology study option in the

Physics bachelor or not. Thus, experiences with the study option and bachelor programme itself are to follow. However, the introductory course on quantum technology ran as a pilot in the fall of 2024, open to all UiO students in the natural sciences and with the appropriate mathematics background.

The goals with the course were to:

- Introduce students to what quantum physics is and how it can be used in QT
- Give a broad overview of QT; computing, sensing, communication and cryptography – to enable further specialization
- Discuss different material platforms for practical realizations of QT
- Expose students to lab demos of cleanroom setting, and quantum programming in qiskit

Some unique aspects of this course are that students learn about quantum physics and technology prior to having any basic quantum physics course. The students seemed to enjoy the topic but found the formalism focused aspects more challenging. Overall, teaching such a broad group of students from all over the faculty can make it challenging to find the appropriate level, but this is true for any cross-disciplinary study programme.

We are excited to develop the study programme options in quantum science and technology further in the coming years.

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 2024

Computational literacy in physics

CCSE associate professor Tor Ole Odden and adjunct professor Danny Caballero, who has a primary position at Michigan State University, published a chapter on physics computational literacy in the International Handbook of Physics Education Research. This handbook, consisting of three volumes (Teaching, Learning, and Special Topics) is meant to act as a primer on the state of the research in the field for new researchers. The chapter synthesized most of the available research on the subject as of writing (2022) and additionally traced the historical roots of computation in physics education back to the formalization of educational guidelines in the United States in the 1960s. It also theoretically situated the majority of this research into four separate frameworks—modelling, computational thinking, practice perspectives, and computational literacy—in order to promote the use of learning theories in studies of computation in physics education going forward. In the chapter, UiO is featured as an example of a department that has a deep focus on cul-

tivating physics computational literacy through their educational programs.

Research on the University of Oslo Learning Assistant Program

CCSE associate professor Tor Ole Odden, together with Anders Lauvland, associate professor Maria Vetleseter Bøe, and Professor Ellen Karoline Henriksen from the UiO Physics Skolelab, published their first article on the University of Oslo's learning assistant program in the European Journal of Physics. This article examined how the Learning Assistant Model, developed at the University of Colorado-Boulder and widely adopted across the United States, needed to be modified to be implemented in European Higher Education. Through a combination of several research methods—design-based research, interviews with LAs, pre-post surveys, and teaching observations—the research team found that LAs who participated in the first three semesters of the program showed more buy-in to active learning methods as a result of the participation. These results form the basis for a cultural change in higher education, and the success of the program has led to its adoption across the University of Oslo, especially in the Faculties of Law and Education. Additionally, Odden is currently in the process of applying for European Research Council funding to build a European network of learning assistant programs with collaborators in Finland, Sweden, and Germany.

Research on computation in Chemistry, Mathematics, Physics, and pre-college science education

As of autumn, 2023, the CCSE research group consisted of four PhD students and one post-doc, spanning a range of disciplines: PhD students Andreas Haraldsrud (Chemistry Education), Karl-Henrik Fredly (Physics Education), Henning Myhrehaugen (Physics/Science Education), Jan-Fredrik Olsen (Mathematics Education), and postdoc Hannah Sabo (Physics Education). The research team had weekly research-group meetings throughout the semester, with regular discussions on the topic of computational literacy across

these different disciplines. All researchers are currently working on articles around their respective research projects: Haraldsrud is examining how computation helps chemistry students to connect mathematical and chemical knowledge and make sense of complex chemical phenomena; Fredly is examining the computational skills needed to complete a computational physics masters degree; Myhrehaugen is examining teacher uptake of scientific programming after computational thinking became a part of the Norwegian national curriculum in 2020; Olsen is examining how computation is used in mathematics research and education, using the UiO department of mathematics as a case study; and Sabo examined how instructors approached the process of assessing computation in physics education. 2023 saw the first publication from this new cohort of PhD students, with Haraldsrud and Odden's article From Integrated Rate Laws to Integrating Rate Laws: Computation as a Conceptual Catalyst published in the Journal of Chemical Education.

Research on assessment of computation in physics education

During 2023, Postdoc Hannah Sabo continued her work on understanding how physics instructors approached the task of assessing computational tasks in physics education. This work proceeded in three phases: first, analysis and member-checking of prior interviews with physics faculty conducted by PhD student Sebastian Gregorius Winther-Larsen on their learning goals for computational activities. This analysis revealed a pattern of computational assessment which Sabo named “gentle assessment”, and which was presented at the 2023 American Association of Physics Teachers summer meeting and Physics Education Research Conference and is also being drafted for publication in the journal Physical Review Physics Education Research. Second, Sabo collected an overview of assessment approaches and goals, and compiled these into an article currently submitted for publication in the journal The Physics Teacher. Finally, based on these two initial phases, Sabo conducted additional interviews with



UiO faculty on their approaches to assessment and active learning with computational methods.

Qualitative analysis at scale through natural language processing

During the autumn of 2023, the CCSE collaborated with a group of three recently-graduated bachelor students—Halvor Tyseng, Jonas Timmann Mjaaland, and Markus Fleten Kreutzer—hired through the INTED SFU, to explore how NLP methods could be used to perform deductive qualitative analysis of educational research at scale. Building on prior NLP work from the CCSE that used topic modeling to inductively analyze large amounts of educational research literature, the group explored how vectorized representations of articles using text embeddings could be deductively used to quantify the rise and fall of different research

topics over time, benchmarking results against the prior inductive topic analysis. The results of the study are currently being written up for publication in Physical Review Physics Education Research. The project is also leading to a new direction in the collaboration with Caballero's group at Michigan State University, who are interested in critically exploring applications of this method, and Ben Zwickl's group at Rochester Institute of Technology, who are interested in applying it to their student-level data. In 2024 the CCSE will also hire a postdoc and PhD student (through Odden's start package) who will contribute to this research direction.

Research on Generative AI in science education

Several members of the group have begun to pilot projects on the applications of generative AI to science education, especially related to scientific programming. PhD students Haraldsrud and Fredly have both initiated data sub-projects on this topic, examining how ChatGPT can be used to support problem-solving in Chemistry and computational essays in physics, respectively. Odden has also begun an application for Norwegian Research Council funding to examine how

generative AI tools can be used in physics and biology education, in collaboration with members of the BioCEED SFU at the University of Bergen and the physics education research group at Uppsala University in Sweden. The aforementioned PhD student and postdoc hires will likely also have sub-projects related to AI in science education.

PLANS AND PRIORITIES FOR 2025

- Continue existing studies of computational literacy in physics, chemistry, mathematics, and pre-college science education, with the goal of submitting 1-2 articles from each project in the course of 2025
- Publish existing work on deductive use of NLP methods for qualitative data analysis, and build a collaboration with Michigan State University and Rochester Institute of Technology. Hire PhD student to extend and apply the method to other datasets and research problems
- Develop and submit grant proposals to study the effects of generative AI on physics and biology education and build a network of European learning assistant programs which will extend beyond the remaining three-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.
A2.2: Activity started 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. Finished in 2024.

UIO LEARNING ASSISTANT NETWORK

The University of Oslo has long aimed to make its teaching and learning activities more active and student-centered. As part of this effort the Center for Computing in Science Education has, since 2018, been working to improve small group teaching at UiO through the use of the Learning Assistant (LA) model. The LA model is a method for integrating active learning into courses which was developed at the University of Colorado, Boulder, in the early 2000's. The corner-stone of the model is the Learning Assistants, pedagogically trained students who facilitate group discussions during lecture and/or small-group teaching sessions. To implement the model, during the fall semester of 2018 we established a weekly pedagogical training seminar for group teachers in courses from the mathematics and natural sciences. These seminars typically enrolled 10-20 group teachers, first from physics and mathematics and later from chemistry, biology, pharmacy, and astrophysics. This training has continued through the present day and is now managed by the Center for Teaching and Learning in Science (KURT).

Although the UiO Learning Assistant program began in the department of physics and soon spread throughout the faculty of Mathematics and Natural Sciences, it has since grown into a university-wide network. This growth was stimulated by the 2022 Nordic Regional Learning Assistant Workshop, organized by the CCSE and held at UiO with facilitators from the University of Colorado-Boulder. As a result of that workshop, several instructors and staff members from various faculties became interested in adopting the learning assistant model. In collaboration with the CCSE, in 2023 they created the UiO LA Network (Nettverk for læringsassistentordninger), which is housed in the UiO Center for Teaching and Learning, LINK. Tor Ole Odden is one of the two leaders of the network (Faglig ansvarlig), along with a representative from LINK. The network now includes representatives from almost all of the UiO faculties, such as Law, Social Sciences, Humanities, Educational Science, and the UiO Library in addition to Mathematics and Natural Sciences. Sev-



Fig. 2: Training Learning Assistants at CCSE

eral of the remaining faculties have expressed interest in joining the network as well.

In 2024 the network held several major presentations, including presenting the learning assistant model and network to the UiO Educational Committee (Utdanningskomiteen), the highest education-focused committee at the University, and presenting examples of its work at the UiO Educational conference (Utdanningskonferansen). Odden presented the network's work to both the UiO faculty of Medicine (who are planning to join) and at the Faculty of Humanities' educational retreat. Working groups in the network were established to look at policies around LA hiring and begin a research program on the effects of the LA model at UiO. The network also had several meetings over the course of the year to exchange ideas and experiences, provide mutual support, and discuss findings from these working groups.

Going forward, the UiO LA Network plans to continue to advocate for the LA model as a way to improve teaching and learning at UiO, as well as to address longstanding educational issues like lack of student attendance in active learning environments. Working groups have also been formed to explore the interaction between AI tools and learning assistants, and connections have been made to similar efforts at other Norwegian universities like NTNU.

Theme 3:

Culture for teaching and learning

Leader: 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 2024

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. Together with the Center for Teaching and Learning in Science (KURT), 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 and have been further refined in 2023 and 2024.

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 2024 we arranged the ODD seminars, which are regular seminars organized every odd week 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. We also organize a yearly Christmas seminar focusing on Computing in Science Education, which in 2024 again was organized in our own facilities.

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 web-site.

Biannual seminars

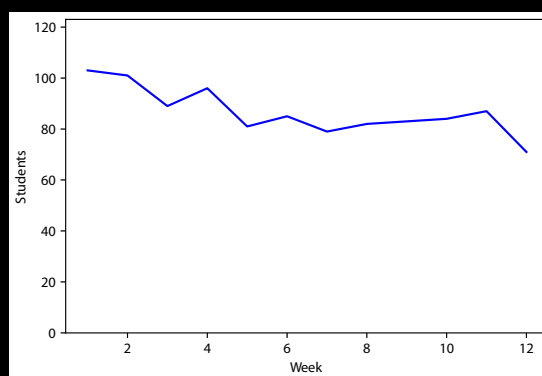
KURT organizes biannual seminars for teachers and group teachers. REAL Undervisning is one of several contributions to MN’s work on teaching culture. The purpose of REAL Undervisning is to raise awareness among MN educators, including group teachers, about their role, facilitate exchange of experiences across departments and subjects, and inspire good teaching. REAL Undervisning offers an English-language version called “REAL Teaching” the following day. The English-language version has a dedicated section on learning culture at MN. In 2024, the topics have been

TEACHING IN THE ACTIVE LEARNING CLASSROOM



The Faculty of Mathematics and Natural Sciences has constructed a large active learning classroom with room for up to 100 students. The room has finely tuned acoustics, making it possible to work with large groups of students that interact and discuss, without creating too much noise or distractions.

The room has been used for several courses in 2024. For example, the course FYS1120 Electro-



magnetism use the room for both seminars and smaller group sessions. In the seminars, students are seated together and work on tutorials that have been designed to inspire to discussions and collaboration. The introduction of the active learning classroom has led to more student attendance and less student dropout from teaching, as seen from the student attendance numbers in the figure.

varied, with a particular focus on the use of artificial intelligence in education and active learning. In addition, we organize REAL Prat. The goal here is to initiate exchange of experiences and reflection on current educational topics. In 2024, we organized REAL Prat on artificial intelligence and active learning.

PLANS AND PRIORITIES FOR 2025

- 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 learning assistants.

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 2024-2026, 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.

MARIUS LYSAKER AT USN BECOMES EXCELLENT TEACHING PRACTITIONER

Marius Lysaker is a professor in mathematics at the Department of Process, Energy, and Environmental Technology within the Faculty of Technology, Natural Sciences, and Maritime Sciences, University of South-Eastern Norway (USN). He teaches mathematics, algorithmic thinking, and programming in the engineering program and is based at the Porsgrunn campus. Additionally, he teaches several continuing education courses aimed at the industry. He has supervised numerous master's and PhD students at USN in the field of modeling and simulation.

Over time, Lysaker has collaborated with CCSE (Center for Computing in Science Education), a center for excellence in teaching. It is largely due to this collaboration that he was awarded the title of Distinguished Educator. He has also published the textbook "Python for Real-fag" (Fagbokforlaget), which is currently used at several universities.



Fig. 4: Picture of Marius Lysaker with his diploma as excellent teaching practitioners (ETP), 2024. (Photo: UiO)

BEN ZWICKL'S ENGAGEMENT AND RESEARCH AT CCSE

Ben Zwickl decided to spend his sabbatical at CCSE during the fall of 2023, where he looked at the career decision making among Norwegian physics students. He talked to students from Stavanger, Tromsø, Trondheim and Oslo, to get a general idea of how the layout of physics programs affects how students form interests within different areas in physics. Ben wanted to work with CCSE in hopes of building a bridge between the American and European education communities.

At the start of 2024 he was hired to work part time at CCSE (20 %). His main focus has been to co-supervise in projects about how students learn computational literacy at an advanced level, and how we can use AI tools to understand qualitative data sets. He also wants to look at how education within quantum



Photo: RIT

technology will develop, as the field itself is new and also developing.

Ben is a resource who expands and strengthens the center.

ELISE LOCKWOOD RETURNS TO CCSE IN 2024

Elise has collaborated with CCSE over many years in the research surrounding the integration of computation in science education. She has supported research fellows with the research and analysis of data for their projects. Elise finds that her connection with CCSE is a very valuable asset to have for both her professional career, but also for her development as a researcher.

Her main focus has been to look into how students at an undergraduate level view computation as a tool when it comes to combinatorics in mathematics, and how the computer can help with mathematical thinking. For her work she won a PECASE award, which is a presidential award, and she connects a lot of her success to her collaboration with CCSE.

Elise finds that CCSE's sense of collaboration nurtures an environment for scientific thinking.

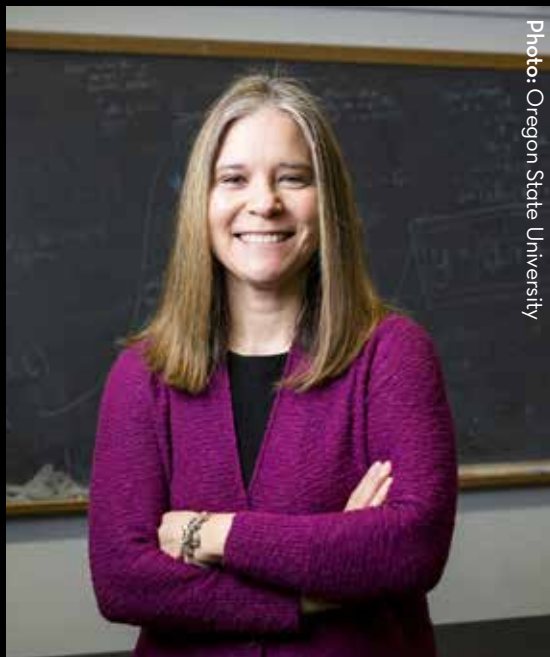


Photo: Oregon State University



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 2024

Research visits by Ben Zwickl, Professor at Rochester Institute of Technology

Ben Zwickl decided to spend his sabbatical at CCSE during the fall of 2023, where he looked at the career decision making among Norwegian physics students. He talked to students from Stavanger, Tromsø, Trondheim and Oslo, to get a general idea of how the layout of physics programs affects how students form interests within different areas in physics. Ben wanted to work with CCSE in hopes of building a bridge between the American and European education communities. At the start of 2024 he was hired to work in an adjunct position at CCSE (20 %). His main focus has been to cosupervise in projects about how students learn computational literacy at an advanced level, and how we can use AI tools to understand qualitative data sets. He also wants to look at how education within quantum technology will develop, as the field itself is new and also developing. Ben is a resource who expands and strengthens the center.

Visit by Jan-Fredrik Olsen (Lund University)

During fall of 2023 and the spring of 2024, Jan-Fredrik Olsen from Lund University spent a sabbatical at CCSE. During his time at CCSE, he completed all

coursework required for his PhD on the use of programming in research and undergraduate teaching by mathematicians and got two conference proceeding papers accepted. Currently, he has returned to Lund University, where he employs artificial intelligence to teach undergraduate calculus and is gathering data for future research projects. Olsen visits CCSE regularly to keep up collaboration with Tor Ole B. Odden and Elise Lockwood.

Teacher education

In order to disseminate our practices widely, we work to disseminate practices to schools and schoolteachers. 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. From 2024 we started to include use of generative artificial intelligence in ways that lead to better student learning. We show how we can use what we know about learning processes in order to use AI productively, in particular in combination with programming, mathematics and natural science. In addition, we have been discussing how AI can help us reach our goal of improved domain-specific understanding through programming, and what pitfalls that exist. The experience from these courses provides the basis for a new set of courses for school teachers in 2025 – ProFag:AI – Programming for domain learning with AI.

PLANS AND PRIORITIES FOR 2025

- 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
- Build European and Nordic partnerships for AI in education and education research.

NOKUT HONORARY AWARD TO KNUT MØRKEN

Knut Mørken received this prestigious award because he is a visionary educator focused on creating a comprehensive science education that prepares students for future challenges while fostering personal development. He is a distinguished and well-liked lecturer who has developed new courses and textbooks to equip students with essential knowledge and skills. Mørken has worked long-term to cultivate a culture of excellent teaching at UiO and has contributed extensively to improving education in Norway and internationally. He emphasizes creating a supportive learning environment where students can thrive and has mentored educators and leaders, prioritizing the organization's goals over his own. He envisions an integrated approach to education involving students, staff, management, and society in a collaborative effort.



Fig. 5: Mørken receiving the honorary award.

CSE and CCSE

Mørken, based at the Department of Mathematics, played a key role in integrating computational methods into mathematics, essential for successful integration into other sciences like physics, chemistry, and biology. The CSE project at UiO, with Mørken as a crucial figure, won several awards, including the University's Learning Environment Award in 2011 and NOKUT's Education Award in 2012. His work was instrumental in establishing the Center for Computing in Science Education (CCSE), MN's first Center for Excellence in Education. Mørken's

vision also influenced Norway's curriculum renewal in 2020, integrating programming into mathematics and natural sciences. This led to the need for further teacher training, and Mørken helped establish ProFag courses starting in 2018, providing programming education to science teachers. He has also been involved in developing the NAT3000 course at MN, focusing on scientific programming. Mørken's efforts have elevated the quality of science education in Norwegian schools.

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

Comments

- A4.1: The first cohort of CompSci PhD students finished their degrees in 2024
 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.

- 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)



Report from the CSE activity at USN

Marius Lysaker and Jarle Tommy Bjerkholt, USN

TNM is a faculty consisting of six institutes localized at Campus Porsgrunn, Campus Kongsberg and Campus Bakkenteigen. In total, TNM offers six bachelor engineering programs: building engineering, machine engineering, computer engineering, electronics engineering and chemistry engineering. All the engineering programs have a common course platform in the sciences that includes: Programming for computing (5 ECTS), Mathematics 1 (10 ECTS); Physics (10 ECTS); Mathematics 2 (10 ECTS); and Statistics (5 ECTS).

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.

During 2024 we introduced activities to focus on programming for first year students. The weekend 16th to 17th of November, over 140 engineering students participated in a coding workshop at USN. The workshop lasted from 10 to 18 both days and was organized in parallel at three campuses at Bakkenteigen, Porsgrunn and Kongsberg. The workshop varied between lectures and group sessions, in combination with social activities and quizzes. The evaluations from students participating in the workshop were very positive. A similar workshop will be planned also for 2025.

Here is an overview of various activities carried out at USN:

- The EVU course PY1010 Python programming for the sciences started in October 2024 and lasts until April 2025. The course is workshop based and taught over zoom. In total 150 participants are attending the course, which is taught by Finn Haugen and Marius Lysaker with student assistants.
- We have had a thorough review of the learning goals and the course plan for IB1020 Programming for computing. From this year we have started to introduce AI tools in the teaching. Through this course, students develop essential experience from using the tool and reflect on its impact on the learning process.
- We have chosen to continue the pilot from 2023 with a mandatory workshop for all student assistants working on IB1020 Programming for computing as Campus Porsgrunn. The workshop contains both professional and social elements. Based on the positive feedback on these workshops, we plan to make this a regular workshop.
- Marius Lysebok was awarded the title of Excellent Teaching Practitioner during 2024. His application was based on Lysaker’s work in computational thinking and computational programming at USN. The collaboration with CCSE is thoroughly documented in the application and has been a central part of the work to integrate computational programming at USN.



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.

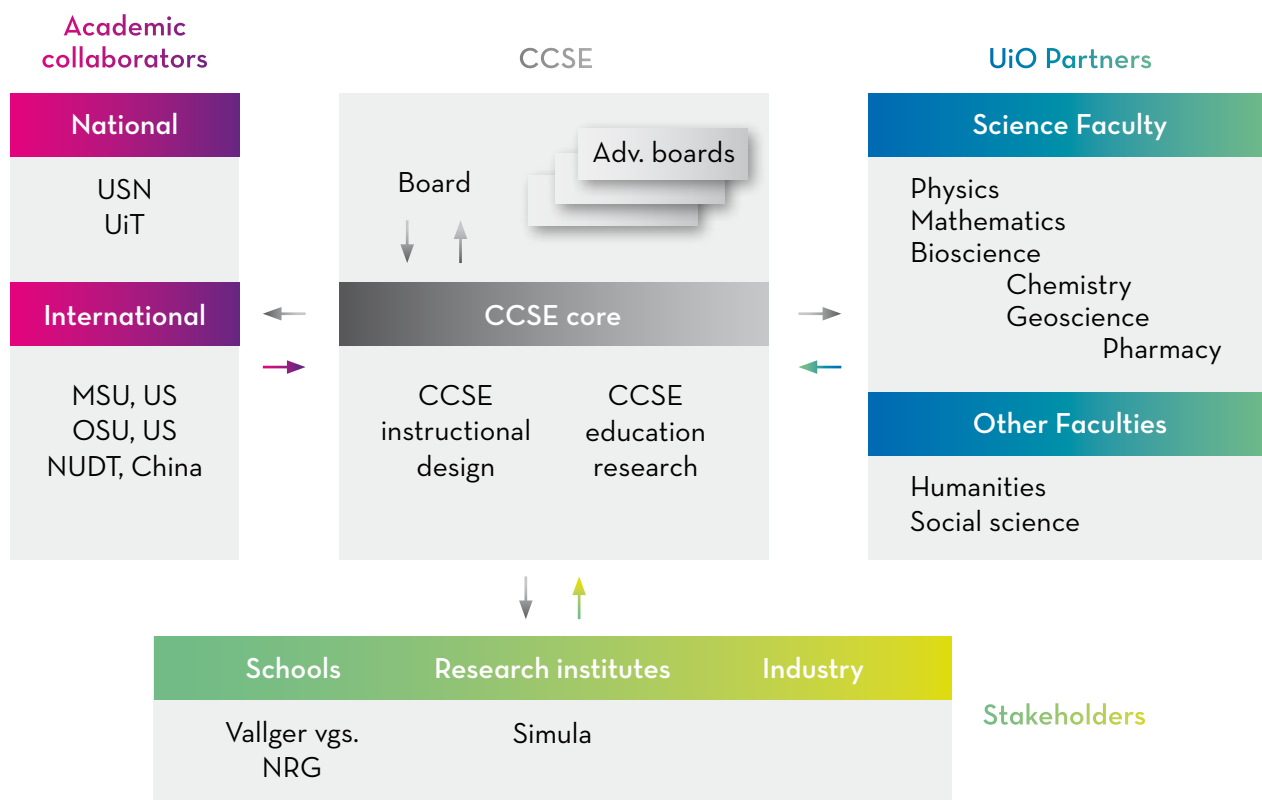
The center has a board with representatives from the four main departments, Departments of Physics, Mathematics, Computer Science and Bioscience, a student representative, and two external representatives. The board will have two meetings a year.

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.

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

Theme 3: Culture for teaching and learning, leader

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

Morten is a computational physicist focusing on quantum many-body theory, quantum computing, and machine learning. He has developed the computational science master program, courses in computational physics, quantum computing, many-body physics and basic and advanced courses in machine learning. He is a Fellow of the American Physical Society and the American Association for the Advancement of Science (AAAS), Member of the Norwegian Academy of Science and the Royal Norwegian Society of Sciences and Letters, winner of the Thon award, and has been awarded UiO's education award three times. He was awarded the title of "Distinguished Educator" in 2021.



ANDERS MALTHE-SØRENSEN

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.



KNUT MØRKEN

Professor of mathematics

Theme 4: Dissemination, leader, 20%

Knut is a founder of CSE and developed one of the key modules in computational mathematics. He has been project leader for educational development at the Faculty and leader of the Bachelor Program in Mathematics and Informatics. He is currently Dean of Education (2019-). He is a winner of the Thon Award (2017) and the NOKUT Honorary prize (2024).



**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*****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******Theme 1: Educational development, 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's 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 was awarded the title of "Distinguished Educator" in 2023.

Education research

**TOR OLE ODDEN*****Associate professor in physics education research******Theme 2: Educational research, leader***

Tor Ole is an associate professor of physics education research, and the research group leader at CCSE. His research focuses on how computation can be leveraged to support student creativity and epistemic agency in science learning, how students acquire disciplinary computational literacy, and applications of generative AI to do qualitative research at scale. Tor Ole holds a PhD in physics education research from the University of Wisconsin-Madison, where his dissertation work focused on how undergraduate physics students make sense of abstract or tricky physics concepts, the specific strategies they use, and how instructors can help them in that process.

**DANNY CABALLERO*****Adjunct professor of physics education research, 20%***

Danny is the Lappan-Phillips Professor of Physics Education, Michigan State University, Leadership Faculty, CREATE for STEM Institute, Michigan State University, and Adjunct 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.

BEN ZWICKL

Adjunct professor of physics education research, 20%

Ben is an associate professor, School of Physics and Astronomy, Rochester Institute of Technology, and the Co-Director for the Center for Advancing Scholarship to Transform Learning. His research has focused on many aspects of physics, such as preparing students for the quantum workforce, communication skills in STEM and learning in complex environments such as lab courses.



ELISE LOCKWOOD

Adjunct professor of math education research, 20%

Elise is a professor of mathematics education research at Oregon State University. She has received an NSF Career grant focusing on how computations affect student understanding of combinatorics and is a 2025 Presidential Early Career Award for Scientists and Engineers (PE-CASE) honoree.



HELENE LANE

PhD student

Helene is a PhD student from 2024, addressing the use of large language models as a research tool in physics education research and the impact of large language models on physics learning.



KARL HENRIK FREDLY

PhD student

Karl Henrik is a PhD student from 2022, addressing computational literacy. He has a master's 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 schoolteacher education programs.



**JAN-FREDRIK OLSEN***Visiting senior lecturer / PhD student*

Jan-Fredrik Olsen is a senior lecturer at Lund University and have been a visiting CCSE on a sabbatical leave from 2023 to 2024. He has long experience with teaching mathematics at Lund and is now pursuing a PhD project on the impact of computing on students understanding of mathematical concepts.

**ANE KRISTINE ESPEETH***Research Assistant*

Ane is a research assistant whose work targets learning and understanding in LLMs, including concept acquisition and internal structures of knowledge.

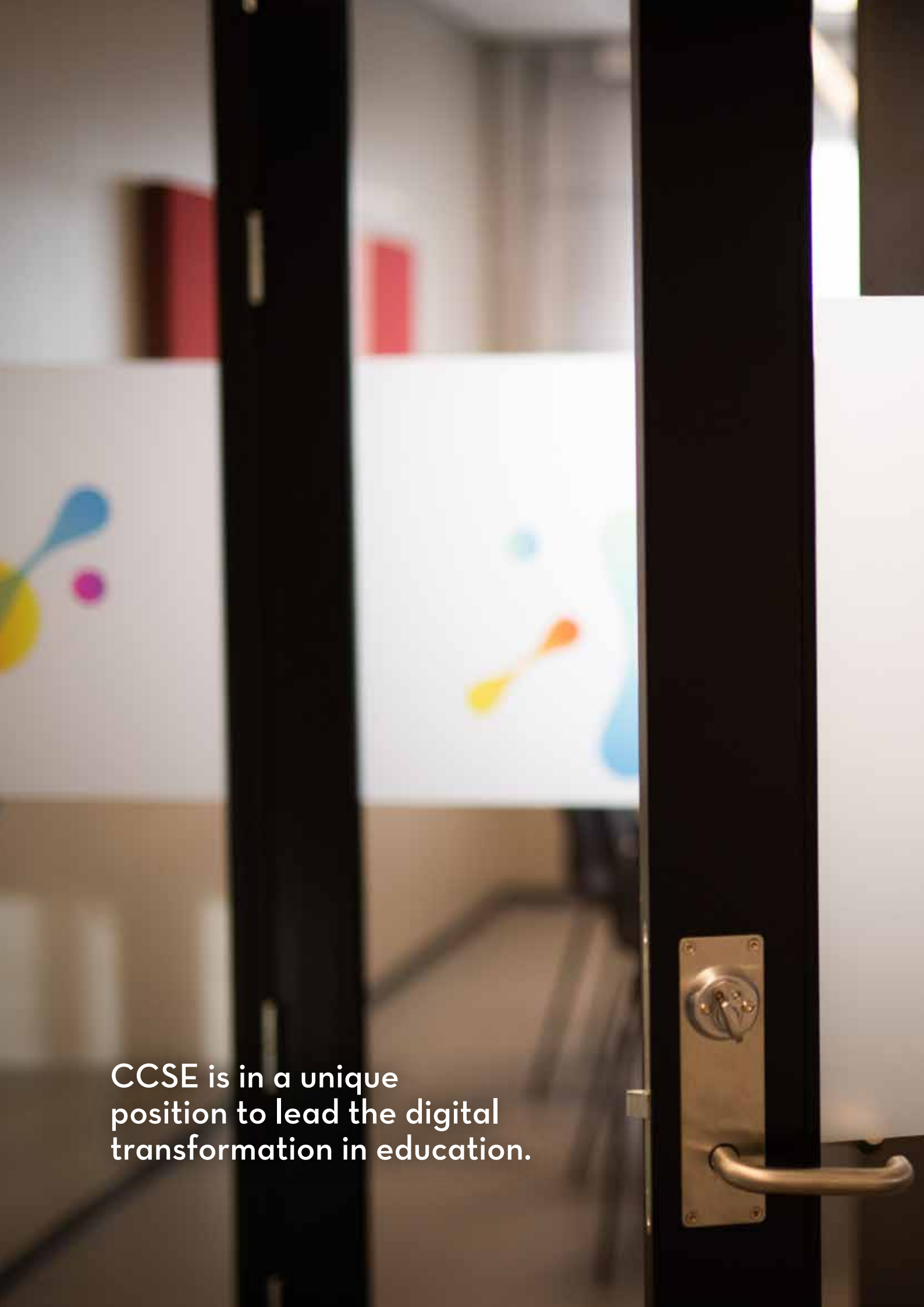
Other scientific staff

**ANDREAS HARALDSRUD***Lecturer*

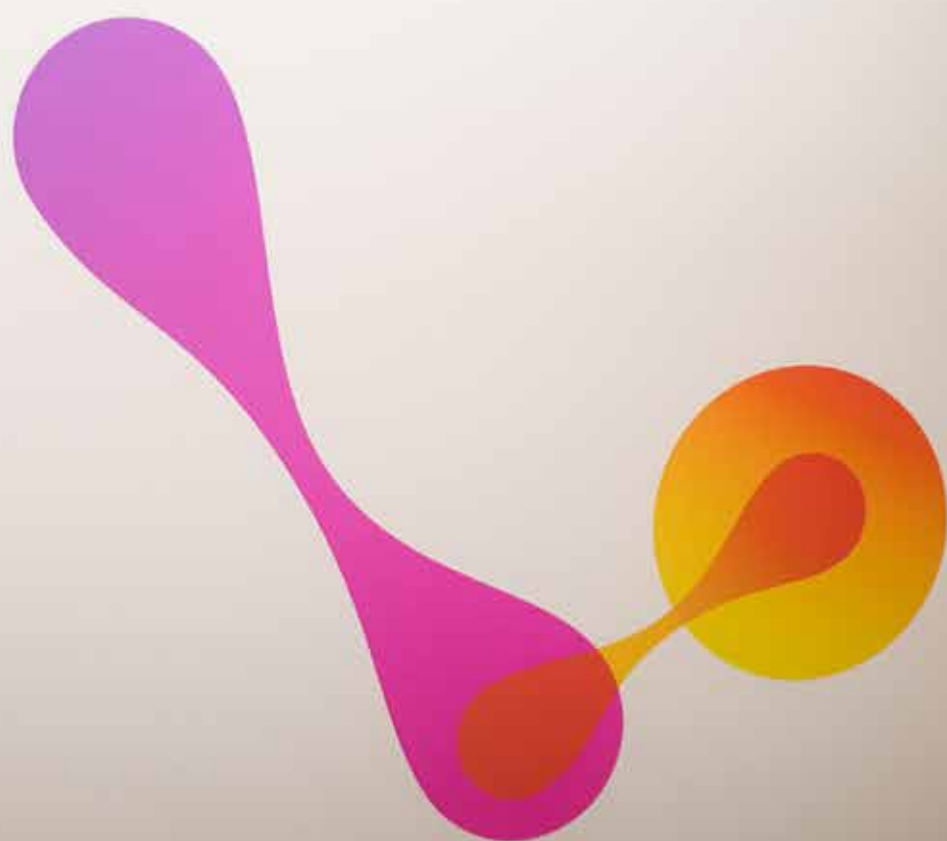
Andreas is a researcher and lecturer in chemistry and works with teaching and learning of chemistry and related scientific disciplines. He holds a PhD in chemistry education and is particularly interested in how computational approaches can be used productively for student learning. He is also teaching scientific programming to in-service teachers and is actively writing textbooks for students in both schools and in higher education. Through his efforts on teaching, he was awarded the title of "Distinguished Educator" in 2023.

**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 coauthored a textbook in programming for schoolteachers.



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



Personnel

Name	Function	Position	Unit
Center personnel			
Anders Malthé-Sørensen	Center leader	Professor	Physics, UiO
Tone Skramstad	Head of administration	Office manager	CCSE
Knut Mørken	WP leader, 20%	Professor	Math, UiO
Morten Hjorth-Jensen	Course development, 20%	Professor	Physics, UiO
Lex Nederbragt	WP leader, 20%	Senior lecturer	Biosciences, UiO
Geir Kjetil Sandve	Course development	Professor	Informatics, UiO
Hanne Sølna	Administrative mentor	Director of studies	Faculty Adm, UiO
Education research group			
Danny Caballero	Education research (20%)	Adjunct Professor	MSU/CCSE
Elise Lockwood	Education research (20%)	Adjunct Professor	OSU/CCSE
Ben Zwickl	Education research (20%)	Adjunct Professor	RIT/CCSE
Tor Ole Odden	Education research	Associate Professor	CCSE
Karl Henrik Fredly	PhD student		CCSE
Helene Lane	PhD student		CCSE
Henning V. Myhreagen	PhD student		KURT, CCSE
Ane Kristine Espeseth	Research Assistant		CCSE
Andreas D. Haraldsrud	Educational devel/research	Lecturer	KURT, CCSE
Jan-Fredrik Olsen	PhD student/Visiting researcher	Senior lecturer	Lund University
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



Name (continued)	Function	Position	Unit
Henrik Sveinsson	Course development, 10%	PhD student	Physics, UiO
Mikkel Lepperød	Couse development, 10%	Researcher	Physics / Simula
Anders Hafreager	Couse development, 20%	Ass. Prof.	CCSE, UiO
Student representatives			
Juval Somer	Student representative		UiO
Frida Lien	Student representative		UiO

External projects

Granting body	Project title	Project period	Funding	PI/partners
EU DIGITAL 2022 SKILLS O3	DIGIWIND	2024-2027	9.662 MEUR	DTU and 9 other partners including CCSE
IKTpluss/NRC	MaxSense	2022-2027	3300 kkr	PI: Anders Malthe-Sørenssen
Intpart/NRC	Bio-inspired Neural Networks for Artificial Intelligence systems: A US-Norway collaboration converging Neuroscience and AI	2020-2025	5709 kkr	PI: Anders Malthe-Sørenssen
CTM/Erasmus+	Computational thinking makes sense of mathematics	2024-2026	463 kkr	PI: Jan-Fredrik Olsen

Accounting 2024

Budget and Expenditures 2024

NOK Norwegian kroner	Budget 2024 HK-dir	Actual 2024 - HK-dir	Actual 2024 - UiO	Total
Personnel and indirect costs	4 212 737	3 560 017	4 828 245	8 388 392
Purchase of services				
Equipment	200 000	200 000		200 000
Other operating expenses	400 000	450 858	124 453	575 311
Student projects			1 183 401	1 183 401
SUM	4 812 737	4 211 005	6 136 099	10 347 104

List of products

Awards

Prize	Who	When
Excellent Teaching Practitioner and member of the Pedagogy academy at USN	Marius Lysaker (USN)	2024
NOKUT's Honorary Award	Knut Mørken (Mathematics/CCSE, UiO)	2024

Graduated PhD students

Who	Topic	When
Andreas Haraldsrud	Thinking Through a Computer - Simulations, Models and Representations in Chemistry	18.10.2024

Visitors

Who	Topic	When
Jenni Rinker	Associate Professor (DTU, Denmark)	February 14-16 2024
Ju Feng	Senior Researcher (DTU, Denmark)	February 14-16 2024
Gerald Feldman	Professor (GWU, USA)	February 18-21 2024
Ariel Steele	Postdoctoral Fellow (UMN, USA)	April 22-May 21 2024

Who (continued)	Topic	When
Sarah McHale	PhD student (UMN, USA)	April 15-May 21 2024
Tony Wong	Assistant Professor (RIT, USA)	May 12-15 2024
Mike Foster	Postdoctoral Research Associate (RIT, USA)	May 12-15 2024
Christian Cammarota	Postdoctoral Research Associate (RIT, USA)	May 12-15 2024
Michael Verostek	Post Doctoral Research Associate (RIT, USA)	May 12-15 2024
Boris Kozinsky	Professor, Harvard University	August 27, 2024
Peter Wulff	Juniorprofessor (PH-Heidelberg, Germany)	October 9-12 2024
Fabian Kieser	Researcher (PH-Heidelberg, Germany)	October 9-12 2024
Drew Jason Rosen	Lecturer (University of Edinburgh, Scotland)	October 9-12 2024
Bor Gregorcic	Visiting Researcher (Uppsala University, Sweden)	October 10-12 2024
Giulia Polverini	Visiting Researcher (Uppsala University, Sweden)	October 10-12 2024
Gerd Kortemeyer	Visiting Researcher (ETH, Switzerland)	October 10-12 2024
Melanie M. Cooper	Professor (MSU, USA)	October 16-17 2024
Niels Bonderup Dohn	Associate Professor (Aarhus University, Denmark)	October 16-17 2024
Jan-Fredrik Olsen	Senior Lecturer (Lund University, Sweden)	December 9-12 2024

Dissemination - external events

THE ROLE OF CCSE

Topic	Where, for whom	Who	When
Quality in higher education	Ministry of Education	Malthe-Sørenssen	11.06.2024
Gjør KI deg dummere	Arendalsuka, DN teltet	Malthe-Sørenssen	15.08.2024
Experiences from interdisciplinary education and research	UiO Leadership Meeting	Malthe-Sørenssen	12.09.2024
Experience from the CompSci cofund project	NMBU	Malthe-Sørenssen	17.10.2024
Gjør KI oss dummere	Hovedbiblioteket, Bergen	Malthe-Sørenssen	12.11.2024
Gjør KI oss dummere	Forskningsparken, Kongsvinger	Malthe-Sørenssen	13.11.2024
Gjør KI oss dummere	IT-avdelingens juleseminar, UiO	Malthe-Sørenssen	29.11.2024

CONTRIBUTIONS TO SEMINARS, WORKSHOPS AND CONFERENCES

Topic	Where, for whom	Who	When
Integrating Computing into Mathematics Education: A Case of Python Programming in Combinatorial Contexts.	James Madison University, Mathematics Department Colloquium	E. Lockwood	January 2024
Norske vgs-læreres perspektiver på programmering i naturfagene Programmeringsnettverket for realfag i skolen	(PRIS) Science education researchers and teacher educators	Henning Vinjusveen Myhrehaugen	21.03.2024
Integrating Computing into STEM Education: A Case of Python Programming in Combinatorial Contexts.	George Mason University, Gateway2STEM Seminar	E. Lockwood	April 2024
How Computational Physics Students Improve their Computational Literacy.	Physics Education Research Conference 2024	Fredly, Karl Henrik; Odden, Tor Ole Bigton; Zwickl, Ben	06.-11.07.2024
Norwegian Teachers' Views on Programming in Physics and General Science	Physics Education Research Conference (PERC) Physics teachers, educational researchers, and teacher educators	Henning Vinjusveen Myhrehaugen	09.07.2024
Hvordan ser norske fysikk- og naturfaglærere på programmering i fagene?	Landskonferansen om norsk fysikkundervisning (Norwegian physics teachers, science education researchers and teacher educators)	Henning Vinjusveen Myhrehaugen	11.08.2024
How Computational Physics Students Improve their Computational Literacy.	Physics Education Research Conference Proceedings	Fredly, Karl Henrik; Odden, Tor Ole Bigton; Zwickl, Ben	2024
Hva skal vi med programmering? Utforske!	Naturfagkonferansen 2024 (Norwegian science teachers, science education researchers and teacher educators)	Henning Vinjusveen Myhrehaugen	17.10.2024

WORKSHOPS AND CONFERENCES ORGANIZED BY CCSE PERSONELL

Topic	Where, for whom	Who	When
ProFag:Didactics	Course for upper secondary school teachers	Haraldsrud, Myhrehaugen	V24, H24
ProFag vgs 2	Course for upper secondary school teachers	Haraldsrud, Myhrehaugen	V24
ProFag vgs 1	Course for upper secondary school teachers	Haraldsrud, Myhrehaugen	H24
NAT3000	Course for upper secondary school teachers	Haraldsrud, Gregers	V24

Dissemination – internal events

CCSE SEMINAR SERIES

Title	Who	When
Computational Literacy at the University of Oslo: Practice and Research	Tor Ole Odden (CCSE, UiO)	13.05.2024
High School Teachers' Perspectives on Implementing Programming in Science: Affordances and Challenges	Henning Vinjusveen Myhrehaugen (KURT/CCSE, UiO)	13.05.2024
A Framework for Social Computational Literacy / Integrating Computational Modeling into Genetics Education	Christian Cammarota (Rochester Institute of Technology, Physics Education Research Group)	13.05.2024
Integrating computation into a physics bachelor's laboratory curriculum	Ben Zwickl (Rochester Institute of Technology, Physics Education Research Group/CCSE, UiO)	13.05.2024
Mapping Impact and Intent: Paths Towards Physics Computational Literacy and Physics Identity	Sarah McHale (University of Minnesota Twin Cities, School of Physics and Astronomy)	14.05.2024
How Computational Physics Students Improve their Computational Literacy	Karl Henrik Fredly (CCSE, UiO)	14.05.2024
The Design of a Computational Literacy Rubric/ How the Computational Tool can Influence Students' Enacted Computational Literacy	Mike Foster (Rochester Institute of Technology, Physics Education Research Group)	14.05.2024
Why are computations controversial in undergraduate mathematics education?	Jan-Fredrik Olsen (Lund University, Mathematics)	14.05.2024
Characterizing Longitudinal Development of Computational Literacy: Highlighting Needs and Opportunities	Tony Wong (Rochester Institute of Technology, Physics Education Research Group)	14.05.2024
Core Stages of Graduate Education Activate Imposter Feelings for Biology Doctoral Students	Ariel Steele (University of Minnesota Twin Cities, School of Physics and Astronomy)	15.05.2024
Computational literacy in chemistry and generative AI	Andreas Haraldsrud (KURT/CCSE, UiO)	15.05.2024
Computational literacy for education researchers: Creating a qualitative data analysis pipeline	Mike Verostek (Rochester Institute of Technology, Physics Education Research Group)	15.05.2024
Best uses of artificial intelligence in learning and teaching	Vidar Skogvoll (KURT, UiO)	15.05.2024
Large-scale spiking models of resting-state activity in monkey and human cortices	Sacha van Albada (Research Centre Jülich and University of Cologne)	20.06.2024
Spike sorting of dense recordings degrades information in a biophysical model of cortex.	Michael Reimann (EPFL, Switzerland)	20.06.2024
Launch/presentation of "Electric Brain Signals"	Geir Halsnes (NORA, UiO), Torbjørn V. Ness (NMBU), Solveig Næss (Norwegian Computing Center), Espen Hagen (Med, UiO), Klas H. Pettersen (NORA, UiO), Gaute T. Einevoll (Physics UiO/NMBU)	20.06.2024



Who (continued)	Topic	When
Deductive qualitative analysis at scale in PER using text embeddings	Tor Ole Odden (CCSE, UiO)	10.10.2024
Large Language Models and Prompt-Engineering in Science Education	Peter Wulff and Fabian Kieser (PH-Heidelberg)	10.10.2024
Understanding the nature of student and (possibly) AI reasoning using dual-process theories of reasoning	Drew Rosen (U Edinburgh)	10.10.2024
Assessing the performance of LMM-based chatbots in understanding physics representations	Giulia Polverini and Bor Gregorcic (Uppsala University)	11.10.2024
Using AI to foster learning in science in high school and university	Vidar Skogvoll and Andreas Haraldsrud (KURT, UiO)	11.10.2024
Ethel - a virtual teaching assistant at ETH Zurich	Gerd Kortemeyer (ETH Zurich)	11.10.2024
Transforming STEM Learning using Theory and Evidence	Melanie M. Cooper (Chemistry, MSU)	17.10.2024
Unlocking Potential - The Synergy of Scratch Coding and Science Labs	Niels Bonderup Dohn (Aarhus University, Denmark)	17.10.2024
Disputation	Andreas Haraldsrud (KURT/CCSE, UiO)	18.10.2024
Computational thinking in teacher education for primary and lower secondary school	Siv G. Aalbergsjø og Katarina Pajchel (OsloMet)	11.12.2024
Doesn't anything work? A reflection on how to organise teaching and problem sessions in introductory calculus, and the potential role of AI	Jan-Fredrik Olsen (University of Lund/ University of Oslo)	11.12.2024
Quantum Computational Literacy	Ben Zwickl (Rochester Institute of Technology/ University of Oslo)	11.12.2024
Development of Computational Skills: From Schools to Higher Education	Andreas Haraldsrud, KURT/CCSE, UiO	11.12.2024



THE BI-WEEKLY ODD SEMINAR SERIES AT CCSE

We have in 2024 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
(How) should the arrival of large language models change the way we teach programming?	Geir Kjetil Sandve, Professor, Ifi, UiO	15.01.2024
Teaching quantum physics on a high school level: How is it actually done?	Jana Legerská, PhD student at Charles University in Prague	12.02.2024
Upper Secondary School Science Teachers' Perspectives on Scientific Programming	Henning V. Myhre, PhD student KURT/CCSE, UiO	26.02.2024
ChatGPT as improv artist or conceptual blender: Models for LLM "cognition"	Tor Ole Odden, Associate Professor, CCSE, UiO	11.03.2024
Deductive qualitative analysis at scale using text embeddings	Markus F. Kreutzer, Jonas T. Mjaaland and Halvor Tyseng, Research Assistants, Physics UiO	08.04.2024
How should we teach programming in physics after the basics are in place?	Karl Henrik Fredly, PhD student, CCSE, UiO	22.04.2024
Impact Over Intent: Mapping Affective Outcomes of Curricular Change	Sarah McHale, PhD student, University of Minnesota	06.05.2024
LLMs and education research, a summerdream	Alan Macgillivray Harkness, student at OsloMet and UiO, Morten Tryti Berg, master's student, UiO	26.08.2024
On the discrepancy between the use of programming by mathematicians in their teaching and research	Jan-Fredrik Olsen, senior lecturer at Mathematics, Lund University/ PhD student CCSE, UiO	25.09.2024
Examining the scope of computational literacy (in physics)	Danny Caballero, professor of physics and computational science, MSU/CCSE, UiO	02.10.2024
The Mysteries of Proteins - Where Real Life Meets Artificial Intelligence	Andreas Haraldsrud, Lecturer and researcher, CCSE/KURT, UiO	11.11.2024
Generative Artificial Intelligence and Conceptual Blending	Tor Ole Odden, Associate Professor, CCSE, UiO	02.12.2024

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	Haraldsrud, Mørken, Gregers, Skogvoll	11.01.2024
REAL education, seminar (English)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Gregers, Haraldsrud, Mørken, Skogvoll	12.01.2024
REAL talk (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Gregers, Haraldsrud, Skogvoll	06.03.2024
REAL talk (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Gregers, Skogvoll, Haraldsrud	12.06.2024
REAL education, seminar (Norwegian)	Teachers at Faculty of Mathematics and Natural Sciences, UiO	Gregers, Haraldsrud, Mørken	15.08.2024
Learning Assistant Pedagogical Training		Skogvoll, Odden	Spring and Fall 2024

WORKSHOPS AND CONFERENCES AT CCSE

Topic	Where	Attendance	When
Computational Literacy Across the Disciplines. Workshop for invited participants.	CCSE, UiO	15	13.05.2024 -15.05.2024
Computational neuroscience mini-symposium	CCSE, UiO	25	20.06.2024
Generative AI and NLP in Physics Education Research	CCSE, UiO	20	10.10.2024-11.10.2024
Computing in Science Education Annual Christmas Seminar	CCSE, UiO	60	11.12.2024
Workshop on deductive qualitative analysis at scale using text embeddings	CCSE, UiO	15	17.12.2024



SEMINARS SERIES ON QUANTUM TECHNOLOGIES, MANY-BODY PHYSICS, MACHINE LEARNING AND QUANTUM MACHINE LEARNING (OR JUST Q&QAP)

Topic	Who	Date
Atomically Sharp and High-Density Sb Doping in Si for use in Quantum Devices	Simon Cooil (SMN, UiO)	22.01.2024
Observing and understanding electron-boson interactions in solids	Justin Wells (SMN, UiO)	29.01.2024
Parameterized Optimization of Quantum Circuits	Stian Dysthe Bilek (Physics, UiO)	05.02.2024
Time-dependent many-body theories	Håkon Kristiansen (Hylleraas, UiO)	12.02.2024
Parametric Matrix Models and Machine Learning	Morten Hjorth-Jensen (Physics, UiO)	19.02.2024
Introduction to quantum error correction	Joakim Bergli (Physics, UiO)	26.02.2024
Synchronization in two-level quantum systems	Joakim Bergli (Physics department, UiO)	04.03.2024
Seminar on Quantum Detectors for high energy physics by Michael Doser	Michael Doser (CERN)	05.03.2024

Student activities

STUDENT DEVELOPMENT OF LEARNING MATERIAL

Course and topic	Student	Teacher	When
Development of assignments for MN courses using A	Morten Tryti Berg	Vidar Skogvoll	10.06.2024-09.08.2024
Mentor for the B-service	Hanan Gharayba	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Tina Kalleson	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Philip Eskov	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Sylvia Jing Yi Huang	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Lars Botolv Ekeli Bråtalien	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Thalia Alex Mecham	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Hauk Sitre	Andreas Haraldsrud	15.08.2023-30.06.2024
Mentor for the B-service	Alessio Maurizio Canclini	Andreas Haraldsrud	15.08.2023-30.06.2024

Course and topic (continued)	Student	Teacher	When
Mentor for the B-service	Mikhail Zaruykin	Andreas Haraldsrud	15.08.2023-30.06.2024
Pattern formation in complex fluids	Pål Eivind Storvik Olsen	Andreas Carlson	01.01.2024-30.06.2024
Improving and developing new programs for the courses FYS-STK3155 and FYS-STK4155	Eric Emanuel Reber	Morten Hjorth-Jensen	01.01.2024-30.06.2024
Decoding social information from neuron populations	Jonathan Winsvold	Marianne Fyhn, Anders Malthe-Sørenssen, Torkel Hafting	01.01.2024-30.06.2024
Artificial intelligence and learning in natural sciences	Brage Brevig	Andreas Haraldsrud	01.02.2024-30.06.2024
Development of assignments for MN courses utilizing AI	Leah Hansen	Vidar Skogvoll	10.06.2024-09.08.2024
Development of assignments for MN courses utilizing AI	Simon Nordensten	Vidar Skogvoll	10.06.2024-09.08.2024
Development of assignments for MN courses utilizing AI	Fuad Dadvar	Vidar Skogvoll	10.06.2024-09.08.2024
Development of assignments for MN courses utilizing AI	Zara Fatima	Vidar Skogvoll	10.06.2024-09.08.2024
Development of assignments for MN courses utilizing AI	Barathy Pirabahar	Vidar Skogvoll	10.06.2024-09.08.2024
Development of assignments for MN courses utilizing AI	Alan Harkness	Vidar Skogvoll	10.06.2024-09.08.2024
Numerical computations in a new astrophysics course	Delfine Vågenes	Øystein Elgarøy	17.06.2024-31.08.2024
Numerical computations in a new astrophysics course	Olav Kristiansen Arnesen	Øystein Elgarøy	17.06.2024-31.08.2024
Programming and modeling assignments in biology	Aleksander Berge Gursli	Per Eugen Kristiansen, Lex Nederbragt	14.06.2024-31.12.2024
Programming and modeling assignments in biology	Ingrid Vik	Per Eugen Kristiansen, Lex Nederbragt	14.06.2024-31.12.2024
Programming and modeling assignments in biology	Philip Eskov	Per Eugen Kristiansen, Lex Nederbragt	14.06.2024-31.12.2024
Write code for the course FYS5429	Brage A. Trefjord	Morten Hjorth-Jenssen	01.06.2024-31.08.2024
Development of a wiki page: by the students for the students	Abdulrahman Mohamed Karama	Osman Gani	01.06.2024-01.10.2024
Computational modeling of Self-Supervised Grid Cells Without Path Integration	Mattis Dalsætra Østli	Anders Malthe-Sørenssen	01.06.2024-01.08.2024



Course and topic (<i>continued</i>)	Student	Teacher	When
Development of FYS312O as a result of Physics in the First Year	Carl Martin Fevang	Are Raklev	01.07.2024-15.08.2024
Development of FYS312O as a result of Physics in the First Year	Andrea Jensen Marthinussen	Are Raklev	10.06.2024-15.08.2024
Extending AST524O/924O with an intensity mapping analysis project	Håvard Skåli	Eirik Gjerløw	17.06.2024-31.08.2024
Educational development of FYS448O	Håkon Kvernmoen	Morten Hjorth-Jensen	01.08.2024-06.09.2024
Dynamic Mind Maps in Mathematics, Physics and Chemistry	Sylvia Huang	Anders Malthe-Sørenssen	15.06.2024-06.09.2024
Creating teaching materials for the Bayesian brain hypothesis correctly	Håkon Kjelland-Mørdre	Mikkel Lepperød	06.09.2024-15.06.2025

STUDENT RESEARCHERS

Theme	Students	Supervisors	When
Topological measures for navigational problems	Mattis Dalsætra	Vemund Schøyen	10.10.2023-29.02.2024
Causal inference for estimating neural connectivity	Jakob Sønstebo	Mikkel Lepperød	01.08.2024-30.09.2024

Publications

Scientific publications

- Cooper, Melanie M.; Caballero, Marcos; Carmel, Justin H.; Duffy, Erin M.; Ebert-May, Diane; Fata-Hartley, Cori L.; Herrington, Deborah G.; Laverty, James T.; Nelson, Paul C.; Posey, Lynmarie A.; Stoltzfus, Jon R.; Stowe, Ryan L.; Sweeder, Ryan D.; Tessmer, Stuart; Underwood, Sonia M.. Beyond active learning: Using 3-Dimensional learning to create scientifically authentic, student-centered classrooms. *PLOS ONE*, **19** (2024)
- De Chenne, A. & Lockwood, E. (In press). Computer programs as semiotic resources for counting problems. To appear in the *proceedings of the Fifteenth International Congress on Mathematical Education*. Sydney, Australia, July 2024 (2024)
- Geschwind, Gayle; Vignal, Michael; Caballero, Marcos; Lewandowski, H.J.. Evidence for validity and reliability of a research-based assessment instrument on measurement uncertainty. *Physical Review Physics Education Research*, **20** (2024)
- Geschwind, Gayle; Vignal, Michael; Caballero, Marcos; Lewandowski, H.J.. Using a research-based assessment instrument to explore undergraduate students' proficiencies around measurement uncertainty in physics lab contexts. *Physical Review Physics Education Research*, **20** (2024)
- Caballero, Marcos D.; Odden, Tor Ole Bigton, Computing in Physics Education. *Nature Physics*, **20** 339-341, (2024)
- Haraldsrud, Andreas; Odden, Tor Ole Bigton, Using feedback loops from computational simulations as resources for sensemaking: a case study from physical chemistry. *Chemistry Education. Research and Practice in Europe (CERAPIE)* (2024)
- McHale, Sarah; Odden, Tor Ole Bigton; Ken, Heller, Mapping intent and impact of activity design in a computationally integrated physics course. *Physics Education Research Conference Proceedings*, 280-285 (2024)
- Odden, Tor Ole Bigton, Computation as a Literacy in Physics. *Physics Education Research Conference*, (2024)
- Odden, Tor Ole Bigton; Tyseng, Halvor; Mjaaland, Jonas Timmann; Kreutzer, Markus Fleten; Malthe-Sørenssen, Anders, Using text embeddings for deductive qualitative research at scale in physics education. *Physical Review Physics Education Research*, **20**, (2024)
- Skogvoll, Vidar; Odden, Tor Ole Bigton, Lære fysikk med språkmodeller. *Fra Fysikkens Verden*, **2**, 74-80 (2024)

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Center for Computing in Science Education
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Center leader
Anders Malthe-Sørenssen

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

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