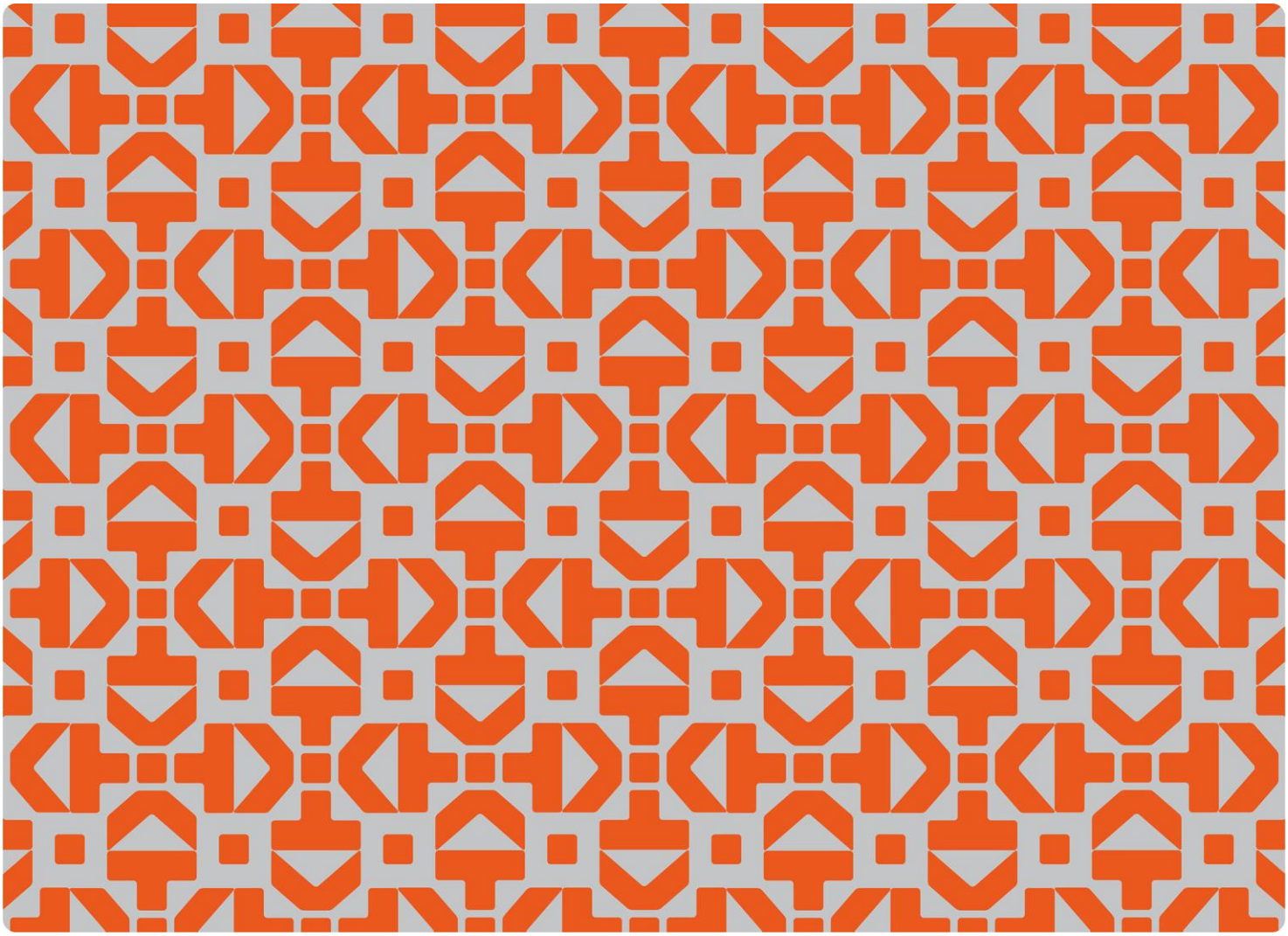
Norwegian Directorate for Higher Education and Skills

9th November 2023

Site visit report

Center for Computing in Science Education (CCSE)



Site visit report

Center for Computing in Science Education (CCSE)

This feedback is based on the site visit to Center for Computing in Science Education on 9th November 2023.

The feedback is written by Michael E. Caspersen, director of It-vest – networking universities and honorary professor at Department of Computer Science at Aarhus University, on behalf of Norwegian Directorate for Higher Education and skills (HK-dir).

The goal of the site visit was to:

- Provide advice to the centre about further development and priorities.
- Provide insight and reflections on centre development in the context of the centre plan and, where applicable, the feedback from the mid-term evaluation.

The written feedback is an important tool to achieve these aims. It is also important for supporting the dissemination of project results for the centre and for HK-dir.

The feedback will be published on the Directorate for Higher Education and Skills' webpages.

Centres for Excellence in Education
Site visit feedback

Part 1. The centre's goals and activities

1.1 How does the centre's activities help the centre reach its goals?

The vision for the Center for Computing in Science Education (CCSE) is to be recognised as a local, national, and international hub for research-based integration of computational methods in in education.

The Center for Computing in Science Education (CCSE) works systematically, goal-oriented and with great effort to achieve its clear and ambitious goals:

1. Develop a research-based foundation for the integration of computing into basic education and to become an international hub for this activity;
2. Lead research-based development of new learning materials, methods and practices;
3. Study the effects of the new learning materials, methods and practices, in particular how they transform the culture for teaching and learning;
4. Involve students deeply in the development of new practices and methods;
5. Disseminate and adapt the practices and results across disciplines in collaboration with key partners.

To match these five goals, CCSE has from early on established five development areas[1], each with a senior leader[2].

In the mid-term evaluation of four Centres for Excellence in Education in 2020[3], it was recognised that:

- CCSE's management structure is well thought out;
- CCSE is well integrated into the wider organisation;
- CCSE is strongly supported through highly competitive grants;
- CCSE is well on the way to fulfil all of its five goals.

All of these are confirmed by the present evaluation.

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[1] See Development areas we are working with @ the CCSE website.
[2] See Work package leaders under People @ the CCSE website.
[3] Mid-term evaluation of 2016 Centres for Excellence in Education, report no. 7, Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education, 2020.

In addition, the mid-term evaluation recognised that CCSE has the potential to become truly world leading – to go from good to great – but that this ambition was not necessarily reflected in the centre plans for the second round, which it should be.

Recent initiatives and derived opportunities indicate that CCSE has taken this advice seriously:

- Intensified collaboration with strong international communities in physics education research:
    - Michigan State University (to which there is a particularly strong relation due to one of the CCSE leaders' co-affiliation);
    - University of Colorado Boulder (where Nobel Laureate Carl Wieman almost twenty years ago initiated the Science Education Initiative and a strong tradition for physics education research and development);
    - Oregon State University.
- Collaboration through international platforms for educational and research partnerships, e.g. the university networks Circle U. and The Guild;
- Organisation of the Nordic Regional Learning Assistant Workshop – a two-day workshop in June 2022 with facilitators from University of Colorado Boulder and participants from the Nordic countries;
- Organisation of the Oslo Physics Education Research Summer Institute 2022 – a week-long workshop for physics education research groups from the three US universities mentioned above as well as Scandinavian physics education research colleagues;
- A chapter – *Physics computational literacy: what, why, and how?* – in The International Handbook of Physics Education Research: Learning Physics, 2023;
- Two incoming Fulbright Fellows and a visiting researcher
    - Associate Professor Ben Zwickl, Rochester Institute of Technology: Physics education research (2022);
    - Professor Gerald Feldman, George Washington University: Active learning (2023);
    - Senior Lecturer Jan-Fredrik Olsen, Lund University: Mathematics education research (2023-2026).
- An upcoming invited review article on computational literacy in physics for the prestigious journal Nature Physics – a clear indication of the status the centre has achieved in the international community.

In the past three years, CCSE has indeed pursued the opportunity to go "from good to great" and become truly world leading.

This development is recognised by the university. The consideration is that CCSE have had more influence than they might know. CCSE was an early initiator of computational methods in science education. Overt time, arguments have gained power, also in research. CCSE is not the only driver, but an important driver for the development – also to influence politics at the international level.

For very good reasons, CCSE is considered a global lighthouse when it comes to research-based development and implementation of computational methods in study programmes at undergraduate as well as graduate level – particularly in the domain of physics education.

1.2 What are the strengths that the centre draws on in achieving its goals?

CCSE draws on several strengths related to internal factors, organisation, and priorities.

1.2.1 Internal factors

First and foremost, the strength of CCSE is the people in and around the centre.

The "founding fathers" and key people of the centre are physicists; thus, physics education research and development is the source from where the centre's activities spring.

The five leaders involved in the centre possess a rare combination of

- strong academic merits
- theoretical as well as research- and experience-based knowledge about education
- deep knowledge about and ambitious visions for computational literacy as a driver for disciplinary renewal
- strong management and communication skills
- bridge-building abilities (for lack of a better word)

When all this comes together and is brought forward with a genuine and appreciative interest in collaboration with others who are experts in the various fields, good things are bound to happen.

In short: people matter. At the same time, this is the essential strength but also a potential weakness of the centre.

1.2.2 Organisation

As pointed out in the mid-term evaluation in 2020, CCSE's management structure is well thought out and with strong leaders in all five development areas:

- Research-based development of methods and approaches
- Research-based development of learning material
- Development of a culture for teaching and learning
- Development of student-driven activities
- Dissemination, dialogue, and communication

The goals of the centre are reflected in these five areas, which all are managed by senior leaders. This is a second strength of the centre, but it will be a key challenge to maintain this at the same time broad and deep focus of the centres activities when the funding period ends.

1.2.3 Priorities

CCSE has made some key priorities for their modus operandi.

3.1 Inside-out and depth-first

The essential priority of CCSE has been to work "inside out" and "depth-first", i.e. to initially implement high-quality computational materials and methods at the bachelor level in physics.

With first year physics as a solid foundation as well as a convincing and inspiring role-model, the centre activities has gradually spread to other study programmes in the natural sciences, at other faculties and at other educational levels before or after the bachelor level (K-12 as well as graduate programmes at master and PhD level). And eventually gradually disseminating materials and methods to other universities in (Southern) Norway.

The "inside-out" and "depth-first" approach has proven to be a highly successful strategy.

3.2 A strong educational research group

Since its beginning, the centre has been and continues to be successful in recruiting international (visiting) researchers, including Fulbright Fellows in strategic focus areas (see details above in part 1).

3.3 Research-based development of materials, methods, and approaches

CCSE has prioritised to develop and maintain a multitude of research-based teaching materials[4].
Complementary to the development of teaching materials, the centre conducts research-based development of teaching methods and approaches[5].

Research-based materials as well as methods and approaches are the bread and butter of the centre's activities and essential for its success.

3.4 Build and maintain a culture for teaching and learning
CCSE works holistically – in several diverse and complementary areas – to establish and maintain a strong and viable culture for teaching and learning[6].

This is an important aspect of all (university) education, and it is commendable that CCSE is also addressing this. However, it is not strictly tied to the centre's overarching goal of advancing computational methods in (science) education.

3.5 Student-driven activities
CCSE is also focused on engaging students as partners at all levels of the educational reform[7].

This is utterly important; students are the future, and it is essential to prioritise and support student-driven activities around the core activities of the centre.

3.6 Network collaboration with "co-suppliers"
CCSE takes advantage of strong network collaboration within the university with many different but relevant types of expertise. The centre has established collaboration with people with educational expertise from other faculties, centres, and departments at University of Oslo including Faculty of Educational Sciences, Centre for Educational Measurement, and Department of Teacher Education and School Research.

This is exemplary, but again it will be a challenge to maintain this broad collaboration after the funding period ends. On the other hand, this is an opportunity to join forces by forming new organisational structures or to establish structures that can facilitate continued development of a culture of collaboration.

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[4] See Research-based development of teaching material @ the CCSE website.
[5] See Research-based development of methods and approaches @ the CCSE website.
[6] See A culture for teaching and learning @ the CCSE website.
[7] See Student-driven activities @ the CCSE website.

3.7 Dissemination nationally and internationally

The success of the centre depends on its ability to transform and transmit its practices to other fields and institutions, locally, nationally, and internationally. Early, the centre developed a dissemination plan based on research into how to best disseminate and spread excellent practices[8].

Local dissemination is realised as extensions to new programs at the University of Oslo; this work is carefully organised through partnerships, typically through a four-stage approach:

- Develop plans with leadership and senior faculty
- Competent PhD students develop new materials and approaches in collaboration with seniors
- Pilot courses are tested with students and adjusted and integrated into regular courses by faculty
- Regularly investigate and adjust approaches – and evaluate and review with leadership.

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The seven priorities outlined above reflect the ambitious goals of the centre and how the centre draws on its strengths to ensure high quality in all activities. Together with the internal factors and the management aspect, they have been essential for CCSE to reach its goals.

But what are the ambitions for the future when the funding period ends? Is it the goal to maintain the status and level of operation that has been achieved. Is it the goal to enhance it even further? Or is it the goal to settle with less ambitious goals and a reduced scope of activities?

Either way, on the forward it will be crucial to ensure alignment between goals and means of the centre.

[8] See Dissemination, dialogue and communication through partnerships @ the CCSE website.

1.3 What possible challenges does the centre face in realizing its goals?

The centre is very successful in achieving its goals.

The main challenge is to maintain the impact when the centre ceases to exist, when the special funding is no longer available, and when status and the derived visibility as National Centre of Excellence ends.

CCSE management as well as management at faculty and university level are well aware of this. They recognise that universities are conservative structures. In many situations, this is not only a good thing but a distinct quality. However, a downside is that conservative structures easily kill innovation. Therefore, special measures need to be taken in order to ensure continued development of computational methods in education across the University of Oslo and beyond.

As a first step, it has been decided to merge CCSE with KURT – Centre for Teaching and Learning in Science.

One consideration is to try to create networks among the various Centres of Excellence located at University of Oslo. This may create a significant critical mass of people, but in order to be viable in the long term, it is essential that the people in the network have a sense of unity and common goal. Whether that will be possible depends on the similarity of the goals of the centres.

A radical model might be to mimic an initiative like the MIT Schwartzman College of Computing and their Common Ground for Computing Education initiative (adapted to the context of UiO).

Globally, there is an emerging trend to embrace computational methods and digital competences – including artificial intelligence – in all areas of research and education. From the humanities over social science, life science, natural science to engineering, computational methods are increasingly embraced not just as a tool but as an orderly, formal framework and exploratory apparatus for research and education.

With CCSE, University of Oslo is at the global forefront of developing educational materials and methods based on a computational approach integrated with other and more traditional approaches.

Consequently, University of Oslo has a unique opportunity not just to stay at the forefront by continuing the efforts of CCSE, but eventually to apply computational literacy as a driver for disciplinary renewal in all areas of the university. It is recommended that the university seize this unique, cross-cutting opportunity.

Part 2. Impact

2.1 What are the centres main contributions to quality development in higher education?

CCSE's main contributions to quality development in higher education, that other institutions, national and international, can learn from are:

- Research-based methods and approaches for developing and integrating computational literacy in (science) subjects – primarily in higher education, but to some extent also in upper secondary education;
- High-quality and research-based teaching and learning material for a broad range of (science) subjects, both in higher and secondary education;
- Exemplary approaches for developing student-driven activities; and
- Documentation of the achievements (approach and effect) in prestigious scientific publications.

Overall, the achievements of the centre are impressive; but even more so due to the high societal relevance of equipping graduates in all disciplines with strong digital skills, particularly with respect to computational methods.

2.2 What opportunities and obstacles do you see in the centres efforts to support other academic communities to adopt knowledge and practices developed by the centre?

Opportunities
CCSE is more than well on the way and with establishing

- a strong, coherent, and experienced educational research group (people);
- a structured and research-based approach to development (materials and methods);
- an increasing portfolio of exemplary cases from different fields (a strong track record of materials, methods and transformed courses/programmes); and
- a solid student base, primarily in physics (computational natives)

Obstacles
The potential obstacles identified relates to the centre's future:

- There is no clear exit strategy for the centre;
- The ideas for future organisation of the centre's activities implies a risk of fragmentation; and
- Distribution of activities may imply lack of critical mass, which may result in degradation of the exceptionally strong position which has been achieved by the centre.

It is not clear who has the responsibility for formulating the exit strategy. It is recommended that all stakeholders (the central university management, the Board of CCSE and representatives from CCSE's management team) join forces in formulating an exit strategy. A complete exit strategy is not only about people but should also address issues related to structures and culture; this is essential to ensure continued viability of the activities.

There are considerations to distribute current CCSE activities to KURT – Centre for Teaching and Learning in Science and Department of Physics. While there are obvious immediate reasons these considerations, it may be relevant to consider these in light of the aforementioned potential obstacles.

Part 3. Summary and advice going forward

For the remaining period of CCSE as a national Centre for Excellence in Education it is recommended that the centre and relevant stakeholders at University of Oslo consider the following key points:

1. Formulate an explicit exit strategy for CCSE.

2. Continue to strengthen the centre's activities and disseminate results both nationally and internationally.

3. Seize the unique and timely opportunity by building on the foundation of Center for Computing in Science Education.

    - With CCSE, University of Oslo is at the global forefront of developing educational materials and methods based on a computational approach integrated with other and more traditional approaches to teaching and learning in higher education.

    - Consequently, University of Oslo has a unique opportunity not just to stay at the forefront by continuing the efforts of CCSE, but eventually to apply computational literacy as a driver for disciplinary renewal in all areas of the university.

    - It is recommended that the university seize this unique, cross-cutting opportunity.

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