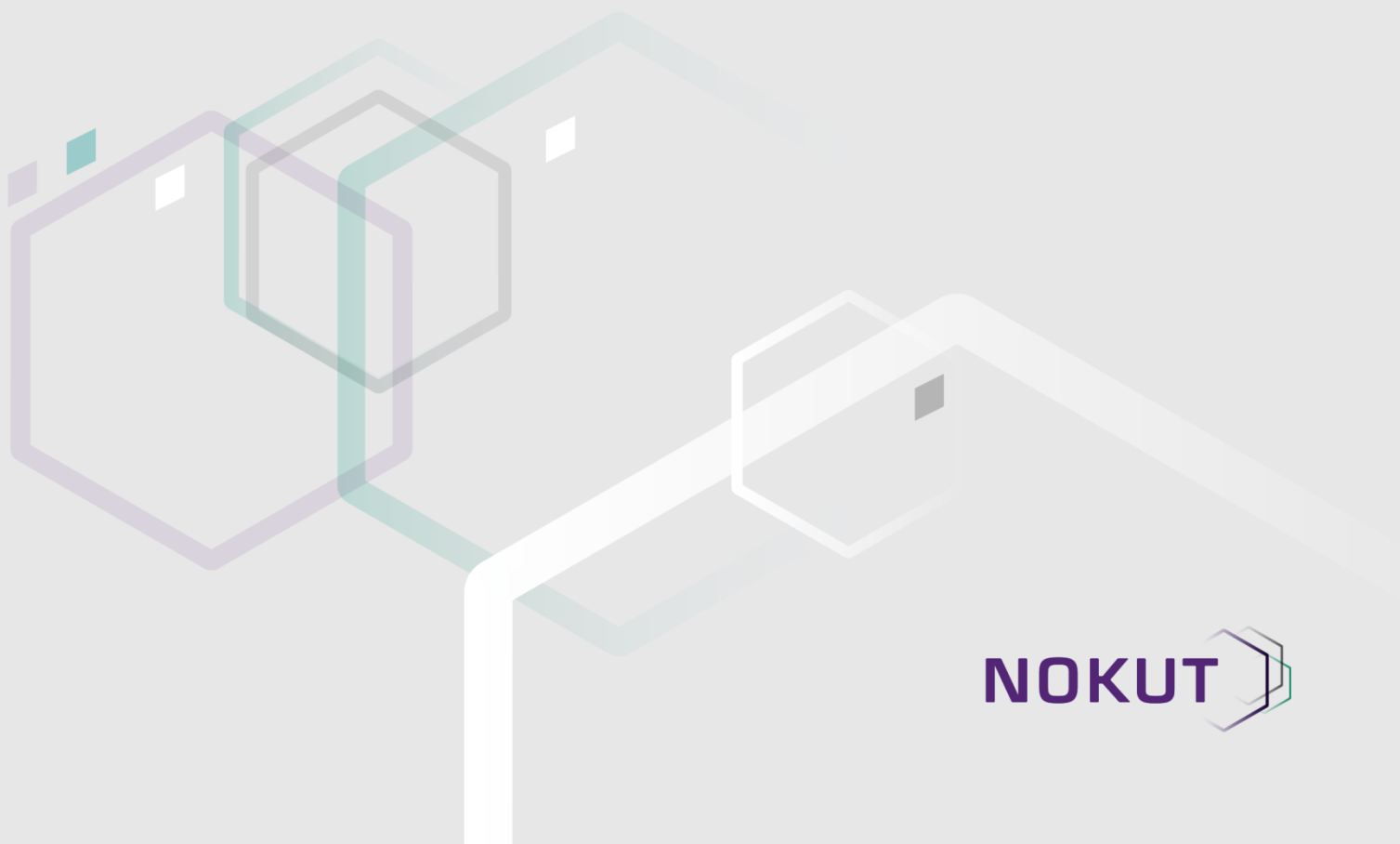


NOKUT's research and analyses

Research as foundation for education: Centres of Excellence and good practices

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Abstract

The Norwegian Centres of Excellence (CoE) schemes in research, research-based innovation and higher education are government instruments for quality enhancement. The CoE schemes constitute the three corners of the knowledge triangle. There is no doubt that these centres produce research, innovation and knowledge that strengthen the quality of education. We show that the centres use new research in their teaching, and include students in their R&D, thus adding important value to teaching and education. Moreover, students are viewed as a resource to the CoEs' R&D. In addition, the centres – to take advantage of their staffs expertise and R&D – establish new study programs at different educational levels. While Centres of Excellence in Research (CoE-R) and Centres of Research-based Innovation (CoE-I) mostly involve PhD and master students, the Centres of Excellence in Higher Education (CoE-E), to a larger degree, target the bachelor- and master level. The centres work actively to recruit talented students, offer their supervision, network and infrastructure, and emphasize the importance of including the students both academically and socially.

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1 Introduction

Norway has Centres of Excellence (CoE) schemes in research, research-based innovation, and higher education. Each of the schemes represent a corner in the knowledge triangle. There is no doubt that the CoEs produce research, innovation and knowledge that strengthen the quality of education and teaching. By law, all higher education in Norway should be R&D-based. We therefore expect that the CoEs hosted by higher education institutions (HEIs) have strategies for interaction between the corners of the knowledge triangle. By seeking out good practices at different centres, this paper provides examples of how the excellence of CoE schemes in research, innovation, and education manifests itself in the quality of education:

- How do CoEs add value to students' education?
- What strategies do the CoEs use to engage students?

First, we present the CoE schemes in question and provide some background information on how research and innovation may enrich education. Second, we describe the methodology for the survey and interviews conducted. Thirdly, we present our results and analysis.

1.1 CoE schemes in Norway

All three CoE schemes in question are instruments of the Norwegian government¹ for enhancing the quality of research, innovation, and education. Universities, universities of applied sciences (University College)² and research institutes may host the centres.

Centres of Excellence in Research (CoE-R) is the Research Council of Norway's (RCN) ultimate instrument for promoting quality in Norwegian research. Scientific quality at a high international level is the main criterion for the selection of applications. The 21 CoE-Rs annual funding from NRC varies from 1-2 mill. Euro. The funding period is five years, with a possibility of a second five-year period.

Centres of Research-based Innovation (CoE-I) is a scheme to enhance technology transfer, internationalization, and researcher training in close collaboration between R&D-performing companies and high quality research. The scheme assumes co-financing between companies, the host institution, and the RCN. The main criterion for selecting the centres is the potential for innovation and value creation. The 21 CoE-Is annual funding from the RCN varies from 1-1.5 mill. Euro. The funding period is five years, with a possibility of another three years.

Centres of Excellence in Higher Education (CoE-E) is a scheme to promote the development of excellent quality in higher education and to highlight the fact that education and research are equally important activities for higher education institutions. The objective of the scheme is to encourage outstanding research and development-based education. The Norwegian Agency for Quality Assurance in Education (NOKUT) selects the CoE-Es, and these centres can be seen as a parallel to

¹ The CoE schemes in research and research-based innovation are administered by the Research Council of Norway. NOKUT administers the CoE scheme for education. Both are government agencies.

² In practice, university colleges rarely host CoEs.

other top centres within research. The four CoE-Es' funding from NOKUT equals about 0.5 mill. Euro per year. The funding period is five years, with a possibility of a second five-year period.

1.2 The relationship between education, research and innovation

The concept of the knowledge triangle provides a way of understanding the relationship between education, research, and innovation and promoting the importance of this relationship for business and society. The Council of the European Union states that:

“(…) for education to fulfil its role in the knowledge triangle, research and innovation objectives and outcomes need to feed back into education, with teaching and learning underpinned by a strong research base, and with teaching and learning environments developed and improved through greater incorporation of creative thinking and innovative attitudes and approaches” (2009, p 4)

Norwegian higher education has adopted a broad understanding of research-based education, including the terms “development-based” and “evidence-based” (Lid 2012; Kyvik and Vågan 2014). The broader Norwegian concept of R&D-based education is included in the law relating to Universities and University Colleges. The law states that Norwegian institutions should provide “higher education of a high international standard on the basis of the foremost within research, academic and artistic development work and empirical knowledge” (Norwegian Ministry of Education and Research, 2005).

It has long been the prevailing view that R&D-based education depends on the teacher's knowledge, attitudes and skills (Barnett 2005). In this way, the teachers' research involvement is a guarantee of quality and a CoE in research is optimal for R&D-based education. However, in the last decade or so, there has been a shift towards student-centred learning. When the students are involved in research or more active learning processes they benefit more strongly from R&D-based education (e.g. Healey 2005). The teachers' research is in this context primarily seen as *possible indicators* or prerequisites for R&D-based education (Lid 2012). Hence, having a CoE in research is not a *guarantee* for good R&D-based education in itself. In this paper, we explore examples of how different CoEs schemes contribute to education and cases of good practice where CoEs succeed in disseminating some of their expertise to the students.

2 Data collection and methodology

We collected data through a survey (see appendix 1) and in-depth interviews with representatives from six centres. We also received an overview of the number of employees in different job categories, students/fellows associated with the centre. Moreover, we received information about study programs taught by centre staff, and the development of new programs included in the centre's strategy and plans.

Sample

We conducted the survey in the spring of 2015, and sent it to all four CoE-Es, and a selection of the CoE-Rs and CoE-Is. As this paper deals with the relationship between the CoEs' activity and

education, we chose CoE-Is and CoE-Rs with a higher education institution (HEI) as their host institution. Because we chose a good practice perspective for the report, we selected centres where the RCNs' midterm evaluations indicated a positive link between centre research and the host institutions' education (RCN 2006; 2010; 2011). The final selection of centres surveyed is shown in table 1.

Table 1 Selection of CoEs surveyed and interviewed, organized by CoE scheme. Table also indicate the CoEs' host institution.

CoE scheme	Name of centre	Host institution	Interviewed
CoE-E	Centre of Excellence in Music Performance Education (CEMPE)	Norwegian Academy of Music	
	Centre of Excellence in Biology Education (bioCEED)	University of Bergen and the University Centre in Svalbard	Yes
	Centre for Research, Innovation and Coordination of Mathematics Teaching (MatRIC)	University of Agder	Yes
	Centre for Professional Learning in Teacher Education (ProTed)	University of Oslo and University of Tromsø (UiT) – The Arctic University of Norway	
CoE-R	Centre for Ecological and Evolutionary Synthesis (CEES)	University of Oslo	Yes
	Centre for Molecular Inflammation Research (CEMIR)	Norwegian University of Science and Technology, NTNU	
	Centre for Geobiology (CGB)	University of Bergen	Yes
	Centre for Theoretical and Computational Chemistry (CTCC)	UiT – The Arctic University of Norway	
	Centre for Multilingualism in Society across the Lifespan (MultiLing)	University of Oslo	
CoE-I	Innovative Natural Gas Processes and Products (inGAP)	University of Oslo	
	Centre for Integrated Operations in the Petroleum Industry (IO)	Norwegian University of Science and Technology, NTNU	Yes
	Structural IMPact Laboratory (SIMLab)	Norwegian University of Science and Technology, NTNU	Yes
	Sea Lice Research Centre (SLRC)	University of Bergen	

The survey was sent to 14 centres, and we received responses from 13 of them, with a total of 51 individual responses. 21 responses came from CoE-Es, 14 from CoE-Rs and 16 from CoE-Is. 11 respondents have indicated that they are centre managers, 27 that they are researchers/faculty associated with the centre and 12 that they are administrative personnel.

The students were not included in the survey or interviews, as they are less likely to know how the centres presence affects their education. The centres did however answer questions on their conceptions of the value added for the student experience.

The questionnaire had four parts. The first part identified the respondent's affiliation with the centre. The second had questions about the centre activities' relevance for educational activities at the host institution and contribution to teaching and supervision among affiliated employees. The third section identified changes in the employees' time for research, teaching, supervision and other tasks resulting from centre status. The last section asked various questions about whether centre activity has led to higher quality in education in relevant study programs at the host institution. For all questions a one to five-point Likert scale was used (1 indicates the lowest and 5 the highest value). Respondents were also encouraged to elaborate their answers with examples in text fields.

We interviewed six centres, two of each centre type. These were selected based on findings from the survey that we wanted to explore further.

We conducted group interviews with several representatives from the individual centres, and we interviewed each centre separately. The aim of the interviews was to identify examples of how the centres prioritize to increase the quality of education. The interviewees were largely able to speak freely about topics and measures with which the centres were concerned.

Choosing a good practice perspective for this report, means that we only to a limited extent investigated any downsides associated with centre status and quality of education. The number of participating centres is also too small to be representative in terms of centre type, subject etc. to draw general conclusions about how different centre types contributes to the quality of education. It does however provide valuable input and good practice examples.

3 Results

98 percent of the survey respondents agreed to the statement "The centre's research is relevant for study programs at the host institution." The interviews confirmed that even though the mandate differs, all the three Centres of Excellence contribute to teaching and learning. This underpins the report's synthesis, that CoEs can have great value for education and teaching.

Below we will elaborate on the different ways CoEs contribute to education. First, we discuss how the centres interact with education at different educational levels because of different intensions. Second, we describe how the students can be a resource into the CoEs' R&D. We discuss how the CoE staff prioritize their time between different activities, before we give examples of how CoEs succeed at involving students. In the end, we present lessons learned from the analysis as well as concluding remarks.

3.1 How do the CoEs interact with education?

The three CoE schemes have different purposes, yet as mentioned above, almost all our respondents believe that the centres' research is relevant for study programs at the HEIs. Below we describe the ways in which the CoEs interact with education.

3.1.1 Targeting students at different levels

According to the survey it is important for Centres of Excellence in Innovation and Research to participate in teaching at PhD³ (average rating among respondents is 4.8 on a scale from 1-5) and master level (4.4) and to a lesser extent bachelor level (3.3). The priorities reflect that their research is relevant for different educational levels. CoE-Rs and CoE-Is use the centre's own research largely in PhD- (4.9) and master level education (4.5) and less often at the bachelor level (2.9). The interviewees said that the students often needed to be at the master level to have sufficient knowledge of research methods and theory to grasp the centres' research.

Centres of Excellence in Education want to contribute to teaching and learning at the bachelor (average response rating 4.9) and master level (4.7), and to a lesser extent at the PhD level (3.2). The output of CoE-Es' research and activities are relevant at the bachelor and master level (4.0) rather than at the PhD level (2.5). At the same time, the centre staff are also academics within their discipline, and engage in research that may be more relevant at the PhD level. They use their own R&D mostly at the masters' level (4.3), then PhD (4.2) and bachelor's level (4.1).

Our results indicates that the CoE-Rs and CoE-Is are relatively similar to each other, compared with CoE-Es. Throughout the report, we will therefor often present the results separately for the two groups.

3.1.2 Different contributions to education

CoE in Research and Research-based Innovation: Changing the content/curriculum of a course/study program

We found that the Centres of Excellence in Innovation and Research are likely to make changes in the content of study program(s) based on their research and innovation. First, these centres have their origin in established academic environments that also run educational activities. The centres' research is based on (a mix of) existing study programs at the institution. As a centre conducts research and makes new discoveries, it updates the content in relevant courses. This could include revising or updating the curriculum of a course/study program, and introducing new technology. The survey indicated that the CoE-Rs' and CoE-Is' R&D largely affect the content in relevant courses at the master (4.0) and PhD level (4.3), and to a smaller extent at the bachelor level (2.4).

Second, with investments made in human resources and infrastructure, the centres are building expertise within its research field. This could lead to development of new courses or study programs. The centres may create new courses based on their research and innovation or as a response to the needs of society and industry. This argument seems to be particularly relevant for interdisciplinary centres and CoE-Is. Because the centres are funded for a limited period, the development of a study program can secure a continuation of their research. In the application for CoE status, some centres also include development of new study programs.

³ PhD students in Norway are fully funded and classified as academic staff at the institutions.

Third, new discoveries and world-leading research is relevant and interesting for future specialists. The staff typically want to include their research in teaching and education to recruit and inspire students for further studies and their PhD programs.

In total, CoE-Rs and CoE-Is report that the quality in education and supervision has increased with the centres' presence, at the PhD (4.5) and master level (4).

CoE in Education: Changing the premises and teaching of a subject/study program

Centres of Excellence in Education conduct R&D projects that aim to increase the quality in education within their field of expertise. CoE-E staff believe they have had the greatest impact on the quality of education at the bachelor level (3.8) and master level (3.5). Their R&D addresses teaching methods, learning outcomes, evaluation methods and structure of study programs. Accordingly, CoE-E activities aim to change the preconditions and teaching of a subject/study program more than the actual content.

First, how the content, the different courses and the study program are integrated, is important to education quality. Through their R&D, and the implementation of it, the CoE-Es can affect the organization of study programs and the students' satisfaction. CoE-Es use knowledge accumulated through their R&D to make changes that increase relevance, reduce dropout rates and improves learning outcomes. These kinds of changes are not necessarily obvious to new students, although the framework of their education is changing. The respondents indicate that the impact mainly has been development of teaching and learning methods and better adaptation of existing courses and modules at the bachelor and master level. The respondents further indicate that the CoE-Es' R&D on average has a larger effect on teaching methods at the bachelor (3.8) and master (3.6) than at the PhD level (2.4). Examples of new teaching methods include the use of seminars/workshops/small groups, more active learning, more varied forms of evaluation, closer examination of the actual learning and increased use of interactive teaching methods.

Second, having a centre that focuses on quality in education seems to change the attitude towards teaching and education at the host institutions. Most of the CoE-E faculty members are also active teachers. When they engage in the centres' activities, they become more aware of different factors that enhance teaching and education. This awareness affects the individuals' teaching as well as the academic environments' attitude and openness towards discussing and sharing teaching efforts.

3.2 Students as resources

Centres of Excellence view students at relevant educational levels as great resources. Hence, it is important for the centres and individual faculty members that the students succeed. This combination gives faculty members a strong incentive to be excellent advisors for their students.

CoE in Research and Research-based Innovation: Affiliated PhD and master students are given opportunities

PhD students are important resources in the Centres of Excellence in Innovation and Research's research projects (average survey rating 4.9). PhD students are considered as part of the professional team and contribute to research projects with their labour and expertise. Master students are also

considered important (4.0), and all the centres' we surveyed had affiliated master students. Students can be relevant for collaboration with the centres through writing theses or conducting parts of research projects. Affiliated master students conduct high-level research and publish in prestigious journals. All the centres we interviewed gave the students access to their infrastructure. Students learn how to conduct high-level research, and use new types of analysis and technologies. Interviewees at several centres were clearly impressed with their master students' accomplishments, and pointed out that the students' performance could sometimes be as advanced as "small" PhD dissertations.

CoE-Rs and CoE-Is prioritize supervision of PhD students (5.0) and master students (4.8). The students are supervised through assignments, which are relevant to the centres and part of the centre's projects. When supervising their students the centre staff benefits from having access to research resources, external supervisors and partners.

To a limited extent, the bachelor students are considered resources for CoE-Rs and CoE-Is (average survey rating 2.3). None of the centres surveyed had affiliated bachelor students and hardly supervised bachelor students on projects relevant to the centre.

CoE in Education: All students are relevant for R&D

Students are the focus of the CoE-Es' R&D projects and activities. The centres considered bachelor and master students (4.6) as great resources, and PhD students to a lesser extent (3.7). Some centres consider all students at the institution/faculty/study program as affiliated with the centre, as the students' feedback is an input into the centres' R&D. None of the CoE-Es have individual master students affiliated. The respondents in general had ambitions to involve students (at all levels) more in the centres' activities.

The CoE-E also consider PhD students as colleagues who participates in the centres' research. Because the centres are establishing a new research field, their affiliated PhD students are viewed as crucial to the CoE-s' success. Still, these centres are more committed to supervise at the bachelor (4.2) and master level (4.2) than at PhD level (3.5). However, supervision of individual bachelor and master students is not a goal in itself.

A general impression is that the results we present on CoE-Es are preliminary as the scheme as well as their R&D projects and activities are in a start-up phase.

3.3 Time for teaching and research

In the survey we asked how CoE staff allocated their work hours now compared to before the centres were established. Most of the respondents now work more hours in total. The largest increase seems to be in time spent on dissemination and research. About 70 percent of the respondents report that they spend more time disseminating the centres' R&D. At the CoE-Rs and CoE-Is 65 percent report that they do more research than before, while 42 percent at CoE-Es do more research than before. On average, the respondents also spend more time on administration.

Combined, the total time spent on students (developing study programs, teaching and supervision) has increased with centre status. CoE-R and CoE-I staff, are on average, less involved at the bachelor level, although almost half of the respondents spend as much time as before. At the master, and

particularly the PhD level, they are on average more involved than before, primarily by teaching and supervision. 52 percent report that they spend more time supervising master students, and 69 percent spend more time supervising PhD students.

For most of the CoE-E staff, time spent on teaching and supervision at different levels have not changed. About 20 percent report that they spend more time on teaching and supervising at the bachelor level and 15 percent at the master level. None of the respondents spends more time teaching at the PhD level.

3.4 How do the centres succeed? Three examples

Here we describe three examples we have found especially interesting. The examples include strategies for recruitment of talented students, the importance of social and academic integration of students, and finally a positive change in the attitude towards teaching efforts. The examples do not necessarily relate to each other and are described based on efforts at specific centres. The examples do therefore not represent general findings, but we believe they constitute good practice cases from which others can learn.

3.4.1 Recruitment

CoE-Rs and CoE-Is attract master students without having to market themselves at the bachelor level. The centres are attractive to students for several reasons. First, the centres have a good reputation and are able to offer challenging student assignments, access to infrastructure, an academic network, and external partners. Second, the students acknowledge the benefit of having an affiliation to a centre of excellence as it could involve work opportunities they might not get otherwise. The centres actively try to recruit the best master students to their PhD program.

CoE-Rs and CoE-Is tend to recruit well to their PhD programs. For some centres, especially within technology and engineering, it is a challenge to get Norwegian applicants, as the Norwegian master graduates are highly sought after in industry and business. This issue might be more relevant to CoE-Is and interdisciplinary centres. It appears that centre staff put more effort into marketing the centres research at the master level when it is difficult to recruit to PhD. The centres also have a self-interest of marketing their research as the students often start working for collaborative companies, thus becoming future users of the centres' research.

SIMLab's recruitment strategy

The CoE-I SIMLab (Structural IMPact Laboratory) at the Norwegian University of Science and Technology has a PhD program tailored to meet Norwegian policies for innovation and industry. SIMLab receive applicants from the entire world to the program, but few Norwegians, as they are very attractive to the industry. The centre recognizes, however, that the Norwegian master graduates are of high quality, and would often be more attractive for their PhD program than foreign students would. To solve this challenge, they have developed a recruitment strategy⁴. SIMLabs' goal is to recruit more of their own master's students, more female applicants (30 per cent) and mostly Norwegian PhD

⁴ SFI SIMLab was discontinued in 2015 after the center period was ending. The same academic environment at Norwegian University of Science and Technology is starting up SFI CASA in 2015, based on the research conducted in SIMLab.

students. To achieve their goals SIMLab, among other things, wants to be more visible to students at all levels, and offer talented students doctorates before they have completed their master degree.

To make the program attractive, SIMLab employ their PhD students for four years (three years is the norm), of which the centre itself finances the last year. During the last year, the PhD students teach at the department, giving the candidates teaching experience. Six months is also used for project related work where the PhD candidates assist an industry partner with implementation of the centres' research, providing relevant work experience. SIMLab also assign master students to these projects, giving the students insight in the centres' research and add relevance to their education.

3.4.2 Social and academic integration

Our data suggests that much of the qualitative added value for the students seems to be linked to factors, which cannot easily be measured and counted. We choose to call it the “hallway effect”, the indirect learning effect of moving in the hallways in an active environment with extensive academic output.

A clear feedback from CoE-Rs and CoE-Is is that a prerequisite for high quality is academic and social integration of students. To enable students to reach their potential, they must thrive and be academically motivated. By including students in formal and informal arenas where science is spoken, they gain academic stimuli and create networks within the academic environment. Co-localisation of faculty and students is viewed as an important factor for success in the academic and social integration of students and staff.

An interesting point that was emphasised by several CoE-Rs and CoE-Is in the interviews is that the centre grants makes it possible to establish social venues and activities where students become engaged in academic discussions. Funding related to other typical research grants is largely tied up in salaries and earmarked experiments, while the financial freedom that comes with centre appropriations makes it possible to spend money on activities for students.

The CoE-Es we interviewed also stressed the same factors, that it is important to create a sense of community attitude. They create forums and networks where academics can discuss teaching and share experiences using different teaching methods.

CEES – an example of academic and social integration

The CoE-R CEES (Centre for Ecological and Evolutionary Synthesis) at the University of Oslo, highlighted co-localisation as a key factor for both academic and social integration of students and staff, and creating a good work environment. The centre is co-located over two floors and all associated master and PhD students have working space in the centres' facilities.

There are about 25 nationalities at CEES and about half of the PhD students are Norwegian. The social aspect is important to the applicants, as the other scientists becomes their network and circle of friends. Temporary staff and PhD students often take initiative to various events. In addition, CEES has about 60 guest researchers per year. To make their expertise available to the students, CEES offers a course with variable content, dependent on the areas of expertise for those present at the time.

CEES highlights the importance of creating arenas where sciences is spoken and the centre's affiliated students are invited to all centre activities. Students do not receive ECTS credits to participate in many of the activities, which are considered useful and good for the students, such as journal clubs, drinking coffee with the centre's staff, after-work beer, parties, internal seminars etc.

CEES organizes a two-day conference, which is mandatory for master students and academic staff (100+ participants). All master and PhD students must present papers. As students' efforts reflect back on their supervisor, the supervisors tend to invest a lot of time in preparing their students.

3.4.3 Changing the attitude towards education

The CoE-Es felt that centre status has given teaching and R&D related to teaching and education a higher priority and status at their institution. Their R&D projects have provided the centres and affiliated teachers/researchers with a more analytical approach towards their own and others' teaching, as described in the example below. In order to achieve this, the centres have worked actively to create arenas where staff can discuss and evaluate teaching efforts and methods, thus succeeding and "de-privatizing" the teaching of individual teachers. In sum, this has increased focus on teaching methods, educational management, and composition of study programs among faculty and administrators at the institutions.

Example - bioCEED

All the staff members of the CoE-E bioCEED (Centre of Excellence in Biology Education) at the University of Bergen are involved in research and teaching. COE-E status has given them a new arena for research on the effects of using various teaching methods, but it has not changed the core research within their own discipline. From the beginning, the staff members did not have a background in pedagogics, and they had to learn many new things when addressing questions of pedagogy and learning.

Research on teaching and learning is central in bioCEED, for instance on the effect of different methods of learning. In addition to improving their teaching, they also aim at publishing this research in international journals.

bioCEED is concerned with how teaching at the university is often a private matter which is not particularly collegial, in contrast to research activity. They create fora and networks where one can discuss and share competence and experience. For example, they host a two-day teachers' retreat for everyone who teaches biology at the University of Bergen, where the aim is to discuss how their teaching can be improved. The initiatives have been positively welcomed by the institutes/departments, and has become popular with staff outside the centre.

Parallel with working to increase the awareness and the collegial culture around teaching and learning at their own institution, bioCEED wishes to reach all the biology education in Norway. For instance, they are conducting a survey with teachers and students in biology at all the Norwegian HEIs, as well as representatives from the private and public sector. They are also working towards creating a network for the leaders of biology education in Norway.

4 Lessons learned

4.1 *Quality in education and research*

Our findings indicate that the CoEs' understanding of quality affects the centres motivation to engage in education. Quality in education is a concept that includes both input, process, and outcome components. The emphasis is not only on students' final expertise, but also on the learning process. The CoE-Es are aware of all these aspects. High quality is encouraged through different initiatives and means, and are typically directed towards analysing learning effects of means and the educational scientific competence of the faculty. In the process, the CoE-E staff develop an analytical relation to their own and others' teaching and education. The students are the most important input factor for their research, as well as the ones who benefit from the initiatives and the process itself.

Research quality on the other hand focuses to a greater extent on results and less on process. We believe it is reflected in the CoE-Rs and CoE-Is' justifications for involvement in education, namely that the time and resources invested in students allow the students to become increasingly successful, which in turn can provide better research results for the centres. The centres' research and innovation is highly advanced, and therefor appears to be most relevant at master and PhD level.

4.2 *Increased quality in education?*

The centres most obvious contribution is that they have very good prerequisites for providing R&D-based education of high quality. The centres provide a large group of experts and the staffs use their knowledge in teaching and supervision, ensuring relevant and updated curricula and student projects. The centres' funding provides an opportunity to invest time and resources in advanced equipment and infrastructure, and activities, from which students benefit as well.

CoE-Rs and CoE-Is have a positive effect on the quality of education primarily at the PhD- and master levels. CoE-Rs and CoE-Is feel that by attracting highly talented scientists, the quality of supervision from centre staff has increased. According to the centres, the students seem to agree. There is great interest from students to be affiliated with a CoE. The students associate the centres with quality, and expect that a connection to a CoE will raise the quality and relevance of their education.

CoE-E staff believe they have had the greatest impact on the quality of education at the bachelor and master level. The status as a CoE-E, and development of R&D projects examining the relationships between teaching/learning methods and actual learning, has increased the status of teaching among staff in general, and created an environment for discussion and analysis of one's own and others teaching efforts. For some centres, it is too early to comment on concrete results, since the first development projects are not completed.

All CoEs report that supervision on relevant levels of education have been affected positively by the centre's research and activities. A common feedback was that the centre's status and presence helped to raise the general level of quality at the university.

4.3 Concluding remarks

Our report shows that the CoEs view the students as a resource for their R&D. The students may be contributors into a research project, future users of research and innovation, or target group for activities and research; hence, it is in the CoEs interest to contribute to teaching and development of study programs. We found that CoE-Rs and CoE-Is are likely to make changes in the content of study program(s) based on their research and innovation. CoE-E activities are to a large degree aiming to change the preconditions and teaching of a subject or study program.

The centers feel a responsibility to consolidate their future position by establishing study programs at different levels.

The centres view the students as crucial to their success, and especially the PhD students. To attract, engage, and motivate the students, the CoEs have different strategies. Recruitment to the centres, as well as, the discipline is important, and the centres takes necessary steps to recruit good candidates, offer their supervision and network, and include the students both academically and socially.

CoE staff reports that their total workload is larger than before centre status, with more time spent for research and dissemination. At the same time, we do not find evidence to suggest that the priority of high-level research happens at the expense of quality in education at these centres. Rather, we find motivated scientists, and especially centre leaders, who acknowledges that students are a part of the centres' success.

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Appendix

Survey: Centres of Excellence schemes and quality in education

E-mail address:

Background information

1. Name of centre you are affiliated with
2. What sort of position to you have at the centre?
 - a. Centre director
 - b. Faculty
 - c. Administrative staff
 - d. Other

3. Does the centres cooperate with any of the following centre types?
 - a. Centres of Excellence in Higher Education
 - b. Centres of Excellence in Research
 - c. Centres of Excellence in Research-based Education

Comment:

The centre and contributions to education

(on a Likert scale from 1-5, where 1 indicate the lowest and 5 the highest value)

4. The centres research is relevant for study programs at the host institution
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
5. To which extent is it an ambition/important for the centre to contribute in education?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
6. To which extent is it an ambition/important for you to contribute in education at?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
7. To which extent do faculty use the centres' research and innovation in teaching?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
8. To which extent do faculty use their own research and innovation in teaching?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

The centre and contributions to supervision

(on a Likert scale from 1-5, where 1 indicate the lowest and 5 the highest value)

9. In your opinion, is it an ambition for the centre to contribute to supervision?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
10. To which extent are the students supervised on assignments that are relevant to the centre?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level
11. To which extent are the students supervised on assignments that are part of the centres' projects?
 - i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Hours spent on research and teaching

12. Have the guidelines for time spent on research and teaching changed for faculty with the establishment of the centre?
- Yes
 - No
 - Do not know

Comment:

13. In your opinion, after the centre was established, do faculty spent more/less/do not know/unchanged time on:
- Research
 - Teaching at bachelor level
 - Teaching at master level
 - Teaching at PhD level
 - Supervising at bachelor level
 - Supervision at master level
 - Supervising at PhD level
 - Dissemination
 - Administration

Comment:

The centre and impact on quality in education

(on a Likert scale from 1-5, where 1 indicate the lowest and 5 the highest value)

14. Have the centres research/activities affected the study program portfolio at the host institution?
- At bachelor level
 - At masters level
 - At PhD level

Comment:

15. Have the centres research/activities affected the content/curriculum in relevant study programs/courses at the host institution?
- At bachelor level
 - At masters level
 - At PhD level

Comment:

16. Have the centres research/activities affected the centre staffs' teaching methods?
- At bachelor level
 - At masters level
 - At PhD level

Comment:

17. Have the centres research/activities affected how others/faculty at the host institution teach?
- At bachelor level
 - At masters level
 - At PhD level

Comment:

18. Have the centres research/activities affected how the centre staff supervise?
- i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Comment:

19. Have the centres research/activities affected how others/faculty at the host institution supervise?
- i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Comment:

20. Students are an important resource into the centres R&D and activities:
- i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Comment:

21. In your opinion, has the centre activities resulted in increased quality in the education to which the centre contributes?
- i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Comment:

22. In your opinion, has the centre activities resulted in increased quality in the supervision to which the centre contributes?
- i. At bachelor level
 - ii. At masters level
 - iii. At PhD level

Comment:

Final comment:

23. Please provide examples of how centre activities and education interact, which is not covered by the previous questions or other matters of significance?