How implementation of PRactice can IMprove relevance and quality in discipline and professional Educations (PRIME)

Knowledge-building project within the FINNUT call

1. Knowledge needs

Educational programs within Higher education are often divided into discipline and professional programs. Professional programs prepare students for a specific profession and will include relevant knowledge across several disciplines based on the needs of the specific profession. In contrast, discipline programs emphasize theoretical knowledge and generally focus on one specific discipline, and will include other disciplines if these are seen as necessary to foster learning within the target discipline. As discipline programs are linked to specific scientific disciplines, training is often more directly research-based and the students develop research competence. The link to research ensures up-to-date knowledge and flexibility for future employment. These programs are therefore less sensitive to fluctuations in demands than profession-oriented programs. However, except for a career within research and higher education, discipline programs provide less obvious links to possible future careers. The transition from student life to working life may therefore be challenging. Newly-educated students generally perceive their most important competence to be knowledge within their specific discipline or profession. Many do not realize that they have achieved valuable transferable skills, such as critical thinking, problem solving, project management, cooperation abilities and communication during their education. This lack of insight into their own competence was reflected in the recent national survey on student perceptions on the quality of study programs in Norway (NOKUT 2014), which indicates that especially students in discipline programs, when asked, would like a stronger focus on practical and explicitly work-related activities in their curricula.

Employers are generally satisfied with university candidates, as illustrated by recent surveys from the University of Bergen (Bøyum 2013), but they find that educators often understate the candidates´ competence. Employers seem to value transferrable skills more than the educators do (Ryssevik et al. 2011). However, these transferrable skills, especially from discipline programs, are not always communicated to potential employers. The transferable skills are seldom emphasized in academic diplomas, course descriptions, or course evaluations. Unawareness of their own full competence and potential may hamper newly graduated students in their search for relevant jobs. Increased professional experience may enlighten these students in terms of their skills, and also increase the students' familiarity with the opportunities offered and the competence needed, within relevant professions. This 'practice gap' is smaller in professional programs, where close cooperation with relevant employers and internships are often incorporated throughout the study programs, providing valuable practical working experience (e.g., trainee and practice periods in Intergrated Master's Programme in Aquamedicine and Integrated Teacher Programme with Master in Science or Mathematics at UiB). This 'practice gap' in discipline programs is puzzling, as most scientific disciplines have high relevance to society. For example, biological theory have relevance throughout society, evolutionary theory is currently having profound impacts on medicine, psychology, agriculture, aquaculture, fisheries, natural resource management, social sciences and humanities. Also, the practical and analytical skills of biologists, from genetic engineering to ecosystem assessment, are increasingly sought-after by biologically-based research and industries, and by governments and NGOs facing increasing demands for evidence-based action in the face of global climate and environmental change.

In discipline programs in biology, theoretical knowledge is complemented by practical skills training from the laboratory and the field. Biology education research (BER) as a discipline is quite young (DeHaan, 2011). Still, there is now compelling evidence that student-active teaching can positively influence students' learning, achievement and knowledge retention, as compared with traditional instructional methods, such as lectures and demonstrations (Singer et al 2013). Student-centered strategies include, for example, answering questions during lectures and working in groups to solve problems, making and testing predictions based on the theory, and explaining their thinking to one another. Practical sessions form an integral part of biology training. However, practical sessions are often planned and performed to foster biological understanding, while other skills students may achieve during practical session are less acknowledged. Further, practical sessions rarely involve the end-users of the biological competence. Opportunities for enhanced learning may thus be missed, as professional practice can have positive impact on students' motivation (Brandt, 2003; Person and Rosenbaum, 2006; Kyndt et al., 2011; Gardner & Belland, 2012) and study progression (Næss et al. 2012). Professional practice, if carefully planned and executed, can enhance both theoretical learning, practical knowledge, and at the same time foster important transferable skills. In addition, improved communication between lecturers, students and end-users may create positive synergies for all parts involved. However, the use of internships in discipline educations remains underexplored in Norway.

In this project, we aim to strengthen the relevance and the quality of both disciplinary and professional educations in biology through identifying opportunities for, testing out, and documenting impacts of enhanced practical learning across the curricula. The biology programs at the Department of biology, University of Bergen (UiB) and the Department of Arctic Biology at the University Centre in Svalbard (UNIS) provide an ideal test case for such a project, because they include both general biology programs in a large general (UiB) and small highly specialized (UNIS) university setting, combined with two professional programs in biology (The Aquamedicine program and the Integrated Teacher Program with Master in Science, UiB). Together, UiB and UNIS have about 600 biology students from the bachelor's level to PhD, where UiB has the largest biology education program in Norway. The project partners also include the Department of Education (UiB) who has expertise knowledge on educational development in higher education, and Uni Research and Institute of Marine Research, who are some of our larger collaborators in the private sector.

The team behind this proposal was awarded a Center of Excellence in Biology Education (bioCEED) by The Ministry of Education and Research in 2013. BioCEED will provide a unique infrastructure for the project, notably as a platform for development of the teacher and student culture, for development and testing new protocols and learning tools for biology education, and for communication with end-user and dissemination of project results.

2. The Knowledge-building Project

Objectives

Our working hypothesis is that internships and enhanced practice have a positive influence on learning in discipline as well as profession education. Our overall aim is to implement internships through collaboration with the private and public sector and develop enhanced practice across our study programs. Thus, taking biology as a case, we will examine the impacts of different types of practice on student motivation, learning outcome, study progression and employment. The project will be performed in close collaboration with professional partners and on the bioCEED platform, and will be based on knowledge-transfer between the existing professional and disciplinary programs, as well as from relevant

experiences at UB and other Universities abroad. Based on existing knowledge and in collaboration with students and employers, we will develop case-studies and modules for enhanced practice across the full range of biological study programs to promote the development of relevant competence sought-after by potential employers. Further, we will evaluate and test ways to improve established practice activities within courses and programs, with special focus on identifying and strengthening both theoretical learning and transferable skills. The knowledge and experience that PRIME will gain in biology will be transferable across disciplinary borders.

Through this knowledge-building project we aim to reach our main goal through a set of sub-goals, each with a corresponding work package (WP):

Aim 1. Identify the key competences (disciplinary, transferrable) held by biologists entering the work force, as seen from the educator perspective, the student perspective, and the employer perspective.

Aim 2. Systematically review and evaluate current study programs and assess how different learning methods applied in those programs (theory, practice, and internships) contributes to build the key competences identified under Aim 1.

We will follow up the knowledge gained in Aims 1 and 2 by:

Aim 3. Develop and implement, at different stages in the study programs:

a. Internship modules of various extent (single-day to whole semester), and for different specific objectives (learn the profession vs. put the theory into context)
b. Enhanced practice modules (field, lab, assignments) within our course portfolio to support both disciplinary and transferrable skills in our students.

In parallel with the work towards Aims 1-3:

Aim 4. Evaluate the effect of implementing different elements of internships and enhanced practice in both discipline and profession educations, and if effective, develop more of such training in our study programs.

Aim 5. Evaluate how different learning methods (traditional disciplinary training, enhanced practice, internships) influence post-study careers.

In parallel with the work towards Aims 1-5:

Aim 6. Communicate findings to relevant audiences within the Higher Education sector, the private and public sector where biologists find employment, and beyond

3. Frontiers of knowledge and technology

An international trend in higher education during the last years includes increased collaboration and tighter links to private and public enterprises (Vabø and Sweetman 2012). A number of study programs open up for practical, profession-based, training as part of their teaching, much as students ask for (NOKUT 2014). Documentation of collaboration effects is piling (Person and Rosenbaum, 2006; Næss et al. 2012), but research on educational collaboration has primarily targeted post-study effects, i.e. how candidates adapt to professions, and has had less focus on its effects on the educational programs (Brandt et al. 2008).

Cooperation between higher education institutions and public and private professions is not uncommon in Norway. A study by Næss et al. (2012) showed that 83 percent of newly educated candidates from universities and university colleges had experienced some form of such cooperation during their study (Arnesen et al. 2012). The most common type is short visits or lectures held by representatives from different professions. Professional training is

typically found within health-care and teacher education, where it often is mandatory. Approximately 30 percent of master candidates from social sciences, mathematics, technology, natural sciences and law report some kind of professional practice.

Previous studies have identified four areas where profession experience may have effect on students: Students' motivation for their study, learning outcome, study progression and employment and job transition.

Student motivation

Several studies show that professional practice has a positive impact on students' motivation (Brandt, 2003; Person and Rosenbaum, 2006; Næss et al. 2012). According to Self-Determination Theory (Ryan & Deci, 2000), students' perception of autonomy, competence and relatedness (feeling understood by and cared for by others) are important in order for them to stay internally motivated. An autonomous supportive environment is positively related to a deep approach to learning (Kyndt et al., 2011), and is found to enhance intrinsic motivation (Ng et al., 2012). Much the same is discussed by Lambert et al. (2013). Here it is demonstrated how priming belongingness in a group of subjects increases meaningfulness. Autonomy, relatedness and perceived competence are, in other words, important for a regulation to stay integrated rather than just introjected (focus on approval from others). Thus, there is much to be gained by developing a learning environment that not only discusses possible gains in having close cooperation with external partners but actually makes this an integrated part of the educational program. As shown by Skøien, Vågstøl & Raaheim (2009), inclusion of students in the professional community not only leaves the students with an opportunity to learn from professionals within this community, it also represents an opportunity for students to learn from each other.

To assess learning outcome from specific learning activities is always a challenge (Karlsen, 2011). However, it is reasonable to suggest that students who take part in professional practice acquire experiences and skills that are useful in their own study. As shown by Billett (2009, 2011) authentic experiences from real professional tasks give the students complementary competences in the form of domain-specific knowledge. Sannerud (2009) claims that students experiencing "real tasks and problems" within the profession also learn from informal feedback from supervisors and colleagues. The Norwegian Qualifications Framework states that a bachelor student should be able to apply academic knowledge to practical and theoretical problems, as well as to plan and carry out tasks and projects in accordance with ethical requirements and principles. Such skills and competences are best developed by "learning-by-doing" activities (Schank, 1995), for instance through profession collaboration.

Study progress

According to Næss et al. (2012), a majority of Norwegian graduates expressed that profession experiences had a positive impact on their study progression. This was confirmed by analyzing the individual length of the study. Among those who reported profession experience, less had exceeded expected study length.

Employment and career

Professional practice during education can have positive effect on future employment. Students may be secured competences that providers of higher education cannot offer alone. Further, as students and graduates rank workplace competencies differently, practice may help develop students' awareness of the importance of graduate competencies (Rainsbury et al. 2002). Different types of profession practice can provide the students with practical skills, process knowledge and specialized competences (Brandt et al. 2008). Studies indicate that

candidates with professional experience are more attractive to employers than employers without this experience (Brandt 2003; Lam 2001). Another effect is that professional collaboration promotes student network building, which is important for future career (Granovetter 1995).

4. Research tasks and scientific methods

Research and development in PRIME is organized in six work packages (WPs). The first two WPs aim at gathering and developing information important for designing practice-based study program. This information is used to design and implement new study programs (WP3). WP4 is organized as a systematic evaluation of the effects professional training and practicehave on students' motivation, learning and progress. WP5 will evaluate the effect of practice on employment and post-graduate carriers. WP6 will focus on dissemination and sharing of best practice.

WP1 Key competences of biologists entering the work force
Several competences are identified in the literature as important features to distinguish superior performers (e.g. Spencer and Spencer, 1993). To identify key competences held by biologists entering the work force, we will conduct semi-structured interviews with (i) university teachers in biology, (ii) biologists employed for 3-7 years in different relevant jobs in the private and public sectors, and (iii) the employers of these biologists (at the line manager and company levels). For each of these groups we will map how they perceive and value the competence of biologists from different programs (disciplinary, professional) in terms of disciplinary competence and transferrable skills. Disciplinary skills include e.g., theoretical knowledge, laboratory and field techniques, and research methodology, whereas transferable skills include e.g. project planning and management, communication and collaboration skills, and critical thinking. We will thus identify variation in the competences achieved by different study programs, as well as variation in demand and valuation of different competences by educators, employers, and employees. We will augment this mapping with relevant data from other sources (e.g. reports, published literature).

WP2 Building of competence in biological study programs
We will carry out a systematic search for ally review our current study programs, as well as 2-3 selected study programs from comparable institutions nationally and abroad, to identify how different theoretical, practical, and internship-based learning methods are applied in those programs, and to what extent the different learning methods contribute to build the key competences identified as valuable by educators, employers and employees under WP1. Analysis will be supplied with interviews. In this analysis, we will contrast and compare courses and activities both within programs and between our disciplinary vs. professional programs. We are aware that the data or direct evidence of the links between learning methods and competence may be scant, thus, our investigations will be combined by extensive literature surveys. Further, we will use the course evaluations and interviews with student focus groups to evaluate how the different learning activities and the building of competences affect students' motivation, learning and study progress. Again, we are aware of data limitations, and both quantitative and qualitative data will be gathered.

WP3 Develop and implement practice modules biology programs
In WP 3 we will build on the knowledge gained in WP 1 to develop and implement new in-course practice modules as well as internships of varying extent (single-day to whole-semester) in our courses and programs. The aims, and therefore the content and learning methods, will vary. We will start with some activities within specific courses identified during

the project planning phase, and we will later expand and develop these activities to other parts of the curricula based on the findings from WP 1 and 2.

As a theoretical framework for developing transferable skills in biology courses and study programs, we will use a model described by Bennet et al. (1999). The model includes five interrelated components (Figure 1), and the central component is transferable (generic) skills. In discipline studies commonly the two components "disciplinary content" and "disciplinary skills" dominate, while the awareness of the transferable skills is less pronounced, and the "workplace awareness" and "workplace experience" components are small or none-existent (Bennet et al. 1999). The model is suitable for identification of different subject designs, and to study effects between the different components.

The first intervention will be to integrate shorter internships (one week) into one course at UNIS (AB-203 Arctic Management). Due to the restricted student number (max 18 students), courses at UNIS provide a good pilot-study for developing procedures for implementing professional practice in biology. These internships will include some direct involvement with the day-to-day tasks, and be a combination of action and observing type of learning. We hypothesize that such shorter internship make students more aware of the competences and the variety of transferable skills appreciated by various employers, and in addition provide some training in applying disciplinary content and skills into practice. Based on the experience from UNIS, we will move on to make professional practice an integrated part of the bachelor program in Bergen. We will start by implementing practical elements as short workplace visits (1-2) days into existing courses for first year bachelor students at UiB. Then we will develop a second- and third-year bachelor course where we will try different internship models The range of workplaces presented in the class will raise awareness of biologist's roles in society, and of the range of competences needed. At UNIS we will progress by revising the arctic marine biology course (AB-202) where we will focus on transferable skills such as collaboration, project design and management, problem solving, and communication. Then, in the last year of bachelor's at BIO, we will offer longer internships (successively longer 4-16 weeks). Under supervision, the students will work as part of the organization. We hypothesize that along with longer internships, the students will in addition to the benefits hypothesized above, show increased motivation where students will get responsibility for their study, have a project or task in a general better learning outcome and study progression. Along with these incorporations of internships, we will also enhance and develop our usage of other practice modules (field, lab) in similar ways, focusing on the skills identified in WP1. The way students are assessed will be changed, to put a higher emphasis on the transferable skills component (Figure 1). We will work out clear and testable aims for student competences to be achieved (rubrics), formalize the collaboration with external partners, remove structural obstacles within the study programs, and establish administrative routines to facilitate practice deployment. Information gathered as part of work

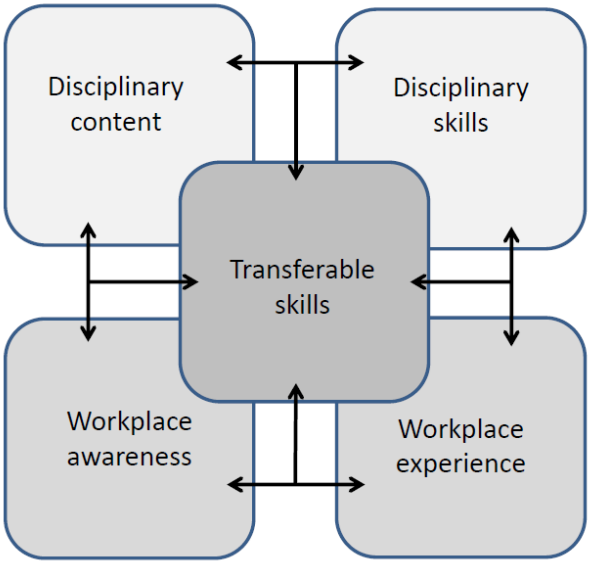

Figure 1.A model of the course provision (Bennet et al. 1999)

packages one and two will facilitate this development. Student evaluations from the last four years will create a base-line for the courses.

WP4 Impacts on student motivation, learning and progress

The practical training elements introduced to the biology courses will be subject to a systematic evaluation. Such an evaluation will be conducted using data from students, teachers and employers. To measure learning outcomes in general and transferable skills in particular in higher education is we need to identify reliable testing instruments. For primary and secondary school, international assessments studies, like PISA, TIMSS and PIRLS, have been used for two decades. For higher education, OECD has implemented a similar program, AHELO (OECD, 2011; Opheim and Aamodt, 2010). In AHELO, four different strands of student competence are measured: the generic skills strand, the discipline strand, the "learning gain" measurement strand and the contextual strand. A part of this program is the Collegiate Learning Assessment (CLA) test, developed in USA. CLA aims to test the student's ability to critical thinking, analytical skills, problem solving and writing formulation skills. Another relevant quantitative instrument is "National Survey of Student Engagement" (NSSE), which is an American survey instrument to assess outcomes of student learning environment (Zhao and Kuh, 2004). We will evaluate the AHELO and NSSE instruments along with other relevant instruments for our purpose and adapt them to this project. These instruments will aim to test three hypotheses:

Introducing practice as part of the studies will:

1. Have a positive effect on students' motivation
2. Facilitate learning of transferable skills
3. Contribute to study progress (less dropout and higher completion)

WP5 Effects on employment and career

A long-term aim of the project will be to monitor how enhanced practice and internships affect student's future careers. The baseline studies in WP 1 and 2 will be set up in such a way that they can be repeated during the course of the project, after three years, in the affected courses, and also further into the future, as part of the bioCEED collaboration.

WP6 Dissemination

Key target audiences for communicating PRIME findings are university professors and educational staff within our departments, in Norway, and internationally, educational scientists, Higher Education administrators and policy makers, and the employers of biologists in the private and public sector. All the key personnel in PRIME are affiliated to one or more of these target audiences, and to bioCEED, and we will make active use of the dissemination initiatives already in place as part of bioCEED. Research collaborations, alumni and the contact with stakeholders established through bioCEED are important starting points for strengthening links between education and society. The results from the project will have relevance to other biology education, but also to discipline studies in general. Therefore will outcome of the project be dissimilated both as articles in international journals and through the dissemination program already established by bioCEED. This includes dissemination of findings on internal and external digital platforms and in annual staff retreats, through our networking within the national Biofagrådet, bioCEEDS's networking activities, workshops and conferences involving (i) the private and public sector end-users, (ii) biology educators nationally and internationally, and (iii) the Higher Education sector more broadly. PRIME will build on this, but also contribute actively by involving end-users and our collaborative partners in industry, research and the public sector actively in our educational programs. The sector communication is critical towards the project's aims, and we will discuss with them the needs of employers vs. the qualifications of our candidates, but

also involve the sector in our educational programs as lecturers (guest lectures, Adjunct Professors), by collaborating over development of research tasks and topics (WP 1, 2, 4, 5), through developing relevant case studies for active student participation and problem-solving, and as hosts for student placements (WP 4).

5. Organization and project plan

The knowledge-building project will be harbored under the Centre of Excellence in Biology Education (bioCEED) and joins two biology departments with complementary strengths. BIO is large, excels across a range of research and education, is embedded in a large university, and has many societal links; AB is smaller, more specialized, and offers a close-knit academic environment. This biological competence will be complemented with research expertise on learning in higher education (HERU), and one of Bergen's largest private research companies with research and biological monitoring activities across the biological domain (UNI Research). Links between the different collaborators and activities are shown in Figure 2.

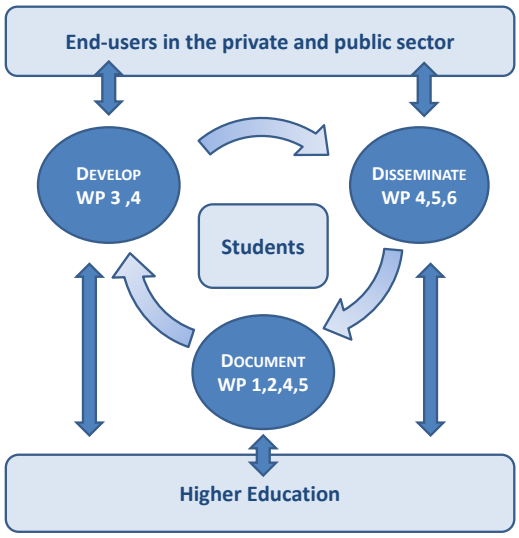

Figure 2. Main actors (squares), interactions (circles) with distribution of the work packages in PRIME

PRIME is organized in work packages, where WP 1-2 reflects survey of the important skills in biology education and employment, WP 3 constitutes the development and documentation of new enhanced practice and internship modules to strengthen those skills in our students, WP 4 and 5 monitors the impact on student educations and careers, and WP 6 disseminates the knowledge to relevant audiences within Higher Education and beyond. Both bottom-up and top-down processes will be used in the design and selection of specific 'educational experiments' (exemplified in WP3), and institutional strategies, teacher commitment, and compliance with the PRIME aims will be important selection criteria.

The project will be led by Øyvind Fiksen, who is head of education at BIO and also teaches one of the courses we want to work with in the project. In collaboration with Pernille B. Eidesen (UNIS) and Gaute Velle (UNI Research) he will be responsible for identifying relevant courses and settings for developing and testing with enhanced practice and internships. Arild Raaheim at HERU in collaboration with Tom Olav Klepaker (BIO) will be responsible for the educational science component, and they will also supervise the postdoc (working specifically on WP 1, 2, 4, 5) and PhD student (WP 2, 3, 4) in educational science, and be important resources in planning, testing, documenting learning outcomes, and sharing experiences within PRIME and with the higher education sector. Gaute Velle (UNI Research)

and Oddfrid Førland (UIB) will be instrumental in developing new models for organizing internship activities from the collaborating institution and Higher Education side, respectively (WP3). All the key personnel in PRIME are affiliated to bioCEED and this will secure that the project will benefit from the organizational support, networks, and dissemination initiatives of bioCEED. Therefore, international collaboration is not directly incorporated in PRIME, but the project will collaborate closely with bioCEED over this, including interacting with the international advisory board and the two international Adjunct Professors in bioCEED, and participation on bioCEED staff workshops and conferences.

6. Key milestones (see application)
7. Costs incurred by each research performing partner (see application)
8. Financial contribution by financing partner or other user (application)
9. Other collaboration (see attachment)

10. Project impact

Impact for national knowledge base
This project will enhance knowledge in a field important for the majority of university educations: how to infer transferable skills and enhance societal relevance in discipline studies. It is a complex task, combining research effort in biology with research on education, and research with education and workplace expertise. The cooperating partners are spear holders in their research fields, but new competence will emerge for all partners from the joint project. The PhD and the post doc positions will provide future research competence on the field. For the partners PRIME will be a strategic important part of bioCEED, and the competence acquired through PRIME and bioCEED will have impact on biology education nationally and internationally, and provide new knowledge on higher education in general.

Relevance for the partners and the society
a) PRIME aims to improve the partners' biology education, and to improve the relevance of their candidates for their future employment. This is within the partners' common strategy through bioCEED.
b) Better and more relevant biology courses and education will impact student motivation and enhance the quality of candidates.
c) Both bioCEED and PRIME aims to contribute to new knowledge transferable to other biology educations and to higher education in general.

11. Other aspects

Communication of results See work package 6.
Environmental impacts Not relevant for this project.

Ethical concerns
No sensitive person information will be gathered. Prior to gathering, registering, processing or storing information about individuals (i.e. personal data), notifications will be sent to Norwegian Social Science Data Services (NSD) in accordance with national guidelines.

Gender issues
Equal opportunity policies will be followed regarding gender, disabilities, ethnic minorities, and language preference, according to the policy at The University of Bergen and UNIS. There is no obvious gender issues related to the project. Both the core group in PRIME and bioCEED is a mixture of both genders. PRIME will be led by a male, while bioCEED is led by a woman.

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