



bioCEED Survey 2015



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Foreword

The bioCEED Centre of Excellence in Biology Education was awarded its status as a Norwegian Centre of Excellence in Education by the Norwegian Agency for Quality Assurance in Education (NOKUT) in 2014. bioCEED is built on the vision that rapid changes within the biological sciences and in biologist's role in society have implications, not only for the content of biology education, but also for how we teach future biologists. bioCEED will reform biology education by effectively combining theory with skills training and real-life work practice in our education programs, by shifting from a teaching to a learning focus, and by developing Scholarship of Teaching and Learning (SoTL) through transferring the strengths of the research culture to the education culture.

The bioCEED Survey 2015 was conducted as a baseline study of major tertiary-level biology education in Norway. The bioCEED Survey 2015 addresses themes such as learning in practice, transferable skills, motivation, laboratory and field learning, didactical approaches specifically relevant to biology education, knowledge needs and experiences of biologists in the workforce, etc.

The bioCEED Survey 2015 reports the results from four separate sub-surveys of tertiary-level biology education, mapping the experiences, attitudes and opinions of university teaching staff, students and student administration and technical staff, as well as biologists in the workforce. This inclusion of different stakeholder groups represents a broad and inclusive knowledge base, and also reflects bioCEED's vision of biology education as a joint effort resulting from the ideas, input and work of all these groups, not only teachers and students.

The bioCEED Survey 2015 was developed at bioCEED – Centre of Excellence in Biology Education during fall 2014 / spring 2015. bioCEED is a collaboration between the Department of Biology and the Department of Education at the University of Bergen, UNIS - the University Centre at Svalbard, and the Institute of Marine Research. It was partially funded by the research project "How implementation of PRACTICE can IMPROVE relevance and quality in discipline and professional Educations (PRIME)" funded by the Research Council of Norway under the FINNUT programme (grant #238043 2014-2018; PI Gaute Velle).

We thank Pernille Bronken Eidesen, Øyvind Fiksen, Sigrunn Eliassen, Tom Klepaker, Tove Gabrielsen, Øystein Varpe, Gro Van Der Meeren, Tina Dahl, Jonathan Soulè, Magnus Svendsen Nerheim, Tone Ulvatn and Cathy Jenks and the bioCEED team for valuable contributions, suggestions, feedback and support. Thank you all for your contributions. We are especially grateful to Oddfrid Førlund for valuable support, feedback and contributions.

We thank all participating universities, university colleges and companies/organizations who agreed to participate and submitted email-lists.

A special thanks to all participants who took the time to answer the surveys.

On behalf of all authors,



Vigdis Vandvik

Centre leader, bioCEED

Bergen, December 2015

Abstract

The bioCEED Survey 2015 is a baseline study of major tertiary-level biology education in Norway. The survey addresses themes such as learning in practice, transferable skills, motivation, laboratory and field learning, didactical approaches specifically relevant to biology education, knowledge needs and experiences of biologists in the workforce.

The bioCEED Survey 2015 reports the results from four separate sub-surveys of tertiary-level biology education, mapping the experiences, attitudes and opinions of university students, teaching staff, and student administration and technical staff, as well as biologists in the workforce. The four questionnaires were distributed during the spring of 2015 to the following groups: a) 1771 students (752 respondents); b) 482 teachers (231 respondents); c) 49 administrative and technical staff (31 respondents); and d) 337 biologists (229 respondents). Teachers and students were recruited from nine different universities and university colleges in Norway. Administrative and technical staff were recruited from the University Centre at Svalbard (UNIS) and the Department of Biology at the University of Bergen (BIO). Workplace respondents were recruited from 52 different workplaces in the private and public sectors.

The survey includes a combination of items developed by the bioCEED team and items adapted from published surveys. The results are relevant for teachers in tertiary-level biology education, curriculum development, biology students and others interested in biology and higher education training and pedagogy.

The results of the survey indicate that students, teachers and administrative and technical staff all perceive leadership appreciation and support of their educational efforts to be low; this is especially significant in regard to the institution leadership level, while peers are perceived to provide support and appreciation across all groups. Students, teachers and the biology employees at workplaces have an overall positive perception about the implementation of workplace practice in biology education, both as a means to develop biology expertise and for students' career opportunities. Students and teachers feel efficacious in regard to their own competence to learn and teach biology. Students' reasons for studying biology are primarily fueled by interest in the subject matter itself. The results show that teachers perceive students to lack general academic skills, especially in mathematics and writing.

The work was conducted within bioCEED (Centre of Excellence in Biology Education) and is partially funded by the research project PRIME - How implementation of PRactice can IMprove relevance and quality in discipline and professional Educations, funded by the Research Council of Norway.

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0.1 Abbreviations

AAAS -	American Association for the Advancement of Science
BIO -	Department of Biology, University of Bergen
bioCEED -	Centre of Excellence in Biology Education
BSc -	Bachelor of Science
HiT -	Telemark University College
MSc -	Master of Science
NMBU -	Norwegian University of Life Sciences
NOKUT -	Norwegian Agency for Quality Assurance in Education
NTNU -	Norwegian University of Science and Technology
PRIME -	“How implementation of PRactice can IMprove relevance and quality in discipline and professional Educations”. A research project funded by the Norwegian Research Council
SDT -	Self-Determination Theory
UNIS -	Arctic Biology at the University Centre in Svalbard
UiA -	University of Agder
UiB -	University of Bergen
UiN -	University of Nordland
UiO -	University of Oslo
UiT -	The Arctic University of Norway

1. Introduction

Biologists fill a wide and rapidly expanding niche in today's society. Biologists develop and research one of the best known and politically most hotly debated scientific paradigms in the world: evolutionary theory. At the same time, biologists master a range of important practical skills; we can assess and understand biodiversity, we know how to quantify ecosystem carbon storage and understand carbon stocks and fluxes, we can reconstruct past worlds, environments and climates based on biological remains in sediments, and we can splice genes, grow fish and understand and fight disease, to mention just a few examples. Both the theory and the practices of biologists thus have strong impacts on society. The bioCEED Centre of Excellence in Biology Education is built on the vision that the expanding role of biology - and biologists - in today's society (Fig. 1) places new demands both on the content of the education we provide and on how we train tomorrow's biologists. Biology education has always been strongly theoretically founded, and practical skills such as training in field, laboratory and computational settings are also deeply embedded in most biology education today. bioCEED aims to expand biology education to involve more of society and society's needs in our programs. In line with current trends in higher education, bioCEED will also strengthen the learning-focus and develop a Scholarship of Teaching and Learning (SoTL) culture within our educational programs (Boyer, 1990; Gibbs, 2009). Finally, bioCEED also aims to develop and spread new pedagogical practices for biology and research-teaching practices, learning and competence development in biology education.

bioCEED was awarded status as a Norwegian Centre of Excellence in Education by the Norwegian Agency for Quality Assurance in Education (NOKUT) in 2014, for a maximum of 10 years. The consortium partners are the Department of Biology, UiB; Department of Arctic Biology, UNIS; Higher Education Research Unit, UiB; and Institute for Marine Research.

The bioCEED Survey 2015 was conducted as a baseline study of major tertiary-level biology education in Norway, as well as of workplaces for biologists in Norway. The survey maps the experiences, attitudes and opinions of students, educators, administration and biologists in the workforce. The survey addresses themes such as learning in practice, transferable skills, motivation, laboratory and field learning, didactical approaches specifically relevant to biology education, knowledge needs and experiences of biologists in the workforce.

bioCEED has a special research focus through the research project PRIME, funded by the Norwegian Research Council FINNUT program, on developing models for student placements in the private, public and NGO sectors, by developing workplace learning as part of tertiary-level biology education (PRIME, 2014). This is also reflected in the survey. The survey results will provide important information for research into a number of key knowledge gaps in tertiary-level education, using biology as a case study. It will also provide information for the development of biology education through bioCEED and provide a baseline for studying impacts of bioCEED educational reforms and projects. bioCEED plans to carry out a follow-up survey in four years' time.

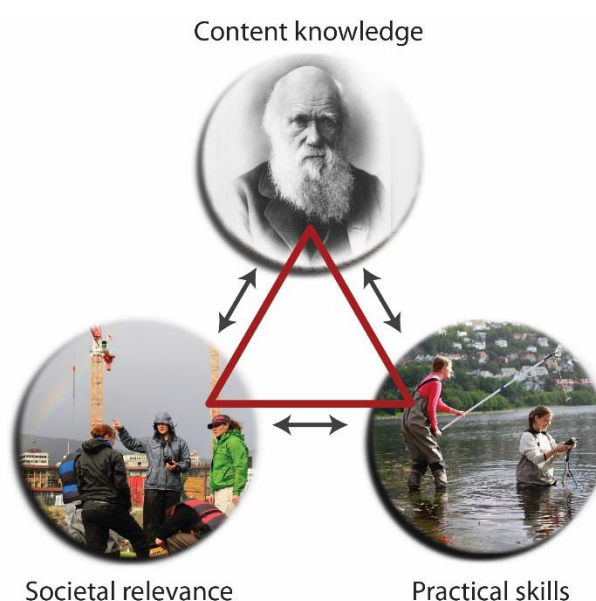


Figure 1. Biology and biologists emerge in the interplay between a strong body of biological theory, the many and critical practical skills that biologists are trained in and the needs and interests of society. We refer to the interplay between these different aspects of biology as the bioCEED triangle (bioCEED, 2013).

The bioCEED Survey 2015 consists of four separate surveys:

The bioCEED Student Survey, conducted with a representative selection of Bachelor (BSc) and Master (MSc) level students in biology in Norway. The survey went out to 1771 students across nine academic institutions and we received 752 responses.

The bioCEED Teacher Survey, focusing on teaching personnel in tertiary-level biology education. We sent the survey to 486 teachers in the same nine institutions as for the student survey and received 231 responses.

The bioCEED Administration and Technician Survey, focusing on study administrators and technicians at the University of Bergen and the University Centre at Svalbard. We sent the survey to 49 staff and received 32 responses.

The bioCEED Biologist Survey, focusing on biologists employed in the public and private sectors and in non-governmental organizations in Norway. We sent the survey to 338 biologists and received 231 responses.

There are several previous surveys of higher education, learning and university-students' experience entering the workforce in Norway. For example, Bøuym's report *UiB student 2013* (2013) addresses themes such as students' perceptions about their learning environment, study quality, education completion and career alignment. *Kandidatundersøkelsen* (Rambøll Management Consulting, 2014) investigates trajectories of University of Oslo graduates, especially assessing the proportion of employment and the relevancy of employment. *Studiebarometeret* (2014) gives an annual basic overview of student perceptions on different study programs at a national scale. Existing studies do not provide questions designed particularly for biology students, nor are they based on a comprehensive theoretical approach to learning and everyday curricular experience.

This report summarizes the results of the four bioCEED surveys. We have concentrated on presenting an overview and some interesting patterns in the variables. Relationships between variables and more thorough analyses of the underlying patterns and processes are not presented here, as they will be analyzed in more detail in scientific publications based on this material. To our knowledge, the bioCEED Survey 2015 is the first survey that focuses specifically on tertiary-level biology education in Norway and on several distinct groups of respondents simultaneously.

The results section summarizes the four different surveys. The first section presents a comparison where similar questions were posed to multiple respondent groups. Data are presented in figures and tables. Following the results section is a discussion section highlighting important findings in the survey and potential paths for further research. All figures are marked with denominations that correspond to survey questions. These questions are published in appendices available from the bioCEED web page.

2. Approach and background

2.1 Questionnaires

2.1.1 Language and development

The questionnaires to students, teachers and the workplace groups were distributed in both Norwegian and English to increase the number of potential participants. According to recommendations from Harkness and Schoua-Glusberg (1998) and similar studies (Deci et al., 2001), a native English-speaking biologist translated the initial Norwegian questionnaires. A back-translation was done by the authors; each item was compared with the original questionnaire to ensure that the intended meaning of each item was captured in both Norwegian and English. In the case of discrepancy between the original questionnaire and the translation, discussions including authors, translator and the bioCEED-team were invoked to capture and ensure the intended meaning of the item. Such a procedure has previously been shown to be both valid and reliable across cultures (Chirkov & Ryan, 2001; Gagne & Jacques, 2008).

Each questionnaire was tested in appropriate groups before full-scale distribution. Reliability and correlations, time-used and a “thinking aloud” procedure for feedback were tested as recommended by Clark-Carter (2011) and Crano & Brewer (2008). The translated questionnaires were piloted and results from the pilot tests showed a coherent understanding of the underlying phenomena investigated. Hence, the translation strategy employed was considered appropriate for the present report.

2.1.2 Theoretical background

In the development of the questionnaires, we implemented different theoretical conceptions about learning, motivation and transferable skills. The themes we employed based on previous studies, experiences among biology teachers and the goals of bioCEED and PRIME.

The Self-Determination Theory (SDT) perspective was adopted to assess students' motivation, perception of teachers motivating style, life goals and dropout intentions. Further, SDT was employed to measure teachers' efficacy, teaching intentions and perception of leaders' motivating style. SDT assumes that satisfaction of universal psychological needs for autonomy, competence and relatedness are important for intrinsic motivation and psychological well-being - as opposed to extrinsic motivation and psychological ill-being (Deci & Ryan, 1985; Ryan & Deci, 2002). SDT differentiates between types of motivation that differ in terms of quality and autonomy. The least self-determined (controlled) motivations are external and introjected regulation. These motivations are labeled controlled motivations since they are associated with coercion, pressure and tension. The most self-determined (autonomous) motivations are identified regulation and intrinsic motivation. Autonomous motivation is associated with endorsement, choice and volition. Further, in a learning situation, a student's motivation is affected by a teacher's relative autonomy-supportive or controlling motivational style. While a teacher's controlling style is assumed to predict controlled motivation in students, autonomy-supportive teachers are likely to facilitate students' autonomous motivation (Reeve, 2006, 2009).

To investigate attitudes and experiences concerning the role of skills in biology education, items were constructed based on the American Association of the Advancement of Science's call for increased knowledge and implementation of practical learning activities in biology education (Singer, Nielsen, & Schweingruber, 2013). The items were adapted to a Norwegian context through use of local curricula and learning-outcome descriptions used in Norwegian biology education.

The questions relating to transferable skills (Question T28 and S29¹) were based on studies performed by the European Commission (2011) and Bennet's (2002) theoretical conceptions about the role of transferable skills in higher education. A previous study on transferable skills in the biosciences (Scholz, Steiner, & Hansmann, 2004) was also important in this work. These perspectives indicate that different types of transferable skills have different antecedents. In particular, some transferable skills are harder to master than others and thus require more concerted pedagogical effort. As a result of this conception, certain transferable skills are more relevant and important for biologists and for future employment (Hole, 2015). In the surveys we included transferable skills that have a high degree of transferability across different circumstances, such as writing, critical thinking and collaboration.

We included two questions relating to plagiarism (Question S24a-b). These questions were included based on international studies showing that plagiarism is quite widespread within different fields and programs at universities, and that time pressure is often given as an explanation by students (Park, 2003; Simkin & McLeod, 2010; Raaheim, 2015). Plagiarism has also been found to correlate with external motivation (Williams, Nathanson & Paulus, 2010; Manuz-Garcia & Aviles-Herrera, 2014).

It is important to note that this background represents conceptual perspectives for constructing new items, i.e. the survey is theoretically founded. However, many items are not validated measures, expect those indicated below.

2.1.3 Measures

Each questionnaire was specifically developed to be relevant to each of the target groups. Several questions were similar across the respondent groups (i.e. changed wording where appropriate), and included for comparison purposes between students, teachers, administrative and technical staff and workplace biologists. Because we wanted questions relevant to our specific aim, most questions were developed by the bioCEED team. Some items are retrieved from other studies and surveys and adapted to our purpose, while some items are based on theory and theoretical assumptions. Below, we present the validated measures used in the survey.

a) *Aspiration index* (Question S6a-e). Four items were retrieved from www.selfdeterminationtheory.org relating to which goals and aspirations students have. An example of one item is "how important was the following reason for starting a biology education - to work for the betterment of society". Previous studies have found support for the validity and reliability of the items (Kasser & Ryan, 1993, 1996).

b) *Student engagement* (Question S8a-c). One of the questions in the bioCEED student survey was retrieved from *Studiebarometeret* (NOKUT, 2014) and altered for our purpose. Where NOKUT uses the term "study program", we use "biology education". "To what extent do you consider biology education to a) be engaging, b) be academically challenging, c) consist of topics that integrate well" (our translation of Norwegian text). To this scale we added d) "have skilled teachers". *Studiebarometeret* measured learning outcomes, as we did, but what *Studiebarometeret* called learning outcomes, we have largely called transferable skills. We have differentiated to a greater extent between learning outcomes in the laboratory, field work and cruises and workplace internships, in line with bioCEED's working goals.

c) *Authority figure's support* (Question S10a-f, T33a-f, A14a-f). Six items were included to assess students, teachers and administrative and technical staff member's autonomy support from authority figures. The items were retrieved from <http://www.selfdeterminationtheory.org> ("e.g. I feel

¹ See *Appendix A: Student, Appendix B: Teacher, Appendix C: Workplace and Appendix D: Administration and technical staff* for detailed overview of questionnaires.

understood by my leader”). Several studies have found these items to be both valid and reliable (Black & Deci, 2000).

d) *Self-regulation* (Question S18a-d, S19 a-d, S20a-d). To assess student motivation, we employed the Learning self-regulation questionnaire retrieved from <http://www.selfdeterminationtheory.org>. The questionnaire consists of 12 items (e.g. “I will actively participate in biology because it’s a good way to improve my understanding of the material”). The questionnaire has two subscales measuring autonomous and controlled motivation. Previous studies show adequate internal consistency (Jeno and Diseth, 2014; Williams and Deci, 1996).

e) *Perceived competence* (Question S21a-d, T21a-d). To assess students and teachers perceived competence (self-efficacy) we employed the perceived competence scale retrieved from <http://www.selfdeterminationtheory.org>. The scale consists of four items. An example of the scale is “I feel confident in my ability to learn/teach this material”. Previous results show adequate validity and reliability (Williams and Deci, 1996).

f) *Basic need satisfaction* (Question S26a-b). Two items were retrieved from the Basic Need Satisfaction Scale from <http://www.selfdeterminationtheory.org> in order to assess students’ relatedness at school (e.g. “I really like the people I interact with”). Previous studies have found support for validity and reliability across cultures (Deci et al., 2001)

g) *Intentionality* (Question S34a-c, T37b-d). In order to assess students’ dropout intentions and teachers’ intentions to change teaching behavior, we employed three items measuring dropout and intentions adapted from Reeve, Bolt, & Cai, (1999) and the theory of Planned Behavior. The theory of Planned Behavior (Ajzen, 1991) suggests that intentions may be as strong as actual behavior when predicting behavior. One item example is “I have often considered dropping out of biology”.

h) *School satisfaction* (Question S35). A one-item measure was used to assess students’ satisfaction at school. The one-item scale was adapted from the short life-satisfaction scale (Zullig, Huebner, Gilman, Patton, & Murray, 2005). Previous studies have found a strong test–retest and relationship between the short life-satisfaction scale and other health-related factors (Funk, Huebner, & Valois, 2006).

2.2. The targeted groups

2.2.1 Selection of universities and study-programs

Nationally, large variation exists as to how education in biology is organized and named. The selection was based on the Norwegian Universities and Colleges Admission Service's (Samordna Opptak) overview of applicable biology education programs in conjunction with information provided on each university's web page. To be included in the selection, institutions had to offer a comprehensive biology education. Institutions that only offer specialized courses (e.g. science didactics) were excluded for comparisonsative purposes. UNIS was also included because they offer general courses and admission is gained subsequent to admission to a mainland institution.

Based on these criteria, all higher education programs with biology education in Norway were included. Within each of the chosen institutions, we included both students and teachers. The sample of students and teachers is thus nationally representative for general biology higher education in Norway and includes both small and large institutions.

The following higher education institutions were included in the BioCEED Survey 2015:

- UNIS - Arctic Biology at the University Centre in Svalbard
- UiO - University of Oslo
- UiA - University of Agder
- HiT - Telemark University College
- NMBU - Norwegian University of Life Sciences
- NTNU - Norwegian University of Science and Technology
- UiB - University of Bergen
- UiT - The Arctic University of Norway
- UiN - University of Nordland

2.2.2 Students

The student survey was conducted between February 18th and March 26th 2015. A total of five reminders were sent by e-mail. All students registered on a BSc or MSc program at the nine universities or university colleges listed above were included. UNIS is an exception as it does not provide BSc and MSc programs, but specific courses for students registered at other Norwegian universities. Students studying at UNIS during the survey-period were included in the survey.

The survey was distributed to 1775 e-mail addresses. We received error messages from four e-mail addresses. Six students who reported being members of a one-year program were treated as BSc students. Two respondents reported being on a PhD program: these are not in the target group and have been removed from the dataset. The total number of student responses analyzed is 751. Of these, 607 students completed the entire survey, while a further 144 completed parts of the survey and the overall response rate is 42.5% (Table 1).

2.2.3. Teachers

The bioCEED Teacher Survey 2015 was conducted between February 18th and March 26th. Four reminders were sent by e-mail. Teachers were defined broadly, as permanently or temporarily employed, adjunct professors and others with teaching responsibilities in biology education. An initial control-question was asked to ensure that all the respondents had teaching as part of their work description. Respondents selecting "no teaching responsibilities" were excluded from the rest of the survey.

The survey was distributed to 486 biology teachers. The overall response rate was 48 percent (231 total, 61% males). The response rate ranged from 22-63 percent among institutions (Table 1).

Table 1. Response rate among students and teachers according to institution

	Distributed to students	Number of responses	Response rate (%)	Distributed to teachers	Number of responses	Response rate (%)
UNIS	57	16	28	65	15	23
UiO	289	92	32	30	21	70
UiA	52	16	31	18	4	22
HiT	68	37	54	28	15	54
NMBU	375	130	35	99	36	36
NTNU	277	142	51	69	39	57
UiB	398	196	49	118	74	63
UiT	182	81	45	40	16	40
UiN	77	41	53	19	9	47

2.2.4 Administrative and technical staff

The bioCEED Administrative and Technical Staff Survey 2015 was conducted between March 11th and May 11th. In total, four reminders were sent. The questionnaire was sent to employees at bioCEED's host institutions, the Department of Biology at UiB and UNIS. Due to differences in organization at various institutions, the selection and definition of who to include in the target group was difficult and the survey was not sent out to the other institutions.

This part includes relatively few respondents. Careful consideration must therefore be employed with regard to interpretation and dissemination of these data. For internal use and development of bioCEED, the administrative and technical staff's responses are of high importance. An important aim has been to map how we can develop the education from an administrative and technical perspective. The survey was sent to 49 technical and administrative staff at BIO and UNIS with a response rate of 63 percent (Table 2).

2.2.5 Workplace

The bioCEED Biologist Survey 2015 was sent out between March 24th and June 1st. The workplace group is defined broadly and includes public and private sectors, research institutions, educational institutions, NGOs and other places of relevance for biologist employment.

The selection of workplaces was a convenience sample. We included workplaces previously contacted by the PRIME project in relation to developing internship programs for students. We added relevant workplaces to this list from our contact networks, by searching net portals, sector search, job advertisement search and overviews of companies employing biologists. We have approximated a geographical spread and a large sector-wise spread. Each workplace was asked to supply the e-mails of up to ten biologist employees. Some small workplaces submitted less than ten respondents. The number of potential respondents therefore varies according to the size of the workplace and the maximum number of ten was implemented to mitigate a skew in responses towards large companies. The questionnaire contains a control question about company size and number of biologists.

A total of 156 workplaces were contacted. Of these, 52 agreed to submit respondent addresses. The questionnaire was distributed to 338 addresses (231 respondents, see Table 2).

Table 2. Distribution and response rate

Survey	N	No. of responses	Response rate (%)
Students	1771	751	43
Teachers	486	231	48
Administrative and technical	49	32	65
Workplace	338	231	68

2.3 Ethics

All surveys were reported to and assessed by the Norwegian Social Service Data Services (NSD) to ensure privacy and ethical conduct. The university and college management of all participating universities and colleges were contacted and asked to permit the participation of students and teachers. They were also asked to submit contact information (e-mail) of the respondents.

The workplace companies/organizations were contacted on a management or company e-mail with information about the survey and asked for permission for employees to participate as respondents, and for the companies to submit contact information.

All respondents were given the following information about the survey: 1) it is voluntary to participate and respondents could withdraw their participation at any point, 2) all answers are registered anonymously and treated confidentially, and 3) that participation will not influence their relationship to their university/employer.

We were interested in investigating the relationship between academic achievement and motivational variables in order to further understand the antecedents of biology students' achievements. Students were asked to submit their student number or their personal identity number in order to retrieve their grades. They were informed about the scientific purposes of this. They were also informed that this information was voluntary to submit, and by submitting their identification number, they gave us permission to gather their grades from the present semester from their university or university college. They were informed that the identification number would be deleted after the grades had been gathered, at the very latest by the end of December 2015. We received academic grades from a total of 310 students. These data will be reported in a separate paper and are not included here.



Comparison of bioCEED surveys



3. Presentation of results

3.1 Comparison

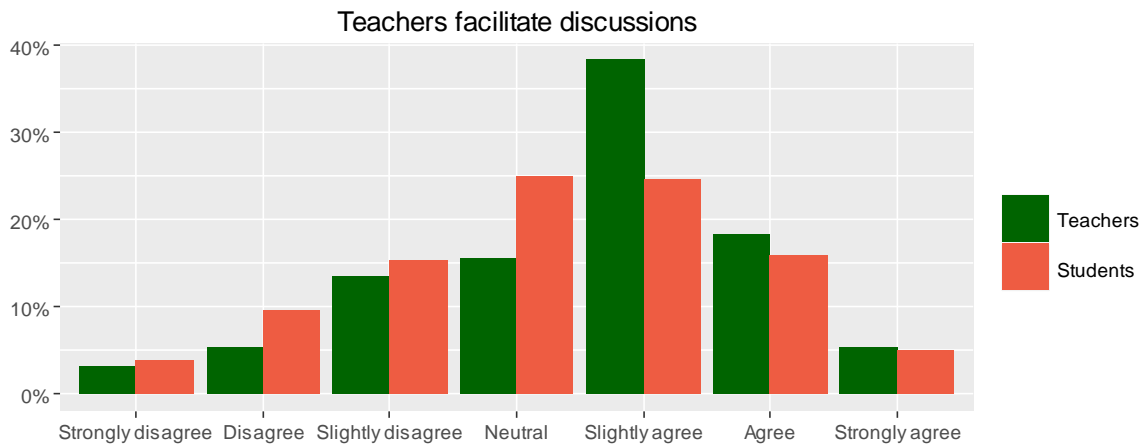
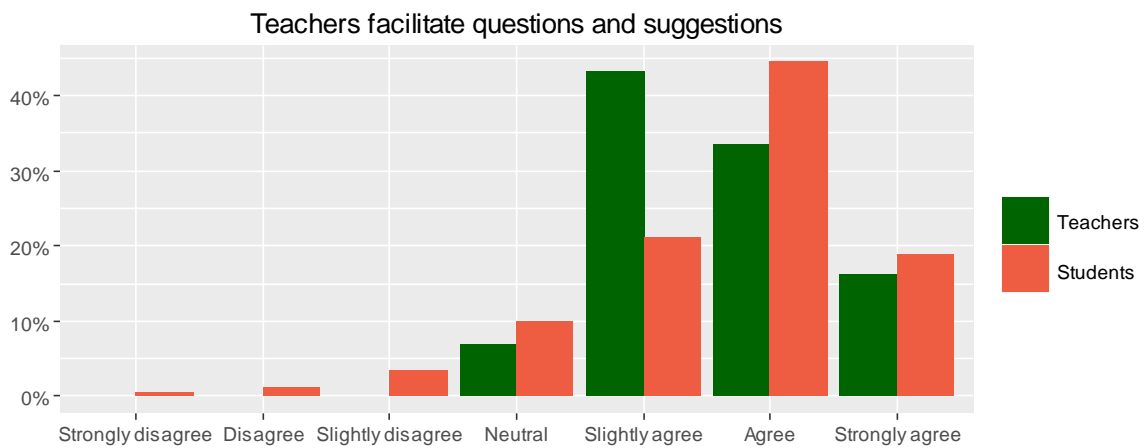
The following sections present the results from the bioCEED Survey 2015. Here, we compare results from the different respondent groups. The following constructs were asked in order to compare the responses from the different groups concerning teachers' ability to facilitate students during class, perceived appreciation, perceived autonomy support, physical environment and organization, learning outcomes in field and laboratory work, perception of transferable skills, and finally, perception of workplace learning and practice. The questions presented here were posed to two or more respondent groups.

Main findings from the comparison:

- Students, teachers and the workplace all perceive workplace practice to have a potential benefit in biology education.
- Students and teachers both perceive that teachers facilitate questions and suggestions during teaching sessions.
- Administrative and technical staff members feel more appreciated by colleagues, students and department managers, while teachers feel slightly more appreciated by university leadership.
- Teachers and students both perceive field- and lab-based learning to contribute to several skills, although students are more positive about their outcomes than teachers are.

3.1.1 Teacher facilitation: Students and teachers

We asked both students and teachers to what extent teachers facilitated a variety of styles of student participation in teaching sessions. We asked them three questions; whether teachers facilitate suggestions from the students, whether teachers facilitate discussions between students and whether teachers combine theory with practical tasks. The results show that both students and teachers perceive that teachers facilitate questions and suggestions from students to a high degree. Only a few students strongly disagreed, disagreed or somewhat disagreed. Most teachers claim that they facilitate discussions and combine theory with practice. Both groups agree about how teachers combine theory with practical tasks (Fig. 2, figure caption includes codes “T21” and “S9”, which correspond to full questionnaires that are available at the bioCEED web pages).



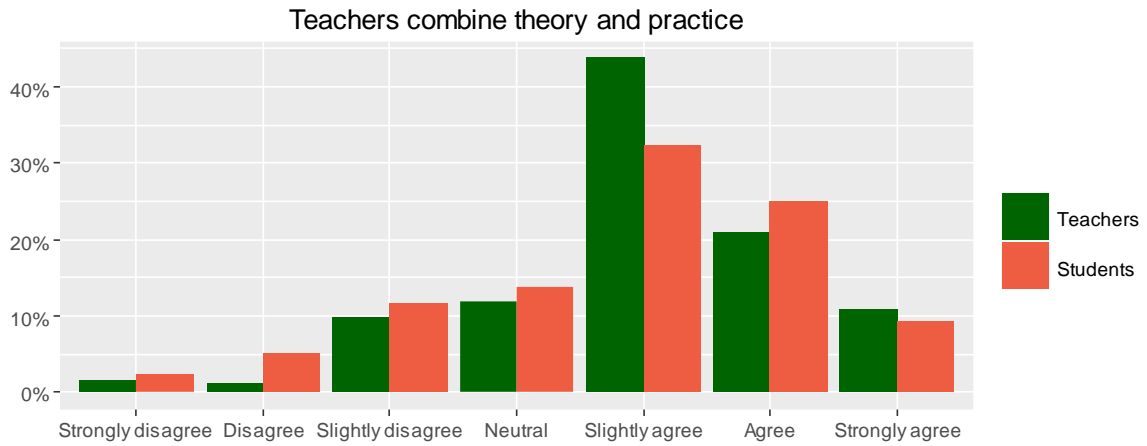


Figure 2. Responses concerning teacher facilitation among teachers (T21) and students (S9).

3.1.2 Perceived competence: Students and teachers

Both students and teachers were asked to assess personal efficacy concerning studying and teaching, respectively. Four items concerning confidence, capability, achieving goals, and meeting challenges were asked. In general, results show that teachers and students have a high personal efficacy. Teachers show slightly higher perceived competence (Fig. 3).



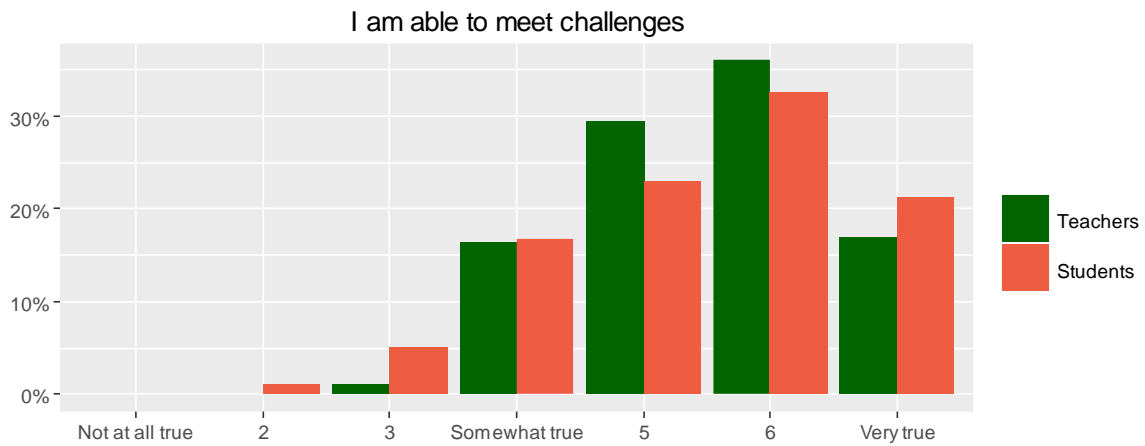
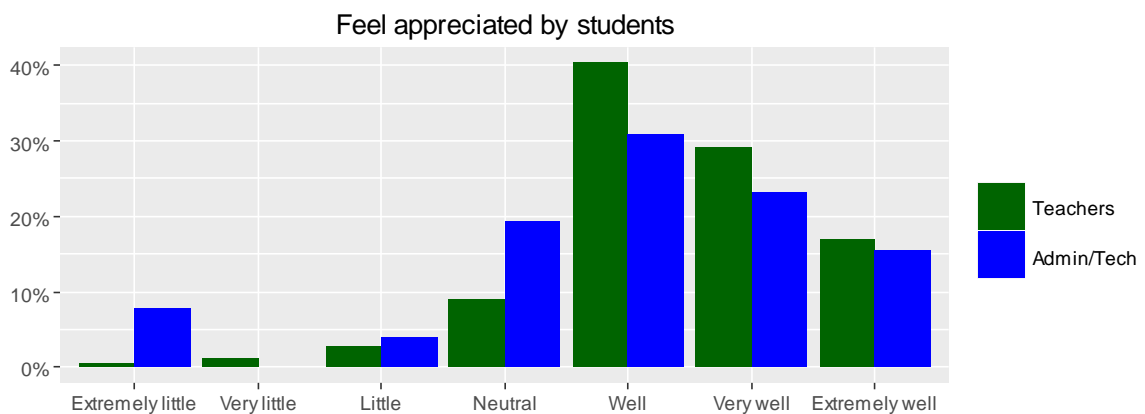
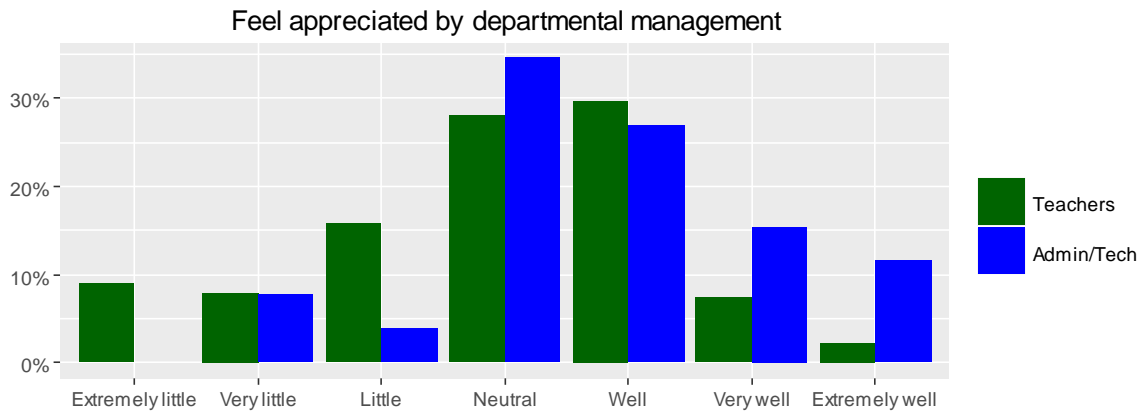
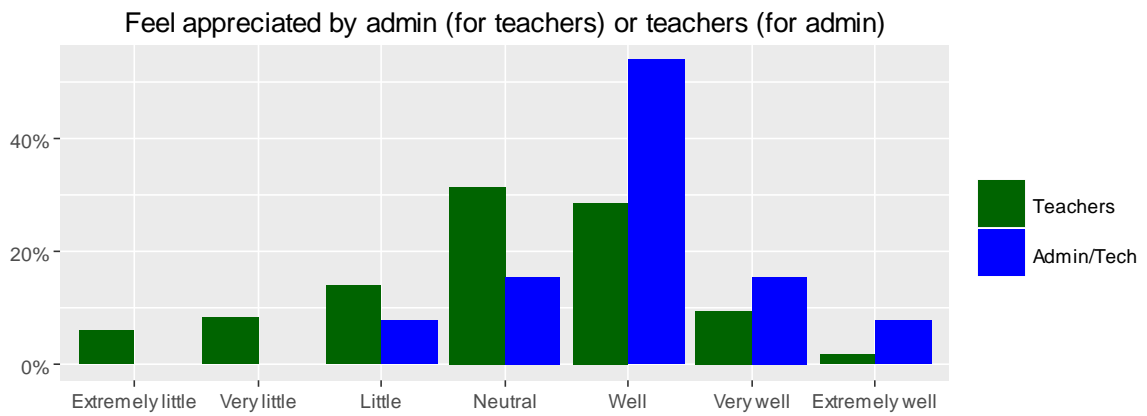
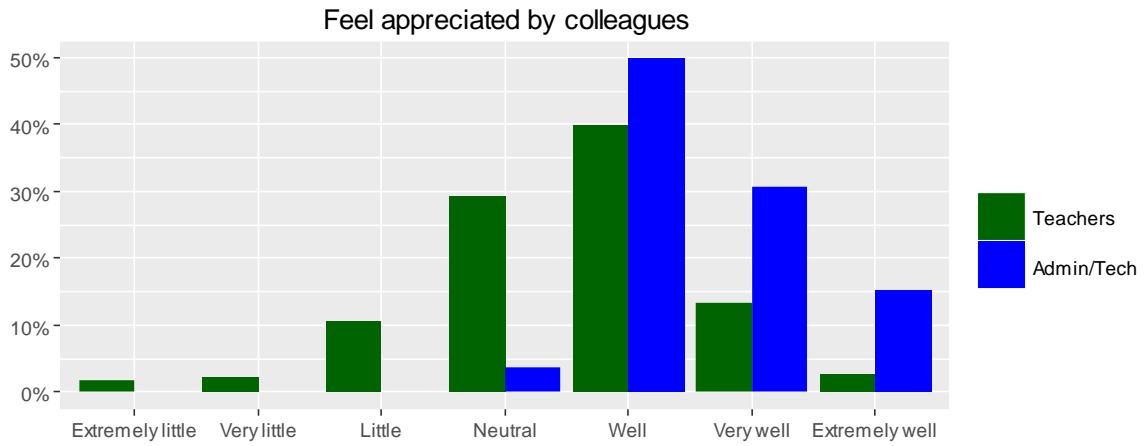


Figure 3. Perceived competence among teachers and students. Teachers were asked about their perceived competence to teach (T22); students were asked about their perceived competence to learn (S21).

3.1.3 Appreciation: Administrative and technical staff and teachers

We asked teachers and administrative and technical staff to express the degree to which they felt appreciated by students, colleagues and leaders. The results show a similar pattern for both groups: they feel appreciated by students and colleagues and less appreciated by department and university management. Specifically, teachers feel more appreciated by students compared to administrative and technical staff, while the administrative and technical staff feels more appreciated by colleagues than by teachers. Interestingly, teachers feel less appreciated by the administration and technical staff than the administrative and technical staff feels appreciated by teachers. Both groups feel under-appreciated by departmental leaders and even more so by university leaders (Fig. 4).





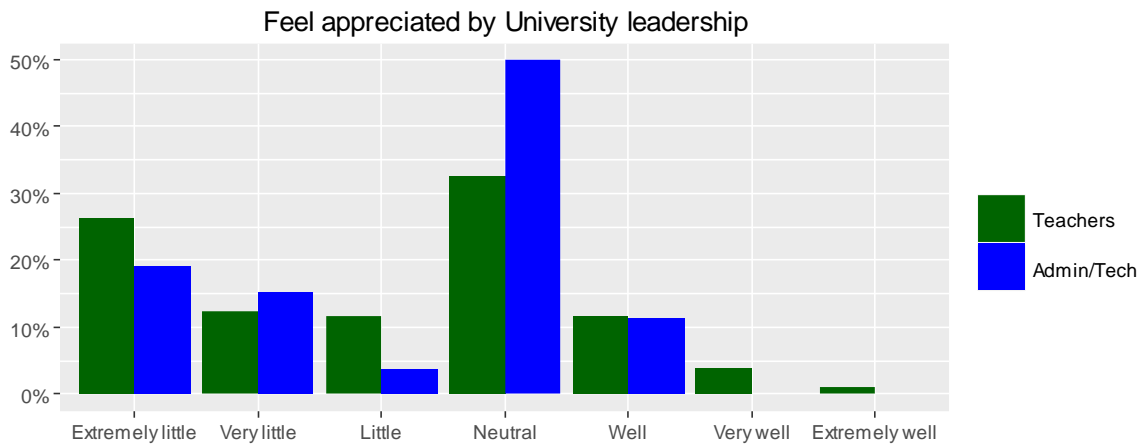
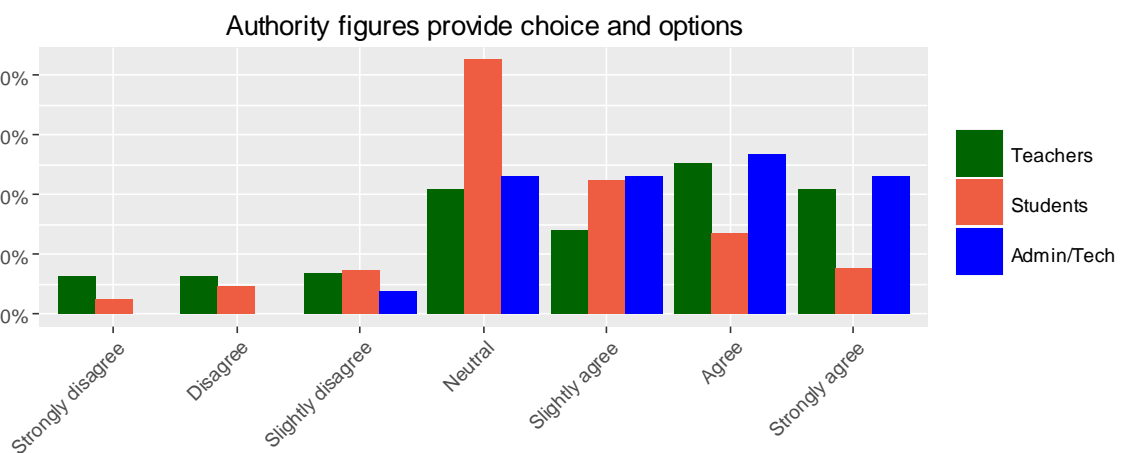
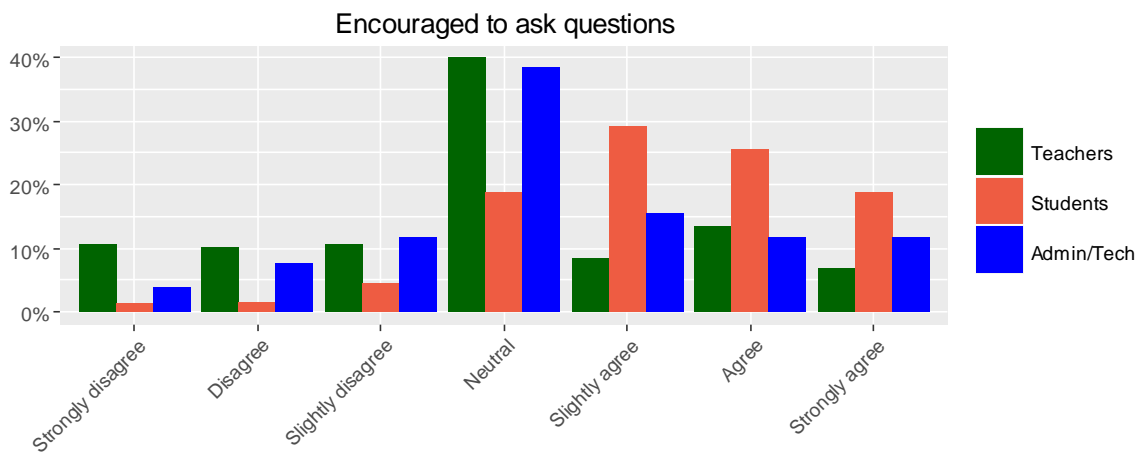
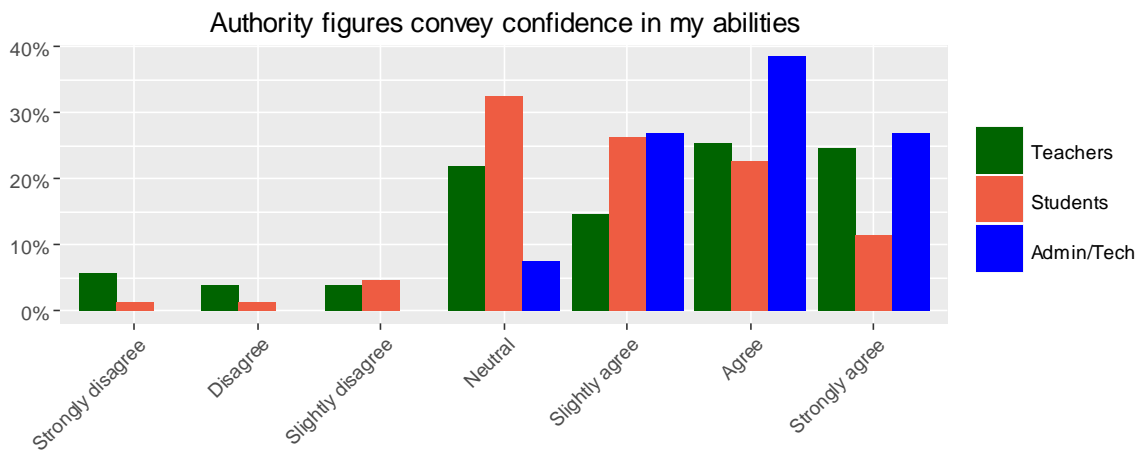
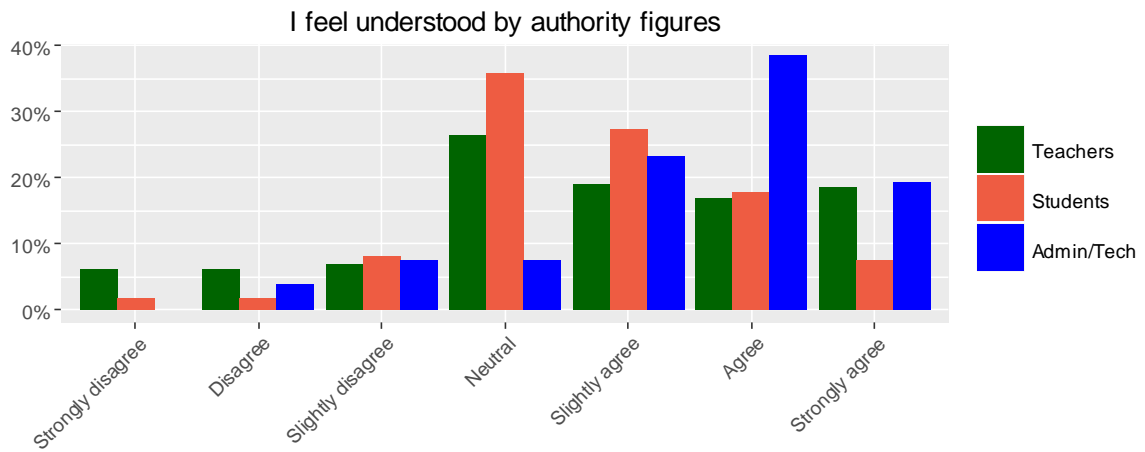


Figure 4. Feeling of appreciation among teachers (T36) and administrative and technical staff (A15).

3.1.4 Autonomy support: Students, teachers and administrative and technical staff

According to theorization derived from SDT, perception of autonomy support is important for a host of factors in the educational domain (Ryan & Deci, 2002). Hence, investigation of perceived autonomy support from the different groups' authority figures was assessed in the survey. Specifically, students were asked to assess the degree of support they received from their teachers, while teachers and administrative and technical staff were asked to express the degree of support they received from their (immediate) leaders. Results show that, in general, all groups perceive that their authority person is autonomy supportive. A similar proportion of teachers both disagreed and agreed with their leaders' understanding of the how they want to do their job before suggesting new ways, while the majority neither disagreed nor agreed. Students perceive that they are encouraged to ask questions more than the other groups; this can be related to the students' role in the teaching arena. Interestingly, for all three groups, a large proportion of the respondents are neutral about the authority person listening to them or trying to understand them before suggesting new ways of doing things (Fig. 5).





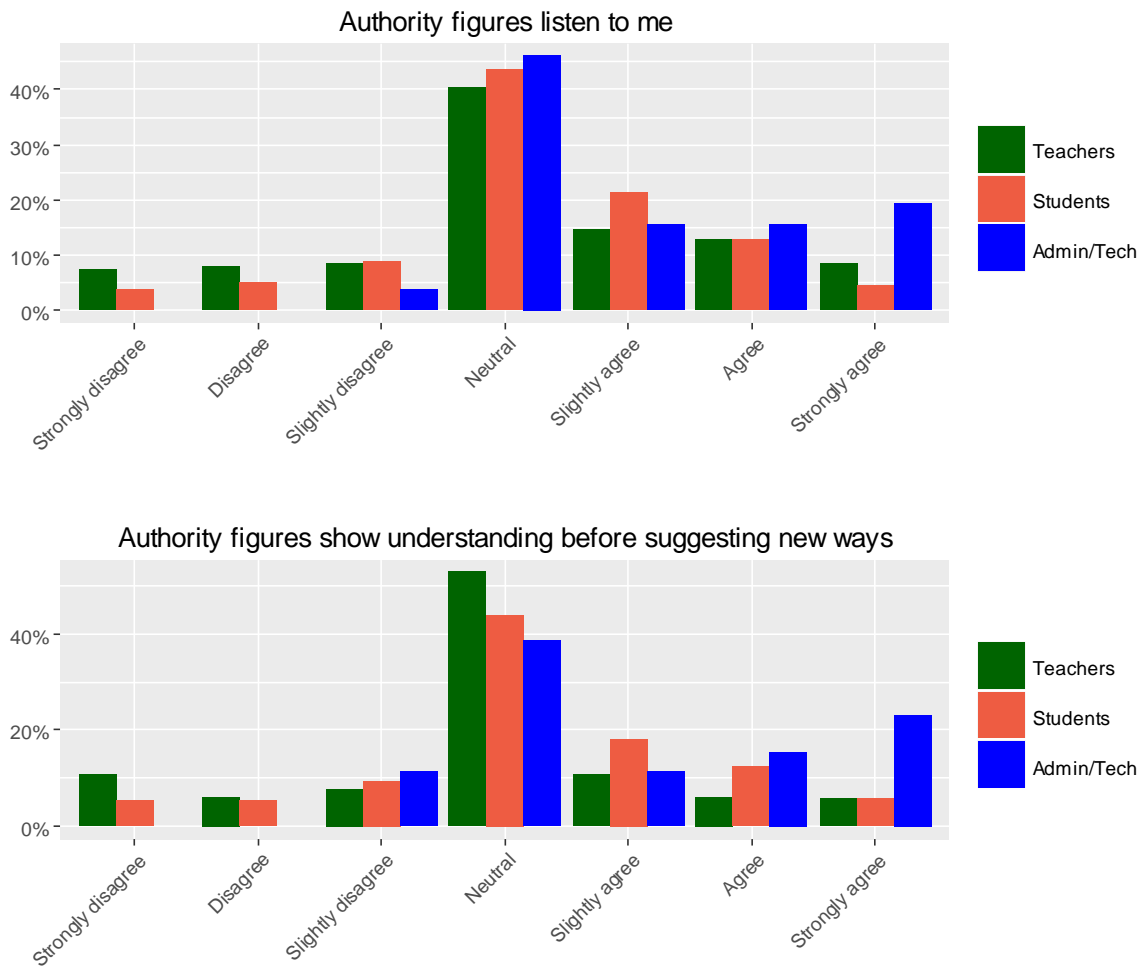
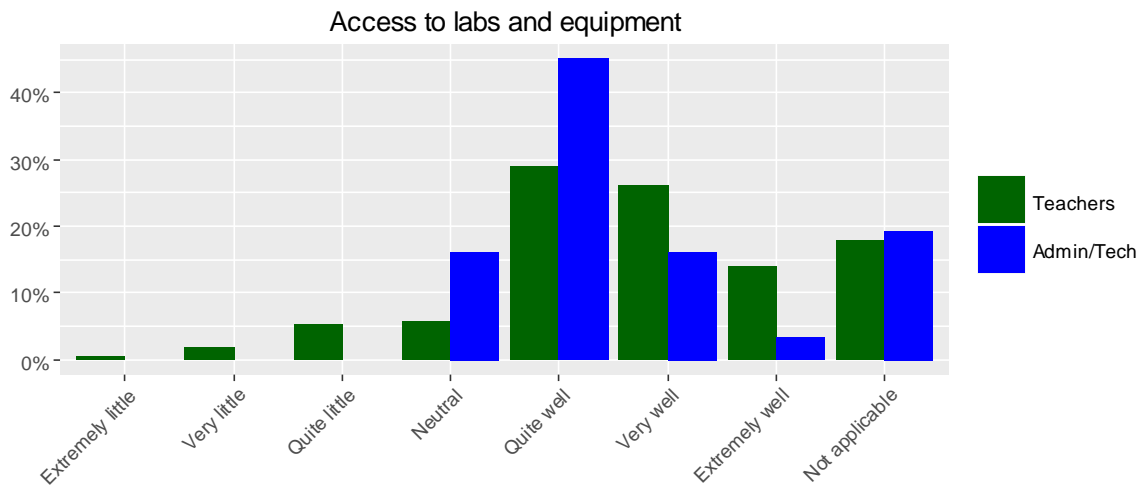
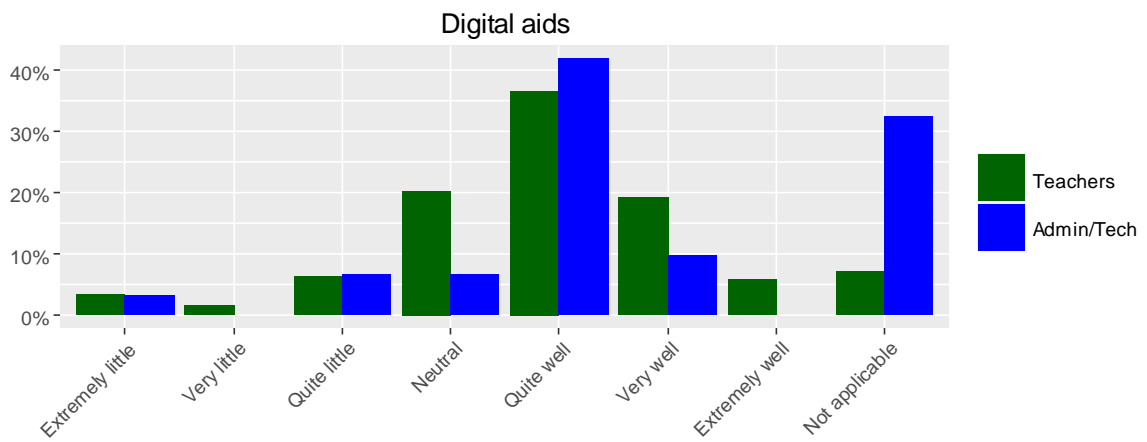
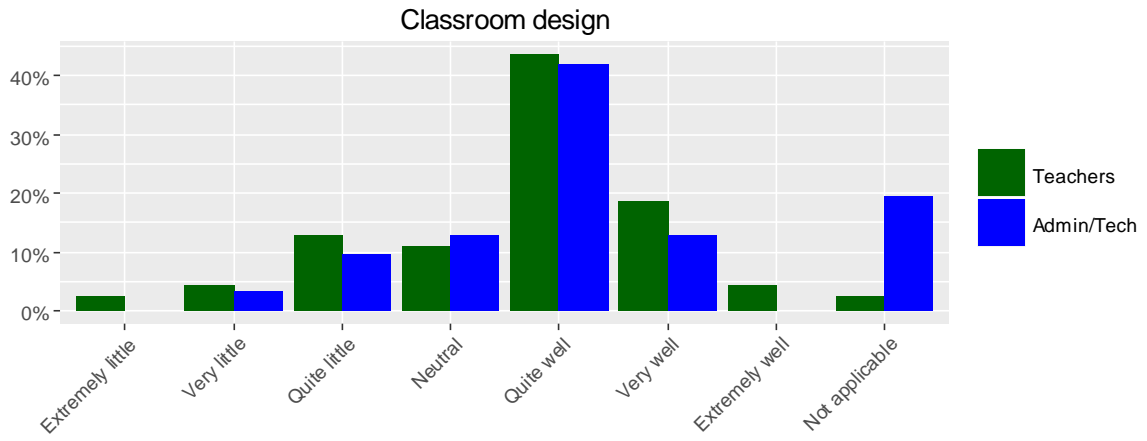


Figure 5. Perceived autonomy support among teachers, administrative and technical staff and students to authority figures. Teachers were asked about their relationship to leaders within a teaching activity (T34). Students were asked about their relationship with teachers (S10). Administrative and technical staff were asked about relationship to leaders (A14).

3.1.5 Physical environment and organization: Administrative and technical staff and teachers

To assess how well the physical environment and organization works across different institutions, we asked teachers and administrative and technical staff seven questions. Note that many items were not applicable for administrative and technical staff. The results show that both groups report that classroom design works well for different teaching methods. Both groups perceive that digital aids function well. Teachers more often than administrative and technical staff reported that the organization of lecture plans works well. Lastly, both groups reported, in general, that the possibility to choose the type of assessment that fits their course and the practical organization of field courses function well at their institution (Fig. 6).



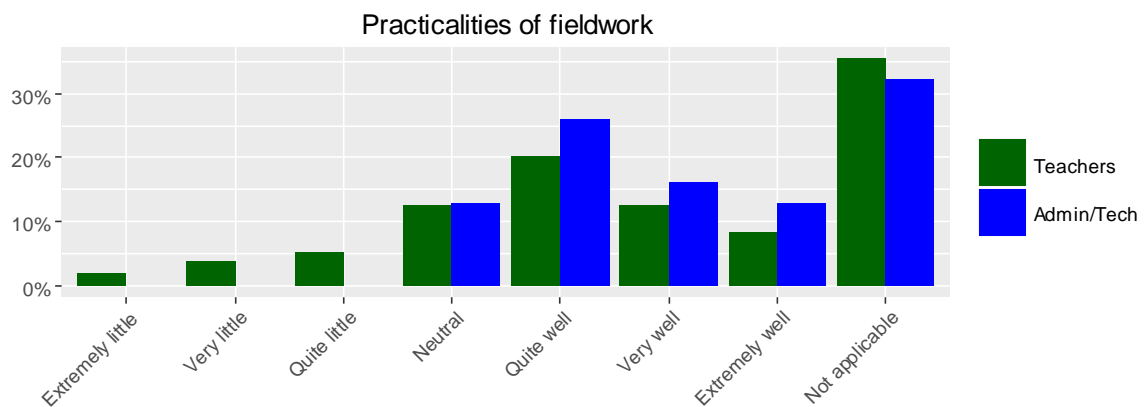
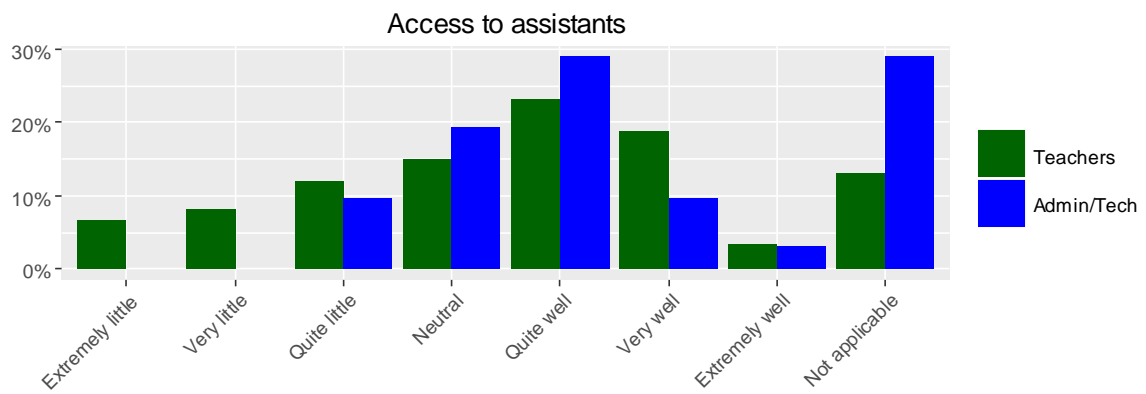
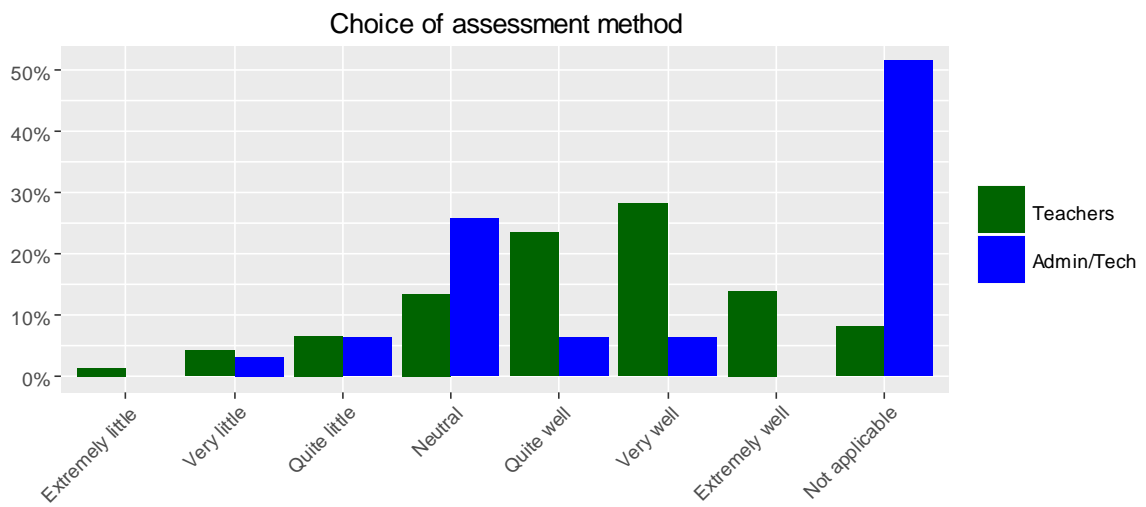
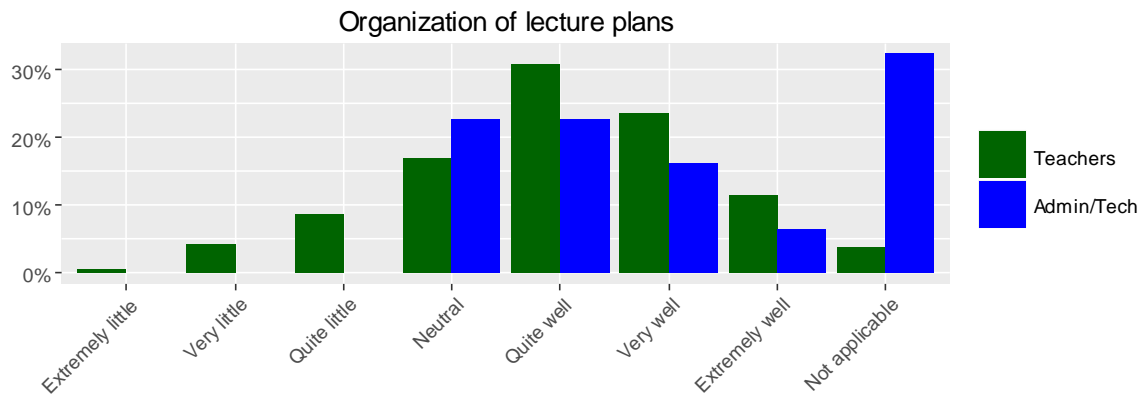


Figure 6. The perception of teachers and administrative and technical staff on the level of function of different course-associated structures and organization (T10; A6).

3.1.6 Perceptions of student learning outcomes in fieldwork: Students and teachers

Both students and teachers were asked to rate the learning outcomes of fieldwork. The areas range from practical skills, skills in research vessels, understanding of methods and theory, transferable knowledge, and higher understanding of processes in nature. The respondents were prompted to answer despite any lack of recent experience with the activity. The questionnaire also included an option for *no experience* in the event that the respondent had no experience with fieldwork/cruises. The figures show that students and teachers perceive the learning outcomes of fieldwork and cruises quite similarly. However, across all items, the students reported that fieldwork provided them with slightly higher learning outcomes compared to the teachers' perception of students' learning outcomes. Both groups generally agree that field courses facilitate several different learning outcomes (Fig. 7 and Fig. 20 in section 3.2.10 and Fig. 28 in section 3.3.7).

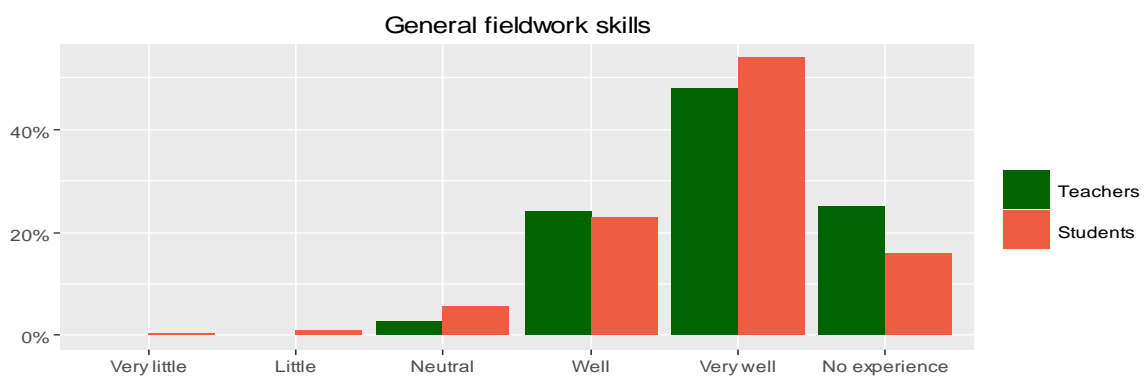


Figure 7. Teacher and student perceptions about the extent of student learning outcomes from general field courses or expeditions (T28; S28).

3.1.7 Perceptions about student learning outcomes in laboratory work: Students and teachers

Students and teachers were asked a set of questions concerning learning outcomes from laboratory work. The same scale as reported above for field courses was used, except the item concerning knowledge and understanding of patterns and processes in nature. In general, teachers reported that laboratory work contributes to the students' learning outcomes; note, however, that a substantial number of teachers reported no experience with the different learning outcomes. Very few teachers and students reported that laboratory work contributed to learning outcomes to a lesser extent. For the students, only a small proportion reported no experience with laboratory work. Across all items, students and teachers reported that laboratory work contributes highly to learning outcomes (Fig. 8 and Fig. 20 in section 3.2.10 and Fig. 28 in section 3.3.7).

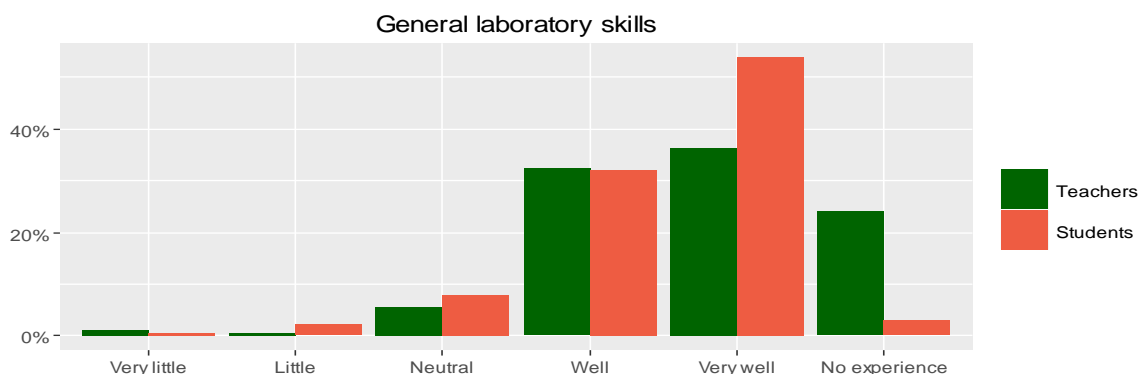
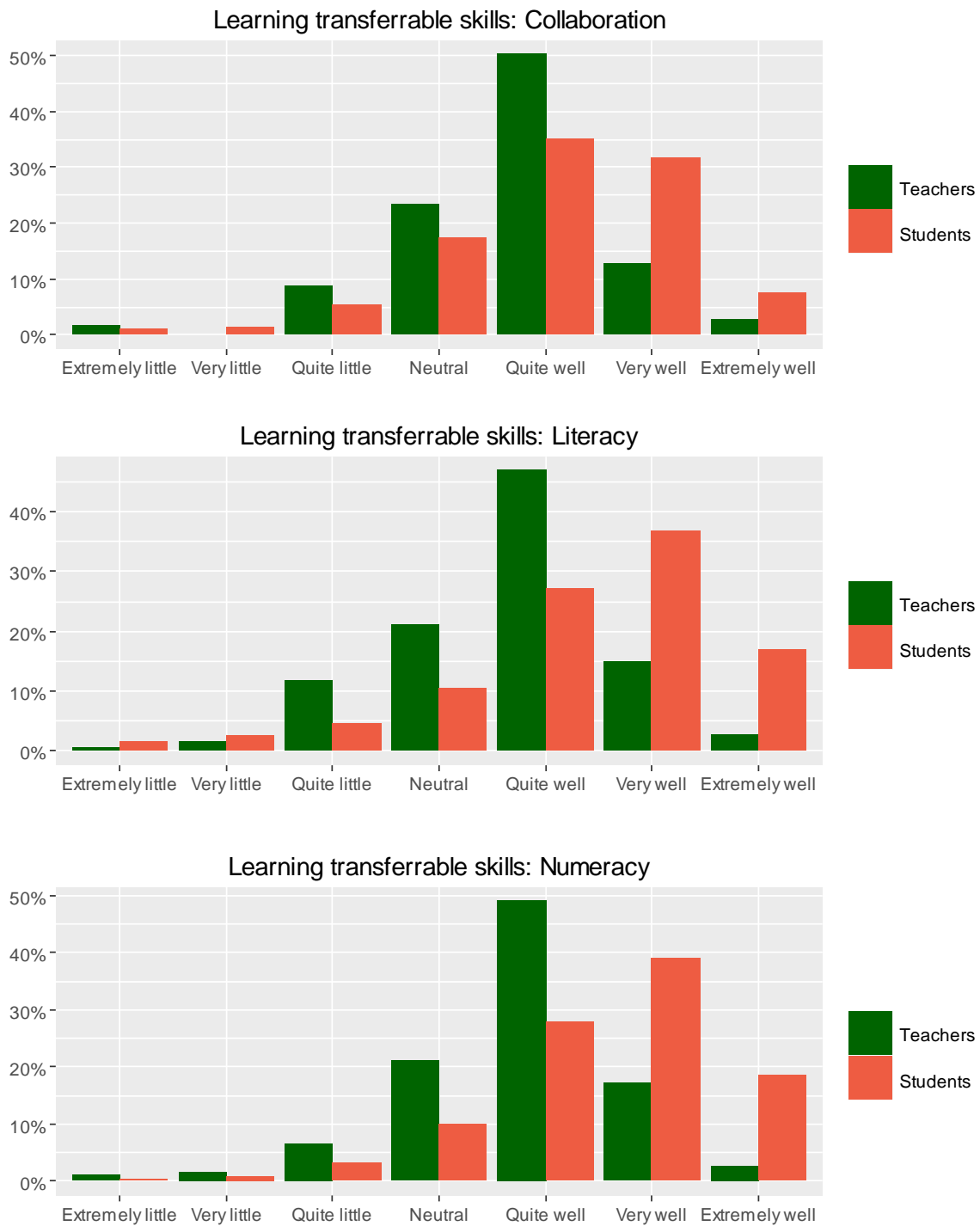


Figure 8. Teacher and student perceptions about the extent of student learning outcomes from laboratory work (T27; S27).

3.1.8 Perceptions about transferable skills: Students and teachers

Both students and teachers were asked about the students' learning of transferable skills. Both groups were asked in relation to collaboration, literacy, numeracy (quantitative competence) and critical thinking. Results from both the students and teachers show that both groups perceive students to learn critical thinking, numeracy, literacy and collaboration well. Interestingly, students consistently rate student learning to a higher extent than teachers (Fig. 9).



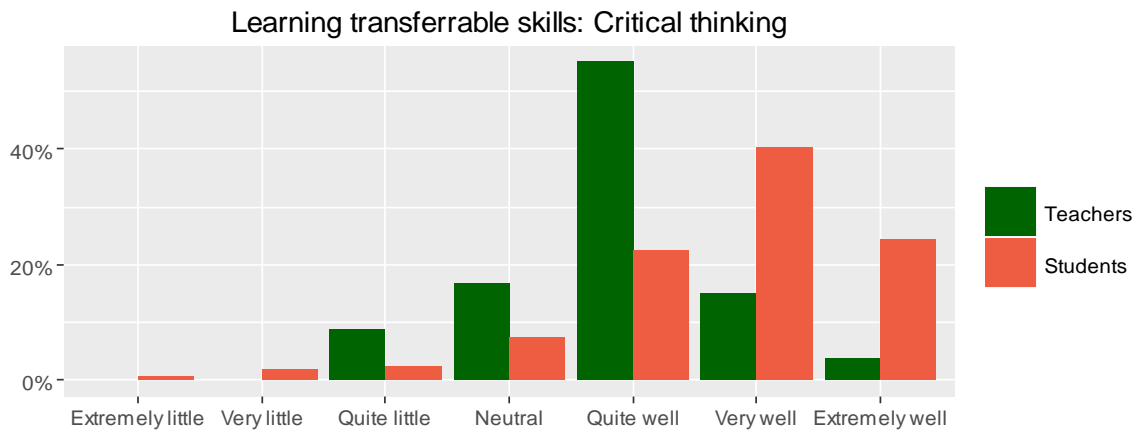
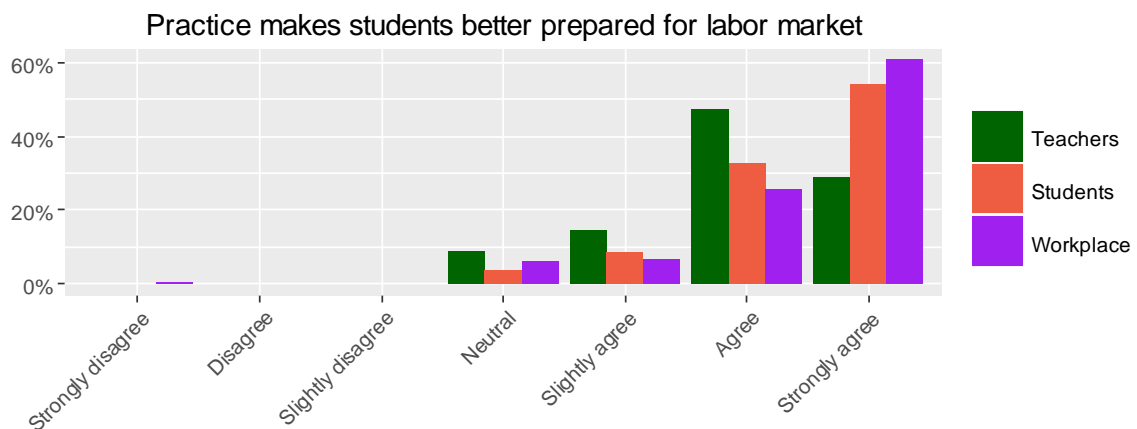


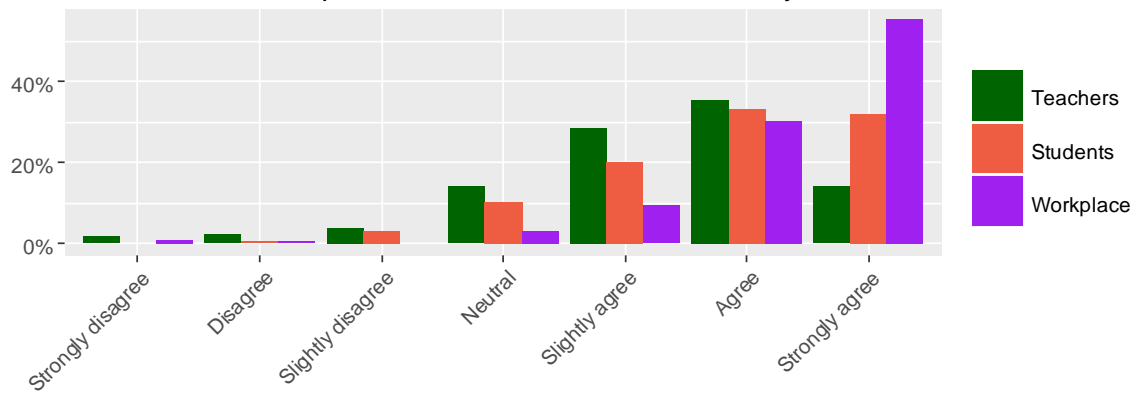
Figure 9. Teacher and student perceptions about extent of student learning of transferable skills (T29; S29).

3.1.9 Workplace learning and practice: Students, teachers and workplace biologists

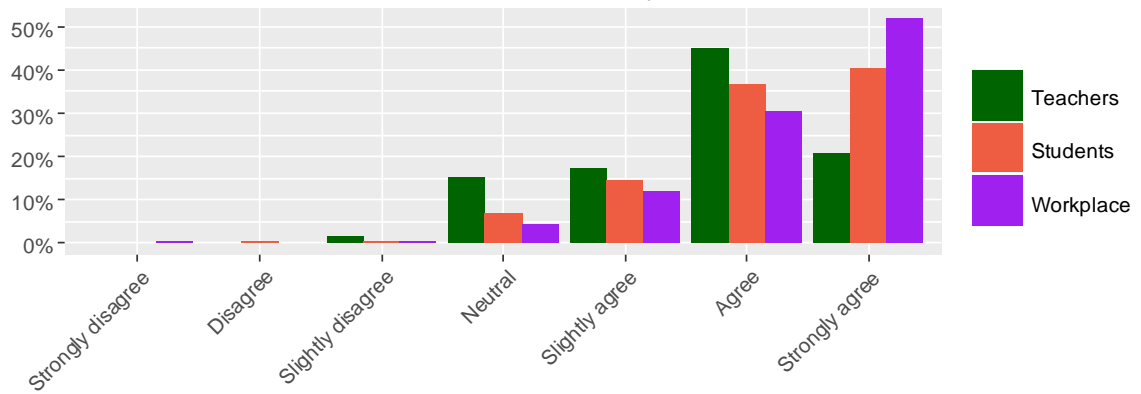
Students, teachers and workplace biologists were asked about their perceptions of workplace learning in relation to biology education. In the questionnaire, it was emphasized to all groups that we would like an answer despite no direct experience with this learning strategy. Overall, the three groups seem to perceive workplace practice as making students better prepared to meet the labor market. The groups are slightly more divided when expressing whether practice comes at the expense of other important learning in biology. The workplace respondents disagree to a higher degree on this statement, while teachers express concern around workplace practice and learning at the college/university. Students' answers are more widely distributed; this may be due to a lack of experience of practice and its possibility and/or consequences (Fig. 10).



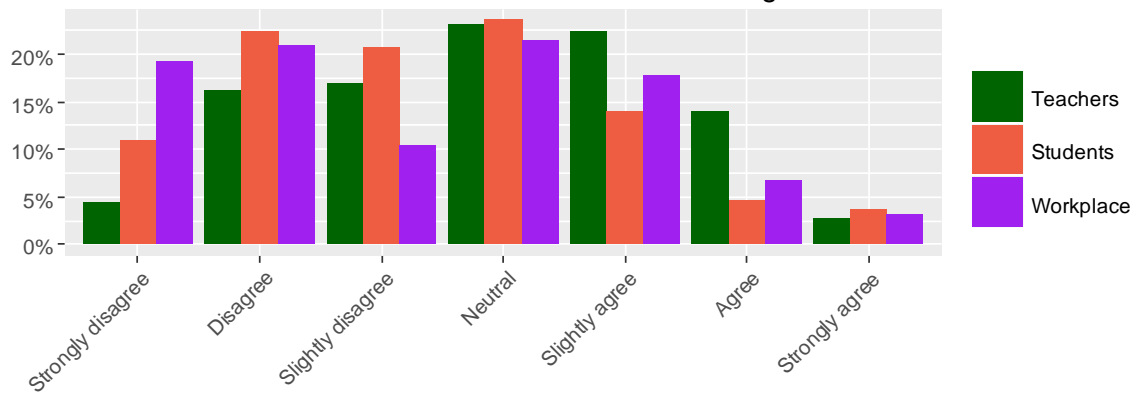
Practice provides skills unavailable at university



Practice illustrates theory



Practice comes at the cost of other learning



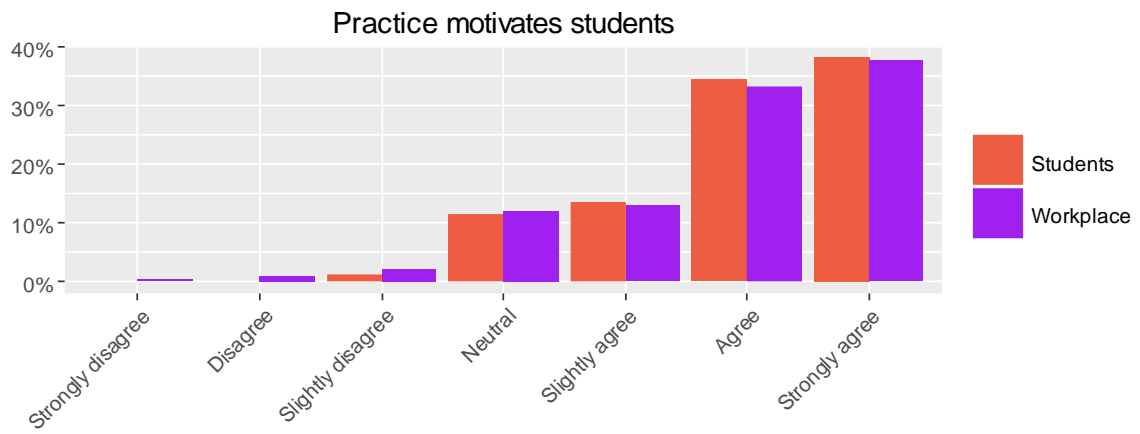


Figure 10. Teacher (T33), student (S30) and workplace (W22) perceptions about workplace practice in biology education. *Teacher respondent group was not asked about student motivation in relation to workplace practice.



bioCEED Student Survey



3.2 bioCEED Student Survey

This section presents data from the bioCEED Student Survey 2015. Data on students are divided between BSc and MSc respondents. In all figures where this is done, the column is split into two colors to show the relative distribution within each course level.

Main findings:

- There are more female than male students at both the BSc and MSc level.
- Many students plan to study abroad, especially BSc students.
- Interest in the subject and intrinsic motives are the main reasons for studying biology.
- A great many students want to work within the field of biology, and approximately half the students have a clear plan as to how they will use their education.
- Students are satisfied with the availability of teachers (available for questions), and a large proportion of students are satisfied with different aspects of the physical environment.
- Both BSc and MSc students are somewhat less satisfied with study groups.
- Students report a great sense of belonging to biology and to their fellow students, as well as satisfaction with their life at university.
- Students feel they are challenged and encouraged by the teachers, but appear somewhat less satisfied concerning availability of discussions in class.
- Students claim to learn best from self-led studying and group work.
- Individual written feedback and conversations with teachers is perceived to function better towards learning than grades and more general feedback to the whole student group.
- Mean number of study hours per week is 35.5; self-led studies occupy 20 hours on average.
- Both laboratory work and field courses contribute to a set of practical and methodological skills, and also towards theoretical skills.
- A large proportion of students are favorable towards internship, seeing this as a good opportunity to prepare for the labor market, and also towards better understanding of theoretical knowledge.
- Very few students reported that they had plagiarized.

3.2.1 Background information

The bioCEED Student Survey had 751 respondents (66% female), 60.5 percent of whom study at BSc level. Ninety-eight percent of students are full-time students and the other two percent part-time (Fig. 11). Females outnumber males at both BSc and MSc levels, but the balance between genders is more even among MSc respondents. Most of the respondents are in their early twenties; the proportion of older students is larger at the MSc level.

Altogether, a large minority (42%) of the students reported having studied or planning to study abroad. Looking at the difference between the two groups of students we find that more BSc (45.2%) students plan to study abroad than MSc students (37.7%).

Table 3 shows the students' reported time spent on studying, the largest partition of time is used on self-study and coursework. The table shows that the students report using more time on average on paid work outside of their studies than on collaboration and academic discussions with fellow students.

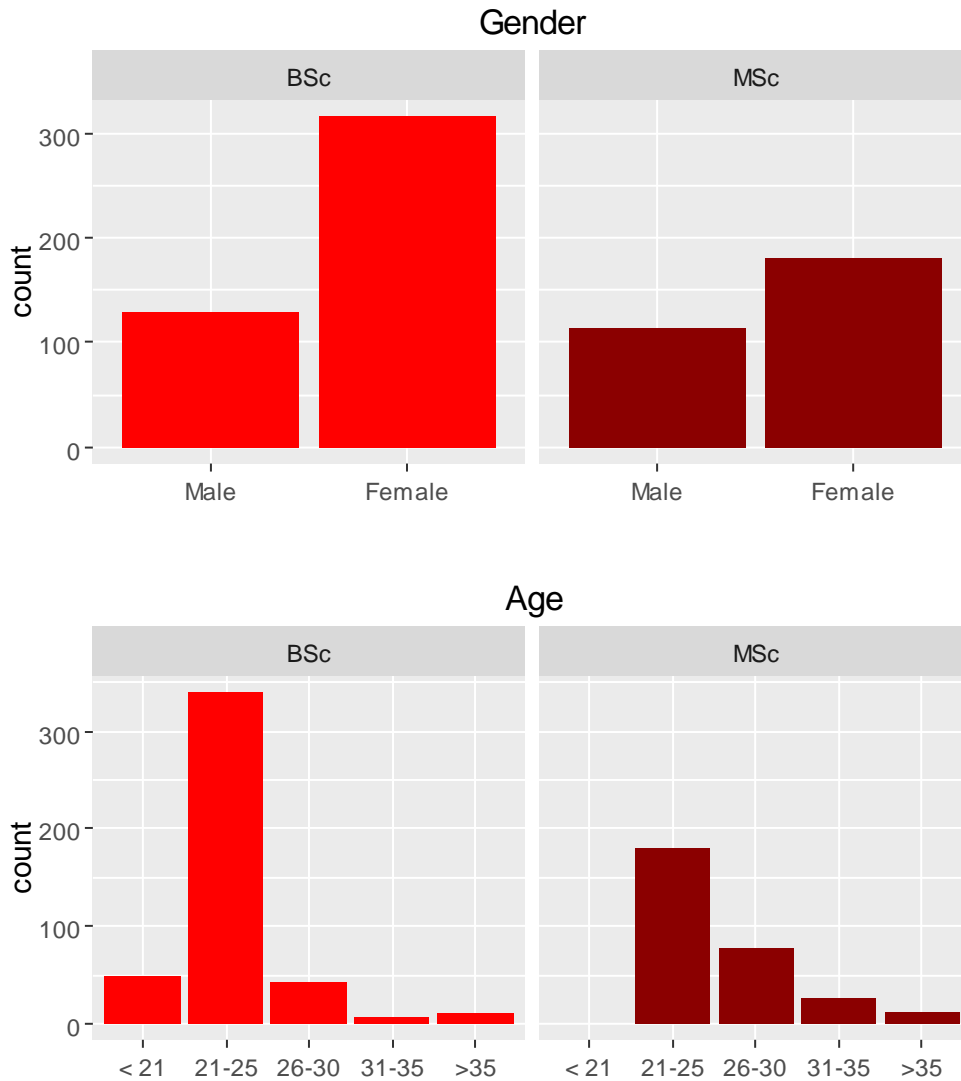


Figure 11. Study level (MSc or BSc) in relation to gender and age group among respondents (S1, 2, 4).

Table 3. Time used on study

	Mean	Mode	Median	Min.	Max.
Organized course-work	12.6	10	12	0	40
Self-led study	19.75	20	20	0	200
Collaboration and academic discussions with other students	3.65	2	3.65	0	30
Paid work outside studies	4.55	0	0	0	40

Note. Students were asked to distribute hours in a normal work week

3.2.2 Reasons for studying biology: Plans and motivation

A high proportion of students reported being motivated by their personal interest in biology. They also reported a desire to work within the field of biology as an important reason for choosing to study biology. The majority of respondents answered that “interest in the subject” was very important for their choice, which indicates a high degree of motivation for studying biology. Likewise, a clear majority answered that “the desire to work within a biological profession/field” was moderately to very important for their decision to study biology (Fig. 12).

The students were also asked if they have clear plans as to how they will make use of their education. Here we find that approximately half the students answered yes. This is interesting as most of the students reported that they want to work within a biological field. Having pointed this out, we should, however, note that the two questions are given a somewhat different formulation. Having “a clear plan” may be comprehended differently from the more vague “wanting to work within the field”. Being motivated by a desire to work within the biological field does not necessarily involve a clear understanding of how one may or can use the education (Fig. 12).

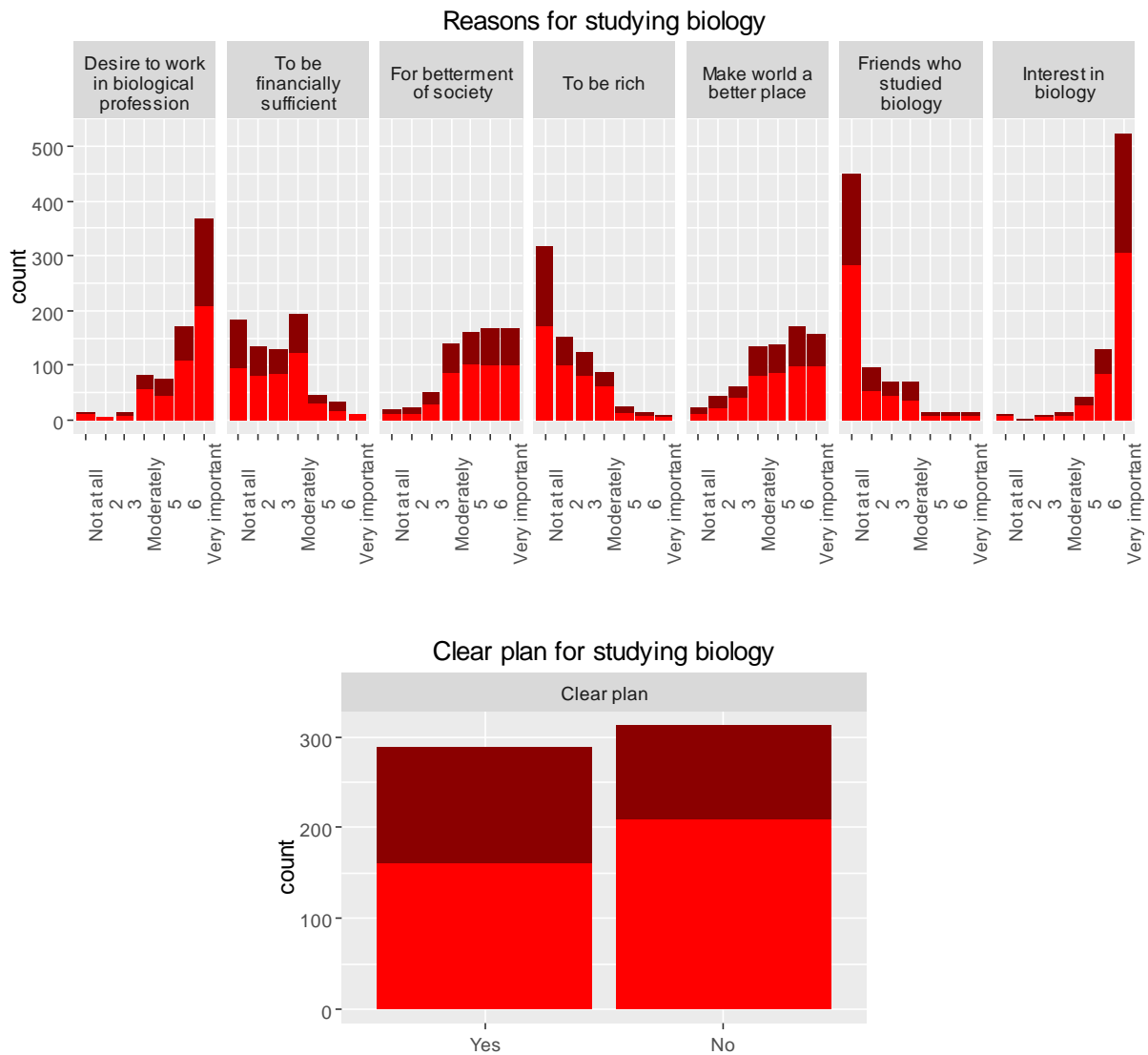


Figure 12. Students responses about reasons to start studying biology (S6) and future plans (S33). Light red indicates BSc-students, darker red indicates MSc-students.

3.2.3 Facilitation and physical environment

Students were asked about how well the university/university college currently facilitates students. Most students have access to a canteen and/or social areas, but fewer students have access to meeting rooms outside of lecture rooms. A large majority of students answered that study rooms are available (applies well or very well). The students were somewhat less satisfied with access to computer labs.

A high proportion of the respondents answered that teachers are available for questions outside class. The students are less satisfied when it comes to the opportunity to take part in organized study groups, with one in three students reporting that they are not satisfied about such groups. The same is true as far as access to laboratories outside of lectures is concerned (Fig. 13).

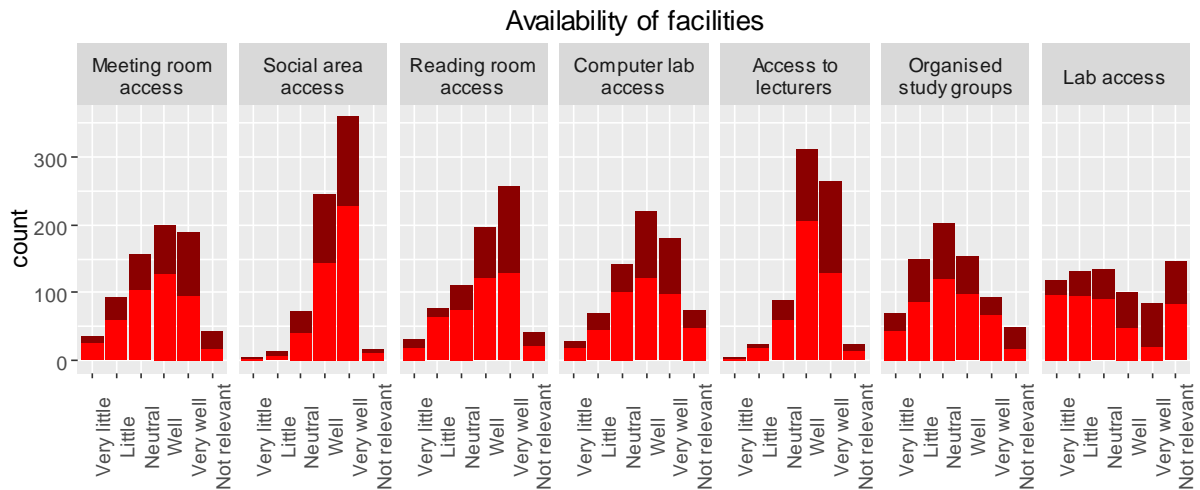


Figure 13. Student perception on the availability of facilities and the physical educational environment (S7).

3.2.4 Student satisfaction and academic experience

We asked to what extent the students consider their biology education to be engaging, academically challenging, consist of topics that integrate well and have skilled teachers. A majority of students at both bachelor and master levels find biology to be engaging and academically challenging. The same is true concerning integration of topics. Although still highly rated, the students are more neutral about the skill of teachers (Fig. 14).

We also wanted to know more about the way students perceive their learning environment. Here we asked two questions related to belongingness. A majority of students answered that they like the people they interact with and many feel that people in their biology courses care about them.

We further investigated how satisfied the students feel at the university/college. Altogether, the students indicate a high level of satisfaction.

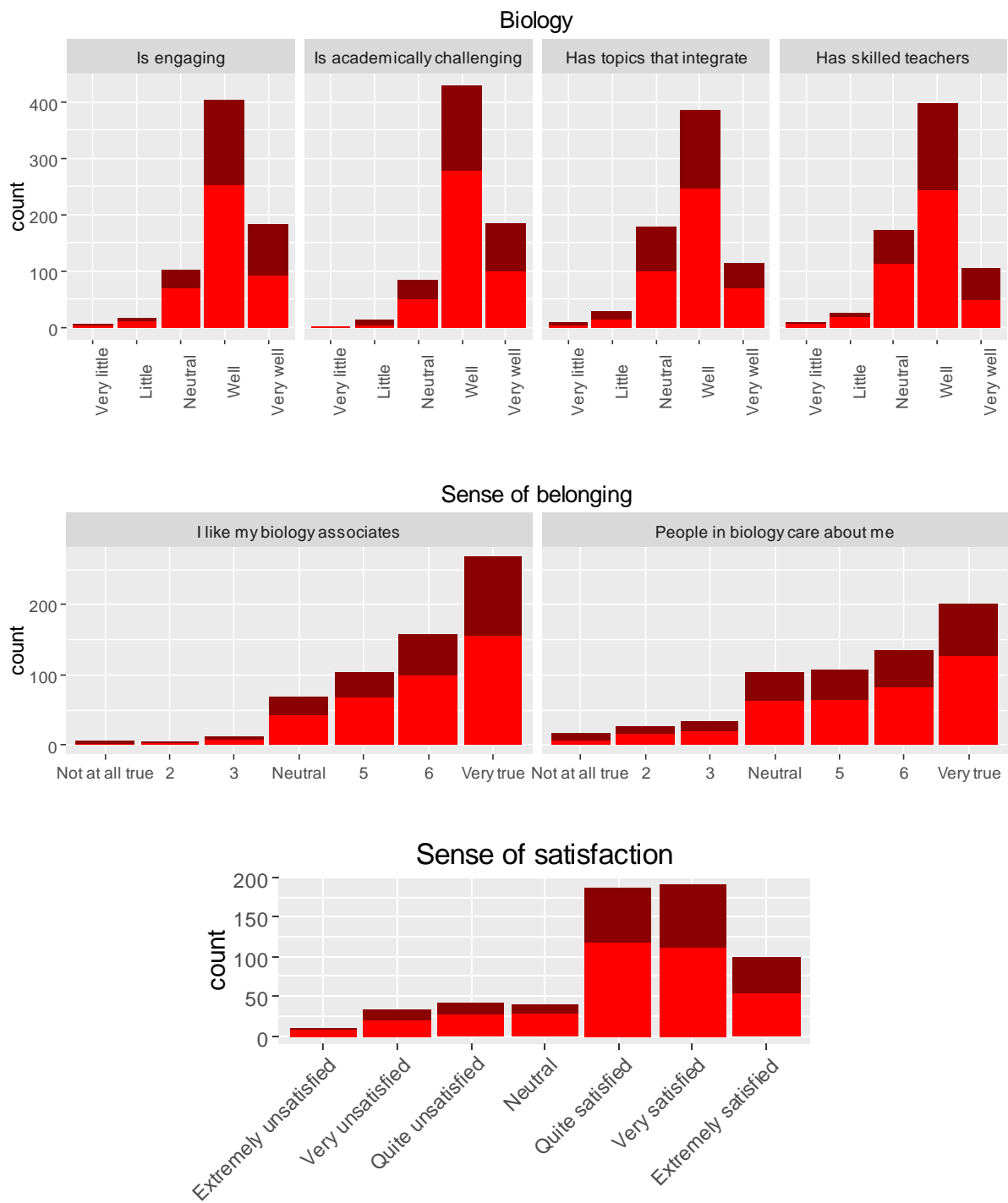


Figure 14. Student satisfaction and academic experience (S8, 26, 35).

3.2.5 Perception of support

The questionnaire included a set of statements dealing with teacher support (Fig. 15). Although many students report positive answers to the different statements, the most common response is neutral, indicating that there is room for improvement when it comes to teacher-student relationships. Students report more favorably to the statement “My lecturers encourage me to ask questions”. Here we find that a clear majority perceives that teachers encourage them to ask questions.

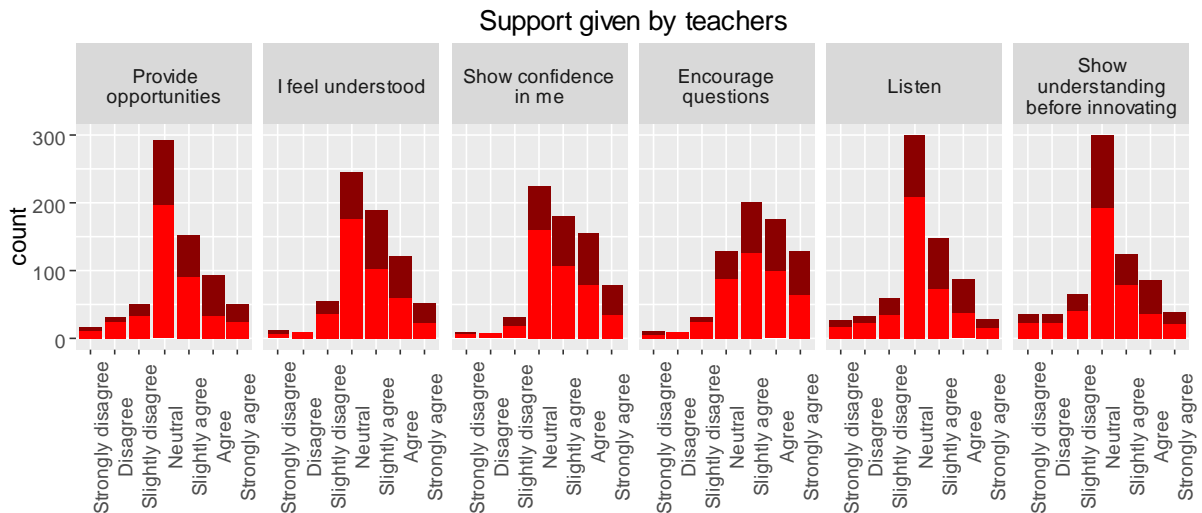


Figure 15: Student perception of teacher support (S10).

3.2.6 Teaching and learning methods

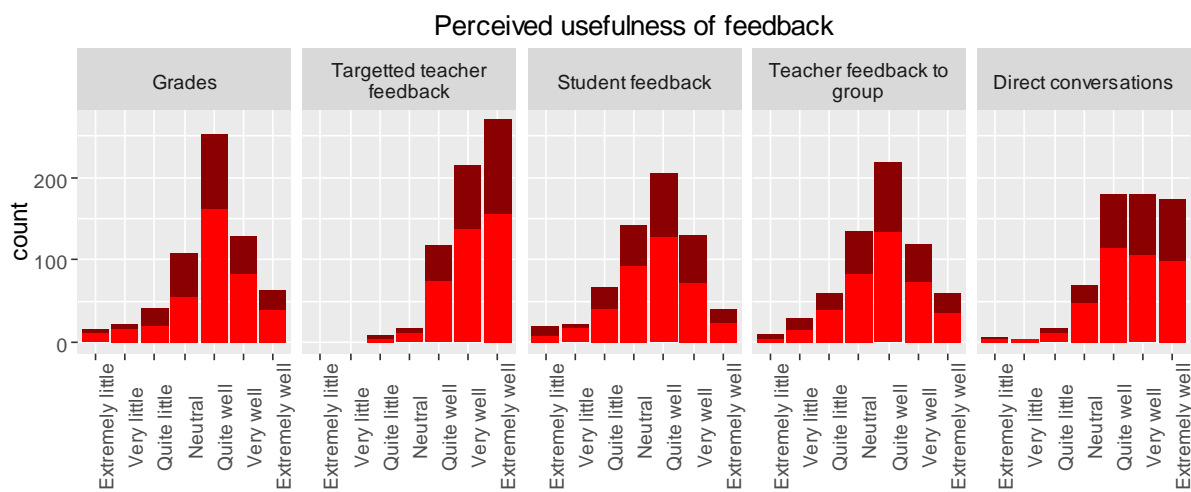
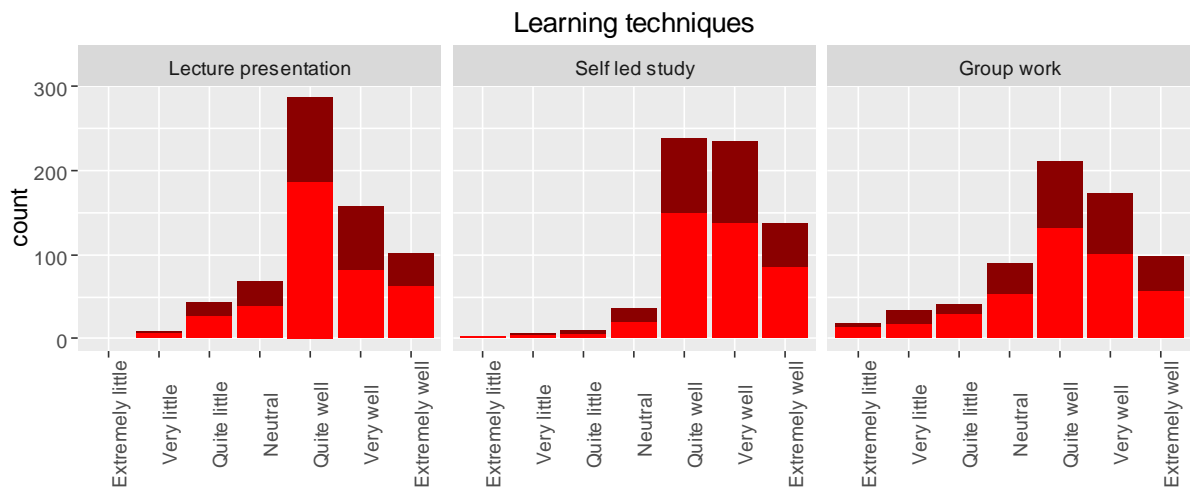
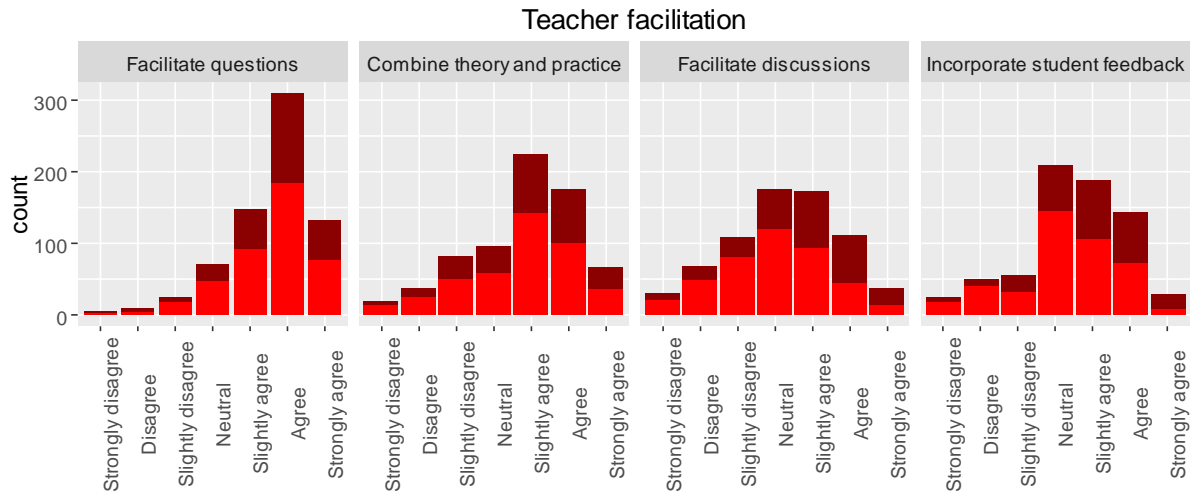
Students were asked several questions about teaching and learning methods. They were given statements about teachers’ facilitation of different learning activities in class. A majority of students reported positively on most of the statements (Fig. 16). However, the students are divided with regards to teachers’ facilitation of peer-discussion during teaching sessions.

Students were also asked to what degree they perceive that they learn from different activities; lectures with black/white board, self-study and group work. The majority of students rate the learning output as “well” for all three activities. As can be seen from the figure, more students answered that they learn “extremely well” from self-studies than from “group work” or “lectures”.

We also measured the students’ perception about the usefulness of different forms of feedback. When asked about grades, a large majority perceive this form of feedback to work quite well, very well or extremely well. When asked about written feedback (specified as some sentences) from a teacher or teaching assistants, a substantial majority see this as useful for learning. The answers vary somewhat more when it comes to usefulness of individual feedback from other students and general feedback to the student group from the lecturer, even though a high proportion perceive these as useful as well. Students also reported that they find individual conversations with teachers or teaching assistants to be useful for their learning.

We asked how often the students collaborate with fellow students. According to the students, the most common method of collaboration is to discuss the curriculum in the canteen or other social rooms. The least-used form of collaboration is providing feedback on written work with fellow students.

Interestingly, a majority of students said they do not prepare for lectures; this is noteworthy in relation to how the students report that many of the teachers facilitate questions and suggestions in class, as well as discussions.



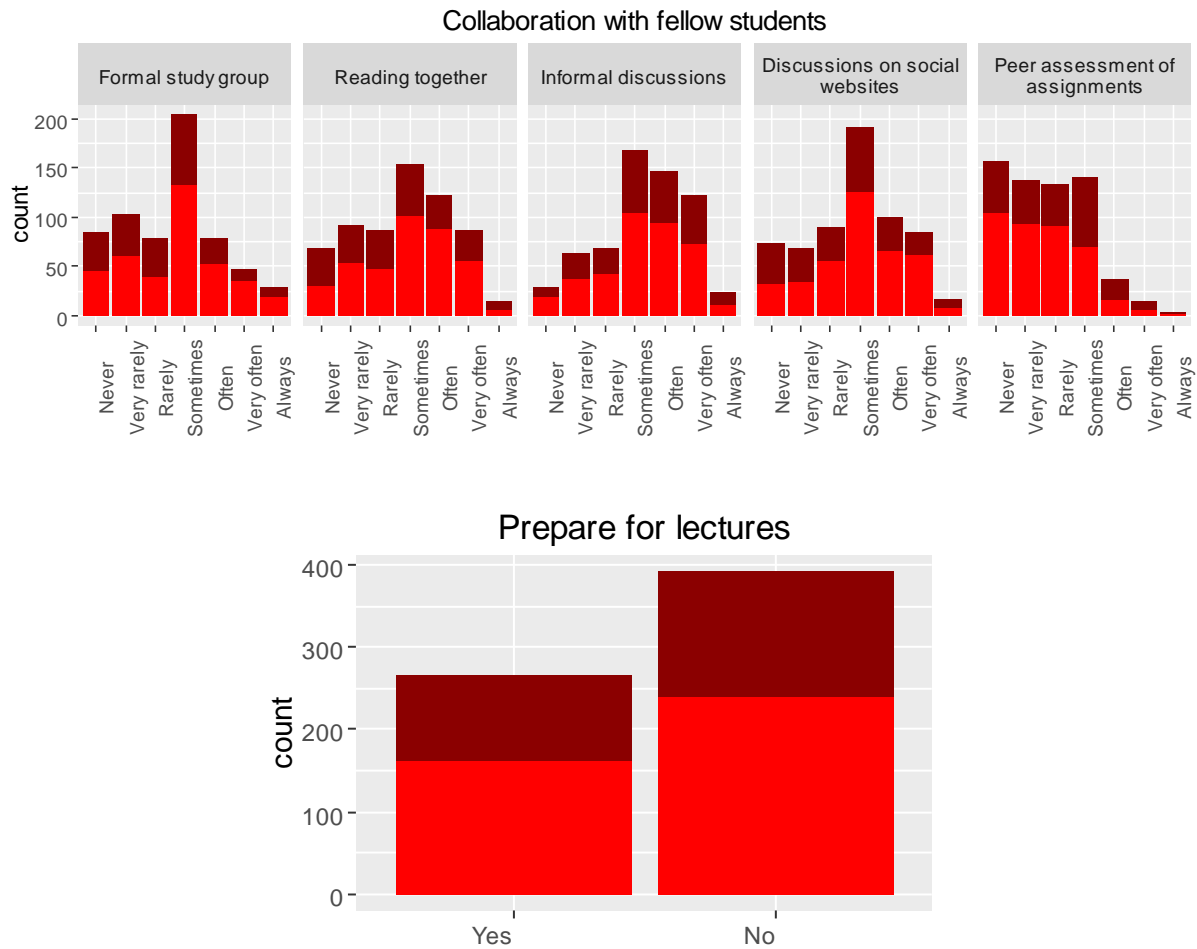


Figure 16. Student perceptions about different teaching and learning methods in biology (S9, S13, S22, S23, S14).

3.2.7 Difficulties in starting to study and managing work load

To investigate possible study-start challenges, students were asked to answer how difficult it was to understand the textbooks, to familiarize oneself with the subject matter, to learn good study techniques and to understand how different courses fit together. The answers to these questions indicate that the student population is quite diverse. Students find it hard to learn good study techniques and they find it (somewhat) difficult to understand how different courses fit together (Fig. 17).

To further investigate students' study effort, we asked how much effort they needed to put into written assignments, reading the curriculum and understanding the terminology. The largest proportion of "Extremely much" effort is for "Reading the curriculum": students found that it required either quite, very or extremely much effort to read the curriculum. Interestingly, the challenges with understanding textbooks are seen as quite neutral in difficulty, whereas reading the curriculum and understanding terminology are both seen as requiring a high workload.

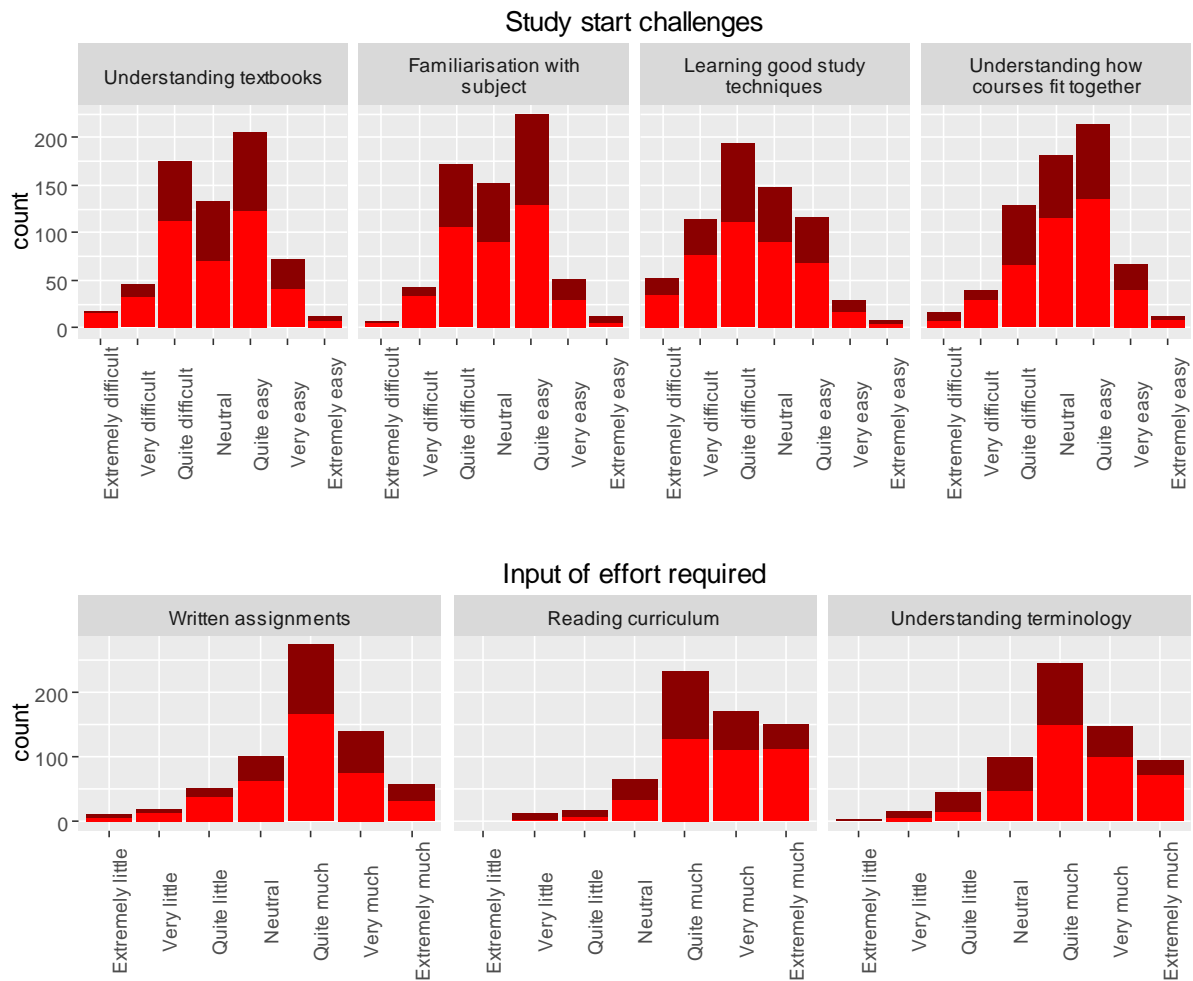


Figure 17. Student perception on study start-challenges and work-load (S15, S16).

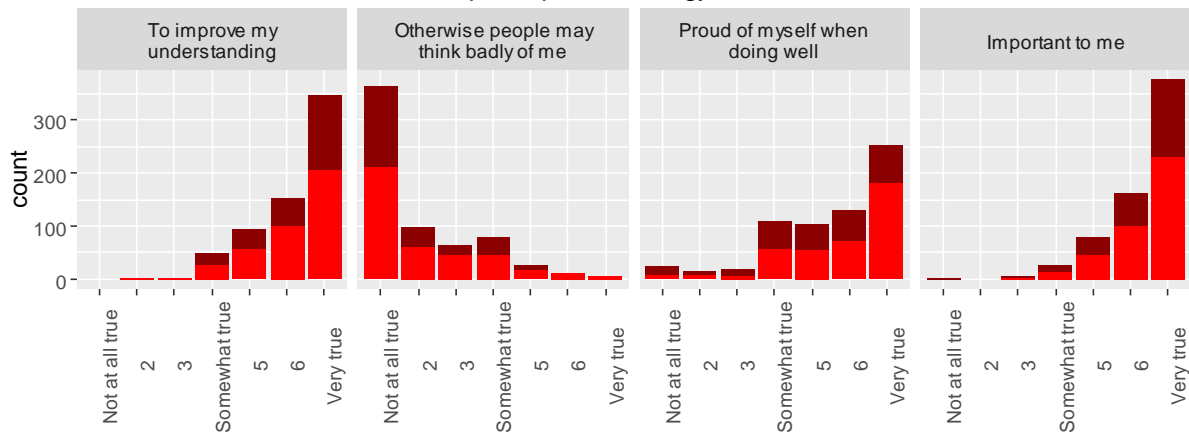
3.2.8 Motivation and personal efficacy

To assess student motivation and personal efficacy we asked two different strings of questions (Fig. 18). In accordance with the abovementioned theoretical assumption (Section 2.2.1.2), we asked about reasons for participating, listening to lecturers' advice, actively engaging and working with biology. Results show that a student's reason for learning biology is, to a large extent, motivated by intrinsic factors such as improved understanding, importance to self, and to a small degree by extrinsic factors such as others' opinions. With regard to following lecturers' suggestions the answers show less clarity. A majority of students thought the statement about following lecturers' suggestions when studying to be slightly positive on all items, although a substantial number of students do not agree. The principle motivator for this response was based on a worry of not doing well in the course. This indicates that students do not always construe teachers' suggestion as a means of learning, but as a means of acquiring good grades. When we asked the students about their reasons for working to expand their knowledge in biology, a clear majority of the students reported studying biology because it is interesting in itself to learn more biology. Only a small proportion reported studying biology to give an appearance of intelligence.

Students generally feel quite confident in their abilities to learn biology, learning the material in the present course, achieving the goals that are set for the present course and that they will perform

well in their present course. Overall, the students seem highly motivated and engaged in their subject, although the relationship between motivation and teacher interaction is slightly more convoluted.

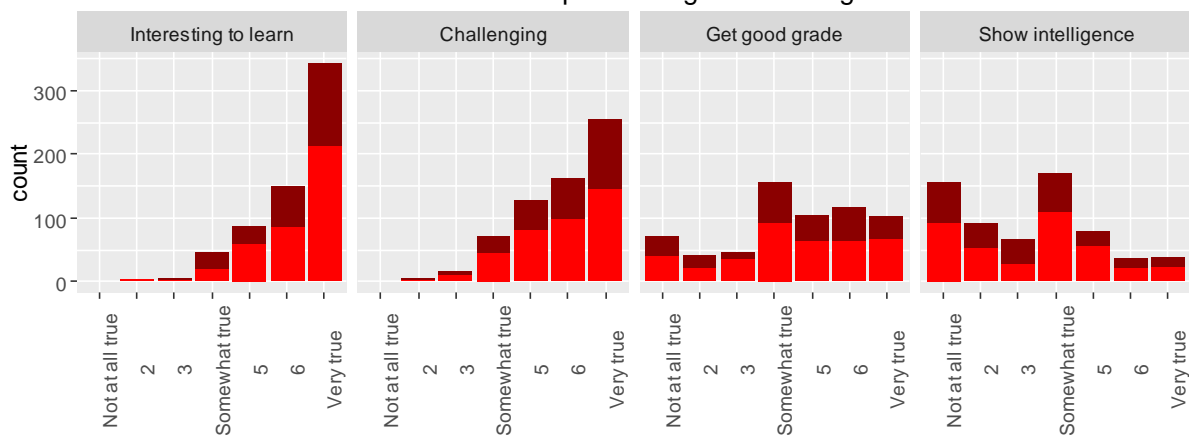
I participate in biology courses



Reasons for following lecturer's suggestions



Reasons to expand biological knowledge



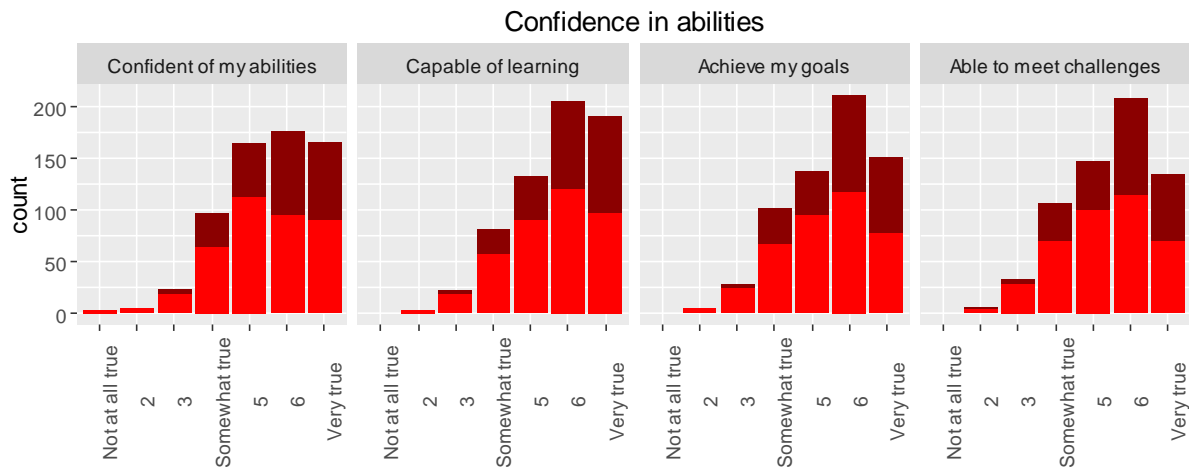


Figure 18. (S19-21). Students' different reasons for participating in class.

3.2.9 Plagiarism

Students were asked two questions relating to plagiarism. It is somewhat surprising to note that very few students reported that they had plagiarized. Students also disagree strongly with the statement that it is sometimes okay to plagiarize (Fig. 19).

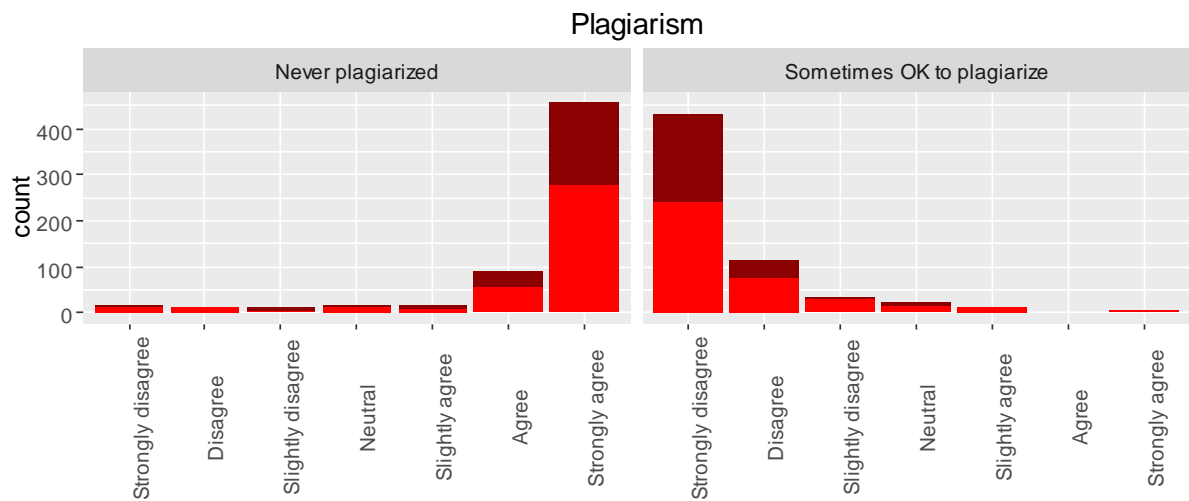


Figure 19. Students' perception of plagiarism (S24).

3.2.10 Laboratory and fieldwork learning outcomes

We wanted to investigate students' perceived learning outcomes in laboratory and fieldwork. Figure 20 shows the distribution of answers for perceived learning outcomes of laboratory work and fieldwork respectively.

A majority of students perceive laboratory work to contribute towards a set of both practical and theoretical skills. As can be expected, laboratory work contributes more towards practical skills than theoretical skills. Much the same is true as far as fieldwork is concerned, although here we find

that many students experience that such work also contributes towards the use of knowledge in new contexts and to theoretical knowledge. Overall, students perceive both activities to contribute substantially to different learning outcomes.

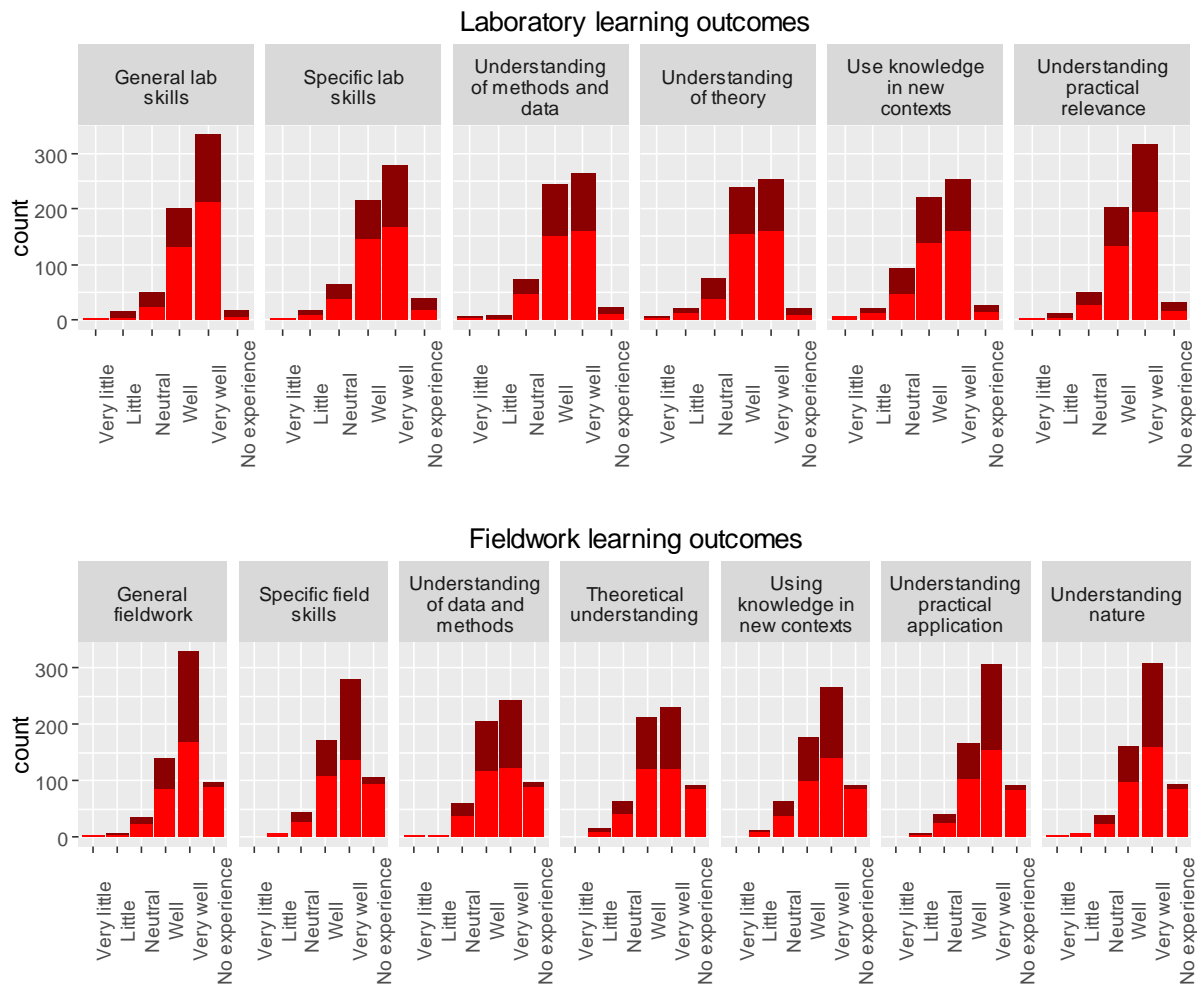


Figure 20. Student's perception of laboratory (S27) and fieldwork (S28) learning outcomes. *Students were asked about patterns and processes in nature in relation to fieldwork but not to laboratory work. Otherwise, all learning outcome categories are the same for both laboratory and fieldwork items.

3.2.11 Transferable skills and competences

Students were asked to what degree they learn different transferable skills during their education in biology. Interestingly, we find that students reported higher learning on critical thinking than on any other competencies. Fewer students, both bachelor and master students, reported that they learnt collaborative skills extremely well compared to other transferable skills (Fig. 21).

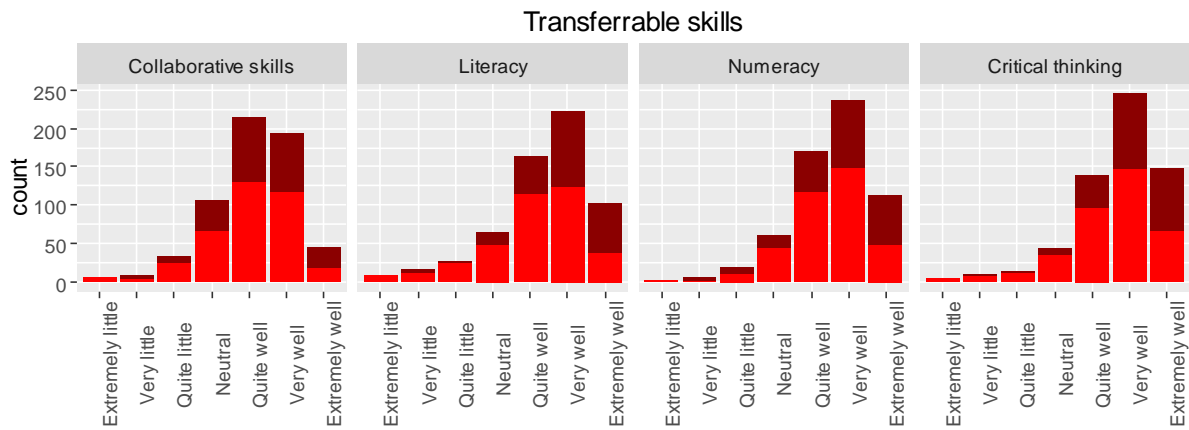


Figure 21. Student perception of how their biology course develops transferable skills (S29).

3.2.12 Attitude towards internship

Students were asked about their attitude towards workplace practice. All items show a positive skew towards workplace-internship (Fig. 22). When asked if workplace internship comes at the expense of other important learning at the university/college, most students disagree. For a comparison with answers from teachers and workplace, see section 3.1.9.

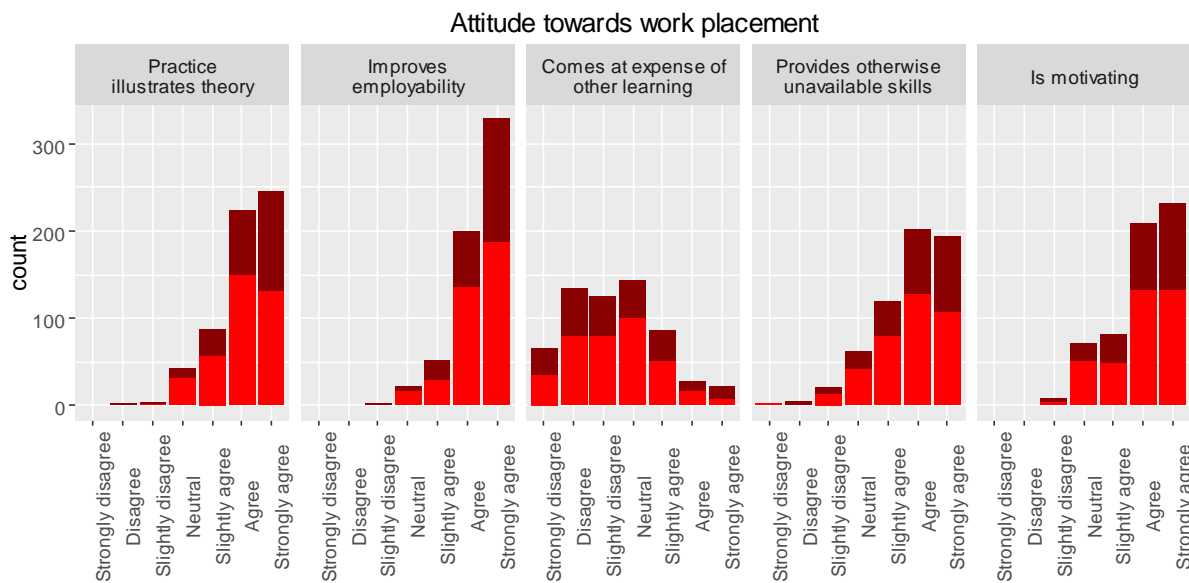


Figure 22. Student attitudes towards workplace practice in biology education (S30).



bioCEED Teacher Survey



3.3 bioCEED Teacher Survey

The following section presents results from the bioCEED Teachers Survey. First, we present the main findings and background information.

Main findings:

- When planning lessons, teachers often ask colleagues and students for advice, but seldom ask advice from management or the IT-department.
- Teachers rarely discuss their own role as a teacher with colleagues.
- Only about half of the teachers have made changes to assessment methods in the courses they teach, while the majority have changed course literature.
- 56 percent of the teachers have completed the pedagogical course offered at their university.
- Of seven different structural and organizational factors, teachers report in general that these work well; however, the accessibility of assistants and technicians works less well.
- Teachers report that PowerPoint as a teaching method is cost-effective, but does not promote active learning.
- Group discussions and student presentations promote motivation, active learning and provide learning outcomes, but are not cost-effective.
- Teachers perceive that they are efficacious in their teaching.
- Teachers prefer evaluation from students as feedback on their teaching, not from department leaders, educational experts or colleagues.
- Teachers report that students lack basic knowledge in mathematics, biology and study skills.
- Teachers report that both field and laboratory work provide students with several learning outcomes.
- Teachers are positive to workplace practice, but believe that it might come at the expense of other learning.
- Teachers feel appreciated by students and colleagues, but not by departmental management or university management.
- Teachers perceive that their leaders support them to some extent.
- Teachers will prioritize research instead of teaching.
- Teachers would like a stronger emphasis on teaching in terms of promotion and focus on teaching quality. They do not wish to prioritize developing teaching skills or use more time on planning and preparing for teaching.

3.3.1 Background information

The total number of teachers responding to the survey was 231 (61 percent male). Age-class in 10 years intervals was ascertained, and half of the teachers were 50 years and older, while very few were between the ages of 20 and 29 (Table 4). A clear majority teach at both BSc and MSc levels (Table 5). In terms of tenure, most had permanent positions as opposed to a temporary position. Respondents with temporary positions may be explained by PhD and post-doc respondents. Some of the sample had their main employment at other institutions (Table 6). Half of the respondents had 15 years or more of teaching experience, in contrast, a fifth had 0–4 years of experience (Table 7).

Table 4. Question T2: Age

Age	Total	Percent
20-29	12	5
30-39	26	11
40-49	64	28
50-59	77	33
60 or older	52	23

Table 5. Question T6: Level taught

Levels taught in the past 12 months	n	Percent
Bachelor	186	85
Master	183	84
PhD	131	60
Not taught	7	3

Table 6. Question T4: Tenure

Employment	Total	Percent
Permanent academic position	149	66
Temporary academic position	36	16
Main employment somewhere else	24	11
Technical / administrative employee	7	3
No teaching	11	5

Table 7. Question T5: Experience

Teaching experience	Total	Percent
0-4 years	39	18
5-14 years	71	32
15- 24 years	58	26
25 years or more	51	23

3.3.2 Working hours

The teachers were asked to indicate how many hours a week they worked. Due to differences in position within universities (e.g. guest lecturers), the minimum number of hours per week was two while the maximum number of hours per week was 80. The mean number of working hours among the teachers was 46 hours per week, which is above the national standard of 37.5 hours per week. There were small discrepancies between the mean, mode (50) and median (45), indicating that the mean reflects a representative score and mean work-week for the teachers across the institutions.

We asked the teachers to indicate the partition of their working hours for research, teaching and administrative duties to sum to 100 percent. While the university standard is 50 percent research, 47 percent teaching and 3 percent administrative tasks if you have a permanent position, our national sample had a mean of 43.3 percent research time, 35.2 percent teaching time and 21.2 percent administrative duties. There might be institutional differences within our sample in relation to working hours.

Lastly, we assessed the percentage of different teaching activities teachers performed within their total teaching time. We selected the categories planning, teaching courses, feedback to students and contact with students/colleagues/leaders, based on pilot work among biology teachers. Teachers reported that 36.3 percent of their teaching time was spent planning, 37.8 percent teaching and 15.2 percent giving feedback to students, while 10.6 percent of their time was spent on contact with the students, colleagues and leaders.

3.3.3 Collaboration

Teachers collaborate with colleagues with respect to teaching to a varying degree. Collaboration might be important for teaching efficacy (Johnson, 2003), however the extent of collaboration in terms of asking for advice and discussion differs and is thus important to assess. We asked the teachers to indicate which groups they asked for advice when planning teaching lessons. The groups were colleagues, students, administrative and technical staff at the department, management at the institute and the IT-department. There seems to be a descending trend when asking for advice as a function of proximity to teaching activity. Teachers ask colleagues and students the most for advice, and the administration, management at the institution, and the IT-department the least.

Another indicator of collaboration we asked the teachers was the degree to which they discussed teaching-related topics with colleagues. Discussing teaching was hypothesized to be an indicator of interest in teaching. We asked the teachers to indicate their answers on academic content, instruction and assessment methods, practical organization, students, and their role as teachers. The topic that elicited the most discussion, often or more frequently, was instruction and assessment methods, followed by practical organization. The least discussed topic was the teachers' own role as a teacher, albeit normally distributed it was negatively skewed (Fig. 23).

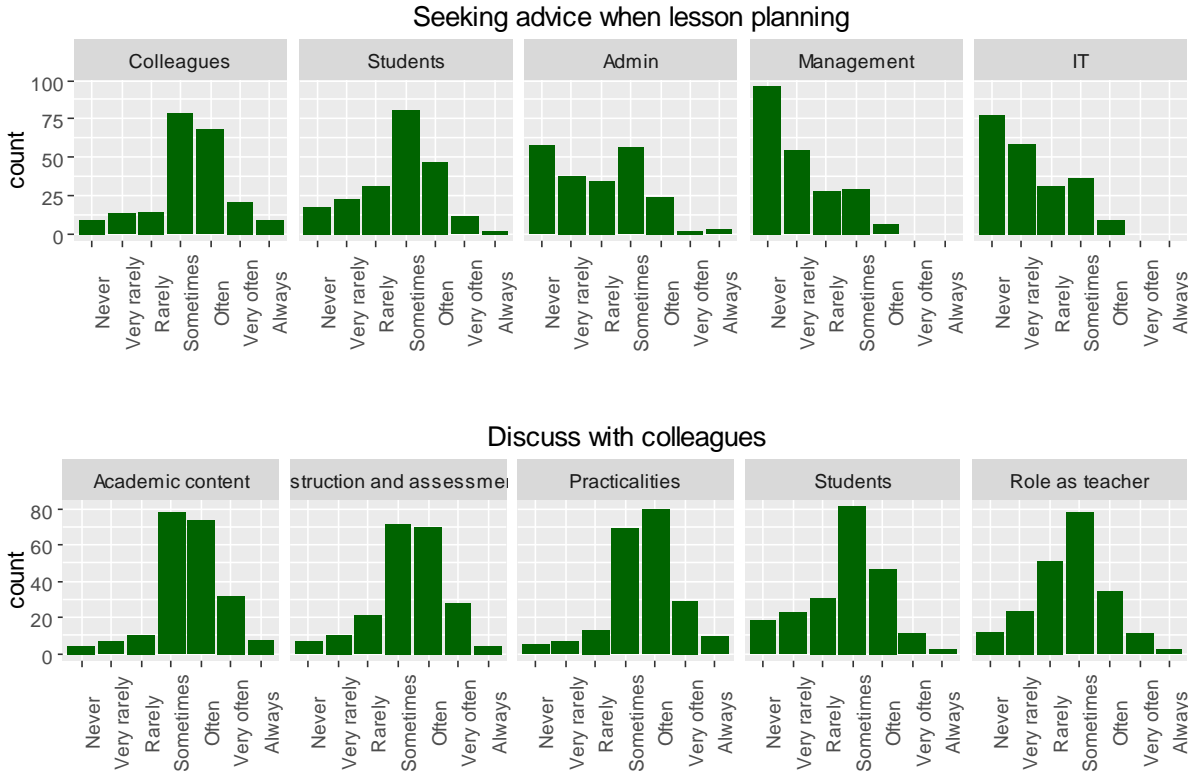


Figure 23. (T8, T9). Teachers' amount of collaboration.

3.3.4 Institutional structure and organization

To assess how the institutional structure works at the different institutions we asked three questions. First, we asked the teachers if they had been involved in designing the curriculum in the subject or module they teach. Of the respondents, 73 percent (148) had been involved in designing their subject. We also asked if they made changes or initiated changes in the courses they teach with respect to assessment, course literature and teaching methods. Results show that most teachers make changes to the course syllabus and teaching methods, but less to assessment methods (Table 8). Second, we asked the teachers to indicate the degree to which they had received support when having made a change in their course from leadership, colleagues, students and administrative and technical staff. The teachers perceived that they received the least support from leadership and study administration, and the most from colleagues and students. As above, this may be due to a function of proximity in teaching activity. Lastly, we asked the teachers to indicate whether different structural procedures functioned well at their institution for seven categories. Access to lab, organization of lecture plan and choice of assessment work extremely well, as opposed to access to assistants and technicians (Fig. 24).

Table 8. Question T13: Course changes

	Yes (%)	No (%)
Assessment	46	64
Course literature	77	23
Teaching methods	65	35

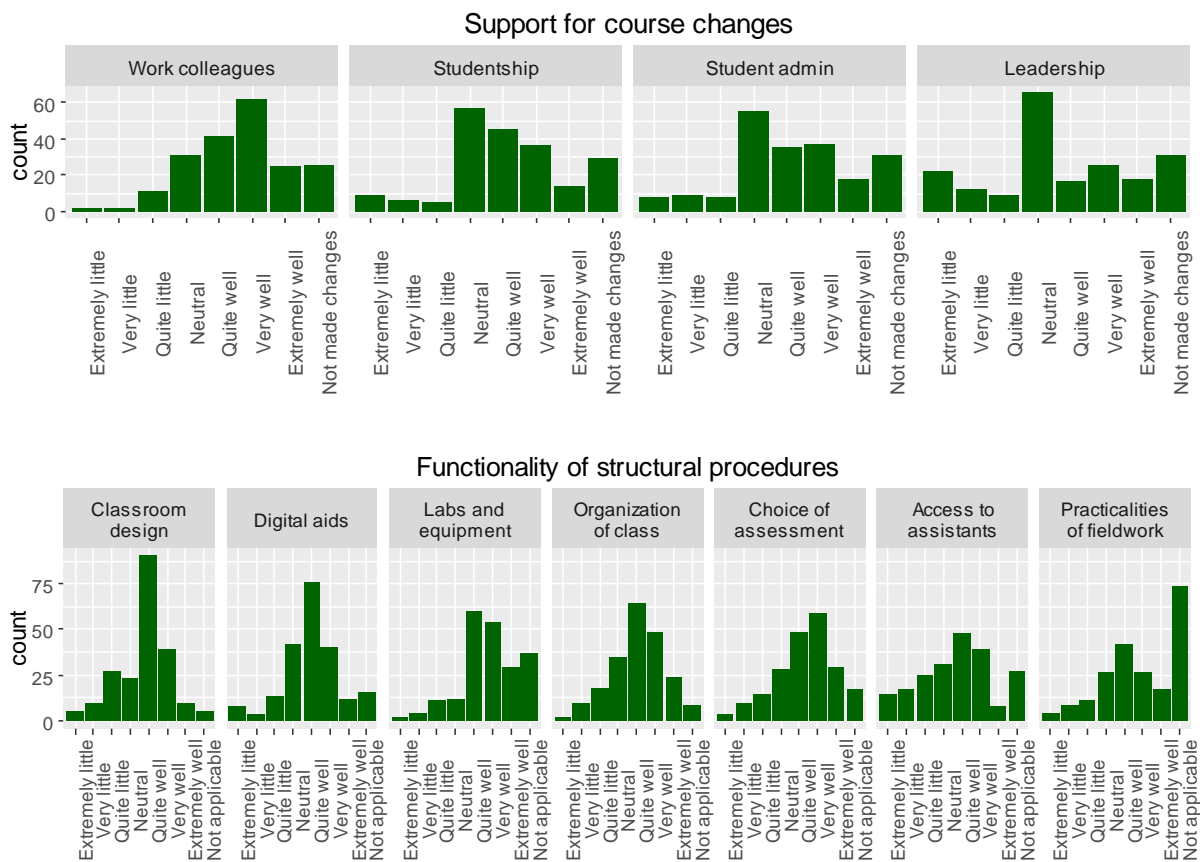


Figure 24. (T14, T10). Structural facilitation and course change.

3.3.5 Teaching biology

To assess how teachers teach and experience teaching biology we used four different measures. First, we asked the teachers whether they had completed a pedagogical course in teaching. This has been a requirement for researchers with teaching responsibility since the early 1990s. From our sample, 56 percent (123) reported that they had completed the course, while 44 percent (96) reported that they had not. Second, we were interested in knowing about experiences with different teaching methods and why they used those methods. Third, we wanted to know how teachers perceived the teaching sessions. Fourth, five items were used to assess each teacher's personal efficacy. We also investigated what kind of feedback teachers would find useful for their teaching.

For our baseline investigation on biology education, we asked the teachers to respond to whether they had experience with seven different teaching methods, with the possibility to comment on other methods that we failed to ask about (Question T19). The seven methods were chosen based on university standards and requirements and biology-relevant methods. The respondents could choose seven rationales for each teaching method. The results show that teachers chose PowerPoint for effective dissemination. Furthermore, hardly anyone had no experience with PowerPoint, and used it to promote active learning. In comparison, written submissions, group discussions and student presentations were not chosen for their effectiveness, although they were chosen to provide learning outcomes and to promote active learning (Fig. 25).

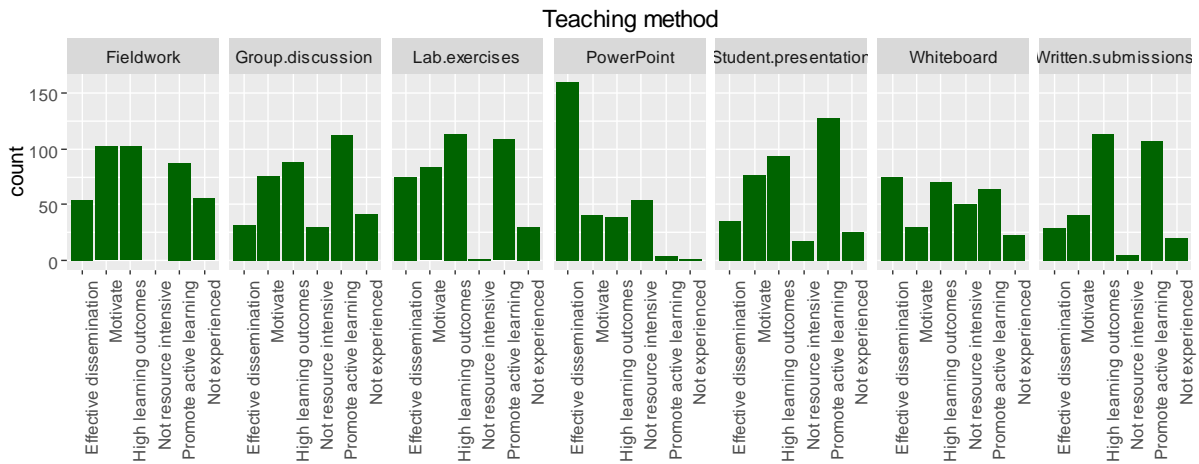


Figure 25. Rationales for using different teaching methods. Note that respondents could select as many reasons they wished (T19)

To assess different teaching behaviors and experiences during the teachers' teaching sessions, we asked them to rate how well each statement applied to their teaching (Fig. 26). Results show that teachers facilitate questions/suggestions from students in their teaching session well. Most teachers facilitate discussion between the students in their teaching sessions, as well as combining theory with practical tasks in their teaching. One-third of the teachers reported that they felt that the workload related to teaching was too large, whereas almost half of the teachers were neutral with regard to this statement.

Five items were used to assess teachers' efficacy. The teachers were asked to rate how true each statement was for them with respect to their role as a teacher. The results show that the teachers perceive that they are both capable and confident enough to teach and that they achieve their goals and are able to meet teaching challenges. Teachers' efficacy might be important for a host of teaching behaviors, such as student motivation and academic achievement (Deci & Ryan, 1985). Assessing and

taking measures to increase teachers' efficacy might be important for future studies. The last string of questions concerning teaching biology was feedback that could be useful for the teachers' teaching. Six items were employed and comprised student evaluation, pedagogical guidance, guidance from colleagues, grades, peer-review and leaders' follow-up, some of which are in use and some that are not. Furthermore, the teachers had the opportunity to comment on other forms of feedback that they might find useful for their teaching (Question T23). The results show that the teachers find feedback from student evaluations as most useful, however, only a few of our respondents found feedback from department leaders useful, which is substantially less than the perceived usefulness of grades as a means of feedback. This is interesting, especially since receiving grades for teaching performance has not been employed in higher education to our knowledge. Only some of the teachers reported that feedback from colleagues and educational experts would be extremely useful for their teaching.

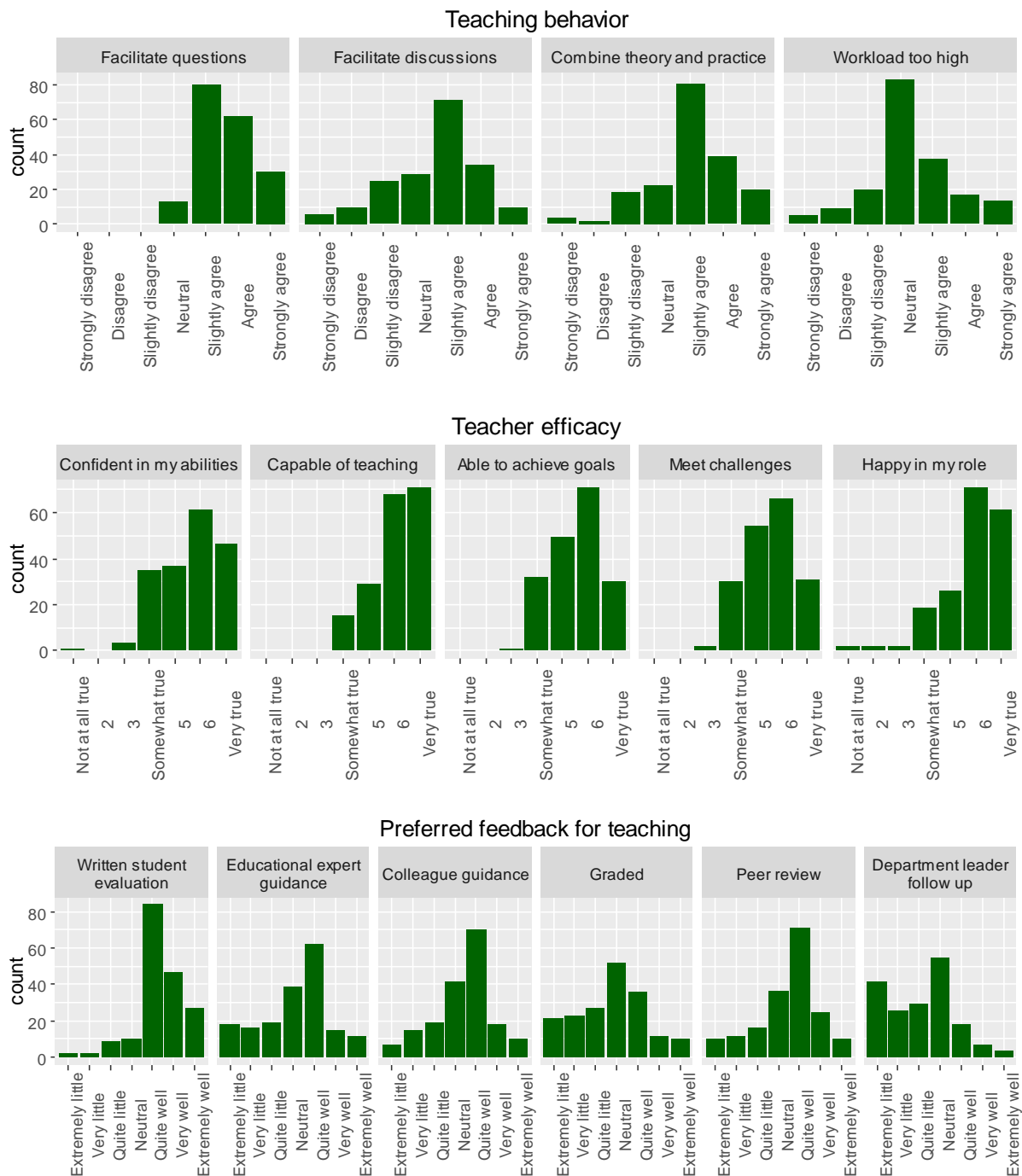


Figure 26. (T21-23). Teachers' behavior while teaching.

3.3.6 Student competence

We assessed how the teachers perceived the students' competencies by asking to what degree the teachers thought that their students have adequate basic knowledge in mathematics, chemistry, biology, physics, writing skills, study skills and technical skills to allow them to benefit from the teacher's courses (Fig. 27). Although there might be other important skills that are needed and necessary for biology students, these were chosen based on pilot work with students and teachers within the authors' institution. The results show that only a few of the teachers completely agree on all seven indicators. For mathematics, over half disagreed with the statement that students have adequate skills. In terms of biology, the teachers' responses were evenly spread across categories, indicating a wide range of perceived competence. Most teachers were neutral concerning the statement about students' adequacy in physics. This may be due to the small necessity for physics in biology. This is true for chemistry as well, although chemistry is generally taught to a larger extent in biology than physics. For writing skills, over half of the responses were skewed negatively, indicating dissatisfaction with students' writing skills.

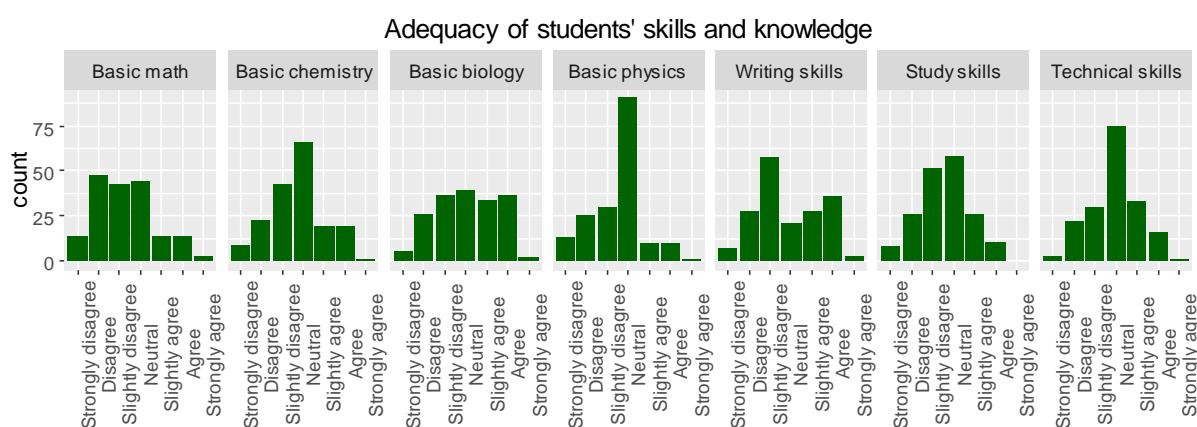


Figure 27. (T25). Teachers' perception of students' skills.

3.3.7 Learning outcomes and skills

To assess whether teachers perceive that students acquire different learning outcomes and transferable skills during their education through means of lab, field and workplace practice, we asked them a string of questions related to biological learning outcomes and skill acquisition. The different outcomes were chosen based on various biologists' reports of important skills (Singer, Nielsen, & Schweingruber, 2013) and on the learning outcomes emphasized at the authors' home institution (UiB.no, 2015).

In order to assess to what extent teachers perceive that laboratory courses and fieldwork or cruises helped students increase their learning outcomes we asked them thirteen questions (Fig. 28). Two-thirds of the teachers reported that lab work increased students' general laboratory skills, but as many as one-quarter of the respondents had no experience of student's having undertaken lab work. This is surprising since important biology skills are laboratory and field related. Although many had no experience, the answers were positively skewed, with the results suggesting that few teachers find that laboratory work does not facilitate students' learning outcomes.

Teachers considered to what degree field courses contributed positively to students' learning outcomes in general field skills, practical skills, understanding in subject methods and theory and knowledge of relevance and application. Again, around a quarter of the teachers had no experience of students that had been in the field. The two student learning outcomes from fieldwork that the

teachers rated highest were general field skills and the understanding of patterns and processes in nature.

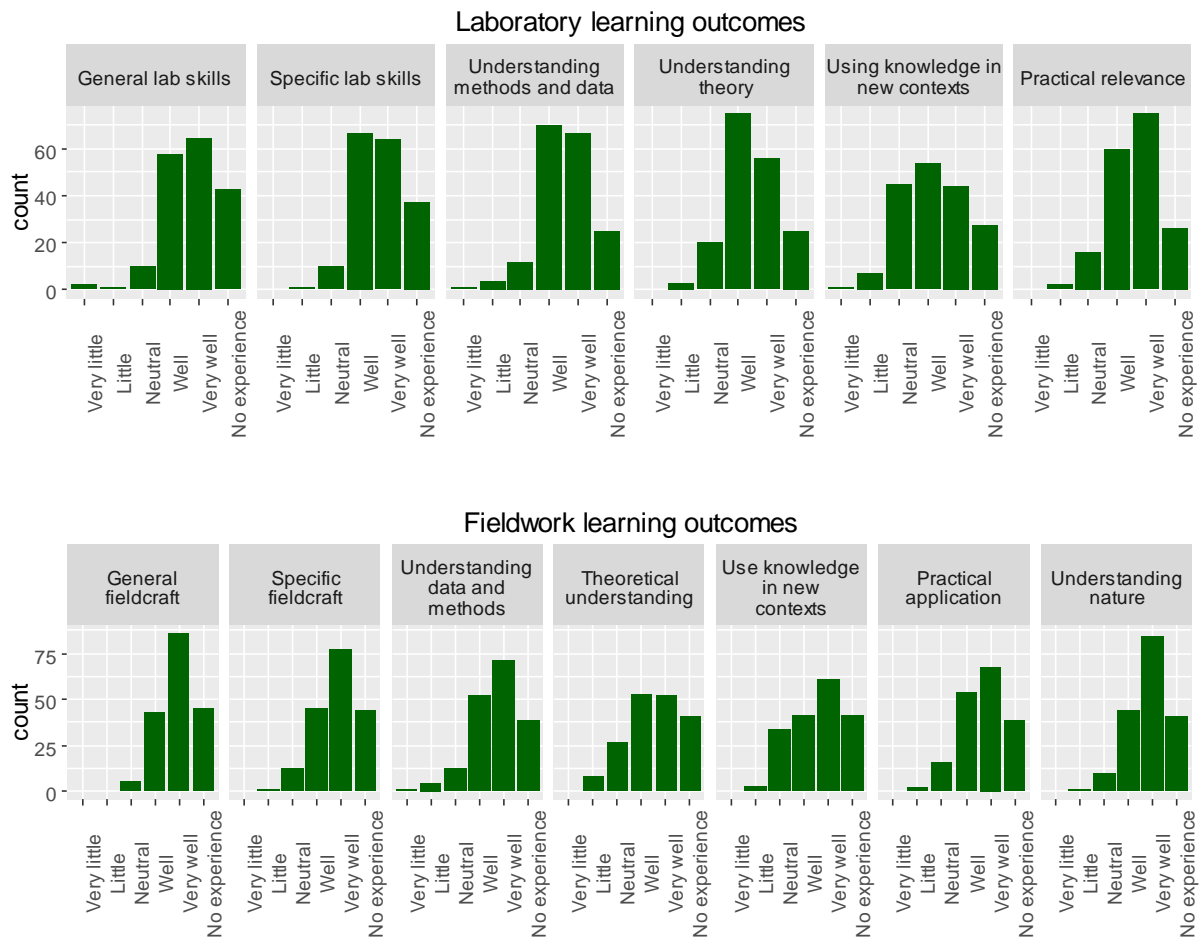


Figure 28. (T27, T28). Field and laboratory perceived learning outcomes.

Transferable skills are generally considered an important learning outcome in higher education. Three different questions were asked to measure teachers' attitudes of students' transferable skills. First, teachers were asked about four different transferable skills in the biology education of their students (Fig. 29). On average, teachers reported that students learn these skills quite well. This is a positive result, as a goal from gaining a University degree is to possess transferable skills in order to undertake different types of work.

Further we asked the teachers to rate how important it is that students learn academic collaboration during their biology education. As expected, the majority of the respondents considered that learning collaboration was important to some degree. Although not surprising that collaborative skills are considered important, facilitating learning methods and tasks that enhance collaboration are a little-discussed and emphasized topic within institutions.

In order to control for teachers' experience with students undertaking workplace practice as part of their education, we asked the teachers a dichotomous question regarding students at their institution (Question T31). Results show that only 38 percent of the teachers had experience with students undertaking practice, while the other 62 percent had none. The last string of questions was to what degree teachers perceive that students acquire learning outcomes through workplace practice, regardless of their previous experience with workplace practice. Teachers were generally

positive towards workplace practice with a positive skew in terms of students becoming better prepared for work-life, learning important skills and a more relevant understanding of their theoretical knowledge. When asked to what extent practice may come at the expense of other important learning at the university/college the teachers are more negative towards workplace practice.

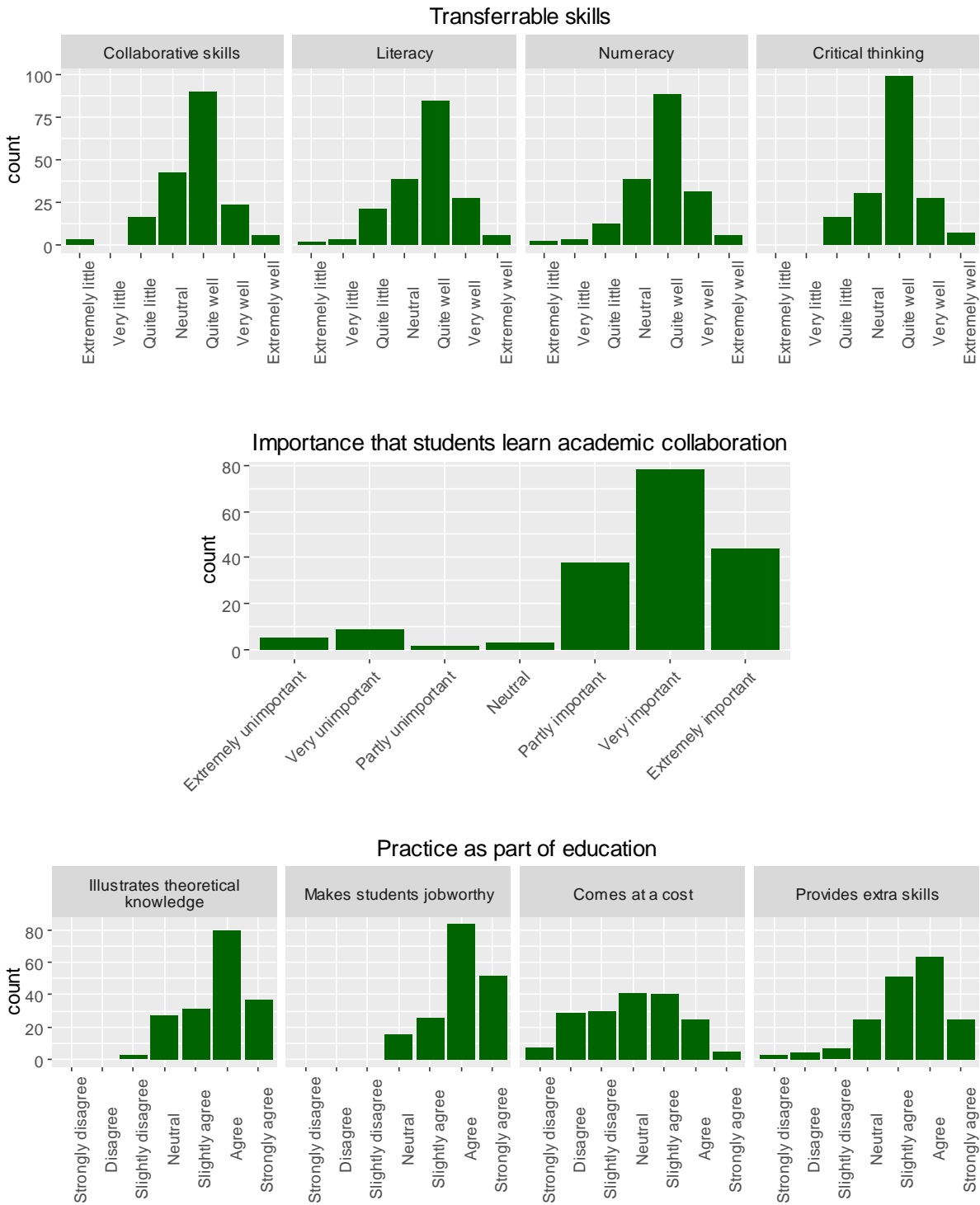


Figure 29. (T29, T30, T33). Teachers’ perception of students learning of transferrable skill and workplace practice.

3.3.8 Perception of support

Three questions were posed to assess teachers' perception of support concerning teaching, effort and management's attitude towards teaching (Fig. 30). Teachers were asked to what extent they received appreciation from students, colleagues, the institute and university/college. A high degree of support may be important for teachers' motivation to teach and persistence in teaching (Pelletier & Sharp, 2009). Six indicators in total were used to assess to what extent the teacher perceived their leaders to provide them with support concerning their teaching. Over half of the teachers agreed that their leaders provide them with choice and options; about half of the respondents felt understood by their leaders; and two-thirds perceived that their leaders conveyed confidence in their ability to do well as a teacher. However, not many of the respondents felt that their leaders encouraged them to ask questions about their teaching.

To assess the relative attitudes within each institution towards teaching, we asked the teachers to rate to what extent they agreed with the statements that management is more concerned with research than teaching and whether it was better for the teachers' career to prioritize research over teaching (Question T34). Results show that two percent strongly disagree and 25 percent somewhat disagree that management is more concerned with research than teaching, while 12 percent strongly agree and 36 percent somewhat agree. In terms of teachers' personal priority for research over teaching, only 5 percent disagreed while 86 percent agreed. This indicates that teachers perceive research to be more important at their institution and that it is more important for teachers to prioritize research over teaching.

The last question we asked to assess perception of support was the degree to which the teachers felt their teaching effort was appreciated by their students, colleagues, administrative and technical staff, departmental management and university management. The apparent support decreases when moving up the system, again, indicating a proximity function. The results show that almost half of the respondents perceive that their teaching effort is appreciated very well or extremely well by their students. Almost one-fifth report that their teaching is appreciated well by their colleagues. Very few of the teachers feel appreciated by their administrative and technical staff, departmental management or by their university management.

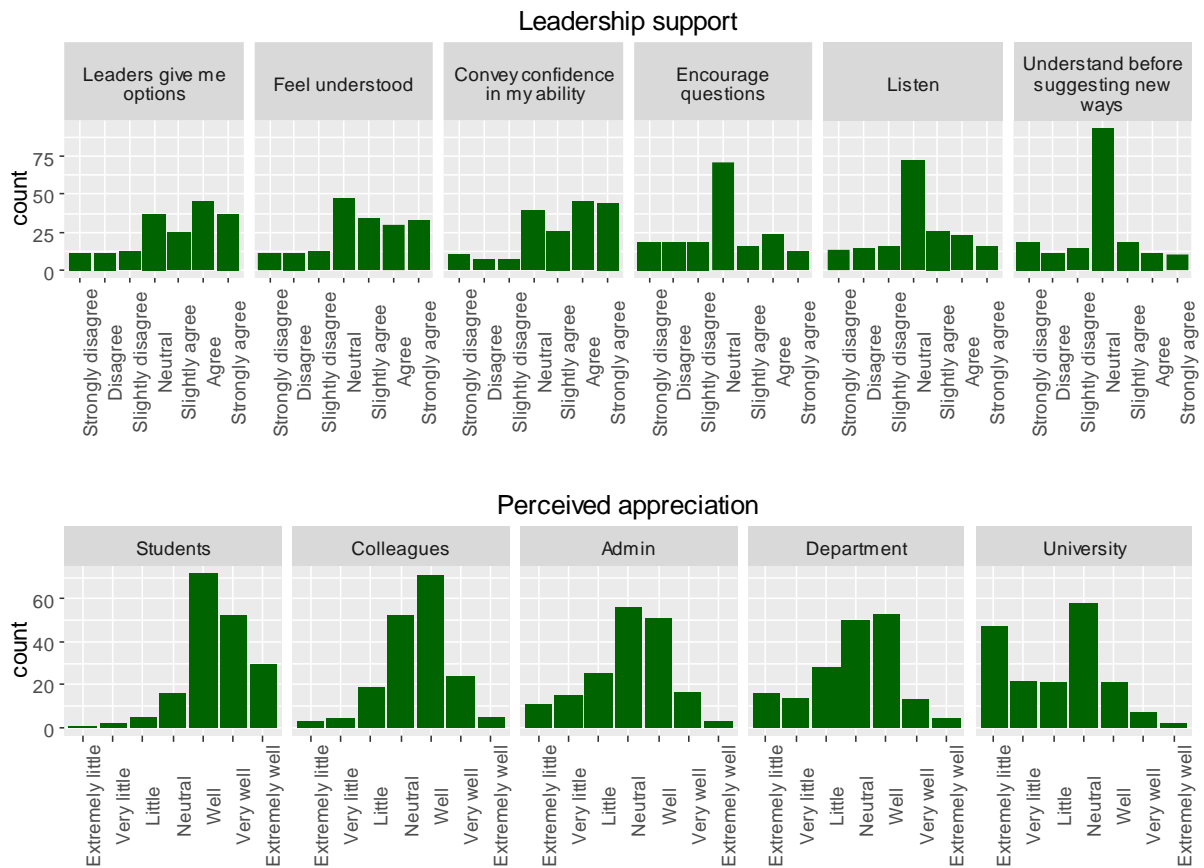


Figure 30. (T34, T36). Teachers' perception of support.

3.3.9 Intentionality

The last part in the questionnaire was about future intentions and wishes regarding teaching (Fig. 30). Of the five items asked, almost all teachers were in agreement that the institution should have a greater focus on teaching quality and most teachers felt that the institutions should place greater emphasis on teaching in relation to employment and promotion. Teachers were more ambivalent about spending more time planning and preparing for lessons; similar responses are found in relation to uncertainty in spending more time on teaching and prioritizing development of their teaching. Perhaps this ambiguous result is due to excellent teachers that would want faculty to promote excellent teaching, while teachers who perhaps don't perceive themselves as excellent do not want to prioritize time to become one.

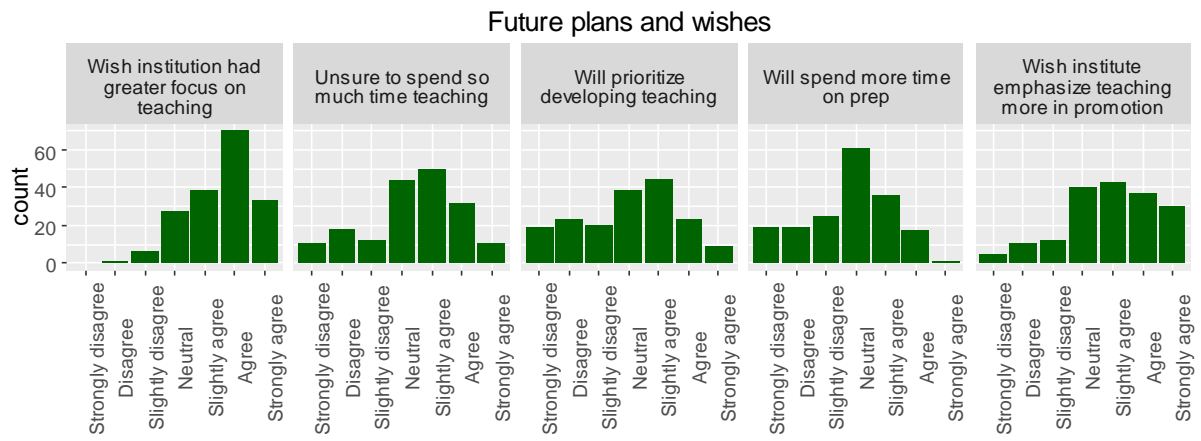


Figure 31. (T38). Teachers' future intentions.



bioCEED Administration and Technician Survey



3.4 bioCEED Administration and Technician Survey

This section presents data from the bioCEED Administrative and Technical Staff Survey 2015.

Main findings:

- Administrative and technical staff members work mainly at MSc level.
- Respondents stated the effectiveness of the practical organization works well. They do not feel that the organization of lecture plans or the choice of exam equipment are relevant.
- Administrative and technical staff members reported that teachers actively use their competence when planning, implementing and developing education, and when adapting the teaching sessions.
- In general, the administrative and technical staff agrees that their leaders support them.
- They felt most appreciated by colleagues and institute management, but not by university management.
- During the last 12 months they reported having initiated changes in both their courses and their courses' evaluation.
- Administrative and technical staff members often collaborate with students and to a high degree with colleagues, teachers and management.
- A large majority of respondents would be interested in attending a pedagogical course if offered.
- The majority of respondents want to be more involved in teaching.

3.4.1 Background data

Of the respondents, 34 percent defined themselves as administrative staff and 66 percent as technical staff. The survey was submitted to staff at BIO and UNIS. Twenty-two percent of the respondents were from UNIS and 78 percent were from BIO. Duration of employment was split into four categories, 0 to 4 years (31 percent), 5 to 14 years (47 percent), 15 to 24 years (6 percent) and 25 years or longer (16 percent). The administrative and technical staff could select more than one level to define the study levels they were mainly working with. Thirteen percent of the respondents stated that students' study level was not relevant to their work. Sixty-six percent work with MSc-level, 47 percent work with BSc-level, while 41 percent work with PhD-level students.

Respondents were asked about their involvement in teaching, whether teaching themselves or assisting academic staff. 62.5 percent of the respondents stated that during the last 12 months they have taught students or have been directly involved in a teaching situation, while 37.5 percent have not.

3.4.2 Practical organization

Respondents were asked how well the different practical and organizational structures were functioning at their workplace (Fig. 31). When asked about lecture rooms, approximately half of the respondents stated good effectiveness. Half of the respondents reported that digital equipment, such as video-recording, video display, student polling and so forth, works well. A majority of the administrative and technical staff reported that the access to laboratory and laboratory equipment works well.

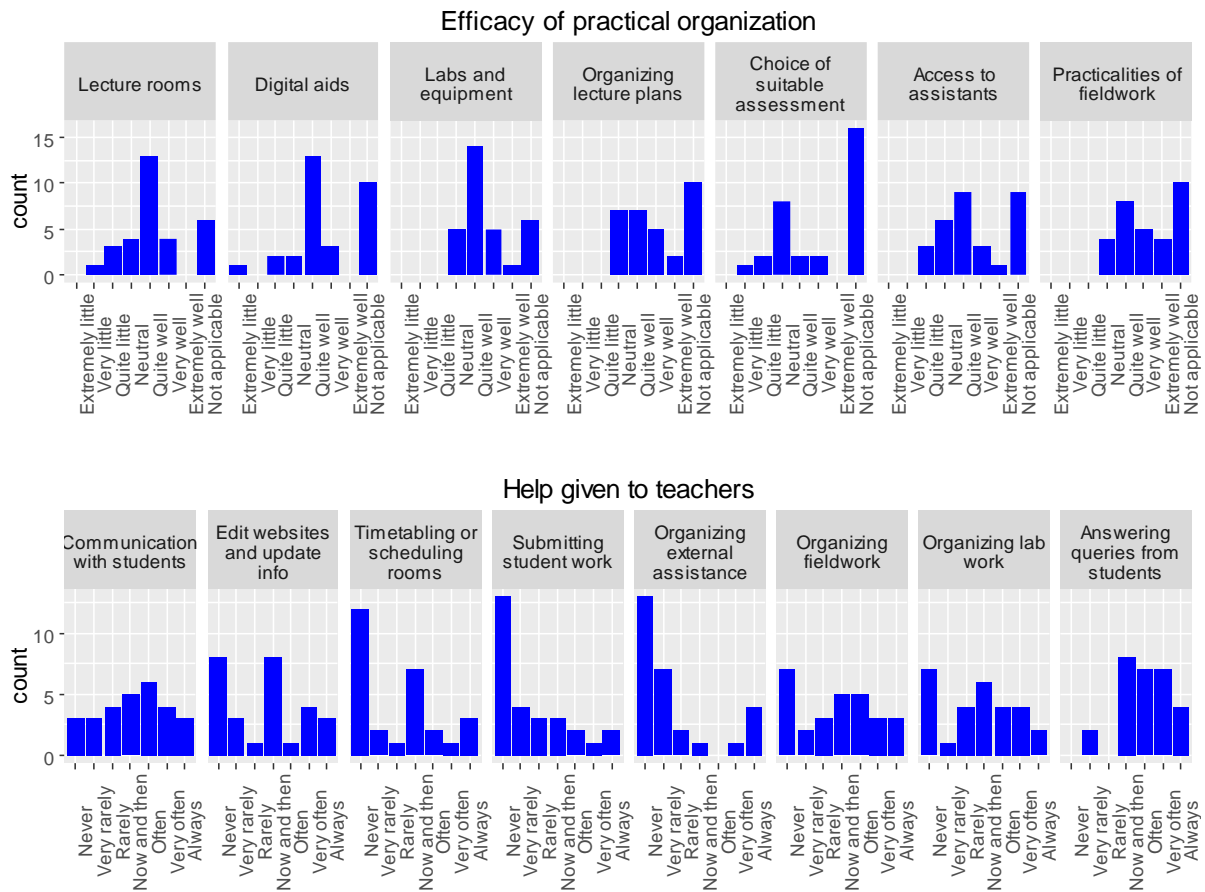


Figure 32. (A6, A7). Facilitation.

Administrative and technical staff members were asked if teachers were actively using their competence for planning, implementing and developing their courses and adapting their teaching to the students. In general, administrative and technical staff reported that teachers do not use their competence (Fig 32).

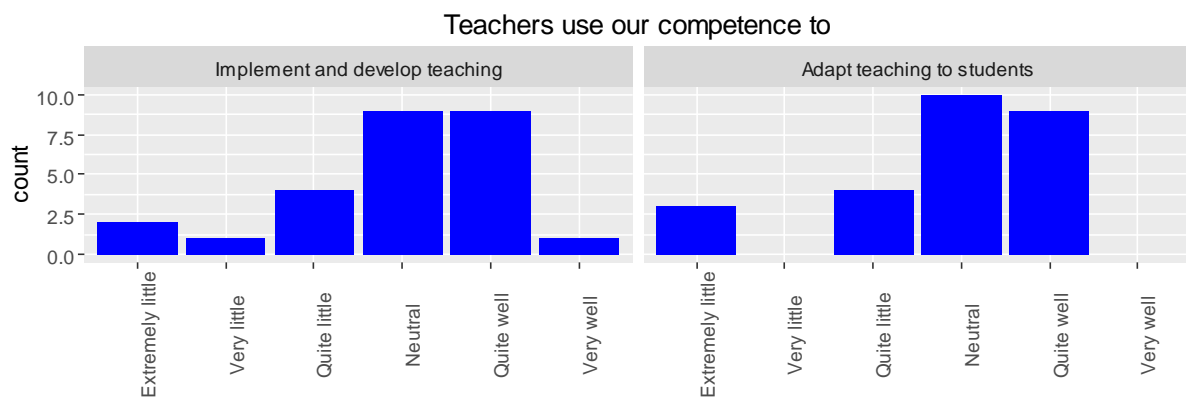


Figure 33. (A10, A11).

3.4.3 Appreciation and support

Two different measures were employed to measure support and appreciation (Fig. 33). Six questions were asked to assess the extent that administrative and technical staff members perceive support of

their autonomy from their leaders. In general, the administrative and technical staff agrees that their leaders support them. The administrative and technical staff perceives that they have choices and options, they feel understood, and their leaders convey confidence, listen and try to understand them.

We asked the administrative and technical staff to what degree they felt valued and appreciated by different groups. Results show that they feel most appreciated by colleagues and institute management, as opposed to university management. This might be due to administrative and technical staff having contact with multiple groups as part of their job. Compare with the results from teachers (3.3.8).

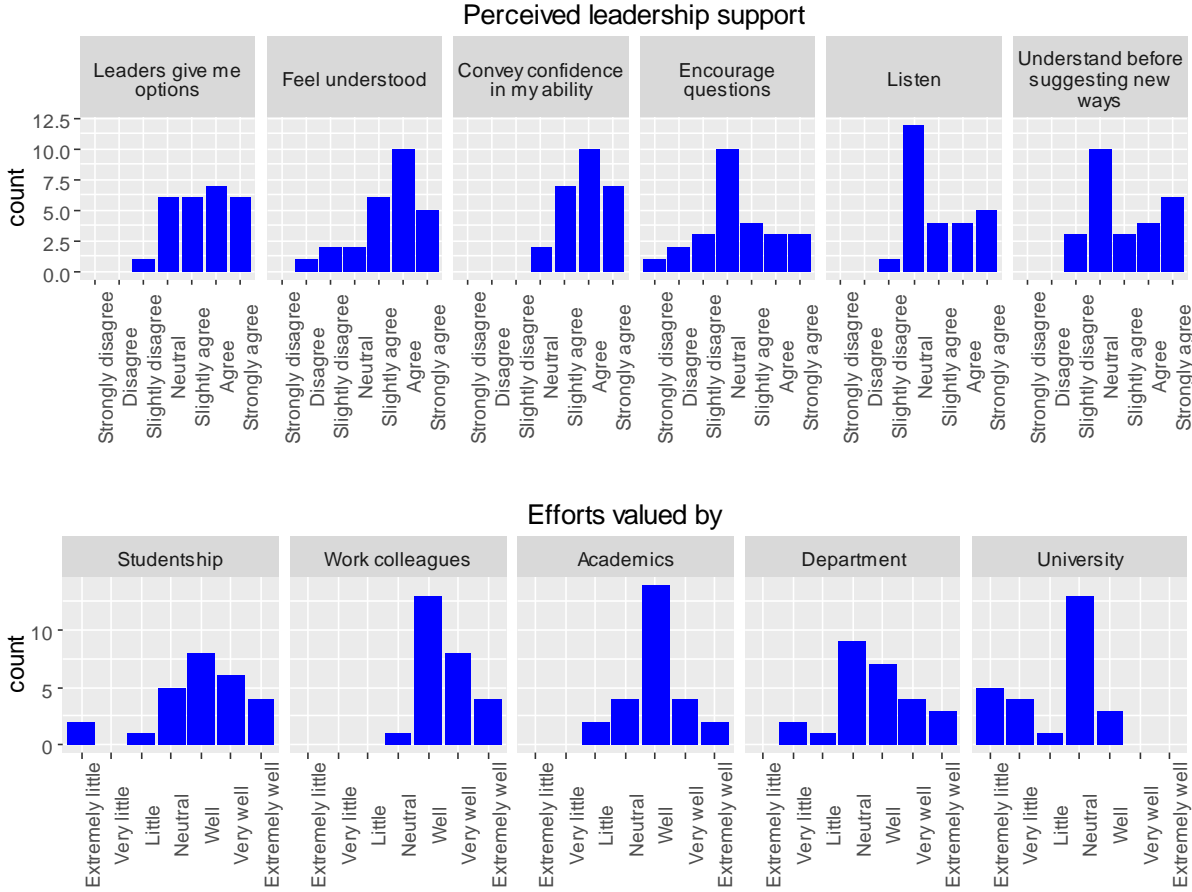


Figure 34. (A14, A15).

3.4.4 Changes and cooperation

We asked the administrative and technical staff whether they had initiated changes in their courses or their courses’ evaluation. Sixty-two percent of the respondents reported having initiated changes during the last 12 months, as opposed to 38 percent who had not done this.

They were also asked to what degree they had received support from different groups when initiating changes, the administrative and technical staff who did initiate changes reported having received some support, mostly from colleagues (Fig. 34). Administrative and technical staff members were asked to what extent they collaborate with other groups. Over half of the respondents reported that they often collaborate with students and to a high degree with colleagues, teachers and management. Almost a third of the respondents reported that they often collaborate with other faculty administrative and technical staff members.

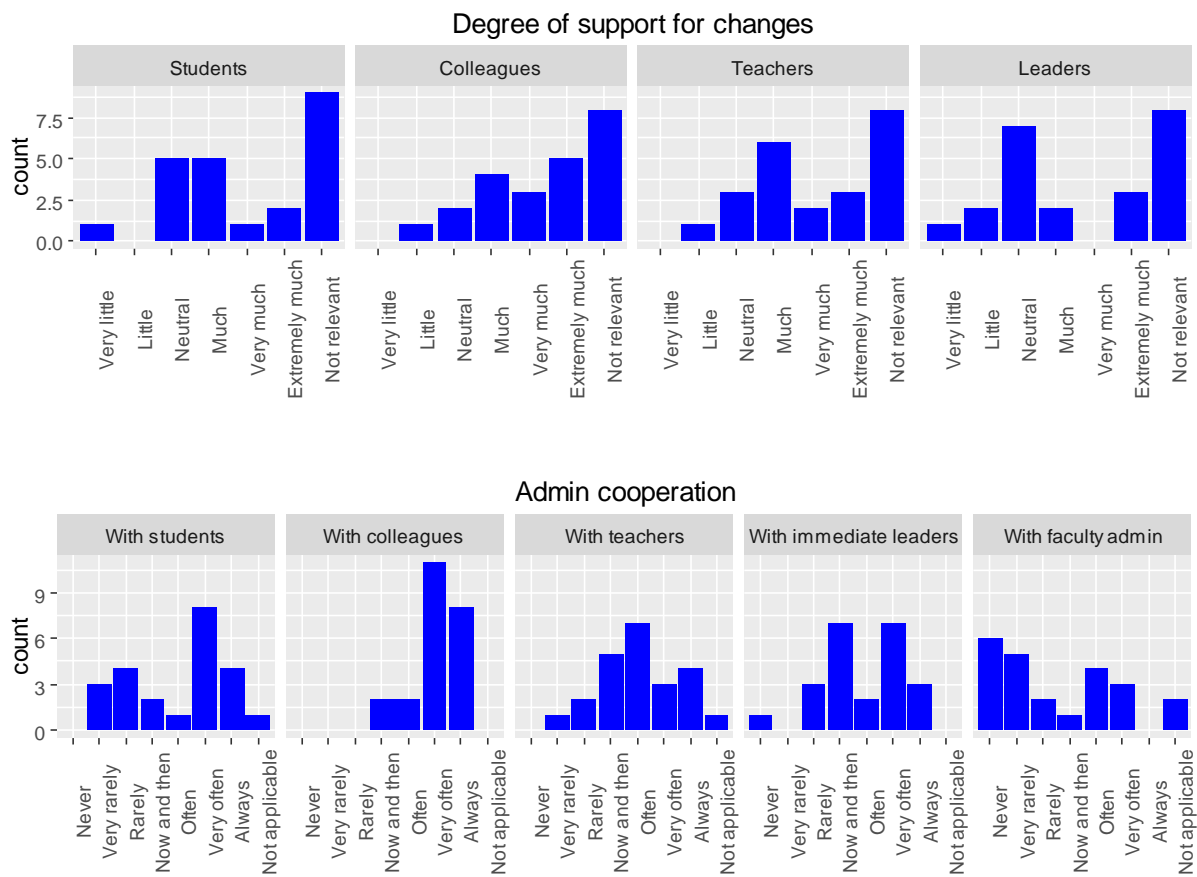


Figure 35. (A20, A21).

3.4.5 Pedagogical courses and teaching

We asked whether the administrative and technical staff would be interested in attending a pedagogical course if offered. Interestingly, as much as 91 percent of the respondents were interested, underscoring the interest of administrative and technical staff in pedagogy. The last question the administrative and technical staff had to answer was whether they would like to be more involved in teaching. Fifty-five percent wanted to be more involved while 45 percent stated that they did not want to be more involved. Thus, respondents want a pedagogical course, but not necessarily for increased teaching responsibilities.



bioCEED Biologist Survey



3.5 bioCEED Biologist Survey

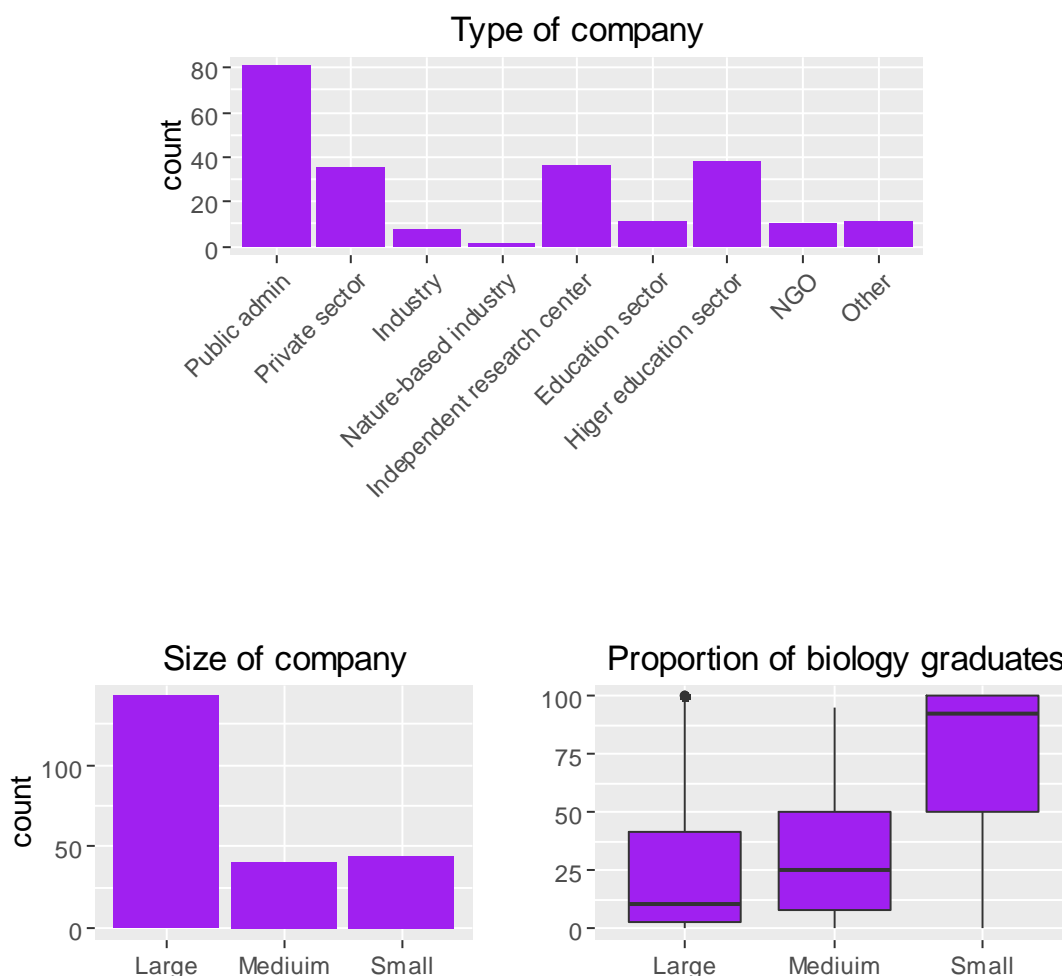
In the following section the results from the bioCEED Biologist Survey 2015 will be presented.

Main findings:

- General scientific education, specific expertise and work experience are important skills when workplaces hire students.
- Fieldwork skills and statistics are important competencies for workplaces.
- Cross-disciplinary competencies, specifically pedagogical competencies and project management are sought after by workplaces.
- Workplaces want students in internships.
- Workplaces mainly collaborate with higher education on research and teaching.

3.5.1 Background information

The largest group of respondents works in public administration. The participants work in roughly equal proportions of private sector, independent research institute and the higher education sector. More than half of the respondents have a MSc in biology, and about a third have a PhD in biology. Research and administrative/procedural employees form the two largest groups; none of the respondents identify themselves as sales employees (Fig. 35).



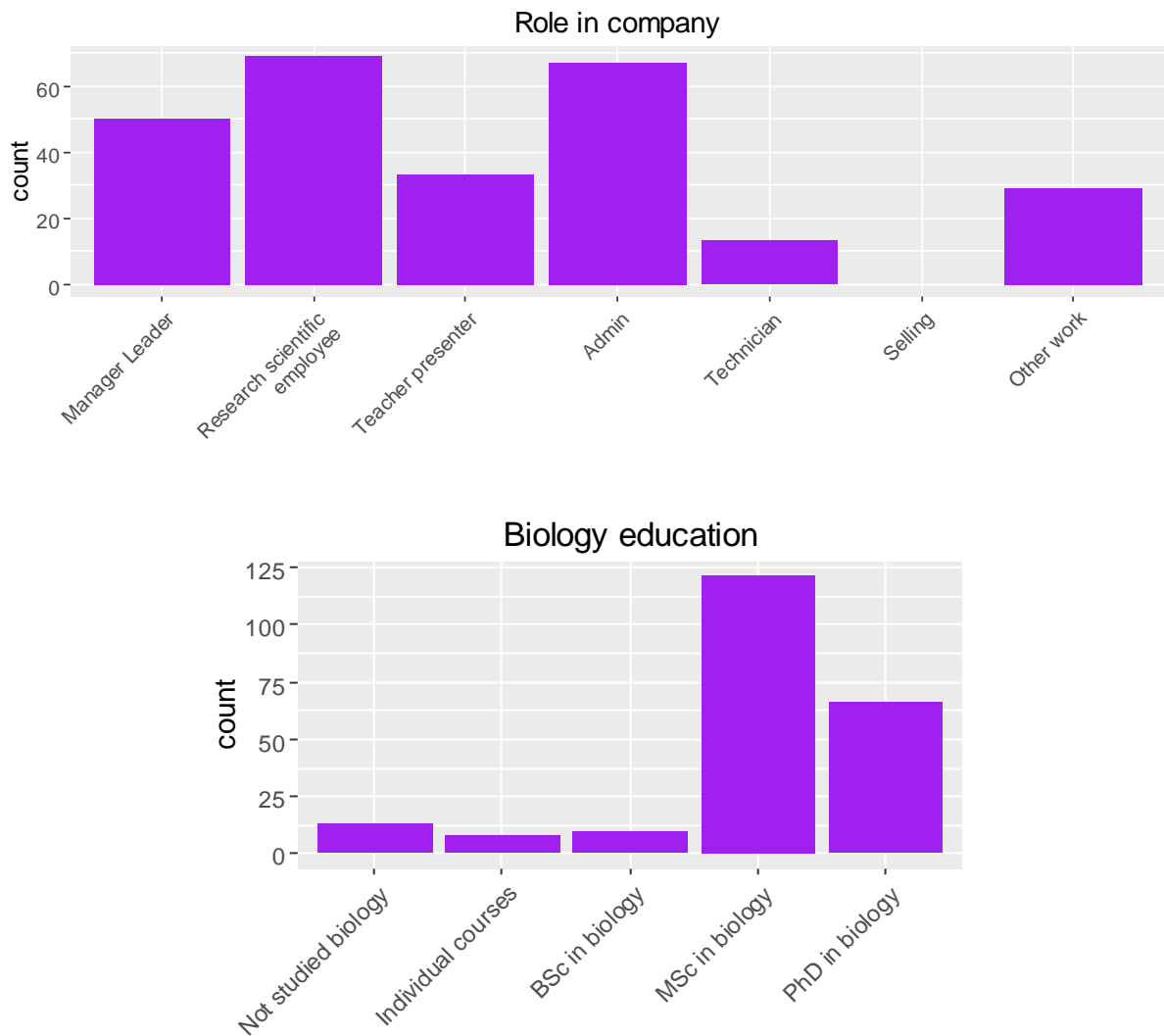


Figure 36. (W1-5). "Proportion of biology graduates" indicates proportion of biologists by size of company. The categories of company size is *small* (fewer than 20 employees), *medium* (between 20 and 100) and *large* (more than 100 employees). Note that this definition is specific to Norway.

3.5.2 Favorable skills at the workplace

According to the answers of the questionnaire sent to the workplaces, candidates that seek employment after their education will have an advantage if their grades are good. However, the grades do not need to be excellent. This is in accordance with a study on the potential job market of graduates from the University of Bergen. In the study, Ryssevik et al. (2011) found that the student grades are not necessarily the most important factor when deciding who to hire. The job market also emphasizes that skills related to cooperation and independence of the candidate are important (Ryssevik et al., 2011). According to our survey (Fig. 36), a long education, implying a higher educational level (MSc or PhD), is preferred in the workplace, whereas study institution is of less importance. Furthermore, work experience and general scientific education is important for workplaces when hiring. The importance of experience is also reflected in the answers on competences and qualifications of candidates when employers are seeking personnel.

According to the respondents, a theoretical foundation is needed, but it is even more important that the candidates are able to apply the knowledge in a new context. Furthermore, the respondents highlighted the importance of knowledge on ecological processes and patterns from the individual to the ecosystem level, as well as the structure and function of biological systems. Theory of

evolution and natural history is of less importance. The respondents report it important to master practical skills in data processing / software / statistics in the workplace, albeit the general competence of numerical analysis is of less importance in the workplace compared to other general competences.

The most important general competences when hiring biological staff include collaboration skills, independence, critical thinking and problem solving, literacy and learning ability. A substantial proportion of the respondents think that general academic and transferable skills are as important as discipline-specific biological knowledge in the workplace. Transferable skills also include critical thinking, problem solving, project management, cooperation abilities and communication. This finding should be seen in context with Ryssevik et al. (2011), who found that employers seem to value transferrable skills more than the educators do, and Bøyum (2013) who found that the educators often understate the candidates' competence. Additionally, the students are seemingly unaware of the need for transferable skills in the workforce since, according to NOKUT (2014), they would like a stronger focus on practical and explicitly work-related activities in their curricula.

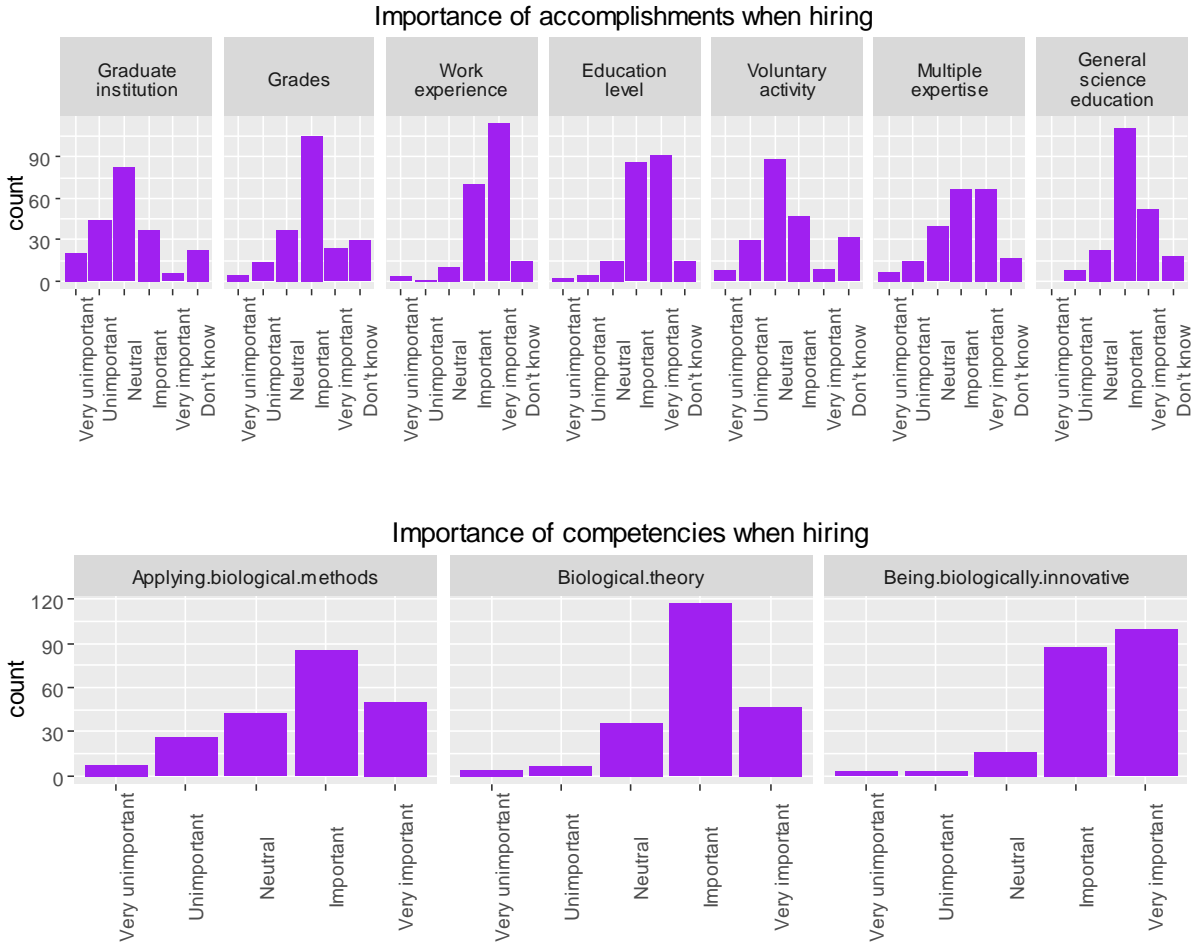


Figure 37. (W9, W10). Importance of different skills, knowledge and competencies when hiring

The workplaces were also asked about specific knowledge at work (Table 9). Skills such as biological system, ecological processes and species identification are perceived as important, while flow, exchange and storage of information at the molecular level is perceived as rather unimportant. In terms of practical skills, both field skills and statistical skills are rated as important by the respondents (Fig. 37).

Table 9. Question W11: Importance of types of knowledge at the workplace

	Very unimportant	Unimportant	Neutral	Important	Very important
Theory of evolution and natural history	5 %	16 %	40 %	29 %	10 %
Ecological processes and patterns from the individual to the ecosystem level	2 %	0 %	15 %	41 %	42 %
Matter and energy cycles in ecosystems	4 %	8 %	36 %	40 %	13 %
Biological systems' structure and function	2 %	4 %	19 %	51 %	23 %
Flow, exchange and storage of information, energy and nutrition at the molecular level	13 %	26 %	39 %	15 %	7 %
The scientific process	3 %	7 %	32 %	43 %	15 %
Experience with modeling, simulation and data processing	4 %	11 %	32 %	41 %	12 %
Species identification / taxonomy	2 %	4 %	18 %	41 %	34 %
Natural science's role in society	3 %	7 %	22 %	48 %	20 %

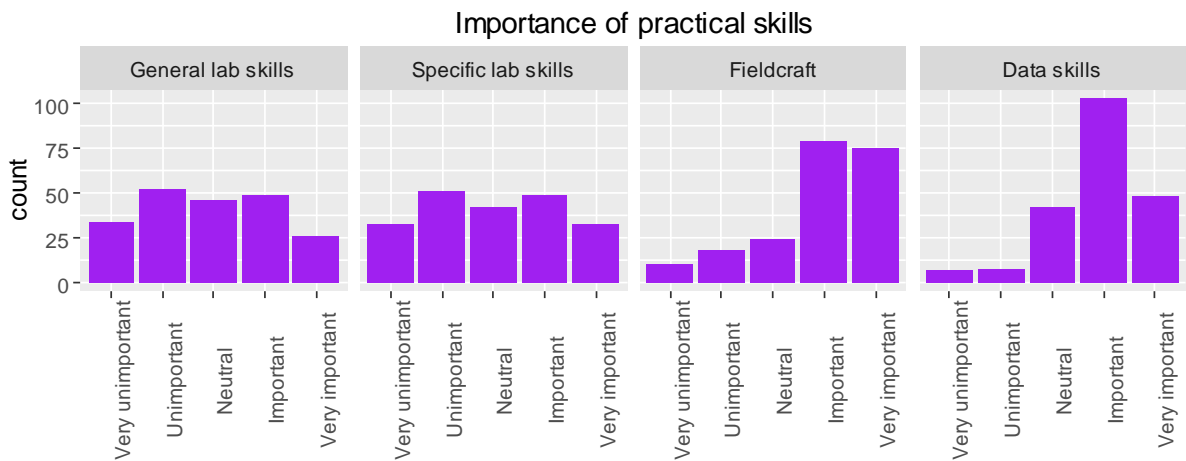


Figure 38. (W9).

When it comes to interdisciplinary competence, the skills sought for are project management and planning and pedagogical competence. This is surprising since these competencies are not typical skills that are needed for biological work. However, skills like these might be more transferable and important for other work-related aspects. The least important competencies are economy and legal expertise. In terms of cross-disciplinary competencies, respondents reported that economy, legal expertise and social science are not important for their company. Interestingly, competencies such as management, IT-knowledge, project management and pedagogical competence are mainly learned

through work experience. Lastly, respondents rated biological qualifications as more important than academic and transferable skills. However, a combination is important according to the respondents (Fig. 38).

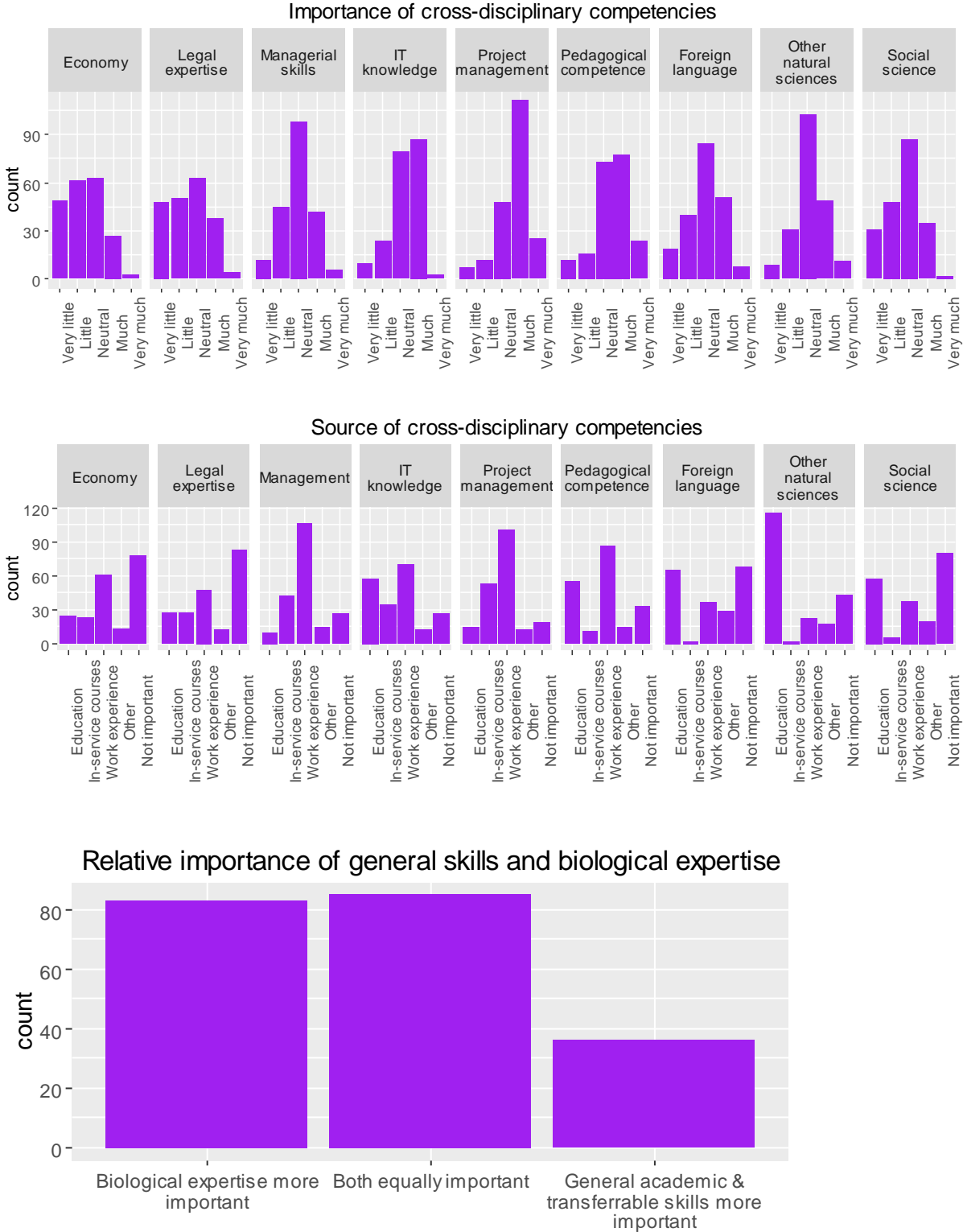


Figure 39. (W15, W16, W14). Importance and source of cross disciplinary competencies.

The respondents were asked to rate the importance of skills when their company is hiring biologists (Table 10). Respondents reported that all the skills below are important; the least important skill is numerical skills.

Table 10. Question W13: Importance of general

	Very unimportant	Unimportant	Neutral	Important	Very important
Presentation skills and communication	1 %	1 %	6 %	55 %	37 %
Collaboration skills	1 %	0 %	2 %	33 %	63 %
Independence	0 %	0 %	2 %	41 %	57 %
Critical thinking and problem solving	0 %	0 %	4 %	43 %	52 %
Literacy	0 %	1 %	3 %	47 %	48 %
Learning ability	0 %	0 %	3 %	43 %	53 %
Numerical skills	1 %	4 %	32 %	53 %	9 %

3.5.3 Cooperation between the workplace and higher education

The answers to the questions relating to internship/workplace practice during higher education provide a positive view on the importance of workplace practice. Firstly, respondents disagree that students in practice is a poor use of resources. Secondly, respondents rate that having students in practice increases the chance of hiring them in the future. Lastly, respondents acknowledge that having students might contribute new knowledge to the company. This last point is interesting since students have not completed their education (Fig. 39).

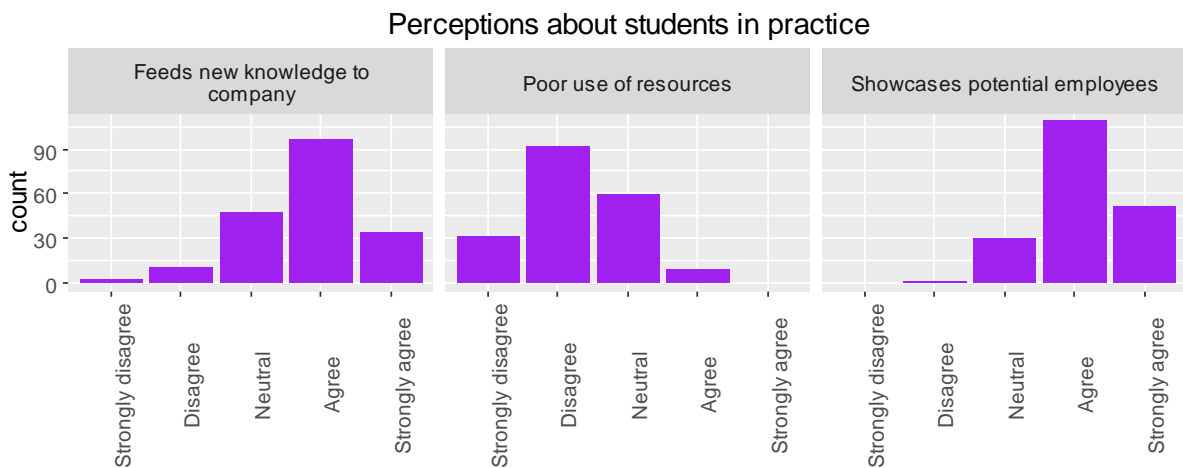


Figure 40. (W23).

The respondents were asked about collaboration with higher education institutions. The results show that the majority collaborate; however, they seldom have students in internship or practice. Research collaboration was the type of collaboration that is most frequent between the workplaces and universities and colleges (Fig. 40). Internship periods may enlighten students when, through practice, they are made aware of the competence they already hold and the competence they need to acquire. Unawareness of their own competence and potential may hamper recent graduates in their search for relevant jobs. Increased professional experience may also increase the students' familiarity with the opportunities offered and the competence needed, within relevant professions.

In addition, there is now compelling evidence that professional practice can have a 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). Cooperation between higher education institutions and public and private companies is not uncommon in Norway. The most common type is short visits or lectures held by representatives from different professions. Professional training is typically found within professional education, such as health-care and teacher education, but is less common in discipline education.

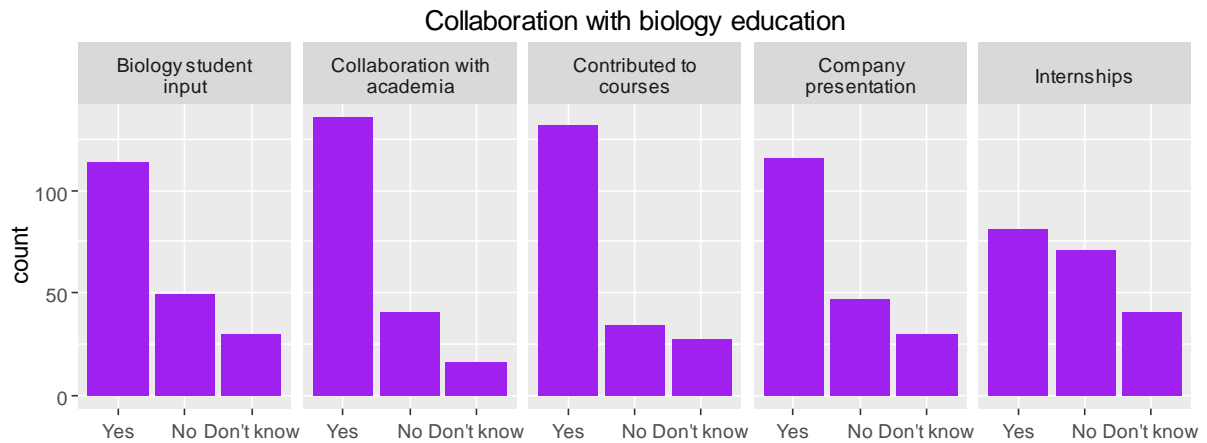


Figure 41. (W20). Reasons for collaborating with biology education institutions.

Almost half the companies/organizations in the survey hire biology students for summer jobs or part-time jobs. Students should be encouraged to take such jobs, given that the workplaces prefer candidates with work experience when they seek personnel.

Interestingly, a substantial number of respondents did not know if their company would want to contribute to biology education. It seems higher education in Norway has a potentially valuable resource by collaborating with professional biologists. Such collaborations could, to some extent, reflect the need for biological competence in society. It is fair to say that this resource is little explored in higher education, apart from in the professional study programs. These programs have a good dialogue with the job market through internships (Fig. 41).

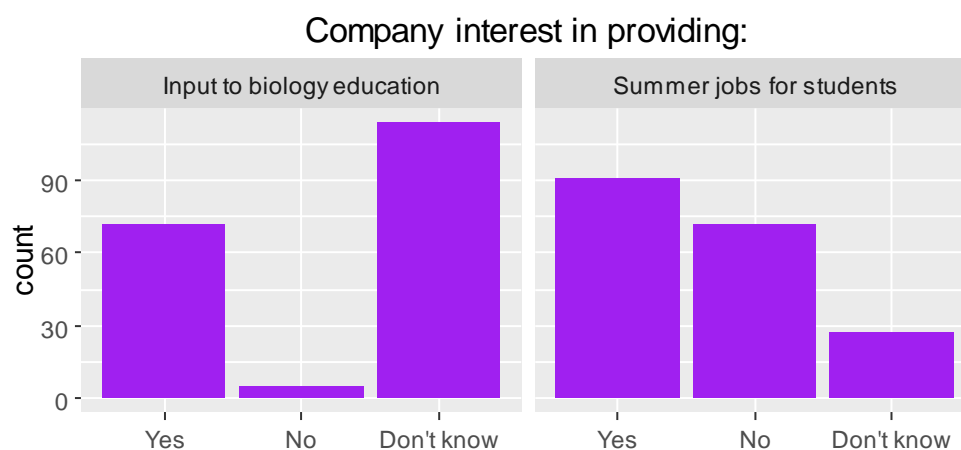


Figure 42. (W25).

4. Status of tertiary biology education in Norway 2015

4.1 Student learning

The main aim of this report is to develop an overview of tertiary-level biology education in Norway in 2015. By assessing an array of factors concerning the whole aspect of biology education, our goal is to map factors that might affect learning in biology based on bioCEED's characterization of biology education as something that emerges through societal developments, practical skills and theoretical knowledge.

Assessing motivational factors can be an important approach to take when investigating student learning (Jeno, 2015; Wentzel & Wigfield, 2009). The present report includes several motivational variables ranging from authority as motivators, aspirations, personal motivation and efficacy. Results show that, in general, students have a high degree of efficacy about learning biology. Students perceive they are able to meet challenges, achieve their goals for learning, have confidence in their abilities to learn and are capable of learning course material. All of these indicators may be prerequisites for high quality learning in biology. The results point towards a high interest and motivation amongst the students for learning the subject matter of biology. The majority of the students have chosen this education based on academic interest.

These results are in line with previous research and theoretical assumptions (Bandura, 1997, Ryan & Deci, 2000, 2002). For example, Niemiec et al. (2006) and Skinner, Wellborn and Connell (1990) found that students with high motivation for learning performed at a higher level compared to students with low motivation. Similar results have been found for employees and variables such as work performance, turnover and job satisfaction (Fernet, Guay, Senécal, & Austin, 2012). However, there might be other factors that relate to a student's motivation. For instance, students report that both practical learning such as field and laboratory work has a beneficial association with learning outcomes and motivation, and are thus practices that seem to enhance student learning. Having an integrated perspective on learning from several groups, such as students, teachers and institutes, is recommended for developing high quality learning (Gibbs, 2009; Jeno, 2015).

The student survey results show that students perceive their teachers to facilitate questions during teaching sessions to a high degree; this result is similar to the teachers' perception of themselves. Facilitating questions is one way to develop an active participatory class. However, preliminary feedback from teachers seems to indicate that students are not active participants during teaching sessions despite the efforts of the teachers. In other words, both students and teachers have the same perception about how facilitation is *attempted*, yet this facilitation does not seem to yield the desired results. This may be due to students' lack of preparation for class, despite interest and motivation for biology. Previous research has found a small but significant relationship between preparation and academic achievement (Dollinger, Matyja, & Huber, 2008). In light of these results, measures to increase class preparation should therefore be encouraged.

4.2 Culture for developing high quality teaching practices

Developing high quality education practices is to some level dependent on teachers' perception of their role as teachers and their willingness to strive towards better practices (Mårtensson, Roxå, & Olsson, 2010). Teacher efficacy and motivation has previously been found to be important for both the teachers' and students' motivation (Bandura, 1997; Pelletier & Sharp, 2009). Results from the report show that teachers report high levels of efficacy across all items. Further, teachers facilitate student learning by combining theoretical knowledge with practical tasks; both the students and teachers agree that teachers include activities that engage students in their teaching sessions.

Results from the administrative and technical staff show that a high percentage of them would take a basic pedagogical course if offered, indicating that this group of higher education employees has some interest in education. The administrative and technical staff may serve as a potential

resource that could aid pedagogical development. That being said, a substantial number of teachers report not having undertaken a pedagogical course, with only 56 percent of the respondents have completed pedagogical courses in teaching, even though this is mostly mandatory across Norwegian higher education institutions. Provisioning such courses, for long-term teachers and for administrative and technical staff, is one concrete measure that can improve teaching practices overall.

Finally, several items show that education is still under-emphasized in comparison to other activities at the university. This is reflected by the under-appreciation teachers feel by management, particularly at the institution leadership level. Also, teachers report that prioritizing education at the expense of research will not enhance their academic career. These results indicate that leadership in education requires systematic improvement and a clearer engagement with teachers in order to foster higher quality teaching practices.

In sum, teachers and other university employees are generally interested and motivated to engage in pedagogical development, while some systematic measures are lacking that could make use of teachers' interest. This particularly applies to pedagogical courses and appreciation of staff efforts to improve educational practices.

4.3 Identifying and facilitating key learning outcomes

The bioCEED Survey 2015 includes several items about learning outcomes, especially transferable skills and competencies. Teachers and students both find that important transferable skills such as critical thinking, writing and collaboration are being developed within biology education, however, students consistently rate their outcomes higher than teachers. This continues a trend where teachers are not satisfied with students' abilities in study techniques, writing and mathematics. Overall, a greater emphasis on basic skills in pedagogical development and courses seems warranted.

The bioCEED Biologist Survey 2015 provides an assessment of skills that should be of particular interest to biology students. Specifically, project management and other skills that require long-term cultivation are highly valued. This also echoes a European Commission report (European Commission, 2011), which calls for comprehensive skill sets to be obtained by students in an increasingly fluctuating job market. Several of the cross-disciplinary skills such as collaboration and project management are seen to be acquired predominantly through work experience, but could potentially be cultivated across student activities such as fieldwork and course projects.

Additionally, the responses of teachers and students to field/cruise and laboratory competencies indicate that the respondents perceive these activities to contribute to important learning goals in both practical skills and general biological knowledge (Singer, Nielsen, & Schweingruber, 2013). This also seems to come in accordance with Bøyum's (2013) candidate survey. Although caution is needed in the interpretation of Bøyum's results due to differences in faculty across study programs, the results show that practice or practical teaching methods are the most preferred teaching method among students at the University of Bergen: 40 percent of the students want more workplace practice. Furthermore, Bøyum's report shows that transferable skills are the least learned skills during university studies, especially cooperative and administrative skills. Although our report is not equivalent to Bøyum's, the students in our sample report that transferable skills are indeed developed through biology education, in contrast to Bøyum's results.

The responses from students, the workplace and teachers all indicate a clear positive perception of workplace practice on learning outcomes. According to our respondents, workplace practice not only contributes to students' careers, but increases theoretical knowledge. This is interesting to note, as the Norwegian Government's white paper (The Ministry of Education, 2014) calls for increased use of "meeting places" between higher education institutions and the workplace. Several learning outcomes desired by the workplace are perceived to be developed through workplace experience, thus there are different bases for using workplace practice as a legitimate contribution to the skill sets of biology students (Hole, 2015).

4.4 Methodological considerations

Although this report is based on both closed-ended and open-ended questions, there are potential limitations in the report worth discussing. The closed-ended questions are based on a cross-sectional design and thus no causal inferences could be made. Experimental work and interventions should be applied to further strengthen the results and replicate them. To secure anonymity for the participants, the study could not collect identifiable data, thus the strategy chosen for the present study was appropriate. Although responses to the open-ended questions will serve as a voice behind the statistics, the respondents could only comment if they desired, and thus no follow-up questions could be made. Future studies should conduct interviews in order to gather in-depth information.

Despite an overall satisfactory response rate, some institutions are under-represented in the survey. Care is recommended when analyzing the results for such institutions. The administrative and technical staff members included in the report are only from two institutions and were a convenience sample. Hence, they are not representative of the entire population of biology administrative and technical staff. Future follow-up studies should include administrative and technical staff from all institutions for comparative reasons. Lastly, although this report was primarily a baseline study and primarily atheoretical (please see previous sections concerning the use of theoretical assumptions and scales), future research should be more theoretical in order to test multivariate relationships in accordance with theoretical and methodological assumptions.

Several measures were taken in order to increase the response rate. Students were offered the opportunity to enter a prize draw to win one of two computer tablets. This was done so that it was not possible to connect the e-mail address to their questionnaire answers, for ethical reasons. Several reminders were sent to the different groups of respondents reminding them of the importance of completing the survey. Lastly, all the contacts at the universities and colleges were sent a PowerPoint slide they could use between classes and in the hallways to increase awareness of the survey. The survey *Studiebarometeret* that NOKUT conducted had a 32 percent response rate in 2013 and a 42 percent response rate in 2014 (NOKUT, 2014). Their response rate ranged between 28 and 54.4 percent at different institutions. The response rate achieved in the bioCEED Survey 2015 is normally considered good for this type of survey. The NOKUT *Studiebarometeret* has the following cut-off points in response rate for publishing data (NOKUT, 2014): in study programs with 6 to 9 students, a 49.5 percent response rate is required for publishing the results; in study programs with nine or more students, a 19.5 percent response rate is required.

We decided to report entry response rate, since the survey was electronic the number of respondents was reduced across the surveys.

The data comprising this report will form part of two doctoral projects, a post-doctoral project, articles and a master thesis. In terms of quantitative analysis, future work will investigate students' prospective academic achievements in relation to motivational variables: these will be presented as part of a PhD-thesis of one of the authors. The open-ended questions will serve as supplementary material for mixed-method studies by another of the authors.

bioCEED envisions a follow-up survey in four years' time in order to compare and assess whether there have been any changes in tertiary-level biology education.

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Please cite as:

Hole, T.N., Jenø, L.M., Holtermann, K., Raaheim, A., Velle, G., Simonelli, AL., & Vandvik, V. (2016). *bioCEED Survey 2015*. Retrieved from University of Bergen, BORA – Bergen Open Research Archive:
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