Studieprogramevaluering 2014 – 2017

Institutt for Geovitenskap

8. april 2016

Executive Summary of work

The primary evaluation work was carried out during 2013-2014 by the working group on teaching (see undervisningsarbeidsgruppa rapport Appendix 1). The group reviewed 1) the entire program structure at GEO, 2) the course portfolio at all levels as well as the sequence of the program plan at both bachelor and master levels, and 3) the consequences of the dramatic rise in student numbers for our ability to teach and on student learning outcomes. The work was carried out by representatives from each of the discipline groups at the department and involved extensive discussions and input from each discipline group. Based upon their evaluation, the report (appendix 1) made preliminary suggestions emphasizing the need to reducing redundancy and reorganise the bachelor program sequence. The program council (programstyret) discussed the proposed changes and noted that there was strong disagreement (both during the evaluation phase and within the program council) regarding some of the proposed reordering of classes. This disagreement reflected the strongly different opinions regarding both the content and the role of specific classes within the bachelor curriculum. The ongoing disagreement led the program council to conclude that, despite the extensive evaluation process, there was still no 'common' understanding of the 100 level curriculum at GEO nor of the specific role that each course played in accomplishing the learning outcomes of the bachelor program. Thus, before concluding the evaluation process and proposing the final program track, the program council decided an additional phase of evaluation was necessary to: 1) map the specific curriculum content and learning/skill outcome of each course with emphasis on the 100 level program, 2) receive additional feedback from our external program sensors and student body about our proposed program changes in light of the detailed curriculum mapping, 3) to assess our mapped bachelor curriculum and its learning outcomes relative to those expected by international geoscience programs, and 4) to evaluate the effectiveness of the bachelor program learning outcomes. This additional work was led by the program council in collaboration with the study administration and carried out during autumn 2014-2015 through a series of Group A meetings, staff discussions, and surveys.

Summary of Evaluation

Program status

Overview

Overall the working group (report Appendix 1) found that the study program was in good shape and provided a wide diversity which was essential to maintain. The recent NOKUT result (Figure 1, see also www.nokut.no) show that the GEO masters are the most satisfied of any program at the MatNat faculty and significantly more satisfied overall than other evaluated GEO programs in Norway.

Figure 1 results of NOKUT survey highlighting relatively high student satisfaction with GEO's Master Program.

The working group noted that bachelor level geophysical lines had recently been revised and that time was needed before additional program changes were made in order to first evaluate the outcome of the recent changes. Thus this study evaluation includes geophysics but is mostly focused on the geology program encompassing ~3/4ths of our bachelor students. The working group pointed out that there was too much redundancy in the geology courses (course overlap) at 100 level, and that the study program course sequence may not be optimal, both of which may inhibit student progression making it hard to achieve the more advanced learning outcomes expected by the bachelor program. These points address an observation raised frequently during the evaluation process that the maturity level of bachelor students, including depth of understanding as well as higher order learning outcomes such as critical reflection, independence, and cross disciplinary problem solving, could be further improved (see section on *program learning outcomes*). Of relevance here is the dramatic increase in the student uptake over the past decade while the effective number of teaching staff has been held steady or declined over the same period. The increase in student numbers, particularly within the geology program track, hinders student progression in a number of ways (see *evaluation of student numbers*) while the lack of commensurate resource allocation (e.g. to maintain student:faculty ratios, insure equipment, laboratory space, field time, contact hours and individual student follow up) poses significant challenges for improving upon (or even maintaining) the program's intended learning outcomes.

Bachelor curriculum and learning outcomes

Comparison to international programs

The detailed curriculum mapping carried out during the second phase of the study evaluation (2014-2015) reinforced and further clarified many of the findings of the first evaluation phase (Appendix 1). Namely that there was excessive redundancy in the geology bachelor program and that the course order combined with the large number of 100 level courses hindered student flexibility (e.g. the ability to take a semester/year abroad) and advancement to higher levels (i.e. 200 level courses).

In addition, the detailed curriculum map provided a template against which we could further assess how our bachelor level curriculum could be better organized to maximize our learning outcomes (for details see **Recommendations** section below). The curriculum map also provided the basis for evaluating whether our bachelor program and its learning outcomes had any missing elements or weaknesses relative to those commonly expected by bachelor geoscience programs internationally. Table 1 summarizes the core skill/learning outcomes common to almost all university level geology programs. Comparing this to GEO's learning outcomes reveals a strong overlap, with almost all of the core skills specified as learning outcomes by our Bachelor program. Likewise, those core skills that are not explicitly specified as one of our learning outcomes are still covered as part of our required curriculum track (100 level) either partially or fully. Likewise, each of the learning outcomes is integrated across our curriculum progression (taken up in multiple classes and multiple forms; see table 1) in order to reinforce and mature these core skills and concepts. Despite the overall good overlap, the evaluation identified some specific areas where GEO can further improve our bachelor curriculum in order to match that expected internationally. These include scientific visualization (e.g. training in G.I.S. and other common software as well as geologic drawing/drafting) and expression skills, scientific maturity, independence (e.g. in problem solving and field work), and critical reflection, as well as more systematic training of scientific ethics.

List of the consensus geoscience core skills and learning outcomes at the bachelor level[1]. Core Skill/Learning Outcome	Specified learning outcome@ GEO	Learning outcome (unspecified)	GEOV 101/102	GEOV 103	GEOV 104	GEOV 105	GEOV 107	GEOV 109	GEOV 110	GEOV 111
Have a basic knowledge of the interconnectedness of different "spheres" (such as the geosphere, hydrosphere, atmosphere, biosphere and cryosphere).		P	✓			✓	✓	✓	✓	
Can identify basic rock-forming minerals and rocks in the field, in hand sample and in thin section, and have a grasp of what each suggests about past conditions, including environmental and formation conditions.	✔		✔	✔				✓		
Understand how and why we sample rocks and fossils.	✔		✔	✓	✓	✔	✓	✓	✓	
Recognize basic fossil types and know how to use them for age dating and paleoenvironment reconstruction.	✔					✔				
Recognize different types of natural hazards and their zonation in hazard assessments.		✔	✔						✓	✔
Demonstrate basic field and laboratory safety techniques (HSE practices)	✔		✔		✔	✔	✔		✔	
Understand how to read and construct topographic maps, geologic maps, cross sections and stratigraphic sections, and how we collect data for them (including honing applied skills like how to use a surveying compass).	✔		✔		✔	✔	✔			
Be able to connect surface stratigraphy, structures and geomorphological features to subsurface geology.	✔		✔		✔	✔	✔			
Understand how plate tectonic processes operate and recognize different tectonic environments.	✔		✔		✔					
Know the geologic history of the student's local region.		P	✓		✓	✓			✓	
Have a sense of geologic time, including the rate and duration of key processes and the incompleteness of records, know the geologic time scale and the basics of dating —incl. which technique is most appropriate for a specific problem at hand.	✔		✔		✓	✔	✓	✓	✓	
Communication Skills (written and oral, including generating field reports)	✔		✔		✔	✔	✔	✓	✔	
Managing scientific literature (including proper citation and referencing)	✔				✓	✔		✓	✓	
Be familiar with common geoscience field, laboratory, and IT, tools and techniques	✔		✔		✔		✔			✔

Table 1. Column 1 lists the consensus geoscience core skills expected as an outcome at university level bachelor programs based on an open survey ([1]Ball, 2013 *Earth* magazine). Those core skills specified as learning outcomes at GEO are marked (✔) in column 2 and those not specified are marked in column 3 (with a "✔ " if they accomplished or "P" to denote that they are partially accomplished). The 100 level curriculum classes contributing to these outcomes are marked either with an "✔" (denoting a primary focus or stated learning outcome of the course) or "✓" (indicating that the skill is partially dealt with or reinforced).

Success of the specified learning outcomes

While there is good overlap between GEO's learning outcomes and those expected internationally we also evaluated student proficiency at achieving the learning outcomes. The majority of GEO's master students were bachelor students at GEO providing a reference group for the assessment. We surveyed our teaching faculty (Group A) regarding the perceived proficiency of beginning masters students (with GEO bachelor degree) at each of the intended 16 learning outcomes of our bachelor programs (geology and both geophysical tracks). The results shown below in Figures 2 and Table 2 suggest that the intended learning outcomes are overall satisfactorily accomplished (level of "satisfactory" to "good" for all outcomes, see summary in Figure 2 and specifics in Table 2).

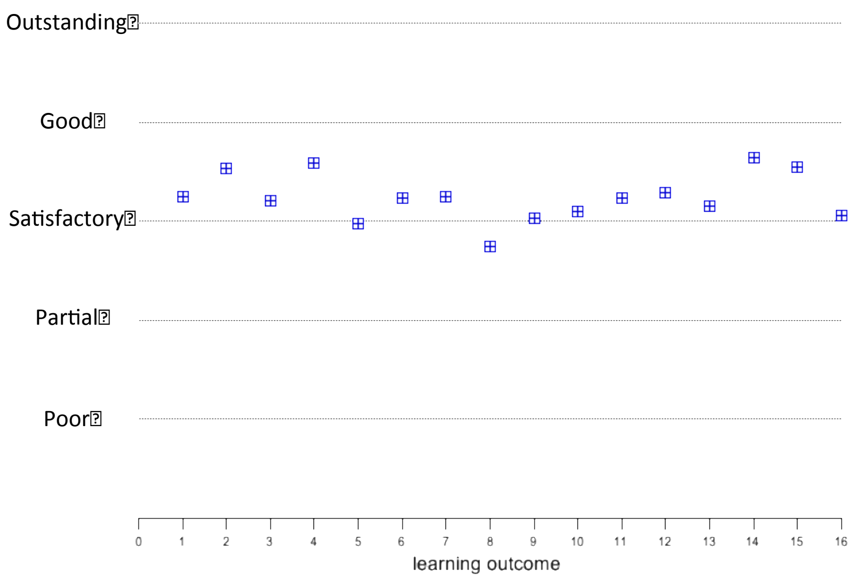


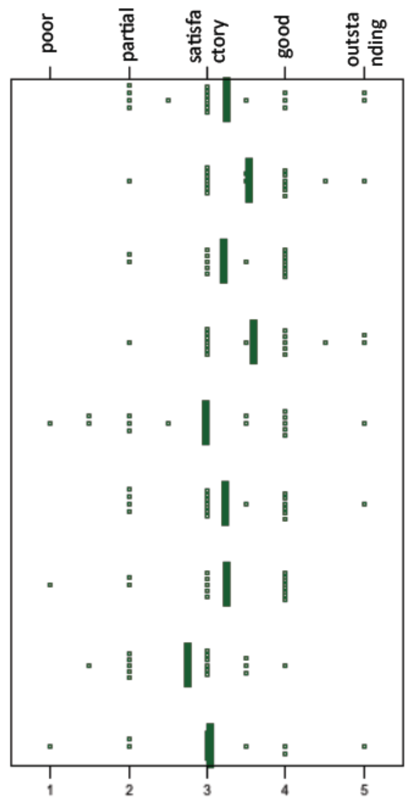
Figure 2 showing the 16 specified learning outcomes of our bachelor programs (x-axis) and the perceived student proficiency (y-axis) at the beginning of the master study. For descriptions of each learning outcome (attached to each number) and spread of responses see Table 2 below.

Ved fullført bachelorstudium I geovitenskap skal kandidaten kunne:

1. Gjere reda for GEO faget sin eigenart og utvikling *(n=20)*
2. Skildre jorda si oppbygging og dynamikk, samt dei indre og ytre prosessar sin former jordskorpa *(n=18)*
3. Skissere hovudtrekka i jorda si geologiske utvikling i frå prekambrium til nåtid *(n=17)*
4. Gjere greie for dei mest vanlege geologiske og geofysiske undersøkingsmetodar *(n=17)*
5. Bruke bibliotek og venskaplege databaser til innhenting av relevant informasjon *(n=19)*
6. Arbeide sjølvstendig og kunne delta i team *(n=19)*

7 Utføre laboratoria – og feltarbeid i samsvar med god HMS-praksis *(n=16)*

8. Bruke laboratoria, felt- og IT-baserte teknikkar for å tileigne seg og bearbeide geovitenskapelege data *(n=16)*
9. Anvende GEO faglege kunnskapar i problemstillingar knytta til resursar og miljø *(n=16)*

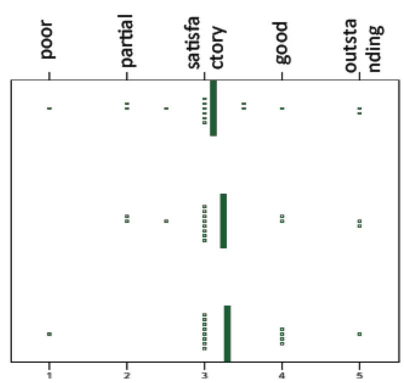


<u>Dersom studentene velger studieretningen innen geologi skal kandidatene i tillegg kunne:</u>

10. Beherske grunnleggende feltmetoder for å fremstille et enkelt kvartær- eller berggrunnsgeologis kart, sedimentologiske logger eller geologiske profiler på grunnlag av egne observasjoner (*n=15*)

11. Identifisere vanlige mineral og bergarter og forklare en bergart sin danning og utviklingshistorie (*n=15*)

12. Tolke sedimentære avsetninger og strukturer i forhold til paleomiljø
(*n=14*)



<u>Dersom studenten velger studieretningen innen geofysikk skal kandidatene i tillegg kunne:</u>

13. Gjengi de fysiske lovene som styrer seismisk bølgeforplantning i jorden (*n=10*)

14. Beskrive teori og anvending for innsamling, prosessering og tolking av seismiske data (*n=11*)

15. Beskrive hvordan marin sesmikk og andre geofysiske teknikker nyttes for å finne- og monitorer utvinning av olje og gassørekomstar (*n=10*)

16. Forklare prinsipp – og anveningsområdet for de ulike potensialfeltmetodene som nyttes innen geovitenskap (*n=8*)

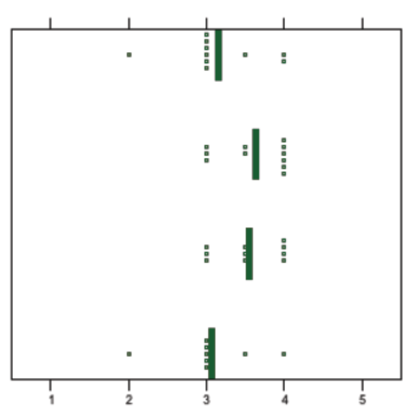


Table 2 showing the individual responses for perceived student proficiency at accomplishing each learning outcome.

Although the perception is that bachelor students achieve reasonable success across the core skills expected at the bachelor level there is no area where they currently and consistently excel. To some extent this may reflect the natural variance in both the student body (partially indicated by wide spread in responses in Table 3 by faculty sub sampling of the population) as well as the variance in faculty perception both of students and of what constitutes mastery of a given outcome. The results, including the general lack of higher scores (good-outstanding), reinforce the observation that while the bachelor students do well they may fall short of the highest level of maturity and mastery that we aim for. In addition, the results show that the field/lab/IT skills are our weakest area; echoing earlier reports as well as points raised during the current evaluation discussions that there is a need to improve field, lab, and IT skills with particular emphasis on field training which places high demands (regarding time and follow up) upon the faculty and courses. Most international geology programs have an extended (4-6 week) field course as part of their core curriculum to facilitate mastery of field techniques and guarantee that candidates can work independently in the field. Without an equivalent course GEO is at a distinct disadvantage and needs to maximize the efficiency of student field training and contact hours.

Recommendations

This section outlines some key areas for improvement and the general and specific recommendations resulting from the evaluation work.

Program course sequence (and obligatory courses)

In order to reduce redundancy in the bachelor program and optimize the progression toward the bachelor learning outcomes a number of changes in the study progression were proposed in 2015. GEOV 106 and GEOV 108 were combined into a new course. The goal is to reduce redundancy in the current curriculum while at the same time broadening our 100 level curriculum. This partially addresses a second shortcoming identified in the evaluation process, the lack of a coherent system science approach in the bachelor curriculum. Comparison of our learning outcomes to international expectations (see also table 1, point 1) showed that we do not stress the interconnectedness of the Earth System to the same extent that other programs do and that we do not train toward this as a learning outcome as a coherent and consistent element of our 100 level courses. Inclusion of geochemistry (GEOV 109) and Quaternary earth system studies (GEOV 110) as required courses will strengthen the Earth System aspects as both of these courses cover essential concepts for understanding the different spheres (geosphere, hydrosphere, atmosphere, etc.) and their interconnections in Earth System cycles.

BAMN-GEOV BACHELORPROGRAM I GEOVITENSKAP

Haust 2016 (gjelder også for kull haust 15)

Ny studieplan: Bachelorprogrammet i geovitenskap, retning geologi

6. V	Val	Val	Val
5. H	GEOV107	GEOV110	Val
4. V	GEOV104	GEOV111	GEOV109
3. H	GEOV103	GEOV105	Val
2. V	GEOV101	GEOV102	MAT102
1. H	Ex.phil.	MAT101/ MAT111	KJEM100/ KJEM110

Emna merka lysegrått er obligatoriske for alle studieprogram ved fakultetet.
Emna merka mørkegrått er spesialiseringsdelen (100stp),
og er obligatoriske emne for programmet.

GEOV 105 historical geology was moved earlier in the curriculum plan (from 4th semester to 3rd semester) due to its central role in providing a framework for understanding the long term evolution of the Earth as well as a frame of (e.g. the Geological timescale and major events and transitions in Earth's history) reference for all later studies. Likewise the curriculum mapping showed that the course provides many of the basic skills and concepts needed in later courses. Feedback from the students (both the PS representatives but also input from the "fagkritisk dag") confirmed that this course was essential to have as early as possible in the progression.

Despite a suggestion by the working group (Appendix 1) to move GEOV 101 to the first semester this change was not adopted due to pedagogic considerations. Having GEOV 101 and 102 run in parallel optimizes coordination between training in theory (GEOV 101) and in practice (GEOV 102) so that each reinforces the other. Based on input from the program sensors as well as strong input from the students (PS representatives and input from the "fagkritisk dag") who stressed that the combination of GEOV 101/102 in the same semester was extremely valuable for achieving the learning outcomes of both courses we will continue to run these courses in parallel.

The reorganisation also made space in the final semester to facilitate exchange and study abroad possibilities.

Earth System approach

As mentioned above understanding the complexity of the Earth System requires an applied knowledge of diverse mechanical, chemical, biological, and anthropogenic processes and their linear and non-linear interactions and feedbacks. This system approach to understanding the Earth builds valuable expertise for later success in interdisciplinary endeavors yet system understanding has not been a conscious and specified goal of our 100 level curriculum progression.

GEO aims to further strengthen the Earth System approach within the curriculum by developing a coordinated curriculum progression that builds purposefully through the bachelor and masters education toward Earth System understanding. The evaluation concludes that this can be accomplished within the current study plan by making small changes in how concepts are presented and linked.

Ethics

The detailed curriculum mapping carried out in 2015 also revealed one surprising result, other than Ex.phil. ethics are currently taught largely *ad hoc* as independent or random elements within our curriculum. GEO lacks a coordinated curriculum progression to foster ethics, scientific integrity, objectivity and scientific best practices. Scientific work entails strong ethical components. Ethics play a role at all levels of scientific work including within experimental design, procedures, and reporting. Indeed the assumption of scientific integrity and objectivity in carrying out the process of science underpins trust and credibility amongst scientists and ultimately between society and scientists. Fostering this trust and a general understanding of the unbiased and critical nature of scientific enquiry should be a key learning outcome of our bachelor and master programs.

To foster ethical development as well as reflection and critical thinking a coordinated curriculum needs to be developed. It should include:

- Academic socialization into ethical conduct through mentoring and exposure/training in research methods in all courses.
- Increase student involvement and engagement in scientific work via internship opportunities connected to field, lab, experimental, and other activities related to ongoing research to impart sound research practices and standards of conduct.
- Project a culture of integrity within the workplace—be visible role models for scientific integrity.
- Incorporate best practice training for citation and referencing at the MSc. level and reinforce ethical practices at all levels through feedback on reports and writing. It is proposed that these changes can be accomplished within the existing program structure through a more consistent and coordinated approach to training (see Appendix 1 for more details)

In addition, GEO plans to adopt an academic integrity statement as part of the course information for all courses in order to stress that ethics underpin all scientific activities. The following statement is a draft of the planned statement:

> "Scientific and scholarly activities require high standards of personal and academic integrity by students and faculty alike. As academics each of us bears the responsibility to conduct our scholarly and research activities with integrity and intellectual honesty. The open exchange of ideas and sharing necessary for research and the advancement of

knowledge require mutual trust that ideas, opinions, data, and insights will be respected, acknowledged and properly credited. In addition, as scientists it is our responsibility to objectively and honestly report all of our information (observations/data/work), its source, and its uncertainties.

This means that as students you are responsible for the full citation of others' ideas in all of your work and you must be honest when taking your exam. Always submit your own work and not that of another student or other source material (book, papers, online materials) without proper citation. Finally, data must always be handled and reported honestly; fabrication, falsification, omissions, or misrepresentation of results are serious forms of misconduct.

For more information about academic integrity guidelines at UiB please see:

http://www.uib.no/en/quality-in-studies/77866/useful-information-students-and-staff

http://www.uib.no/en/education/49058/use-sources-written-work-university-bergen#"

Student numbers and advanced learning

The dramatic rise in student numbers has created new challenges for maintaining teaching quality and learning outcomes. In some cases facilities and equipment are inadequate and students do not have the physical space they need to work efficiently. Likewise the large student numbers makes it increasingly difficult to find teaching rooms where there is flexibility in the teaching methods (e.g. group work, lab work, and seminar space for larger class sizes) and where it is possible to give feedback effectively (see more details in Appendix 1).

The increased student to faculty ratio reduces the individual student contact time—a key metric for student training quality and progression. In addition to total contact hours the quality of student-faculty interactions and the engagement and motivation of students is essential. Given the reduced contact hours available to each student it is essential to strengthen the independent learning and maximize the affectivity of student-faculty contact. In addition, it is critical that GEO develops mechanisms for students to tailor their own educations, build key competency, and increase relevance for outside stake-holders.

In order to foster self-learning, student engagement, independence and competitiveness GEO aims to:

- Employ a broader range of teaching tools and approaches to maximize learning outcomes and facilitate independent study (e.g. digital tools and flipped classroom approaches).
- Facilitate more self-learning and engagement (e.g. via digital modules) using a greater proportion of the student contact time for guided student

practice, questions/discussion to evaluate progression, review activities, and providing scaffolding for accomplishing difficult tasks.

- Increase experiential learning opportunities through departmental research internships (from bachelor) to foster independence and provide opportunities tailored to students interests/abilities.
- Maintain close contact with industrial partners in MSc and PhD education
- Strengthen transferable skills within computing and oral and written communication.
- Apply research-based teaching in both senses of the phrase:
    - Expose and engage students in research and scientific best practices at all levels.
    - Apply pedagogic approaches shown by research to be the most effective.

Field training

Field, laboratory and survey training are essential for teaching geoscientists to integrate fragmentary information, to reason temporally and spatially, and to critique and properly utilize empirical data. However, as these training elements are particularly demanding, expensive, and necessarily distributed amongst a finite group of academic staff members, they must be accomplished as efficiently and effectively as possible.

With a doubling or even tripling of student numbers in some of the key courses it becomes increasingly difficult to provide individual follow up for each candidate. The result is to exacerbate the long-standing challenges posed by not having enough resources (course time in the field; see Cruise and Field working group report from 2010 part of Appendix 1). The evaluation working group (Appendix 1) noted that some, but not all, of the action points from the "Cruise and Field working group report (2010)" were followed up on and that there is a need to further strengthen and coordinate field and lab training activities. In addition, student feedback pointed out clearly that given the large numbers of students there are not always enough field assistants to provide adequate feedback in the courses.

In order to improve field training GEO proposes the following actions:

- Continue to reinforce our focus on problem-based learning in field teaching within a coordinated and transparent curriculum of field and practice. This will require an additional mapping of our curriculum activities related to field work and to improve our description of the field courses, their learning outcomes, methods and skills mastered, as well as localities used.
- Introduce field and data collection activities early in the Geophysics curriculum so that all students encounter empirical methods.
- Involve more academic staff in practical training in the basic courses.
- Reduce the days devoted to passive learning activities (e.g. excursions) and increase independent problem solving activities in the field.