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# Aligning Expectations In Bachelor Research Supervision

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## Introduction

For many students, the bachelor research project represents the culmination of the first phase of their secondary education. It is their first chance to do 'real science'; an opportunity to take ownership of the knowledge they have gained in their coursework, and apply it with an unprecedented independence. Under the guidance of their project supervisor, students are expected to produce a report that demonstrates their ability to formulate and critically analyze a scientific problem. But what type of guidance do these students require? While certainly the answer to this question depends greatly on the individual student, it broadly requires that the supervisor is familiar with the expected scale of the project, with how well prepared the student is in their third year of study to execute an independent research project, and with the expected quality of the final report.

This study, inspired by my inaugural year advising students in their bachelor thesis projects, aims to define what to expect and what my responsibilities are as an advisor. Guidelines from the SCIENCE study administration state that as a principal supervisor, I am responsible for "Ensuring that the bachelor project is of a scope that can be completed within the specified time frame." As a first-time advisor, and an international researcher unfamiliar with the academic structure and rigor in Denmark, I do not yet have the tools to meet this responsibility.

In order to better understand the role of the bachelor project within the education of Geology and Geophysics at the University of Copenhagen, I completed interviews with an assistant professor at the Natural History

Museum, an associate professor and a professor at the Department of Geosciences and Natural Resource Management, an external censor who regularly examines bachelor projects, and a recent graduate of the bachelor program who is currently a PhD student at the Natural History Museum. In the faculty interviews (Appendix A), we discussed faculty's expectation of workload, in terms of hours spent and the scale of the final project, what skills and competencies they observe their students gaining through these projects and to what extent that helps them as they continue their education, and finally any personal experiences they deem relevant. I compared the answers of the faculty members with the criterion by which the censor evaluates bachelor projects, and the perceptions of the student about the purpose of the bachelor project, the role of the advisor, and the rigor of assessment.

Two clear outcomes emerged from the interviews. First, while there is generally agreement on intended learning outcomes for the bachelor project: to be able to analyze a problem critically, synthesize information from the literature, and present knowledge clearly in a report, the types of projects, level of advisor involvement, and standards for assessment are decided individually by each faculty member. There is no reference to a common rubric or departmental standard, and there is no way to compare outcomes across the faculty. Second, every interviewee identified two critical factors that they observed optimized students achieving these learning outcomes. Students are most successful when they feel ownership of their studies by carrying out their own research project, from developing a hypothesis, to collecting and analyzing their own data. Students also require a significant time to think; the best projects were those when students had more time to analyze their data and synthesize that with what they learned through scholarship.

In the following sections I will briefly introduce the individuals interviewed for this project, review the intended learning outcomes of the bachelor project and how those are perceived by the faculty that I interviewed, discuss how independent research projects optimize those learning outcomes, and explore the role of assessment in the bachelor project. Finally, I offer suggestions to the study administration on methods to improve the constructive alignment between the learning objectives and assessment, and propose a reconsideration of the existing bachelor study plan to better meet the learning objectives of the bachelor project.

## The Interview Subjects

It is not within the scope of this study to get a comprehensive and statistically significant overview of how faculty, students and censors perceive the role of the supervisor in bachelor projects. Rather, this work is intended to help me prepare for the role of bachelor project advisor, and develop tools that might help other new faculty as they prepare for the same role. Representatives were therefore recruited to share their individual experiences and impressions of the bachelor project process in order that I might obtain a holistic view of the value, scope and expectations of the bachelor project and how this is taught to faculty who advise, students who participate and censors who assess. Interviewees were selected for their diversity of perspectives on the subject, and include:

Adjunkt: an assistant professor at the Natural History Museum; has co-supervised two bachelor students.

Lektor: an associate professor at the Institute for Geoscience and Natural Resource Management; has advised 15-20 bachelor projects.

Professor: a professor at the Institute for Geoscience and Natural Resource Management; has been a faculty member for 14 years, advises several students each year.

Censor: an emeritus researcher at the Geological Survey of Denmark and Greenland; has served as a censor for about 20 bachelor projects, advised by several different faculty members.

PhD Student: a current PhD student at the Natural History Museum; completed his bachelor project under the supervision of a faculty member at the Natural History Museum for the study program of Geology and Geophysics (offered through the Institute for Geoscience and Natural Resource Management).

All members are working within the study program of Geology and Geophysics. In the interest of privacy for those who participated in the interviews, their names have been omitted, and they are referred to in the subsequent text by their Danish title only.

## Intended Learning Outcomes of the Bachelor Project

*"I remember that being a major issue, I was looking everywhere and was asking people in the administration what are the … like, how many pages are you supposed to write, what are the rules to the bachelor project? What*

*do people expect that I do, and I just couldn't find any material on it. No one was really, sort of… no one knew anything." – PhD Student*

Every course offered at the University of Copenhagen enters the curriculum only after clear learning objectives are defined by the course responsible, and approved by the relevant study boards. These learning objectives are advertised in the course catalog, and courses are assessed (and educators evaluated) on how well learning objectives were met through class teaching and learning activities. In the bachelor project, learning outcomes are only found in Bilag 3 of the Rules of Study for the BSc program in Geology and Geophysics, available – but not accessible through an obvious link – through the KU intranet. The document is only available in Danish. My own translation of the learning objectives is presented in Inset 1 (see Supplementary Notes for navigation details to the bachelor project guidelines available on intranet.ku.dk).

Of the three faculty I interviewed, none were familiar with the published learning objectives of the bachelor project, or where to find them. Rather, each faculty member identified their intuition and experience as the primary tools they use to guide their advising, and each prioritized a different aspect of the project as the most important learning objective. The Adjunkt felt that the main goal of the project should be teaching students to become self-motivated, so that they are able and eager to take on a research project independently. Learning to navigate the literature and to write a clear and professional thesis was prioritized by the Lektor, whereas the Professor identified one of the most basic and important of geological skills: learning to read the landscape and make observations in the field, as the most critical outcome of the project.

*"Why is [the learning objectives] not part of the contract? Whenever we get the contract, why is it not just page 3 stapled onto that?" – Lektor*

The result of not having the learning objectives of the bachelor project easily available to all relevant faculty and students, is that each faculty member guides their students based on their personal motivations and attitudes about what is most important. Inexperienced advisors, and their students, are distinctly disadvantaged in such a system. And while it is likely that a bachelor student can find value in their project regardless of their advisor, as each faculty member's personal learning objectives have merit when training a young researcher, it makes it difficult to compare students, and for a censor to know what the basis is for grading. Without being aware of learning outcomes expected by the study program, neither the student, the advisor nor the censor can fully reflect on whether the completed project

is appropriately meeting the aims of the activity. Further, as the censor I interviewed pointed out, at the time of the bachelor project, a student's future career is not yet decided. Thus, training at the bachelor level should give them tools they can use in a variety of professions after graduation, and advisors who emphasize the training of skills that are specific to academic research because that is what they value most, may be doing their students a disservice.

**INSET 1: LEARNING OBJECTIVES FOR BACHELOR PROJECT IN GEOLOGY-GEOSCIENCE**[3]
*(personal translation from Danish)*

A student who has completed a bachelor project in geology-geoscience will have the following learning outcomes

**Knowledge in:**

- How to explain how a geological problem is defined and handled within a given geological discipline, with emphasis on formulating and analyzing the problem
- To reflect on existing or new knowledge within the specific discipline
- To critically evaluate academic literature within the field of geology, as well as theories and models used, and any data (obtained?)

**Skills in:**

- Analyzing geologic problems, observations and results within their scientific context in a meaningful and comprehensive way
- Compare and contrasting one's own observations with another's observations and analyses based on underlying principles as well as knowledge of a scientific method's strengths and limitations
- Choosing the most appropriate theories and methods to apply to a geologic problem
- Communicating a scientific problem clearly and simply, both orally and in writing, using correct geological terminology, and language appropriate to the audience

**Competencies:**

- Implement a small research project within a geologic field
- Independently develop their own knowledge and skills related to the subject area in which the project is aimed

## The Importance of Independent Research

*"I think what they find fun to do is the action. That you can actually be out there and collect your own data, and … we are usually in a place where we know absolutely nothing, or just a little bit. So, it's like a Klondike adventure. … I don't know anything and they don't know anything. I think they are inspired by this puzzle." – Professor*

The learning objectives intended for the bachelor project emphasize critical thinking: formulating a problem, choosing appropriate methods to

apply to the problem, evaluating the literature and data, and being critical of your own as well as others' observations. Also listed in the learning objectives, and articulated by each of the faculty I met with, is the importance of developing independence; students must learn to develop and execute their project independently. The observation of the faculty members has been that almost invariably, students who do their own research project in which they collect and analyze their own data, have been more motivated and more successful than those whose projects were solely literature based or used existing datasets.

As the PhD student noted, bachelor students have little opportunity in their studies to do "some sort of real work," and most are eager to get their hands dirty. The Professor I interviewed noted that he receives so many requests from students to do bachelor projects with him, because they know that a project will involve fieldwork, data collection and modeling – and that it will be real research; investigating a problem no one has ever looked at before. In the interest of aligning the learning activities of the bachelor project to the intended learning outcomes, designing the project as a student's first true independent scientific research endeavor makes sense. There are advantages to the faculty advisor, too: bachelor projects have become seeds for masters' projects, they have been incorporated into PhD theses and provided a forum for PhD students to gain experience in co-advising, and they have provided preliminary results that supported funding proposals.

*"… the external examiners and myself always find that the students are much more engaged when they are generating their own data, because they understand where they are coming from, and they get a fire going, and become proud of what they are producing and then contrasting that with the literature. So, that makes much better bachelor projects." – Lektor*

Despite the pedagogical evidence (e.g. DeHaan, 2005; Seymour, Hunter, Laursen, and DeAntoni, 2004) and anecdotal support of the value of integrating real research into the bachelor project in increasing student activation and deep learning, a recent redesign of the study program for the bachelor in Geology and Geoscience will make it nearly impossible to do. Beginning with the bachelor class of 2018 (students who began their studies in the Autumn of 2015), it will be mandatory for students to complete their bachelor project as a full-time course load in the fourth block of their third year. The current study program allows students to choose a full-time one-block (eight week) bachelor project, or to do their project part-time over a

sixteen week two-block period. All of the interviewed faculty encourage or require their students to do their project over the sixteen week period.

As expressed by the Professor interviewed here, the new rule for the bachelor project is "a disaster." With limited number of analytical equipment and the possibility of maintenance problems, it is impractical for all bachelor students (about 50 to 60) to undertake analytical work within the same short time span. Even if there was enough 'machine time' for each student, eight weeks is too short to do extensive, or in some cases any, experimental work. Already, faculty encourage students to do their fieldwork or begin their sample preparation or analyses before the beginning of their sixteen-week, part time project.

In addition to the logistical hurdles and risk associated with doing research in such a short time scale, critical thinking requires time. As this is usually a student's first experience critically reading the literature, synthesizing large amounts of information, and writing a large and professional manuscript, being forced to work quickly ensures that students will learn less deeply. Among the individuals I interviewed for this study, there was unanimous agreement that requiring the bachelor project to be completed within one full-time study block hinders a students' chances of attaining the learning objectives presented by the program's study board.

*"Well, especially when you are dealing with lab work, you want to have time for things to go wrong. Also, doing a research project, you want to have time to absorb things, and with only one block, of course you can dedicate all your time to learning something, but you don't always absorb knowledge the right way, and you might not gain the deeper understanding that leads to more advanced understanding." – PhD Student*

## Alignment of Assessment with Intended Learning Outcomes

Bachelor projects are assessed by two people: the project supervisor and an external censor. They grade the final written report, the student's public presentation of their findings and their answers during an oral examination. There are no clear guidelines for how students are evaluated (see Supplementary Notes for navigation instructions to information for students on the bachelor project), the scale or rigor of expectations, and what the role of the two assessors are. Through my interviews, and limited experience thus far, each censor and faculty member makes their own interpretation of these

criteria. Some censors simply observe and offer comments but allow the advisor to select a final grade. Other censors act as an external examiner, and expect that their more unbiased review of the student should primarily determine the final grade. Some faculty expect that the report be well written and professionally formatted; others evaluate solely or predominantly on the report's scientific content.

*"I don't think I know what the objective requirements would be, but when I see it, then I have a feeling whether they understand what they're trying or not. That's sort of what I take as… but maybe you could say that the whole process could slide and all students because they don't expect much of themselves are doing well on that new scale. So, again, here I think it would be good to have sort of a guideline from the university of what it requires. But I haven't seen that." – Adjunkt*

This method of evaluation is problematic, for several reasons. First, the project advisor is not unbiased. They have played a large role in the progression of the thesis, and feel a fair amount of responsibility regarding its outcome. Further, as we have observed, most advisors are unfamiliar with the learning objectives, so their assessment may not be valid (it may have systematic errors) or consistent with the purpose of the bachelor project. Finally, with no common rubric for assessment, the reliability, or consistency across faculty, of the assessment is also significantly compromised. The written reports are not public, so there is no way to compare how students advised by different faculty are being assessed, and there is also no way to evaluate whether faculty are constructive advisors, because the success or failure of one faculty members' students cannot be compared to those of another. Most critically, unless an advisor makes the effort to clearly outline how the student will be assessed, students themselves do not know what they are being graded on, and therefore how to manage their time in preparing their final report and presentation.

## Conclusions and Recommendations for Improvement

The study board for the bachelor education program in Geology and Geophysics have designed clear learning objectives for the bachelor project. These should be used as a cornerstone for formulating the project that the student will complete, establishing expectations between the student and advisor for how the project will be carried out and what the final outcome should be, and determining the metrics for how the student should be eval-

uated. It is policy within the faculty of Science that when a bachelor project begins, a written contract is made where student and advisor agree on the project to be completed and the expectations of each party to ensure the project's completion. For my own students, the meeting in which we write the contract will henceforth also include discussion of two documents: the learning objectives for the project, and a rubric that clearly details how the student will be assessed on meeting these objectives. Empirical research has shown that when rubrics are topic-specific and analytic (a score is assigned to each dimension of the task), their use can increase reliability in assessment as well as promote learning (Jonsson and Svingby, 2007). A working draft of the rubric I will use is in Appendix B.

In the interest of increasing the continuity of scale and purpose of bachelor projects across faculty advisors, and the validity and reliability of bachelor project assessment, I would encourage the study board to incorporate the learning objectives and an evaluation rubric similar to the one I have developed (designed or agreed to by the study board), to the formal bachelor project contract so that all advisors and students are asked to work within a systematic framework. I believe this will not only place more of the responsibility for success on the student than the advisor, but it will also optimize their chances for success, as the goals and expectations for their project are made clear from the start.

Further, it is critical that the study board reassess whether the new curriculum format, in which students have only eight weeks to complete a project, is well aligned with the learning objectives for the bachelor project. If the purpose of these projects is to teach students to independently develop knowledge and skills in the field of geology, learn to critically evaluate their own work and the work of others, and prepare a well-executed written and oral presentation of what they have learned, they should have the time to do it. Students who have the opportunity to do their own research, and ideally also their own fieldwork, will have a much greater opportunity to appreciate what they are doing, be inspired by their own success and learn for their own satisfaction as much as for a study program requirement. Making it nearly impossible to carry out a bachelor project in this way diminishes its importance, value, and outcome, and is an enormous loss to the bachelor student.

## Supplementary Notes

Transcripts of all interviews are available upon request. Contact: emily@snm.ku.dk.

Information regarding completion of bachelor projects for the BSc program of geology-geophysics at the Department of Geosciences and Natural Resource Management within the faculty of SCIENCE is available through the Copenhagen University internal information web portal, *KU Intranet*. There are two resources available; one for faculty, and one for students, summarized below.

1. Faculty of SCIENCE (intranet ® faculty of science ® study administration ® bachelor projects, theses + other projects ® bachelor project). Discusses administrative policy regarding the bachelor project: which department handles the project, requirement of a bachelor project agreement, administrative responsibilities of the principle supervisor and department.
   The only guidance on what the project should consist of are the following statements:
   a. the principal supervisor is responsible for ensuring the bachelor project is of a scope that can be completed within the specified time frame.
   b. the purpose of the Bachelor project is to allow the student to demonstrate his/her skills in formulating, analyzing and processing issues within a defined academic topic, which is determined in collaboration with the project supervisor(s)
   c. learning outcomes (in Danish only, paraphrased in Inset 1 of this text)
2. Department of Geosciences and Natural Resource Management (intranet ® faculty of science ® for students ® bsc programmes: geology-geoscience ® udannelsens forløb (in Danish only) ® bachelorprojekt) Provides students information on how to complete their bachelor project, specifically focusing on rules and regulations, and administrative steps. The only guidance on project content is the following statement (translated from Danish):
   a. Apart from rules guiding the language and the summary there are no formal requirements for the content, setup or scope of your project report. It is your supervisor's responsibility to ensure that your bachelor project has a scope that is appropriate for you to complete within the required timeframe.

## References

DeHaan, R. L. (2005). The impending revolution in undergraduate science education. *Journal of Science Education and Technology*, *14*(2), 253–269.

Jonsson, A. & Svingby, G. (2007). The use of scoring rubrics: reliability, validity and educational consequences. *Educational research review*, *2*(2), 130–144.

Seymour, E., Hunter, A.-B., Laursen, S. L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: first findings from a three-year study. *Science education*, *88*(4), 493–534.

# A Faculty Interview Questions

Interviewee:

Position:

What is your experience advising bachelor students? (e.g. How many students?)

Are there any resources you use from the department, university, etc. to guide your approach to advising bachelor students?

Do you think there is value in advising a bachelor student project? If so, what?

What skills and competences do you observe students gaining through these projects?

To what extent do those skills contribute to their continued education?

Do you think these gained skills are reflected in how the students are evaluated?

What is the faculty's expectation of student workload? What scale is the final project?

(Publishable? Part of a published study? Presentable at a meeting? Just a small exercise?)

What do you think is your role as an advisor? What is your workload?

To what extent do you take responsibility for the success of your students' project?

Any other comments/questions?

# B Evaluation Rubric

| | | Grade: 12 | 10 |
|---|---|---|---|
| SCHOLARSHIP | Review and synthesis of the relevant literature | Student presents an excellent review of the topic, deeply exploring the literature, and synthesizing and analyzing others conclusions as well as placing their own problem into the context of the field. | Student effectively presents a coherent review of the topic, demonstrating a clear understanding of the context of their problem. An appropriate number of literature references are used, with a mix of classics, reviews of the field and recent advances. |
| | Understanding of theory and methodology | Can explain the reasons for the application a theory or method to geological problem, can properly describe how it works and associated assumptions and uncertainties. | Gives a good summary of theory or method used, can properly describe how it works and associated assumptions and uncertainties. |
| ANALYSIS | Identification of the geologic problem and its relevance | Student clearly describes the geologic problem, does an excellent job of identifying its importance in the context of the field and how their study will address the problem. | Student clearly describes the geologic problem and identifies its importance, and gives an (imperfect) explanation of how their study addresses the problem. |
| | Critical evaluation of models, theories or data (from literature or obtained) | Results of model, data or theoretical derivation are clearly and concisely presented in figures and/or tables and summarized in text. Student gives a thorough and critical interpretation of their results, and develops concrete hypotheses, conclusions or suggestions for further study. | Results of model, data or theoretical derivation are clearly and concisely presented in figures and/or tables and summarized in text. Student gives a critical interpretation of their results, and develops some hypotheses, conclusions or suggestions for further study. |
| | Placing observations and results in its scientific context | Student synthesizes the results of his study with insights from literature review, and draws logical conclusions on how the project outcomes affect the state of the art of the field. | Student makes some clear connections between the results of his study and his synthesis of the literature, and suggests some ideas for how the project outcomes affect the state of the field. |
| PRESENTATION | Well organized report with concise and formal writing | Report is very well written, in a formal scientific style. Text is concise, clear, and organized properly with sections that follow an academic journal format. | Report is well written, in a formal scientific style. Text is clear and organized, with sections that follow an academic journal format. |
| | Proper formatting and editing* | Report is clean and well presented. Figures are clear and easy to read with well-written captions. References to figures, tables and sources are consistent and follow journal format. There are little or no spelling or typographical errors. (<1/pg) | Report is clean and well presented. Figures are clear and easy to read with captions. References to figures, tables and sources are consistent and follow journal format. There are few spelling or typographical errors. (1-2/pg) |
| | Professional, clear and quality oral presentation | Presentation is informative, well organized, well rehearsed, and has clear and logical visual aids (e.g. Powerpoint slides). | Presentation is informative, reasonably organized, well rehearsed, with good visual aids (e.g. Powerpoint slides). |

*Essays written in (non-native) English will not be graded negatively for grammar mistakes, but will be graded negatively for excessive spelling or typographical errors.

| 7 | 4 | 2 |
|---|---|---|
| Student presents a decent review of the topic, using several literature sources, and minimal dependence on textbooks. A satisfactory understanding of how their problem fits in the context of the field is displayed. | Student reviews the topic using only sources recommended by the advisor, and shows little or no synthesis or independent understanding of the state of the art. | Student does a minimal review of the literature, missing key references, or key concepts required to understand the context of the research problem. |
| Gives some summary of theory or method used, how it works and lists associated errors. | Describes the theory, but there are gaps in the methodological description, and little to no reference to assumptions or errors. | Gives only a cursory description of the methods or theory behind the study. |
| Student clearly describes the geologic problem, and attempts to address its importance. | Student explains the geologic problem, but either the problem is not clear, or its relevance to the field is unclear. | Student describes the problem, but gives no indication about why it should be studied. |
| Results of model, data or theoretical derivation are presented in figures and/or tables and summarized in text. Student makes some reasonable interpretation of their results, and develops some hypotheses, conclusions or suggestions for further study. | Results of model, data or theoretical derivation are poorly presented in figures and/or tables and summarized in text. Student makes little or no interpretation of their results, or presents interpretations inconsistent with their results. | Results of model, data or theoretical derivation are unclear from the presentation. Little or no effort is made at interpretation. |
| Student attempts to place the results of their study within scientific context, and suggests how project outcomes affect the state of the field, although ideas may be incomplete. | Student makes little attempt to place the results of their study in a greater scientific context, or present clearly erroneous conclusions on the impact of their results to the state of the field. | Student makes only a cursory effort to place their results in a larger context, providing few substantive conclusions. |
| Report is organized in an academic format, and is written in a formal style. Some content is obscured by poor or unclear writing | Report is not well organized, and writing is frequently unclear or too informal. | Organization does not follow a scientific journal standard, and poor writing or poor organization significantly obscures the content. |
| Report is well presented. Figures are fairly clear and captioned. References to figures, tables and sources are consistent and follow journal format. There are several spelling or typographical errors. (>2/pg) | The report is not well presented. Figures are hard to read, and formatting is inconsistent. There are enough typographical or spelling errors to make it obvious the report was not proofread. | Report is poorly presented, with little or no formatting, confusing and inconsistent referencing, and/or an unacceptable amount of errors |
| Presentation can be followed, most visual aids (slides) are good, and project can be reasonably understood. | Presentation is difficult to follow, and little effort has been put into visual aids or rehearsal. | Presentation does not demonstrate that the student has learned the subject or put effort into preparation for the oral portion. |