

# Laboratory supervision of MSc projects

## Qualitative interviews, thematic analysis, and recommendations for the supervisor

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### Introduction

A range of skills can be obtained by students doing a M.Sc. thesis with a laboratory component. By learning in the practical domain the student can gain a deeper understanding through trial and error. Often the laboratory also include working together with other students, PhD's, postdocs, laboratory personal and others on joined projects including development of interpersonally skills within team work, negotiation, planning and collaboration. As a supervisor the laboratory M.Sc. thesis offer opportunities to often interact with the students and provide assistance and feedback personalized and in a timely matter (Wakeling, Green, Naiker, & Panther, 2017). However the evaluation of the student experience in the laboratory as part of the M.Sc. thesis is often limited to the exam (written and oral), which is focused on the scientific topic and not on other skills obtained while in the laboratory or during the student learning experience.

Here I have made qualitative interviews, based on the questions presented in appendix A, of 5 M.Sc. students from the Ice and Climate group to evaluate their experience doing an M.Sc. with a laboratory component in the interdisciplinary field of ice core science. The interviews were analyzed by common themes. The questions covered prior laboratory experience, experience during the thesis, learning outcomes as experienced by the students as well as questions on how supervisors could improve their supervisions. Through a thematic analysis (Braun & Clarke, 2006) of the student

responses I suggest how we can improve supervision in the laboratory for coming M.Sc. project students.

### **Studied group**

The 5 students represent the Msc students who were working in the laboratory within the past year; 2 were international (England, Austria) the remainder were Danish. 3 were female. 3 did their MsC program in physics, 1 in Chemistry and health and 1 was part of the international EnvEuro program. The average grade for the students was a 10, reflecting “a very good performance displaying a high level of command of most aspects of the relevant material, with only minor weaknesses”. The students are all students who did their thesis within the subject of Continuous Flow Analysis (CFA) of ice cores and who had MsC projects with a significant laboratory component. Thus the laboratory was not only their place for consolidation, but the primary learning environment. In the following the students will be referred to as students S1 through to S5 to ensure anonymity.

### **Thematic analysis of student answers**

The studied group of students is small and while this may limit the validity of the results to a larger student base still the thematic analysis (Braun & Clarke, 2006) and categorizing of student answers has common directions. Based on the student interviews suggestions on how to improve supervision for Msc doing a laboratory based thesis is presented below.

### **Expectations and relating to prior laboratory work experience**

Most students have only limited experience with both the specifics of the CFA laboratory and with ice cores in general. They come from a variety of study (and cultural) background making it a challenge to modify generic Msc project descriptions advertised online to suit the individual students. Our general approach is to interview the students prior to starting the thesis about their skills in statistics, programming and laboratory work and we try to let them know what to expect from doing a thesis with a laboratory component, yet several of the students answered that they did not know what to expect when going into the laboratory. Surprisingly the interviews also revealed that especially **the foreign students had no (!) prior experience**

**in the laboratory and the Danish students did not connect experiences from previous laboratory work to this one:**

- (I) did not really know what to expect. The only lab work I had done prior to CFA was the mandatory lab exercises in mechanics, electro-dynamics and quantum mechanics. I expected these to be quite different from CFA which they were .-Danish student
- I did not have prior experience with laboratory work.-International student
- I had previously only worked on design projects or short term lab projects all combined only 10 days or less in the lab-International student

This suggest that a more thorough introduction to general conditions of working in an experimental laboratory is needed. The supervisor should **relate the “new” laboratory to students previous student laboratory experiences** if such exist (eg. laboratory notebooks, protocols, keeping lab clean). With the advantage that this could improve student self-esteem by making the laboratory seem more familiar.

For all students **the professional research experience was important and motivating factor.** The students expected and to some extend were motivated to learn how to work in a professional environment and were intrigued by seeing the process from start to end, one student was also very motivated by working independently within a project. Most our students work on “real” projects that are valuable to our scientific society. The students know this and are motivated by this especially in the beginning. Similar motivation increase among students, when the purpose of being in the laboratory is clear has been observed in other studies (Russell & Weaver, 2008).

- I did expect to learn a lot and specially how to act in a professional lab.-S3
- I was interested going to the laboratory in order to gain knowledge about where the data actually comes from. So I expected to gain knowledge about the continuous flow measurement system, the single measurements, how to interpret the graphs, the interaction between the different measurements and also how to identify faulty data-S2.

### First experiences in the laboratory-The apprenticeship

The first day in the laboratory we mostly instruct the students how to do things, they are normally brought in as an extra set of hands and thus do not fill a specific position in the laboratory the first time they are there. We purposely **aim at making the initial supervision an apprenticeship** (Rie-necker, Jørgensen, Dolin, & Ingerslev, 2015) based one, giving the students simple, yet important, tasks to ensure success or have them observe how the rest of us behave around the laboratory, while explaining our reasoning for behaving in a particular way with the aim of osmosis. This is well reflected in the student's description of the experience, it makes them feel comfortable meeting the new place to have thorough instructions and they are further happy that they quickly get something "real" to do.

- In the beginning, I was always assisted while working with chemicals both making sure that I had everything I needed, learned how to use things like pipettes etc. and to make sure that I felt confident repeating it on my own later on. I felt really comfortable with the supervision in the beginning-S4

However, especially the students from outside of geophysics Msc programs (eg. international students) describe it as a **challenge to get introduced to something completely new** and meeting a new environment. Also the actual acquire of new skills was described as challenging, but **learning new skills were also described as motivating.**

- The first challenges I faced was to be put into a new environment, but I was warmly welcomed at the lab and felt very comfortable from the first day. . . . I wanted to achieve all steps required by myself. So it was a mixture of being stressed and having positive feelings about new achievements. The achievements were motivating.-S2
- I remember feeling quite stupid and somewhat ashamed -since it was my first day doing actual lab work, but no one commented on my mistake as a failure or with negative comments. It was mostly a feeling I had myself, and it was hard to admit to others, so I didn't verbalize it-S5

As a supervisor, especially when the student is new to the subject, it is important to accommodate the challenge the students face meeting a new environment. Relating to students previous experiences, praising them with the fact that they are engaging in this new experience, putting them to work

at simple tasks that they can complete easily but which still has purpose, vocalizing that this is a new experience for them and that it is natural that they have questions and asking them what surprises them are all tools that the supervisor can use to engage the students in the new environment (chapter 1.2).

### **Progressive learning (From apprenticeship to partnership)**

All the students experience a difference from the supervision taking place in the beginning to the one received toward the end. They experience a **move from apprenticeship to partnership** and appreciate this move. This reflects that while the students ask for a better measure of their progression during the thesis, they all at the end **feel they have progressed significantly to a level where they are partners and fellow researchers rather than students.**

- My goals changed more times after I became new insights and ideas from you throughout the process. I felt that I always have somebody to ask if I don't know further-S2
- I was always supervised when doing new things in the beginning, which has really taught me a lot on how to work in the laboratory. After I started to feel confident on my own in the laboratory, I had my freedom to work independently on my projects well aware that I could always ask for help or supervision. I found this very motivating and I have never had the feeling of being left alone with tasks.-S4
- At first I was the new girl, and I slowly progressed to be a more experienced member of the group as I participated in multiple melting campaigns and worked with my own lab instrument. I would help teach other new msc. Students about the rules and methods of the lab and cold room, which gave me an even better understanding of the lab work and which made me feel assured of my place in the group and sure of the science-S5

### **Students motivation**

The students describe a variety of things that motivated them. Just being in the laboratory doing the same as “real scientist” was one;

- I wanted to experience how it would be like to work in lab for a longer term and see the process end to end.-S2

- I quickly got to be part of the routines, doing a lot of the same things as more experienced people did. That was a really nice experience and made me want to learn more and do more things.-S3

Being part of generating real ice core data and doing a valuable job was also motivating for all the students. They further want even more work on generating and working with “real” ice core data.

- The laboratory was motivating because it was exciting to melt ice cores and watch the data first hand. . . . I find it motivating to gain knowledge about what I do and what for I am doing it.-S2
- I had few expectation of the group work, the methods and the science itself as I was new to the field, but I was very excited to know that I would be working with ice and analyzing it for proxies of past climates, which I think is pretty badass-S5

Having a thesis with a variety of assignments also was motivating for the student and the fact that the laboratory is part of the thesis work is a motivating factor for all our students:

- it’s nice to be able to do somethings practical and not just sit in front of a computer all day. Being able to go down in lab and work with your hands and do some experiments is important for me. Only sitting at my desk would decrease my productivity greatly.-S3
- I personally like to build and develop things and therefore the CFA laboratory provided me with all the academic and practical challenges and motivation I wished for.-S4
- The practical lab component was in my case very motivating as it was a new development and I was allowed to be creative in my design process which suits me and which I’m good at –S5

## Being part of a group

The main motivation for the students however was the social aspect, interaction with other students, and other people (real scientist) in the laboratory, and all students have stressed this as an important part of their Msc experience. Research suggest that students **opportunities for meeting others outside formalized sessions is crucial for their learning**, eg to network and debate (Rienecker et al., 2015), and there is also evidence that if students find themselves to be an integrated part of a research environment,

they perform better (Rienecker et al., 2015). The **students coming from other than geophysics Msc programs stress that they liked or wished that they had joined a group of other students**. This reflects that the subject is on the edge of their study program and thus they benefit from other peers to reflect on their thoughts of the laboratory work. These students also ask for more pointers as to where they are during the progress.

- It was nice having other master student there, so that way I was not the only one with little/no CFA experience because this made it a bit more comfortable . . .(I would advice. . .) to have maybe 1-2 students with similar experience level because this allowed for sort of mutual learning and idea sharing -S1
- Maybe make a buddy system where the “stupid” questions can be asked between students msc., phd, bach even?, or a monthly discussion session with similar content – this could be arranged across groups at CIC (Center for Ice and Climate, red)-S5

On the contrary the geophysics students are mostly motivated by working independently:

- I like to work independently, knowing that I always can ask for help if I need it. It has therefore been a great motivation for me that I had my freedom to do this within this group, both for settings things up and testing my setup in all thinkable ways. –S4

The **students experience that being part of a laboratory group working with multiple people at different academic levels have been beneficial for their project**, but also complain that sometimes they are not properly introduced to other people working in the laboratory hindering such a positive interaction. Thus the supervisor should be aware that the student may not (especially initially) have the confidence to introduce themselves in an academic setting and thus the supervisor should be the initiator of contact between students and others in the laboratory.

- Even though I didn't have any experience within this field, I felt quite comfortable working on my own in the lab because I always could ask others in the group for help/advice.-S4
- The laboratory was motivating because I had the privilege to be in a team-S2
- Maybe a better introduction to others who will be in the lab at the same time, even people from other teams such as the gas team, so that they

know who the student is and why they are there . . . of course they did soon anyway, but a more clear initial introduction. . . maybe?-S1

The students in the CFA group take part in weekly meetings where they can present and discuss their laboratory work. These are held very informal over coffee and everyone is encouraged to present where they are at with their own project. Such meetings are useful for student progress and motivation and Dunne (2014), who introduced such feedback sessions within a course having a laboratory component, our students also find them useful. In the study by Dunne (2014), 74% of students indicated that this sort of feedback session was useful. Stevens et al. (2016) evaluated how using a specific joined group project to teach and transfer good scientific practices for PhD students could be beneficial, and found that **“that this process was clearly beneficial to students in helping them to become a strong cohort who learn from each other and are more confident in their research.”** . It seems the combination of face time, the option to ask both peers and supervisor and get direct feedback on some particular part of the project was received also very positive by the students, who explain both the benefit of the specific project and for them feeling they belong in the group. The group meetings were appreciated equally by the more independent students.

- Another very motivation for me was the weekly CFA meetings where you could present your results from tests in the lab and both professors, Postdocs, PhDs and other students could discuss your results, your approach, problems etc. and provide you with new knowledge and new ideas for future tests. This is off course a very convenient way to get a better academic understanding of your project but it also made me feel like a part of the research group on an equal footing with the others-S4.
- (working on something useful for the group, red) and it made me feel like I contributed to the whole group’s work and expertise by designing this new instrument-S5

However the students express **the wish for even more group interaction and peer-feedback** and they themselves suggest even more student presentations for the scientific group.

- make us present the lab and the data-results for someone else, so that the we also can feel and understand how much we’ve learned during the thesis process-S5

While this oral style of presenting own material may be great for student learning this is time consuming as only one student would get feedback. To



save supervisor time it may be better to rather use **student peers and to arrange small presentations between students**. The students are already expected to present results and discuss them at the weekly CFA meetings, however it may be that this **expectation should be more directed to specific students so that they know to prepare and present material** during weekly meetings. Journal clubs as suggested by the student below is another way to facilitate good practices, they serve the purpose of keeping up with the literature, they can be used to teach the forms of sharing and evaluation of scientific findings and students learn the written conventions for presenting science by reading articles and seeing what is well received (Golde, 2007).

- Maybe set up a journal club within the group, to make the students learn how to be critical of papers relating to the lab equipment, methods or results. I did an initial review of a paper for my supervisor, we then discussed it and I learned LOADS from that one hour session: How to review a paper, how to review my own work (!), how to relate the paper's results to the group's and the lab's and it made me think how I could design other experiments, setups and instruments to test if the paper's hypothesis was right-S5

Further **journal clubs** rehearse student dissemination skills used in the final thesis presentation. Such journal clubs could be set up to work between the students without much supervisor time spend, besides the facilitation and booking of space, however including PhD's and postdocs would serve to check that the Msc students do obtain the necessary knowledge from the articles. Many of our students read the same articles describing equipment and background ice core research and over the course of a year one with journal club once a month or every two weeks the students could go through those relevant to all. However some initial pointers as to what to obtain from the articles may be necessary from the supervisor.

Another option is to ensure that Msc students have a **student buddy**, who is also doing a Msc project with a laboratory component. Ideally the buddy would be a few months ahead of the Msc they are buddy for. This buddy could act in multiple ways, having been already part of the group for a few months, they would be able to answer practical questions on how/where to find things in the laboratory, who to ask, what kind of official regulations/forms are required when doing an Msc, give feedback on initial written text etc. The problem with this format is that we only have limited number of students and also that not all students are capable in pro-

viding feedback to other students in a good way. Some sort of “contract” explaining the conditions of being buddy should be used if we choose to implement this strategy. Dependent on the academic level of the two students involved and especially of an imbalance in this it could also cause more uncertainty and anxiety between the students.

As a student supervisor of projects in the laboratory one can take advantage of knowing the students initial motivation for the project. Students are bound to face challenges and variation in the amount of motivation, while doing a thesis lasting between half a year and 1 year. **However if the supervisor is aware of the student motivation, they can easier connect to the student by referring back to the initial motivation in times where the student is feeling challenged.** Thus interviewing the students thoroughly on their initial motivation can be valuable for motivating them later in the thesis process.

### Student supervisor relations

While the research group is important for motivation, the students also stress the importance of time with the supervisor. They even **would like more time with the main supervisor.** Further they stress the **importance tailoring the supervision to the individual need of the student.**

- It is important that there is a good communication between the supervisor and student throughout the entire project so both parts know exactly how much supervision is needed for the individual student . . . both in and outside the laboratory- S4
- My other classes were badly timed, so I had almost no time in the lab together with my supervisor. Even though I was excellently supervised by others (Phds and professor, red) I would still recommend to allow the student more time with the (main, red) supervisor-S2

The students all **stress the importance of time with the main supervisor. Thus meta-communication regarding the supervision (and sometimes the lack of supervision) is key.** At the moment we do not have any written communication regarding the nature of the supervision, but spend some time prior to the students starting their project to discuss the mutual expectations. We as supervisors in the CFA group often make use of co-supervisors, because we are often absent in longer periods due to teaching, travel or other obligations. Co-supervisors are PhD’s and/or Postdocs. However it seems that the students do not recall or do not experience that supervision having similar value. Thus negotiating expectations by the beginning

of the thesis by **making a written *Memorandum of understanding*** (Rie-necker et al., 2015) could be useful. Further **written student-supervisor agreement**, stressing to the Msc that they are being supervised in a team may make the lack of direct time with supervisor not as an issue of neglect to the student, which is how it is currently experienced by some. Actually several students' address the lack of time with supervisor at different stages of the thesis process. Reflecting the fact that supervision time is often a limited resource due to other supervisor obligations.

It is hard to find more time for one on one supervision, we could seek to improve this feeling of lack of supervision by other means. The students generally wish for more time and more introduction with the supervisor. Again meta-communicating about the lack of time that can be spend on supervision could help the students accept the situation instead of stressing about it and introducing a buddy system or making it very clear who is to ask for supervision when the main supervisor is absent would give the students a clear place to turn. Another mean is to have the students be part of a group supervision. This is already done and the student experiences are described above. Other solutions to the students wanting more supervision, but the supervisor not being able to provide that due to other constraints could be to make it even clearer that the students can always ask, but also that it is the student own responsibility to ask when they need guidance. **The students have generally not expressed the need for more supervision during the thesis progress** and of cause many reasons for this may exist one being the uneven relationship that naturally is between student and supervisor or that the student simply did not realize they needed guidance until after the thesis submission. As a supervisor it is crucial to be aware that student silence does not necessarily mean that the student is progressing as expected. Some students also were keen to get a **better idea of their progression during the thesis work**. Keeping better track of the progress could be beneficial for both student and supervisor. The students themselves suggest

- Maybe make a progression sheet with more fixed deadlines so the student knows what is expected and the supervisor will remember as well?—S5
- Maybe some mini deadlines... knowledge showing points while doing the lab work would help more, although not so much that it is hand holding. It was nice to be able to have my own schedules but maybe one mini deadline, or presentation on what the student has learned,

once a month or something like this could also be helpful for learning. We had the mid-way review and that was good, maybe also a quarter way and  $\frac{3}{4}$  way review?-S1

Such progression monitoring is currently only done by the weekly meetings. However doing the weekly updates in a group can also hinder the students stating that they are truly lost or need help in fear of losing status. Progression monitoring could be done by **keeping small log-files written by the student** or as suggested by de Kleijn, Meijer, Brekelmans, and Pilot (2015) a log made by the supervisor could even increase supervisors' consciousness concerning their own supervision practices, as well as help the supervisor adapt to the specific need of the individual student. The log for supervisor used in the de Kleijn et al. (2015) study included the following questions.

1. Based on what student signs did you decide on what strategy to use in the supervision meeting?
2. To what extent are you satisfied with your role in the supervision meeting?
3. About what specific aspects of the meeting are you satisfied and/or dissatisfied?

While such a supervisor log is definitely a great idea for the supervisor to improve, it does not solve the main problem, which is lack of one on one time. Further when supervising laboratory Msc's often the supervision is done on the fly in the laboratory and thus rather than having a specific time set aside for supervision with the potential of reflecting on this afterwards. Using supervisor self- reflection logs as a laboratory supervisor would require the supervisor to set time aside by the end of a busy laboratory day, and being able to remember specific supervisor student interactions long after they have occurred, neither is always possible, though likely would be beneficial.

## **Summary of suggestions for the supervisor**

Based on the outcome of the interviews and the following thematic analysis I suggest the following improvements on supervision of MSc students working in the laboratory.

- **Be aware of student differences.** Tailor supervision to the individual student. Students coming from other than geophysics Msc programs stress that they liked or wished that they to a larger degree had joined a group of other students, while the geophysics students were motivated by working independently. Foreign students had no (!) prior experience in the laboratory and the Danish students did not connect experiences from previous laboratory work to this one, help the students relate to their previous student laboratory experiences
- **Move from apprenticeship to partnership.** Make the initial supervision an apprenticeship, the students feel challenged by getting introduced to new items in the laboratory, but motivated when successfully acquiring new competencies. But later move from apprenticeship to partnership. The students like to move to a level where they are partners and fellow researchers rather than students
- **Make student part of a group.** Introduce the students to (all) other people in the laboratory environment. Opportunities for meeting others outside formalized sessions is crucial for their learning. The students experience that being part of a laboratory group working with multiple people at different academic levels have been very beneficial for their project. It creates students who learn from each other and are more confident in their research. Further the professional research experience was important and motivating factor, relate the student thesis to the scientific field and current research in the larger group too.
- **Ensure feedback.** The students wish for more feedback, consider as a supervisor how you can facilitate even more student group interaction and peer-feedback, eg by arranging small presentations between students, journal clubs and or creating a student buddy system.
- **Meta communicate about expectations and limits.** Have time for the students and if you don't metacommunication about your lack of time. Be direct about your expectations during group meetings so that students know the expectations you have for them and the purpose of the meetings.
- **Write it down.** Consider making written *memorandum of understanding* and/or a written student-supervisor agreement. This way both student and supervisor can remember how much time was planned for supervisor interaction and it is clear which other people can act as co-supervisors in your absence etc. Consider having the students write small log-files on progress and as a supervisor logs reflecting on your own supervision practices can increase your ability to supervise.

## References

- Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77–101.
- de Kleijn, R. A., Meijer, P. C., Brekelmans, M., & Pilot, A. (2015). Adaptive research supervision: exploring expert thesis supervisors' practical knowledge. *Higher Education Research & Development*, 34(1), 117–130.
- Dunne, J. (2014). Peer teaching in the food chemistry laboratory: student-produced experiments, peer and audio feedback and integration of employability.
- Golde, C. M. (2007). Signature pedagogies in doctoral education: are they adaptable for the preparation of education researchers? *Educational Researcher*, 36(6), 344–351.
- Rienecker, L., Jørgensen, P. S., Dolin, J., & Ingerslev, G. H. (Eds.). (2015). *University Teaching and Learning* (1st ed.). Samfundslitteratur.
- Russell, C. B. & Weaver, G. (2008). Student perceptions of the purpose and function of the laboratory in science: a grounded theory study. *International Journal for the scholarship of teaching and learning*, 2(2), 9.
- Stevens, C. J., Brockett, B. F., Baxendale, C., Birkett, A. J., Brown, C., Cole, A. J., ... Quirk, H., et al. (2016). Tackling the crisis in phd supervision through group active-learning. *Teaching and Learning Together in Higher Education*, 1(19), 4.
- Wakeling, L., Green, A., Naiker, M., & Panther, B. C. (2017). An active learning, student-centred approach in chemistry laboratories: the laboratory as a primary learning environment. In *Proceedings of the Australian conference on science and mathematics education (formerly uniserve science conference)* (p. 134).

# A

## Interview guide

The students were interviewed based on the following questions.

**1) Describe your expectations prior to working in the laboratory**

*eg. Why were you interested in going to the laboratory? What were your expectations? why? Did you have prior experience with laboratory work, which? Why did you choose this thesis?*

**2) Describe your first day(s) in the laboratory**

*eg. Which challenges did you meet? What was motivating, what was discouraging? How did you feel?*

**3) Describe your overall experience doing a thesis with a laboratory component**

*eg. Which challenges did you meet when doing a thesis with a laboratory component? What was great about doing a thesis with a laboratory component? In what way (if any) was the laboratory component motivating? How did you feel during your thesis process? why? Did your goals or motivations change during the thesis? What did you learn? How was/is that useful to you now?*

**4) Describe how you experience(d) your role in the laboratory?**

*eg. In relation to your supervisor? In relation to other students? Did it change over time?*

**5) What 3 advice(s) would you give your supervisor to make for a better experience in the lab for the coming students?**

**6) What 3 advice(s) would you give your supervisor to make for better learning outcome in the lab for the coming students?**

**7) What 3 things would you suggest your supervisor stop doing to make for a better experience in the lab for the coming students?**