

Implementation of Guided-Inquiry to an Inorganic Chemistry Laboratory Course

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Introduction

Laboratory based courses are traditionally a central part of natural sciences education curricula at the university level. The role of such laboratory courses is not simply to just complement theoretical courses taught most commonly in lectures but is far more complex and addresses the issue of constructing knowledge through experimentation. Construction of knowledge through experimentation, as a scientific method, was first advocated by Francis Bacon in the 1600's. Bacon's ideas form the basis of the Baconian empiricism that is an inquiry-based method that uses evidence (experimental or observed) as a tool to investigate nature and thus, construct knowledge by developing theoretical models that can account for the observations, and thus, describe the natural phenomena under investigation. The role of laboratory courses should be to educate the future scientists or engineers on how to use enquiry-based techniques to construct knowledge and subsequently how to use this knowledge in a concrete way to solve a practical or theoretical problem or even conceive a new theoretical frame based on what they have learned but going beyond that.

At this point it might be useful to give a definition of the term inquiry. According to Hofstein et al. (2005, 2004), Hofstein & Lunetta (2004), Zettili (22-24 March 2009), The *National Science Education Standards* (National Research Council 1996) define the term inquiry in two ways:

1. inquiry as *content understanding*, in which students have opportunities to construct concepts, patterns and to create meaning about an idea in order to explain what they experience.
2. inquiry in terms of *abilities*. Under the category of abilities or skills, are included: identifying questions, forming hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments.

From the above it appears that the inquiry-based approach to learning, especially in a laboratory course, can prove to be really beneficial for the students. However, and somehow paradoxically most laboratory courses are constructed in the complete opposite way of the inquiry approach, namely by use of the *direct instruction* approach (Zettili 22-24 March 2009). In the *direct instruction* approach the teacher assumes the role of authority in the study field and constitutes the sole source of knowledge/information. The role of the students is to assimilate the information transmitted to them by this authority, they are thus reduced to a passive receiver role. Within this context there is no space for creativity from the students since their role is reduced to passively receive information. The evaluation of their learning is also reduced to the mere verification of the teacher's knowledge. Within the *direct instruction* approach the teacher evaluates the students by asking them to reproduce knowledge that he possesses, not by probing the students ability to construct their own knowledge and subsequently use it as they themselves feel appropriate.

With the above in mind we designed our inorganic chemistry laboratory course by implementing the inquiry-based approach to take advantage of its many obvious, at least to us, advantages. The inquiry-based approach places the student at the centre. The learning process is based on the students' activity, asking of questions, draw conclusions and use of these to go further in their experiment. In this way the students construct their knowledge by asking question that are meaningful to them within the context of the performed activity at the specific time and place. The role of the teacher is not this of an authority but rather this of an advisor that does not have all answers, at least most of times, but facilitates the learning process by asking himself relevant questions instead of giving definite answers that have the status of absolute truth.

Problem definition

My pedagogical project for the adjunct pædagogicum course is conducted within the frame of the two laboratory-based courses that I was teaching in the first block of the academic year 2012-2013 and that run simultaneously, namely “Uorganisk Kemisk Syntese” (5230-B1-1E12, UorgSyn) and Videregående Uorganisk Kemisk Syntese (5230-B1-1E12, VidUorgSyn). UorgSyn is a 7.5 ECTS course where 25 students are enrolled. VidUorgSyn is a 15 ECTS course where five students are enrolled. The course description of these two courses is appended at the end of this document.

In these two courses the students have to complete the synthesis of a series of inorganic complexes and to report their work in the form of a dissertational style report (for three compounds) or a more rudimentary scheme (rest of the experiments). For these experiments the students receive a list containing the names and chemical formulas of the eight compounds to be synthesized. This is the only initial information provided. Thus initial information is kept to a minimum level. The students’ task is to find themselves all necessary further information on how to complete their synthesis. Once they think that they are ready to start with any of the individual experiments, they have to present to one of the teachers what they are about to do and why. At this point the teacher might demand them to go back at the library and prepare more or to allow them to start their experiment. In the latter case, the students are required to find the necessary equipment and chemicals themselves in order to proceed with their experiment.

In this course we aim to make the students take initiative about their actions and think about what they are doing. We encourage an independent approach to taking part in the course meaning that we do not ask the students to follow closely a script and we do not provide them directly with the materials they need. We rather prefer that they think about what they are about to do, how to do it and we also give them total flexibility concerning the order that the individual synthesis are to be completed. We thus give the students the minimum amount of initial information, ensuring the highest possible inquiry character of their work in the laboratory.

Our teaching consists in individually discussing with each student about questions that arise during the synthesis assignments and in asking questions individually to all students to stimulate their curiosity, induce a deeper understanding of the concepts related to their assignments and most importantly, prompt new questions that make their understanding of the subject matter advance.

In addition we also favor peer teaching, in the sense that we assign some students the same assignments and do not discourage conversations in the laboratory. In fact we often encourage students to talk to each other about their experiments, inducing in this way a social constructivism behavior (Zettili 22-24 March 2009) in the group of students that have related experiments to perform.

The students that follow the 15 ECTS course are expected to be more critical in their reasoning and reach a deeper understanding of the concepts related to their assignments relative to the students that follow the 7.5 ECTS course. In addition, at the end of each week these students are asked to present shortly (in about 10 minutes) what they have done during the week in question and what they have learned. This is a new element added to this course related to the author undertaking the present pedagogical project. As part of their course the advanced course students are also asked to complete a larger multi-step assignment resembling more to mini research project rather to a typical laboratory assignment, in the sense that the suggested end product might not be known.

According to (Zettili 22-24 March 2009), guided-inquiry can be defined as the process where the teacher initially defines the problem by asking the starting questions and then acts as a supervisor in the learning process of the students. In the Inorganic Chemistry laboratory course described in this project, a guided-inquiry approach has been implemented and used since numerous years. Conduction of this pedagogical project by the author has prompted the addition of few additional elements in our course, always within the frame of the guided-inquiry approach. The object of this project is to investigate how the students perceive the role of our implementation of the guided-inquiry approach in the inorganic chemistry laboratory course of the academic year 2012-2013, with respect to their learning outcome from this course. In this project I intend to investigate how the students perceive the format of this course, how they think that this format affects their learning outcome from this course and how they think this course stimulates their learning in general. In addition, for the group of students that follow the 15 ECTS course I will investigate how they perceive the role of the short oral presentations at the end of each week and of the larger scale synthetic assignments with possible open ending, in their learning outcome.

Results and discussion

The above matters were investigated by means of a questionnaire distributed to all students following the 7.5 ECTS course and by interviewing the students following the 15 ECTS course. The questionnaire and an edited transcription of relevant parts of the interview are appended to the end of this document.

To the students following the 7.5 ECTS course were proposed the following sentences:

1. I liked that no detailed instructions manual was given in this course.
2. I got enough help with the experimental aspects of the exercises when I needed it.
3. I got enough help with the theoretical aspects of the exercises when I needed it.
4. I liked that there was a flexible attendance policy.
5. I liked I could myself choose the order in which to perform the experiments.
6. I liked that I was given the responsibility to find myself the experimental procedures.
7. I liked that I could discuss with my fellow students about the experimental and theoretical aspects of the exercises.
8. I liked that I could discuss with my fellow students about the reporting aspects of the exercises.
9. I liked the way I interacted with my teachers.
10. I liked the general set-up of the course.

The students were asked to state their level of agreement with the above sentences on a scale from 1 to 5 ranging from strongly disagree (1) through neutral (3) to strongly agree (5). The results are plotted in Figure 9.1 (in the caption is given the question number).

From the above plots it is clear that in general the students of the 7.5 ECTS course like the guided-inquiry approach. Only some of them do not actually like that there were no detailed instructions (*direct instruction* approach) on how to perform their experiments. Most students think that they got enough help with the theoretical and experimental aspects of the course, when they needed it. They all liked the flexible attendance policy. However, this aspect as was uncovered by the interviews of the 15 ECTS course students, was not only related to the fact that the student liked the fact that they assumed responsibility for their course but also because this facilitate them

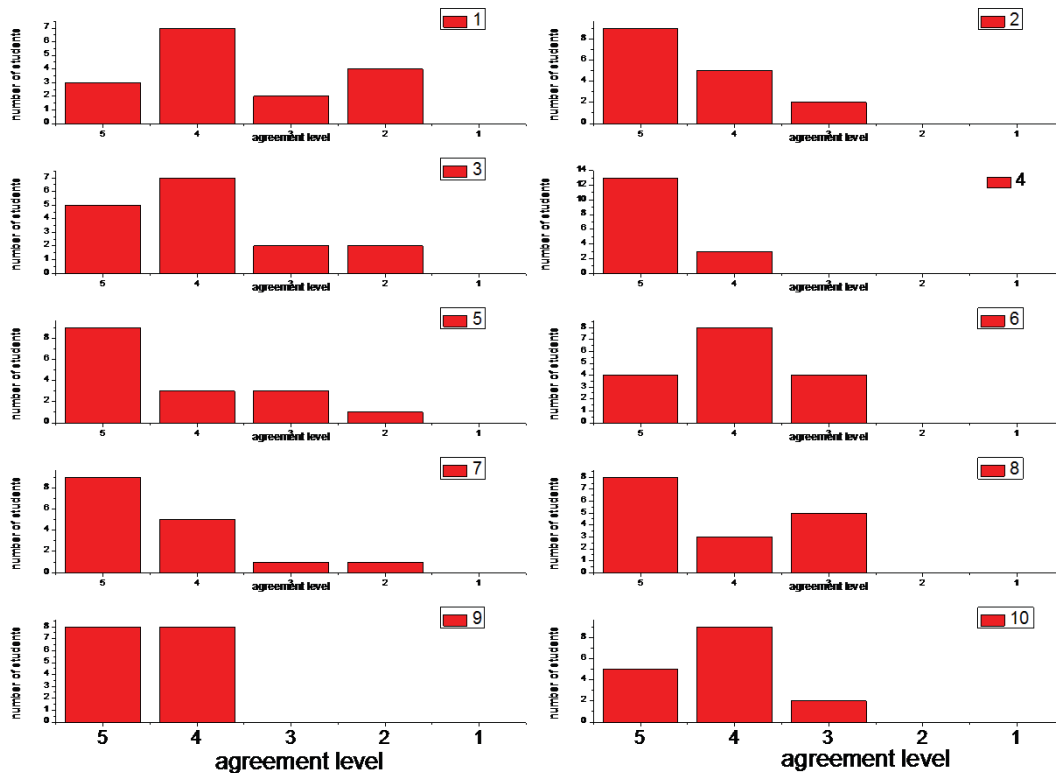


Fig. 9.1.

handling other courses that they were attending simultaneously to ours. Finally, the students in general appreciate the interaction with their fellow students (*social constructivism* element) and with their teachers (guided-inquiry aspect).

The analysis of the questionnaire data reveals that in general the students appreciated positively the course set-up. However the information obtained by the questionnaires is not quite transparent since there is no additional explanation on each statement of level of agreement with a given sentence and thus the individual input of the students is lost.

However, the interview of the group of student following the 15 ECTS course has proven an invaluable source of information. In this interview four students participated, referred to as K, J, E and S. The main points from analysis of the interview follow. An edited transcription of relevant parts of this interview is given, as appendix at the end of this document, for the interested reader.

- The students appreciate that no detailed instructions were provided as that made them think what they were actually doing.

- In relation to the above point the students also appreciated the fact that there was no time pressure in the course, so they had the time to think what they were doing and not simply rush through a set of instructions.
- The students liked having the responsibility of conducting the experiment because they learn from their mistakes
- The students appreciated learning from their peers by discussing with them about the experiments they were performing and learning from what other people had to say about what they did – and also from other people’s mistakes! Here we see how the social constructivism is beneficial in such a set-up of laboratory course.
- The students really liked that they had to present at the end of the week what they did during the week.
- The students really appreciated that the teachers edified a safe environment in which they could ask any question they wanted. Even “stupid” questions were asked! The students really perceive the freedom of asking questions as a factor that affects dramatically the quality of their learning outcome.
- The students thought that having the responsibility to decide what was relevant to be reported for their experiments was by far the biggest challenge. The experience was perceived as rather positive but negative sides, as creation of panic, were also evoked.

From the interview it was obvious that the students really appreciated to be given the opportunity to take possession of their assignments, to be allowed to make the assignments their property and to have the full responsibility of conducting the experiments, the teachers being assistants and not assuming the role of authorities.

Concluding remarks

In conclusion, from this project it is clear that the guided-inquiry approach that we adopted is highly appreciated by the students and has a very positive effect on their learning outcome. The main factors that create this positive effect is that the student feel free to ask all questions they find relevant, do not operate under stress since a safe environment is created by the teachers, fully exploit the possibility of learning by their peers (social constructivism) and find that the assignment they performed is their own, it has become their intellectual property, and the teacher has just assisted them in doing so.

The findings of this project will contribute in ameliorating our courses by further implementing the guided-inquiry approach and by improving the presentations sessions of the 15 ECTS course, based on the students invaluable input.

A Edited transcript of relevant parts of the interview

(Introduction, starting at 0'.00'', ending at 1'.58'')

Me: So I will say again that I will record that, if you don't mind. This synthesis course that you just had, it's conceived in a way that we want to give you the students the initiative about performing your experiments, about reporting the experiments and about getting motivated to performing the experiments. Other experimental courses are done in a such a way that you get a cook book, you get a package in front of you with all the reactants inside and a small manual about how to use all instruments that you are going to be in touch with and then the instructions say go from step one to step 2, then to step 3 and so on. This is absolutely what we didn't want to have. So, in this course we want you to go to the cupboard find your chemicals yourselves think if that is the chemical I need, make mistakes, learn from that, then find yourselves the experimental procedures, because you have to think is this what I want? How I am going to set up this? In general the initiative is given to you, so it is an academic format, if you want to do it you are free to do it, if you don't want to do it you probably won't do it. We of course try to stimulate your interest but is not up to us to make you do things. So this is the general idea. I thought I would do my pedagogical project on how the set up of this course affects your learning outcome. Now you should tell me what you think about that.

(Transcript 1, starting at 2'.19'', ending 13'.34'')

Me: I would like to start by asking you if you had other experimental courses before and in which way there were set-up?

K: We had "course 1".

E: Yes and "course 2".

K: In "course 1" it was kind of we had this kind of book and we had to go through that book chronologically and I didn't feel that I worked that much because we were under time pressure so it was a matter of just reaching to the end of that book, in time to finish, so you would just do whatever it said without even considering what you were doing or why you were doing it, at least for me ...

E: Yes, we were given a solution of up to about ten compounds then it was our job to test for every single compound, whether it was a positive or a negative test

Me: With respect to how you were instructed to perform all this: was it much more specific than what you just did in this course?

E: Much

J: Yeah, there is just one way to do things, you just do as it is written. And the same with "course 2". We had a book and there were actual pictures of how our setup should look like when we were doing different experiments. So there were no room to think for ourselves at all.

Me: S what about you as you are coming from some kind of a different direction, maybe you have some different previous experiences?

S: I had many lab courses and I think that it was important that you don't have the time stress in this course, that was really nice, because usually being in the lab with a lot of people in the lab, for me it stresses me

Me: What stresses you, that there are a lot of people?

S: Well it stresses me that there is the time pressure, and also that there is a lot of people but I don't think that there was so much stress in this course, so that was nice. And also not having the instructions because if something goes wrong with the experiment then you try to do it in another way

Me: So just to have a concrete opinion on that because we heard some previous experiences, so specifically what did you think about this way of performing the experiments

E: Much better

Me: in which respect?

E: Teaching the students not just to follow a prescription but actually adjusting the prescription to what actually you need to make.

Me: Why do you like this?

E: It requires thinking and not just reading

K: The other courses we had were basically just following whatever other people have done before you so there isn't any need to use your brain at all it's kind like: Oh I am supposed to do that and that and that then I will do and then what is the next point... Ok I will do that ... whereas in this way you have to be a lot more engaged in what you are doing because you need to evaluate all way through you need to change the doses and stuff like that depending on how your synthesis is developing.

Me: If you had some specific instructions then it would be sure that you followed a given procedure the right way. Do you think that you have learned in detail how to handle specific experimental protocols? For example you tried inert atmosphere synthesis and distillations. Do you think that you got the same amount of experience and you learned as much as you would have if you just followed a set of specific instructions, that would make you go through the steps of a specific procedure?

J: You go through the steps thinking about it for yourself or you go through the steps as you are directed to do it. It is clearly, I think, that you learn more if you are thinking it through by yourself, I mean the first time I tried to distil something it went of course horribly wrong and I had assembled the entire thing all the wrong ways and then that told me a lot about distilling things and

Me: S what about you, you also started saying I think that you preferred this kind of approach

S: I think having the responsibility it is important because being instructed is sort of taking the responsibility away.

K: I think just as J said you learn more by making errors and then being able to correct them but the problem with this kind of course is that then we learn a lot about how to do our own projects but we come up with different competences. S knows to do something that I don't, I haven't tried it at all and I don't have that same experience and I have some experience that S doesn't have so we haven't learned the same things after this course.

Me: The main selection of experiments reflects a main category of synthesis so there might be a bit of variation but all of you did inert atmosphere synthesis at some point and all of you made some acac complexes and so on.

K: I am not thinking about the small synthesis but when I say we come out with different experiences I am thinking more about the big synthesis we were making here because they are different which means we learned something completely different.

Me: You would prefer that there is a common coverage?

K: Not necessarily but it depends what other people expect you have learned from this course. If somebody asked me to use liquid ammonia I wouldn't know how to do it but if somebody else asked you guys to use an autoclave, you wouldn't know how to do it.

S: I think in general, about learning different things, the thing to focus on is that we learn how to troubleshoot, how to approach a problem, how to solve a problem. I think that this is a nice thing, I think that in the industry or other working environments sometimes things do not work out and you have to find solutions.

E: It is a fine line actually, if everyone does the same compound with the same methods then you have a big chance to learn from each other than to learn from your own mistakes which also means that because K made some mistakes from her synthesis of cyclam then I did not made these mistakes, instead of making that myself and then do it again.

Me: We will come back to common coverage. We were thinking that maybe in this course we lack some lectures about how to do things. So, coming to the point that K made that you don't all learn the same things, maybe if we had a series of presentations about each technique you would have an idea at least in theory of how things should look or how things should be done.

J: I am quite pleased that there weren't lectures where theoretically you learn about how to something. The classes on Friday were an excellent way of learning from each other it is very interesting to see what the others are doing, especially for me, E, and K, we are doing something very similar in very different ways.

E: And it also forces you to rethink what you have done for a half week. And that's quite helpful.

(Transcript 2, starting at 18'.25'', ending 25'.37'')

Me: In this course you were free to find your own procedures about the experiments, you could choose the order of performing them, how long an experiment should take, you were let free on the attendance, I mean there is a minimum required to pass the course but keeping that in mind we were not really strict on coming and leaving from 9 to 17 every day, you could stay home and write your reports or read ..., you were having the responsibility to find out how to report the experiments, what to write down. I think what we should discuss now is the attendance policy. What did you think about that?

K: I thought that was very good. When you are in the lab all the time it is very nice to be able to simply just be in control of your own day if you work better by starting late and then stay late you were able to do that instead of having to meet up early when you are not at your best and then maybe go home early and use your best hours at home. I thought it was really nice I was in control of it.

Me: It should be always with respect to how much you learned. So you thought that this makes you learn better?

K: Because for me in the morning I don't really take a lot in. When I started early, it hasn't been as efficient for me as the later hours.

(S has to leave so there is a small interruption)

Me: Ok, so I see that you K appreciated this, but what about the others?

E: I took the most out of the late hours, I think this was because passed three some people went and then you had more talking time with the teachers and that helped a lot to understand what you were doing.

K: I also think it is the fact that you can create your own deadlines and dispose your own time as you will it also means that you don't have the time for it you don't get pressurised you don't think oh I have to reach this point today and I have to be at that point tomorrow and staff like that, you are not as pressed on your time which means that you are more able to focus in what you are doing and really dig in deep because you don't have the pressure

Me: But what about with respect to not being here but still doing some work for the course. I mean reading home or searching for some information. Did you do that?

J: Not really, we here every day. We turned up every day and did some work in the lab or wrote or talked or something.

Me: So that doesn't really diminish attendance, the fact that you are given the flexibility.

E: Not for the people that has the big course, I think. Maybe for the ones that have the small one. Because they have another course. It leaves them a lot of time to focus on the other course.

K: When you think about the others I noticed that in the beginning they were put on specific groups and at some point they started not showing up at those specific times but showed up at other times which means that the possibility has made them able to basically dispose of their day better so that they get the most out of their days

J: It is easier to panic, to do all the work at the last minute. I mean someone like J who did in the first five weeks one synthesis and the last three weeks he did 5 or 6. It is a bit of a problem for someone like him but ... there is a lot of people who in the last two weeks have been in the lab almost every day.

K: I was actually surprised that some of the people in the small course were actually at some point further along their course than I was.

E: M and C for example were just as fast as me, we had the same synthesis, so they reached their sixth synthesis just about at the same time that I did, on half the time, I was twice as much in the lab as they were.

(Transcript 3, starting at 26'.02'', ending 32'.06'')

Reporting: what about your reports. We told you, you should report what is relevant. That was all information you were given. What do you think about that?

E: That is a huge challenge to find out yourself what is relevant. It is a huge freedom but also a huge demand.

Me: What about with respect to learning? Did you also learn from trying to figure out what was relevant? Did you like it? Would you prefer it done in some other way?

J: I can only speak for myself here but I almost panicked at the idea of having to think for myself what to write and report. That was nothing I have ever tried before, to decide what is relevant to write and that is a huge challenge, to learn to adapt with thinking **what is it actually** that other people would like to know. We come from a culture where it is just what the teacher wants to know, you can ask and you can ...

E: Sometimes they tell you (laugh)

K: I think that is exactly the challenge that we are used in getting told what the teacher expects of us.

J: It is a healthy think to learn if you want to go in the scientific world of course but it is still what I found the most challenging about this course.

E: The big freedom in the reports was the bigger challenge, by far.

Me: But how did you see that, as a positive or as a negative experience?

E: As a positive one.

K: I think a bit of both I think it was a big challenge and sometimes I panicked just like J and other times it was kind of like Oh well I don't really have to think I just have to write whatever comes to mind, and in that way there were no restrictions I mean I just basically could take it anywhere I wanted which was nice but at other times I completely panicked, I said oh should I write about that or that or wait is this unnecessary or should I ... And that was a bit of a hassle.

E: The worst thing was to hear what other people were writing in their reports. That was hell..

Me: Your evaluation is a running evaluation, and then we also evaluate your reports. However you were completely free to discuss with each other and to ask things before you handed in your reports. So, is this a good thing that you can discuss with other students and see what they did? Do you learn from other students?

E: Yes, a lot.

K: Definitely.

J: Yeah, there were a lot of like team work within the groups of people who got the same synthesis in the first 6, who among each other what did you do, how did you do it and learned from each other so I think it is an amazing opportunity to

K: Yeah, I was really surprised because I have talked to other people about it outside of the course, outside of the university. I thought it was a great course because not only you learned yourself and by talking to your teachers but also the fact that you could walk around and say: Oh you are making that. How you are making it and why you are doing it? Which made me at least learn something else that I was actually doing. I was like trying to keep up with the other synthesis, I was going around, and we had the big synthesis it was just like J said they were quite similar but still different, I found it really perfect actually that we were at our corner and we were able to talk across, we just basically discussed what we were doing and thought "Oh wait should I do it like that?" and "no way" and "how" and "can I use something that you did", it was awesome.

E: I worked a lot with C and M because we had the same synthesis and they helped me a lot with the theoretical analysis of the synthesis and I helped them practically because most of them I had made before they started.

Me: Is this a common thing? Or in other courses you are more isolated with respect to evaluation or to talking to other students? Or is this something common? Can you do the same in all courses?

K: I think you can do it in all courses but whenever you have a time pressure you don't really have the energy to walk around and keep up with other people and talk about something else than what you are doing because you are so pressed on time that you need to hurry to get through it otherwise you won't be able to finish on time. You don't have the overview to think about whatever everybody else is talking like imagining their synthesis, imagining their crystals and whatever because you use all your focus on your own when you are pressed on time and the fact that you have time and you are able to take breaks and walk around and staff like that it made that possible.

E: It is a big problem in other courses with the time pressure.

(Transcript 4, starting at 32'.15'', ending 38'.27'')

Me: So, I think I have more or less covered the points I wanted to discuss with you. Do you have anything else you think its worth discussing that I forgot? Something that you really liked or something that you really didn't like or something that maybe made you not have such a good learning outcome from this course?

K: For me how much I learn from a course it is very dependent on my relationship with whoever is teaching it so if the teacher is good or the teacher is engaging and fun I work better and learn more, so its been really important for me and really great that you guys have been very interactive with us not only on the courses matter but also joking around and staff like that so its more of a natural relationship and so it is more easy learning. You kind off learn without even having to think about it.

E: It gets easier to relate to your teacher when you can have fun with them too.

Me: What about you J, what do you think about it?

J: I don't know what to say other than that has been said already, I really liked this course, I really-really liked it.

Me: Now we had this point about creating a relaxed and safe atmosphere: You think it is an important factor for learning?

E: Yes

K: It is easier to ask questions if you ...

J: You know that you won't be ridiculed

K: Yeah

J: Even though for some questions you know that you ought to know this, so it is a bit embarrassing to ask, you can still ask those. Which is nice because sometimes you just forget something.

K: If the only relationship you have with your teacher is that he stands at the end of the auditorium and lecturing and you are sitting at the back it is very hard and you don't want to do it as often. I shouldn't walk down and ask questions. But because we had a natural relationship and were having fun it was easier to go up and ask. It is something you do more often. You are asking about a lot more. A lot of irrelevant stuff that is chemical stuff but it's kind of like it's not directly relevant but it's just because it pops into your head and because you have a very direct relationship it is completely ok and you will get your answers and so you learn more than just your synthesis.

E: If you compare this course to "course 2" with S you have all these horror stories about how he exposes people's failures in the class. You don't have that here. It is quite lovely.

Me: Just to make a remark here about "stupid questions". You said (*addressing K*) yesterday you had a stupid question. There are no stupid questions. It is a *cliché* but it is also true. There are no stupid questions. What you asked yesterday, it actually took me a long time to figure it out myself. I think people realise things at different paces and degrees, in different subjects. Always a question concerns something that hasn't been understood. So it can't be stupid.

K: But I think that there might be a downside to it also because when you are "allowed" to ask questions all the time sometimes, at least for me, I would ask questions that I would guess the answer but I would like to make it completely sure. I did that quite a lot, which means that maybe I didn't make as many errors. Like I said, you learn from your mistakes and because I asked that much I didn't I made a lot of mistakes but I could of have made a lot more, it wouldn't have been fun, it would have probably taken the joy out of doing it but I might have also learned more.

Me: It is always a question of the teacher having the choice of answering or not what the student asks. Many times we answer by asking a question to lead the student or by saying to the students to go back to the library and figure it out themselves.

E: If you look at a bachelors project you have a supervisor who is a lecturer or a professor or something and have a support supervisor who is candidate or PhD so you can ask the candidate or PhD the stupid questions and the wiser questions to the professor so he doesn't have to answer every single ... But you and Høgni actually took up both roles.

B Questionnaire

QUESTIONNAIRE

One of the teachers in the Inorganic Synthesis course (Stergios Piligkos) is preparing a project for the Adjunct Pædagogicum course, investigating the effect of the Inorganic Synthesis course format on the student's learning outcome. The Inorganic Synthesis course's set-up gives the initiative and the responsibility to actively participating in the course to the students.

Please state your level of agreement on the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I liked that no detailed instructions manual was given in this course.					
I got enough help with the experimental aspects of the exercises when I needed it.					
I got enough help with the theoretical aspects of the exercises when I needed it.					
I liked that there was a flexible attendance policy.					
I liked I could myself choose the order in which to perform the experiments.					
I liked that I was given the responsibility to find myself the experimental procedures.					
I liked that I could discuss with my fellow students about the experimental and theoretical aspects of the exercises.					
I liked that I could discuss with my fellow students about the reporting aspects of the exercises.					
I liked the way I interacted with my teachers.					
I liked the general set-up of the course.					

General

comments:

Thank you!

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/2013-6/

The bibliography can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/kapitler/2013_vol6_bibliography.pdf/