Coaching Sessions for Lab Assistants

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1 Introduction

In the last few years, the structure of the physics lab courses at the VU has changed. Previously, students were taught by the permanent staff and a few assistants. With the increasing amount of students that participate in these courses, this became too much work for the permanent staff. Therefore, the students are now mainly taught by the lab assistants, who are in turn coached by the permanent staff. An advantage of this system is that the staff can easily coach more lab assistants, which then allows for more students taking part in the course.

The coaching is done via weekly coaching sessions that take place in parallel with the lab course. These sessions serve a number of purposes. Firstly, it is intended that the lab assistants learn some didactic skills which they can apply during the lab course. This will improve the education for the students. Secondly, the sessions must give structure to the lab course. Also, the sessions must ensure that all students are graded equally and get equal chances at passing the lab course.

In the document 'Coaching Sessions Lab Assistants' written by G. Kuik , a lay-out for these coaching sessions is proposed. In this article, I will try to provide a justification for the topics discussed during the coaching sessions, based on experiences from a SBI lab course roughly using this lay-out.

2 The physics lab course

The main goal of the physics lab course at the VU university is to teach students to independently conduct a scientific research. This means that students have to learn a number of academic skills. They need to be able to construct a research question, that results in measurable quantities leading to a quantitative conclusion. Once the student has a research question, he should be able to set up and perform an experiment. For good results, data analysis should be performed both during and after the measurements. It is important that students can present their results and conclusions both orally and in a scientific report.

It is the philosophy of this lab course that it is best to learn these skills by experience. This can very well be described using the learning cycle introduced by Kolb (see for example

'Leren en Doceren in het Hoger Onderwijs' by Kallenberg (dutch)). This cycle consists of the following phases:

- Concrete experience
- Observation and reflection
- Abstract conceptualization
- Application of conclusions in an action plan

The learning process can be started in any of these four cycles. Some students like to start with a simple trial, while other students will start by reading the manual or available theory. For example, the first students will start with a simple trial when constructing a research question, e.g. 'What is the maximal power output of a solar cell'. Other students will start by reading the manual to find the requirements for a good research question. The progress of the students does not depend on where in the cycle they start.

There are a few requirements for the efficiency of this learning process (distilled from 'Experience as a base for learning' by David Boud). First of all, the students need to be motivated. In the lab course, this motivation can be sparked by the topic of research. If the students are interested in the experiment, they will want to carry out a successful experiment. This will give the students motivation to solve problems they encounter while experimenting.

The motivation ties in nicely with another requirement for efficient learning: knowledge of the goal of the education. If a student does not know what he should learn, he can not work towards that goal. It is not possible to reflect on previous experiences.

Another requirement is the availability of some theoretical framework. After reflection, the theoretical knowledge must be used to improve the action plan. It is important that some theory is presented to the students. This is usually done in the form of articles in the manual and on blackboard, where the student can look up the material when necessary.

Finally, the student will need some initial experiences to start working. In general, the students have many experiences from previous education. This experience influences how they learn from their experiences in the lab course. The introduction exercises at the start of the lab course are used to ensure that all students have a suitable basis to start the experiments.

Guidance of the students mainly comes in during the reflection-phase of the cycle. In the example of the research question, students do not yet have the ability to construct a good research question. This makes it harder to spot flaws in their research question. It is very useful to engage in a discussion about their experiences with the teacher. The teacher, or assistant in the case of this lab course, can help with the reflection. This allows the students to make better improvements to their research question

The students are guided and evaluated by lab assistants, who are in turn coached by the lab staff. The lab assistants can be Ph.D. students, masters students and third year bachelor students. While some of these have assisted in earlier lab courses, most of these assistants have no experience with guiding a lab course. A secondary goal of the lab course is to teach these lab assistants.

3 Coaching sessions

There are a few options to train the assistants. A straightforward option is to give a short course in advance to the lab course. In the course of a few days, it is possible to cover a large amount of theory concerning the coaching of students. The assistants can then try to apply this theoretical knowledge during the course. An advantage of this system would be that the course can be given to a large group of assistants, and it would require relatively little time of the lab staff.

There are also a few disadvantages to this system, however. First of all, there is a delay between the explanation and application of didactic concepts. The result is that assistants will forget much of what they have learned before they can apply it. Furthermore, reflection on the work done by the assistants will often be limited. Even if there is sufficient reflection, it is not possible to apply conclusions following from these reflections. The result is that the assistants do not learn from their experiences.

Apparently, it is important that concrete experience and reflection happen during the same rough timespan. This can be achieved using weekly didactic coaching sessions in parallel with the lab course. This limits delay between theory and application to a few days, and allows the assistants to cycle through the learning process multiple times. During the coaching sessions, the assistants reflect on the previous lab sessions together with the lab staff. In addition, the coaching sessions are used to prepare for the next lab sessions.

For the learning of the assistants, the same requirements as those for the students apply. There needs to be a clear goal. In the case of the assistants, this is to guide the students in acquiring their goals. This in turn requires knowledge of the goals for the students: construct a research question, conduct a scientific experiment, write a scientific report and give a scientific presentation. The coaching sessions for assistants will be centered on these four topics.

The assistants also need to be motivated, not only to guide the students in the lab course, but also the motivation to improve their own didactic skills. In general, the assistants of the lab course have a clear opinion on the teaching style at the lab course. This will often lead to useful discussions about the lab course. Even if an assistant does not have such a clear opinion, he will still participate in the discussions. In general, motivation is not a problem. In any case, the lab course is a professional environment, so it is reasonable to expect some input from the assistants.

Most assistants at the lab course have little concrete experience with guiding a lab course. All assistants, however, have participated in some lab course as a student. All these assistants have an intuitive idea of how they should coach the students. Depending on what lab course the assistants attended, these opinions may differ. To ensure that the assistants start the lab course with the same mindset and plan of action, it is important to start with a coaching session on the structure of the lab course. This will provide the assistants with an equal basis from which they can start learning.

Along with this basis, a theoretical framework on coaching is necessary. This should be provided in the form a document that describes the structure of the lab course. The document should also give the assistants some information about the guidance and evaluation

of students. This is most easily explained using a few examples. While it is possible to give all the information in advance of the lab course, assistants should not be asked to read everything in advance of the lab course. It is more useful to only let the assistants read the necessary material for one week at the time. Even then, the amount of reading should be limited, as most assistants will not be motivated enough to read through more than ±3 pages of information each week. It is more useful to let the assistants read the basics, and discuss the details during the coaching session.

The main topics of the coaching sessions follow from these considerations. They are:

- Structure of the lab course
- Research question
- Student guidance & evaluation (also covers 'conducting a scientific research')
- Reports
- Presentations

These coaching sessions are used to let the assistants reflect on their experiences as a group. The topics and discussions are aimed to benefit all assistants. There are cases in which a more individual kind of guidance is necessary. This can be the case when an assistant has difficulty with some part of the lab course. For example, some assistants may find it hard to do presentations for a group of students, or to discuss some part of the experiment with a group of students. If the other assistants do not experience this problem, it is not necessary to address it during a coaching session. Individual guidance during the lab session is more useful for the assistant.

4 Structure of the lab course

The first coaching session according to Kuik focuses on the start of the lab course. This session is special in the sense that there is no reflection to be done, because there hasn't been a lab session yet. However, there are many things to prepare before the start of the lab course.

4.1 Preparation of the introduction exercises

During the first few lab sessions, students do a series of introduction exercises and experiments. The exercises serve introduce a few basic concepts in physics to students. In many cases, these exercises and experiments are centered on the output impedance of a function-generator. Based on this experiment, students learn the basics of data analysis, using Origin and writing a simple measurement report.

Often, the best method to prepare for this part of the lab course is simply to carry out the experiment. This ensures that the assistants can answer questions regarding the introduction experiments. However, this does not mean that the assistants understand why students should do these experiment. To be able to give sufficient guidance to the students,

the assistants need to know the goals of the introduction experiments. This can be addressed during a discussion following the assistants' preparation.

During this discussion, the different topics can be addressed using the questions 'What questions will students ask on this topic?' and 'What kind of answer can I give?'. For example, students have to learn to use Origin. A student may ask: 'How do I make a graph using Origin?'. As there is a large chapter on Origin in the manual, and as Origin is only used as a tool for data analysis, in this case a simple answer would suffice.

On the other hand, if the student asks, 'How do I measure both the current through and the voltage over a resistor?', a simple answer will not suffice. The students have just read an introduction on the topic of currents and voltages. They have also made a few exercises. For such an experiment, they have to ask themselves 'How can I do this?'. So in this case, the assistant should not just give the answer. A better option would be to ask: 'Can you draw a scheme in which you measure the current? Can you now include a voltage meter?' These questions can help a student to think about the problem and to solve it on their own.

The measurement report students have to write will also be discussed during this coaching session. It is more useful to discuss what the requirements are of such a report, in stead of asking what guidance should be given while writing a measurement report. It is the first scientific report that students write, and the requirements are not as high as the requirements for the later reports. Although students do not receive a mark for this report, it is still important that the reports are graded equally. It would be useful to discuss this using an example report from a previous lab course.

4.2 Preparation of the experiment

In addition to preparing the introduction exercises, the assistants also have to prepare the experiments. While the introduction exercises can be prepared as a group, this is not possible for the experiments. Each assistant has his own experiment, and per experiment, there are only two assistants. The preparation of this experiment is usually done in pairs. It is often not necessary to discuss this topic in a coaching session with all the assistants. It may be useful if a member of the lab staff discusses the experiment with the two assistants. During this discussion, most attention should be paid to the first day of the experiment. The students need to get an introduction, and they will need to do some kind of introduction experiment. The content of this introduction, and the topic of the introduction experiment are a good topic for discussion.

During the preparation of their experiment, assistants will need to construct a few research questions, and in some cases a client question. These questions will be discussed during the second coaching session.

5 Research Question

The second main topic discussed during the coaching sessions is the research question. The coaching session(s) on this topic will usually take place before the start of the first experiment.

The students are still finishing their introduction exercises. It is therefore not yet possible to let the assistants reflect on their own experiences regarding the introduction of their experiment, the construction of research questions and client questions.

In preparing the experiment, the assistants have made up a client question (if necessary) and constructed a few research questions. During the coaching session, these questions will be evaluated. How these questions are introduced to the students should also be discussed. The client question, which is only used to spark some extra interest in the students, can usually be given directly during the introduction. The research questions should not be given directly, though. The students must learn to construct a research question through experience. The assistant can steer this process by asking questions and helping the students reflect on their trials. In some cases, it may be useful to provide a rough subject for the research question. How this is done, will also be part of the research question.

Overall, the question that needs answering is: 'How can I guide the students in constructing a research question without doing all the work myself?'. It would be useful to discuss this using an example. As the assistants have not yet seen any examples, the lab staff should provide these in advance to the coaching session. Suitable examples could be initial trial-questions of students from previous years. The assistants receive a set of these incomplete research questions prior to the coaching session. Preparation for the coaching session would be to improve these incomplete research questions, and to think of how to guide the students in improving the research question.

Directly following the construction of a proper research question, the students start working on a work plan. As part of the work plan, they have to translate the research question into measurable quantities. This is discussed in the second part of the coaching session. The assistants can prepare by reading the information available in the manual and on blackboard.

In addition to the material on blackboard and in the manual, samples of work plans from previous years should be sent to the assistants prior to the meeting. During the coaching session, the evaluation of these work plans will be discussed. Therefore, it is useful if the assistants spend some time evaluating the samples prior to the coaching session.

A few points regarding the work plans that are often unclear are how detailed the work plans should be, and how much time the students should spend on it. In general, the students have only 30 minutes to work on the work plan at the end of the first lab session of the experiment. They have to show a complete work plan at the start of the second lab session. The result is that very often, students spend the first hour (sometimes even more!) of the second lab session to finish the work plan. How to deal with these situations should be discussed during the coaching session.

While the philosophy of the lab course states that is would be best for the education of the assistants to let them reflect on their actions in previous lab sessions. The topics in this coaching session need to be discussed in advance of the lab session. Therefore, it is only possible to reflect on material from previous lab courses.

6 Student guidance and evaluation

The coaching sessions on guidance and evaluation take place somewhere in the middle of the lab course. The assistants have had some experience with guidance and evaluation. They have guided the students extensively during the introduction experiments, and less extensively during the first days of the first experiment. They have evaluated the first measurement reports, some exercises and the work plans. It is now possible to let the assistants reflect on these experiences.

6.1 Evaluation

Ideally, the assistants have written down comments on their students about their performance. This should be encouraged at the start of the lab course, and perhaps mentioned again during the coaching sessions. For easy sharing and documentation of these comments, a Google Drive document is available. In this document, assistants can write down their own comments and read comments of other assistants. The document should be structured such that comments can be given for each student for each part of the lab course. These comments can then be used for the final assessment of the students at the and of the lab course. For the assistants, it may be useful to carry a notepad during the lab sessions. It is easy to note some comments on the notepad during a lab session. These comments can then later be added to the Google Drive document.

During these coaching sessions, several aspects of guidance and evaluation will be discussed. Most of these discussions will be based on examples from the experiences of the assistants. For example, the evaluation of experimental skills is discussed. Often, the discussion of initial results from an experiment with the assistant can provide insight into the experimental skills of a student. During the coaching session, an assistant could describe such a discussion and explain which experimental skills are visible in this example. The same approach can be used for creativity, originality, commitment and so on.

It is not always easy for the assistants to come up with an appropriate example. The assistant needs to have a rough understanding of the characteristic he is looking for. Therefore, when the assistants get the assignment to find such examples, they should also get a document which roughly describes the evaluation of students. Still, the assistants may find it hard to come up with suitable examples. In this case, the coaching session can be started with an example from the lab staff.

6.2 Discussion of initial results: guidance and evaluation combined

The discussion of initial results, as mentioned before, is an important part of the experiment that takes place around this time in the lab course. In order to check whether their work plan will lead to a quantitative conclusion, students should do an analysis of their initial measurement data. If this analysis does not lead to a useful conclusion, it is still possible to improve the work plan.

The discussion of the initial results is usually done together with the assistant. The assistant can help the students when it comes to the reflection on their results, and it is also a useful moment to evaluate the scientific progress of the students. A large part of the final assessment makes use of these discussions.

A possible issue here is the distinction between guidance and evaluation. If a pair of students has crappy initial results, the assistant will help the students to improve their measurements. Then, more discussions follow. The question is here: 'Should receive a bad mark because they did not have good initial results, or should they be assessed based on their improved results?'.

At the lab course, students are expected to learn by experience. They should be allowed to make mistakes. In fact, if the students learn from their mistakes, they may even learn faster than students who do not make these mistakes.

The discussion on the distinction between guidance and evaluation is very useful, and should be encouraged during the coaching session. The problem should be explained to the assistants by means of a few examples. The assistants can then try to find similar cases in their own experiences. These cases can be discussed during the coaching session. This will most likely lead to a better understanding of guidance at the lab course.

6.3 Guidance

When it comes to guidance, the first question that comes to mind is 'How much guidance should be given?'. In some cases, guidance can be given using a simple example. In other cases, it is better to guide a student by giving a few hints. There are also cases where even less guidance is necessary. A student may be able to solve his problem if he can find the right information. In that case, pointing the student to a certain article, paper or book may be sufficient.

It is clear that guidance can be given on many levels. At the lab course, guidance is often limited to a bare minimum, as this will force students develop their experimental skills. However, there are many cases in which more extensive guidance is required. The kind of guidance required depends on the problem at hand, the importance of the subject and the time available.

During the coaching session, some time will be spent discussing which kind of guidance to use, based on examples from the experiences of the assistants. Therefore, the assistants need to get an assignment in advance of the meeting. They should receive a short explanation of the problem, in which the different levels of guidance are described. The assistants are encouraged to think about this problem, and to find situations during the lab courses in which it is unclear which kind of guidance to use. These situations will then provide the basis for the coaching session.

6.4 Difficult cases

The last subject of the coaching sessions on guidance and evaluation focuses on cases where guidance or evaluation is difficult. For example, this is the case when students are not

motivated enough, or when there is a large difference in the abilities of students in a pair. Often, the way to deal with such cases is straightforward. Therefore, a written explanation of how to handle these cases will be sufficient. The time spent on this subject during the coaching sessions can be limited. Should the assistant encounter difficult cases, or cases in which the explanation is not clear, discussions may be useful.

7 Reports

The coaching sessions on reports usually take place when are writing their first report, or when they have just finished it. In many cases, students have already had feedback on the first version of the first report. For the evaluation of the first version, the assistants have received the instruction to provide as much feedback as reasonably possible. This provides the students with enough points they can improve for the final version.

For the evaluation of the final version, it is important that all the assistants grade the reports approximately equally. This is the main goal of the coaching session on the evaluation of reports. This is only possible if all assistants know the requirements for the reports. Therefore, assistants should prepare themselves by reading the documents available on report writing. It is also useful when the assistants attend the lecture give to students on writing a scientific report.

To ensure that all assistants grade the reports on an equal basis, it is useful to discuss a few samples from older reports during the coaching session. These samples can be provided by the lab staff. If the assistants spend some time evaluating these samples prior to the coaching session, it it possible to compare the evaluations. A second check that may be useful is to compare the marks for the final versions. If there is a large difference between the average marks given by different assistants, it may be necessary to review some of the marks.

In cases where there are multiple coaching sessions on the writing and evaluation of reports, it is possible to base the second coaching session on experiences from the assistants. Every assistant can select a few paragraphs that show (the lack of) specific academic skills. If these samples can be shared in advance of the coaching session, assistants have the chance to prepare properly for this session.

Another issue that can be discussed during the coaching session is how to guide students in writing a report. This discussion can be based on the same samples as used for the comparison of evaluations. Questions that may come forward during this discussion are 'How much of the report do you read during the lab session?' or 'Do you give feedback and guidance only when students ask for it?'.

8 Presentations

The final topic of the coaching session focuses on the presentations that students have to give. Most of the coaching session is centered around providing feedback on the presenta-

tion outlines students make. In this case, it is not possible to reflect on prior experiences from the assistants. In stead, the discussion is based on examples of presentation outlines from previous years. The assistants receive these examples prior to the coaching session, in addition to the theory available to students on how to do a scientific presentation. There is also a lecture on giving a presentation for the students which the assistants can also attend. In preparing for the coaching session, it is most important that the assistants check out the requirements for a scientific presentation. During the coaching session, these requirements will be discussed, based on the samples of presentation outlines.

A second topic that may come up during the coaching sessions is how the presentations should be graded. As these are oral presentations, students should receive their marks immediately after the presentation. It is not possible to compare the marks different assistants hand out. To ensure that all students get a fair assessment, it is useful to discuss what marks are expected on average. The best way would be to show parts of presentations on film, and evaluating these during the coaching session. However, as the presentations represent only a small part of the final mark, this may not be necessary.

9 Final remarks

For the education of the lab assistants, it would be best to let all coaching sessions except for the first be based on reflection of their own experiences. The first coaching session explains the structure of the lab course to the assistants. This discussion gives the assistants a short introduction to the didactic structure of the lab course. Following the first coaching session, the assistants are basically thrown in the deep, to try out the guidance of students during a lab course.

The following coaching sessions are based on reflection of the assistants. This is possible for the sessions on guidance and evaluation of students, and partly for the sessions on writing and evaluating reports. For the sessions on research question and presentations, it is not possible to reflect on experiences of the assistants, as there are none. In the last cases, the lab staff will have to provide samples on which the discussion can be based. By sending these samples in advance of the coaching session, the assistants can prepare by reading and commenting them. In the cases where reflection from the assistants is possible, it is still helpful to have a few examples in reserve. It is not necessary to send these cases prior to the coaching session though, as it would be better to let the assistants try and collect their own examples. Therefore, it is useful if the back-up examples are easy to explain to all students.

In addition to these examples, it is important to provide the assistants with some theoretical framework for the coaching. This could take the form of a document describing the entire structure of the lab course. This document should also include a theoretical basis for each coaching session. While the structure of the lab course can be described in detail, it would be best to keep the amount of theory on coaching limited. It should be just enough to help the assistants in identifying and evaluating useful examples for the coaching session. Links to more extensive sources of theory can be provided, for when the assistants need a more firm theoretical basis.