How to support student learning during labs?

Foundations for Teaching in Higher Education

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Video

EPFL

- What is your **role** when you supervise a lab?
- How do you **prepare** for it?
- What type of **difficulties** will students have?
- What will really **help** students **learn** from the lab?

Imagine you have just learned you will supervise labs this semester and it will be the first time you do it. What questions would you ask yourself? Stop this video and write down your questions. Start again when you're ready. Okay you have your list. Here is the minimum set of questions, I suggest you ask yourself before supervising any lab. First what is your role exactly when you supervise a lab? How do you prepare for it? What type of difficulties will students have? And then What will really help students learn from the lab in practice? The goal of this video is to help you answer those questions.

Notes

Summary

0m 04s

Obviously, your main role as a teaching assistant during a lab is to assist students, but not with any kind of assistance. Remember that labs are situations where students should learn by doing. Unfortunately, it is perfectly possible for a student to complete all the tasks in a lab without understanding anything about what he has just done. So, your main job as a T.A. is to ensure that no student comes out of the room without having learned from doing the activities in the lab. In practical terms not only should students be able to redo the lab without your help but they should also be able to explain what they have done. Now the question is, how do you achieve this in practice?

Notes

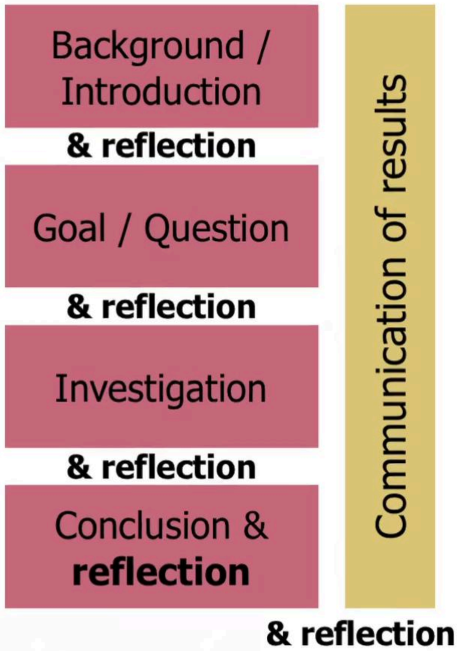
Summary

0m 49s

The key: "doing with understanding"

Learning-by-doing is efficient **if students are driven to reflect on what they learn**

(Barron et al., 1998)



As we have seen in a previous video, learning from doing happens when students are given the opportunity to reflect on what they do. We have also seen that reflection opportunities should not only happen at the end of the lab but rather at each stage of the lab. Whether the lab includes such reflection phases or not, you can highlight the importance of reflecting in the way you interact with students. Let's see how.

Notes

Summary

1m 44s

Questions to trigger reflection

Help students make sense from the lab by asking **why**, **what** and **how**?

- "Why are you asked to do this?"
- "How does that relate to what you have seen in the lecture?"
- "What are the 3 most important things you have learnt from this?"

A key to reflection is questioning. It is when students question what they are doing and why they are doing it that they learn most and you can help them by asking them questions. These questions should be open so that students are given the chance to explain their thinking. An easy way to come up with open questions is to start with the keywords: Why, what and how. For instance 'why are you asked to do this?' helps students think about the implicit goals of the lab and this is an essential step to make sense of what they are doing. Another example is 'how does that relate to what you've seen in the lecture?' You can use this question to help students identify the links between the theory and the practice which they frequently find difficult to do. Finally 'what are the three most important things you have learned from this?' is a question that you can frequently use to help students reflect on what they have just learned. Now these are only examples and I strongly encourage you to think about other questions. You could even come up with questions that make students think about their own thinking for instance.

Notes

Summary

2m 14s

Actually as you will see in other videos questioning is not specific to labs. You could use questioning to make students reflect in any type of teaching activity. What is specific to labs on the other hand is the opportunity to practice scientific inquiry skills. So another major role for T.A's in lab sessions is to help students develop their inquiry skills.

Notes

Summary

3m 39s

Questioning to develop inquiry skills

Design questions to draw students' attention on the **key inquiry skills**:

1. Identify scientific questions
2. Design and conduct investigations
3. Draw conclusions supported by evidence
4. Critically assess these conclusions
5. Communicate results

Adapted from Minner et al., 2010

Questioning is a key element to kind of inquir-ify any type of lab. Using questions you can at the same time draw students attention to the essential inquiry skills and model for them how to frame questions. Ideally the questions you design could be integrated into the lab worksheet so that they become part of the lab activities. But if this is out of your reach then taking any opportunity to ask those questions during the lab is a valid alternative. In the following we will review examples of such questions, as well as other strategies that you can use in complement.

Notes

Summary

4m 07s

Examples of questions to develop inquiry skills (I)

1. Identify scientific questions

- What questions are we trying to answer in this lab?
- How can you decompose this question into several sub-questions?

2. Design and conduct investigations

- Can you predict the result of this experiment?
- What is constant and what is variable in this experiment? Why?
- What type of data should you collect to show X?
- Why should you repeat the measure several times?

The first of the inquiry skills is the ability to ask scientific questions. To help students learn how to do it, you can proceed in two steps. First you can encourage students to identify the questions that are more or less explicit in the lab worksheet. In the second step you could give them opportunities to generate questions by themselves on the topic of the lab. The second skill is investigation design. Now whether they have the opportunity to design their own experiment or not, you can drive students to think about key aspects of investigation design. For instance, you can draw their attention to the dependent and independent variables in the experiment they are doing even if they are not named explicitly in that way in the lab worksheet. You can also make them generate hypotheses about what they are going to observe before they do the experiment. Or you can frame a range of questions around data collection and data analysis, for instance.

Notes

Summary

4m 49s

Examples of questions to develop inquiry skills (II)

3. Draw conclusions supported by evidence

- What data allows you to draw this conclusion?
- What was the hypothesis you wanted to test?
- Does the evidence you collected support your hypothesis? Why?

4. Critically assess these conclusions

- What are the limits / biases in your experiment?
- Can these conclusions be generalized? Why?
- What counterarguments could someone oppose?
- What would you do differently next time?

Two areas where students have major difficulties are first, formulating conclusions that are supported by evidence, and second assessing those conclusions in a critical way. So how can you help students make progress on this? First you can emphasize the importance of using evidence by making them identify which of their conclusions might not be so well supported by the data. You can also make them think back at the hypothesis they had at the beginning to identifywhether the data they collected actually supports their hypothesis or not. At this point discussing their conclusions with other students can help them refine their thinking. Once they have worked on their conclusion it is essential that they develop the habit of looking at them from a critical point of view. An easy way to help them with this is to play devil's advocate and to list some arguments that a reviewer could opposed to their conclusions. but it would be even better if you could organize a debate between students from different groups, because ultimately your goal should be that students develop the habit of putting themselves in the role of the reviewer.

Notes

Summary

5m 58s

Questioning to develop inquiry skills

Design questions to draw students' attention on the **key inquiry skills**:

1. Identify scientific questions
2. Design and conduct investigations
3. Draw conclusions supported by evidence
4. Critically assess these conclusions
5. Communicate results

Adapted from Minner et al., 2010

To guide them in the reviewing process, you can provide them with examples of questions such as 'What are the limits of your experiment?' or 'Can these conclusions be generalized?' The last inquiry skills we're gonna look at is communication skills. One study we conducted at EPFL shows that the area where students receive the most feedback during labs is on their report writing skills. While this is positive, other sources of information tend to show that students have difficulties presenting their data in a meaningful way and synthesizing effectively their conclusions. In addition, many students struggle to see the purpose of a lab notebook. Therefore your questions to students should target not only the way in which they report their results but most importantly the reasons why it is important to report them in that way. In this domain another effective strategy is to have students analyze documents such as research articles, scientific reports or lab notebooks which implement both good and bad practices. Being put in the position of a researcher trying to understand the work of others, can be a very insightful experience for students.

Notes

Summary

7m 24s

Questioning to develop inquiry skills

Design questions to draw students' attention on the **key inquiry skills**:

1. Identify scientific questions
2. Design and conduct investigations
3. Draw conclusions supported by evidence
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5. Communicate results

Adapted from Minner et al., 2010

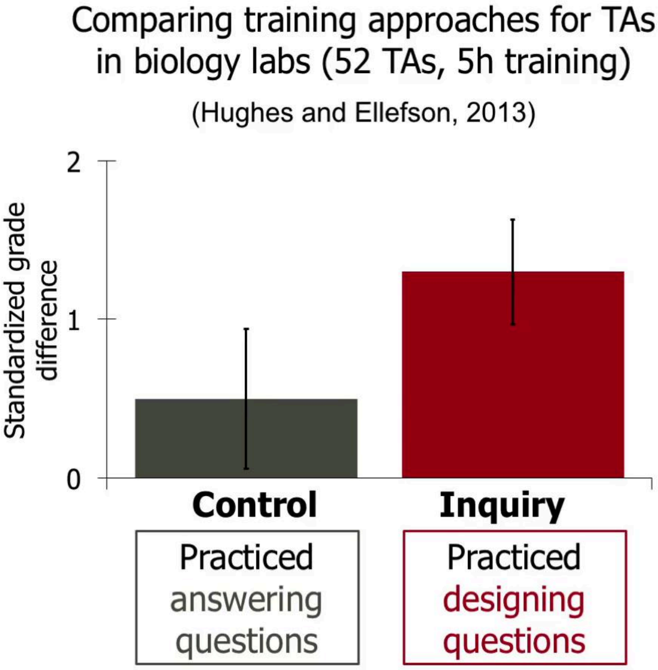
Okay so what we have just seen is a range of questions that you could use to help students develop their inquiry skills. Now you might wonder is it really sufficient to improve student learning? Actually, two researchers have looked at exactly this question.

Notes

Summary

8m 55s

Does that make a difference?

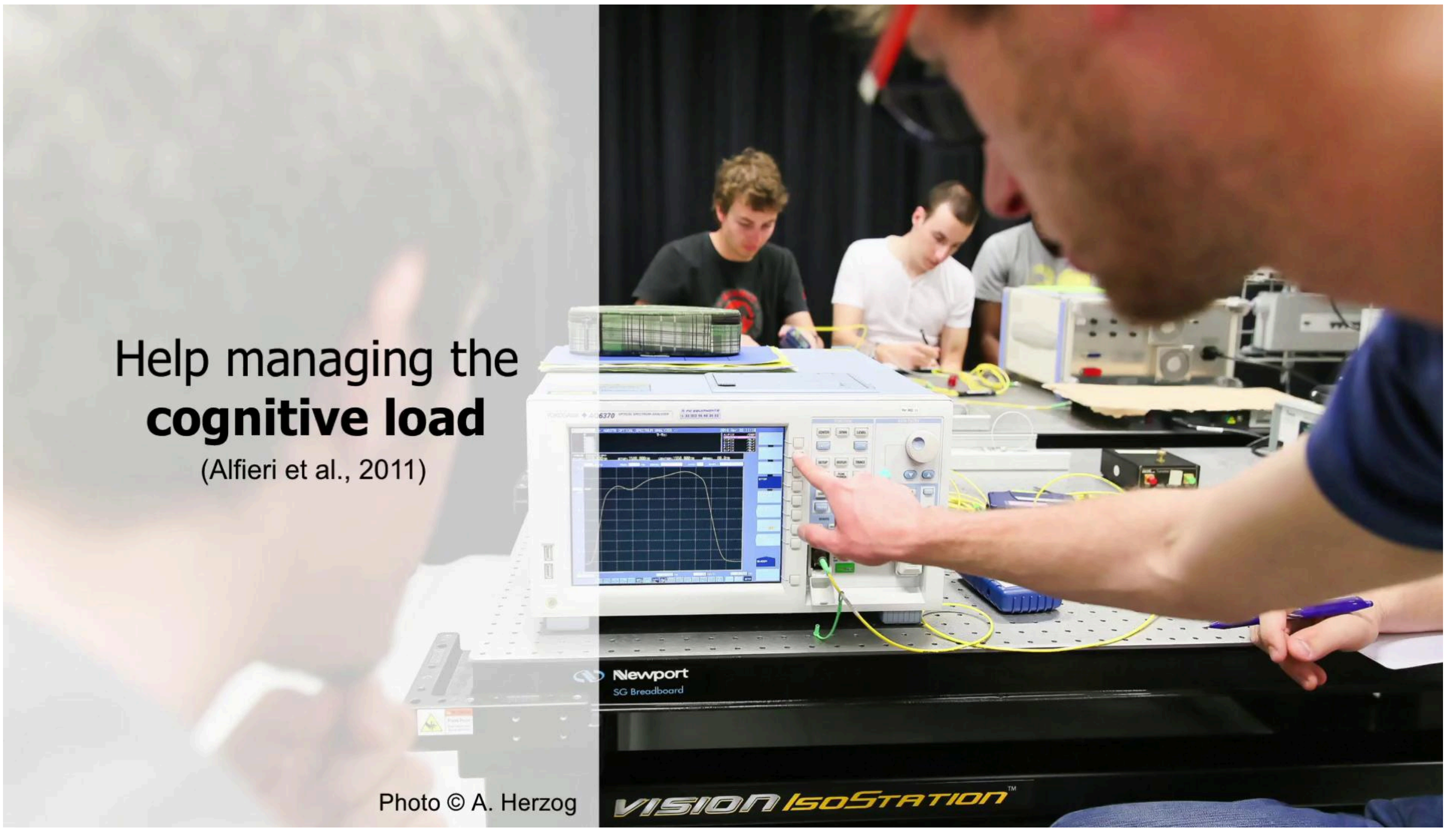


In their experiment Hughes and Ellefson have compared the overall achievement of two groups of students depending on how their T.A's were trained? In the control group the T.A's received a general teaching training and they practiced answering students' questions using the lab protocol. In the other group the TA's received training on inquiry-based learning and they learn how to design questions to ask students. As you can see from the graph, the final course grades of students who had the inquiry trained TA's are higher than the rate of the control group. Of course we have to take into account that the grades reported here include both the lab grade and the final exam so these results may not only be due to the lab T.A's but what is the take home message here? Actually, these results say something about the way in which to prepare for supervising labs. Thinking about how to "inquirify" a lab is one important element, and preparing questions to ask students is another.

Notes

Summary

9m 14s



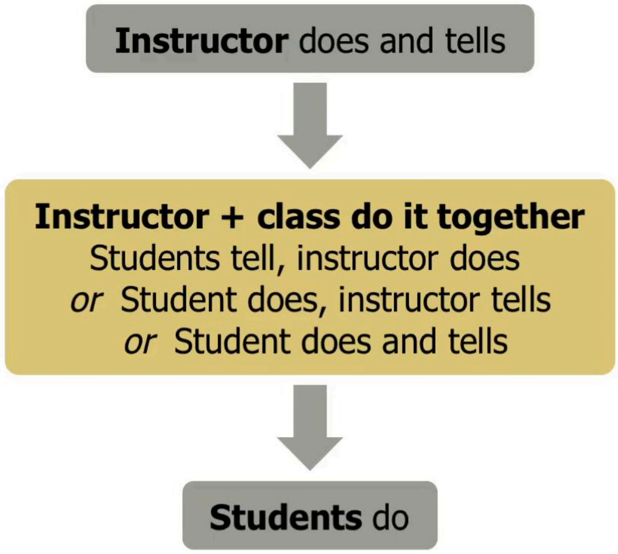
To look at some other ways you can help students to learn from labs we will now review two major students' difficulties that are specific to the lab situation. The first difficulty identified in the literature is a problem of the cognitive load. You have already heard about this concept in another video and you have seen it illustrated on a calculus exercise. There is one specific feature of labs that adds another layer to the cognitive load of students. It is the fact that at the same time as everything else they have to apply specific laboratory techniques or to use complex equipment.

Notes

Summary

10m 33s

Teaching lab techniques/procedures



The way in which you teach students the lab techniques and procedures can help. It happens frequently that students what you demonstrate the procedure but then struggle to reproduce it when they are back at their bench. So, to make your demonstrations more effective, one strategy is to proceed in three steps. In the first step you demonstrate the procedures while explaining what you are doing as you would usually do. Be sure to stress out the important points and the safety rules to apply. It might sound obvious but you can encourage students to take notes. In the second step, your goal is to involve the students in the demonstration. There are several ways to do this depending on the level of interaction you have with the students. For instance you could ask the class to guide you through the different steps while you are doing them in front of them. Alternatively you could call for a volunteer to do the demonstration. Iif the student is okay to do the demonstrationbut feels nervous about explaining the different steps, then you can do the talking while he or she performs the steps. In the third step, students use the procedures by themselves while of course you monitor their progress. Your key to effective demonstration is that second step: in this way you can make sure students engage with the procedure before trying it by themselves.

Notes

Summary

11m 17s

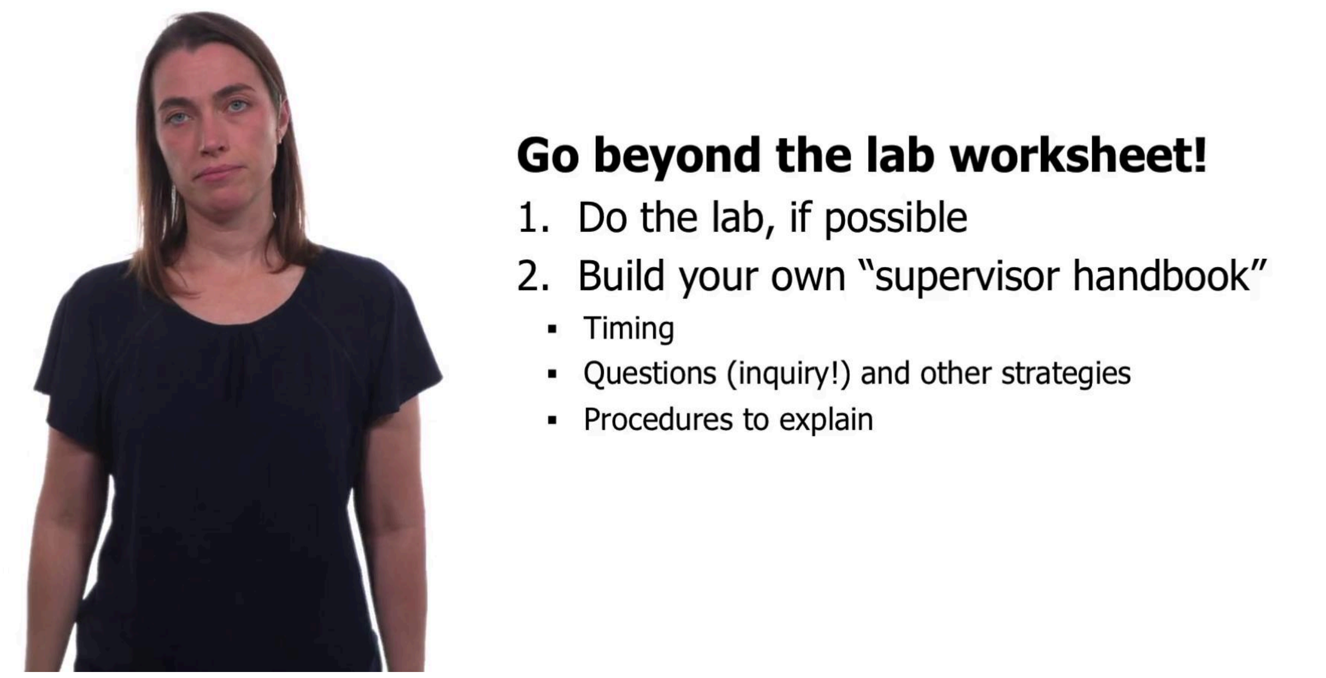
The second major difficulty that students have in labs is time management. One study done at EPFL shows that not having enough time to finish their lab work is a source of anxiety for 35 percent of the students. This number even reaches 68 percent for students in the first year of Bachelor.

Notes

Summary

13m 00s

How to prepare for a lab?



So how can you help? The first thing is to provide timing indications to students. For instance, you could write on the board that they should complete the first part of the lab by 3 p.m. for instance. Of course this implies that you have an idea of the time needed for the different tasks. The professor usually has this information but the best way to figure it out is to do the lab by yourself. When you monitor the progress of your group be sure to identify the students who are getting late and be sure to give them feedback. You can help them work out what they need to do to get back on track and this can include setting priorities depending on what they absolutely need to compete in the lab and what they can do after. Reminding students of the assessment criteria can also help them manage their priorities for themselves. As a conclusion my main advice for you is first to do the lab if that's possible and second to write your own supervisor handbook for each lab you will supervise. Be sure to include an indicative timing of the different activities. Don't forget to list examples of questions that you can ask students to have them reflect and develop their inquiry skills. And finally rehearse and practice the procedures you will have to explain.

Notes

Summary

13m 24s

Other roles include…

- Safety & equipment
- Grading

There are some other responsibilities that we didn't discuss in this video. Otherwise it would have been too long. One of them is ensuring safety and managing the lab equipment. It is absolutely essential that you refer to the appropriate regulations and that you discuss these issues with either the professor or the lab supervisor before your first session. The other role you might have during labs is grading students. Now assessment techniques are a topic in itself and you might have to assess students not only in labs but also in other settings. This is why we have addressed this topic in a separate video of this Mooc.

Notes

Summary

15m 06s

Special thanks to…

- Siara Isaac
  EPFL, Teaching Support Center

Finally, I would like to thank Siara Isaac my colleague from the teaching support center at EPFL for her help in the development of this video.

Notes

Summary

15m 52s