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## Teaching Laboratory Classes in the Natural Sciences (2)

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September 2019, English version September 2020

## 2. During the Laboratory Class

### Overview

1. Beginning of class
2. Conducting the experiment
3. Concluding the class

Beginning of class	Conduction the experiment	Concluding the class
<ul style="list-style-type: none"> <li>• Introduction: brief and well-structured</li> <li>• Hands- on demonstration</li> <li>• Lab safety test</li> </ul>	<ul style="list-style-type: none"> <li>• Walk around the lab</li> <li>• Time management</li> <li>• Explanations for all students</li> <li>• Communication</li> <li>• Options for implementation in large classes</li> </ul>	<ul style="list-style-type: none"> <li>• Contextualize: illustrate relationships</li> <li>• One-minute paper</li> </ul>

## 1. Beginning of class

- **Brief, well-structured introduction:** At the beginning of class, introduce briefly and in a structured manner what the session will be about (including conceptual and practical questions/problems, and hypotheses to be tested, experiments, and the student learning outcomes). Avoid going into too much detail, as this will reduce students' independent preparations for experiments. Instead, focus on relating the upcoming experiments and the lecture or previous laboratory classes. During your brief introduction, you may find it helpful to provide visualisations or to write important formulas or key information on the board. You may also ask students to explain their understanding of the theoretical context. An anxiety-free working atmosphere is crucial to assure your students that you are not trying to put them on the spot.
- **Hands-on demonstration:** Demonstrate selected procedures or how to use equipment. Make sure all students can see your demonstration. If you make a mistake, consider it an opportunity to discuss the reason for the mistake and how to proceed.
- **Lab safety test:** Safety tests are typically included in the introduction to a session to make sure students understand all safety issues of the respective experiments.

### Please note:

This article assumes that all students or small groups of students conduct the same experiment in a lab session. However, there are classes in which students conduct different experiments at the same time, and rotate experiments as the course progresses. The previous points (hands-on demonstration, lab safety test, etc.) also apply in this case. However, they should either happen at the beginning of course or with small groups before specific experiments.

## 2. Conducting the experiment

**Walk around the laboratory:** Walk from group to group while your students are conducting experiments. This way, students can easily approach you. Ask each group at least once during a session how they are doing (*"How is it going? What stage of the procedure are you working on?"*). It is important that you also check in with groups that do not come forward on their own. How you proceed depends both on your goals (*How important is it to you that students work independently? What kind of support do different students need?*), as well as on the available resources and general context (class size, number of teaching assistants and tutors).

**Time management:** Estimating how long each part of an experiment will take is part of the learning process. Establish a clear time line for the individual steps of a procedure and inform your students when to begin working on the next step. Keep track of the progress of your class and observe whether some groups lag behind in their experiments, so you can intervene in time if necessary.

**Notice on the number of experiments per session:**

If you notice that many students have problems with your time requirements, it may be valuable feedback on your course design. Sometimes it may be more effective to reduce the number of experiments.

**Explanations for all students:** If two or more small groups ask the same question about an experiment, interrupt the class to clarify this point. Most likely, others have similar issues.

**Communication:** The subtle level of communication between teachers and students holds great learning potential for students. The way you phrase questions or react to student questions can stimulate a deeper understanding in students (see: Encourage Learning: How Is It Done? (</en/start-page/course-types-disciplines/teaching-laboratory-classes-in-the-natural-sciences/3-encourage-learning/>)). Ongoing feedback on students' practical work provides them with important orientation, as they develop their experimentation skills. Remind your students regularly to observe the rules of cleanliness throughout all working stages and of proper waste disposal. Respond promptly if anyone does not conform to the safety requirements. Some teachers in laboratory classes value conversations with their students, which can develop in small groups and a less structured working atmosphere. Informal conversations on your current research activities, issues of research ethics, or developments in your field can be very beneficial for students' socialisation in the discipline.<sup>[1]</sup>

**Options for implementation in large classes:**

- If you are concerned that not all students will be able to see your demonstrations properly, you may want to produce a simple instructional video for students to watch, as they prepare for class. A video is an especially useful tool to convey unchanging content and fundamentals (e.g. introduction to microscopy), and you use it repeatedly over time.
- Explain or demonstrate a step of a procedure to a small group. Then ask the group to pass on that knowledge to other students.
- If there are multiple teaching assistants, break up the class into small groups and assign them to individual TAs. Then rotate the groups so that all students benefit from different TAs and their different ways of explanation.
- In the case of multiple teaching assistants, another option is to assign experiments/tasks to different TAs. Then one teacher explains how to use an instrument, for example, while another one supports students in using the data processing software.

### 3. Concluding the class

At the end of a session, it is important to reserve some time after experimentation to widen the perspective from the specific experiment to the broader context. You can achieve this by either providing comments yourself or by having students work it out themselves. For example, you could

ask students to summarise the most important points.

Possible topics include:

- **Generalising, looking ahead, and “zooming out” thematically:** Discuss additional connections with the lecture content, other laboratory sessions, ongoing research projects, or applications outside of the university. By relating this session to the upcoming one, you can pique your students’ curiosity on what will happen next.
- **Student learning outcomes:** What conceptual understanding or competencies did today’s class focus on?
- **Compare and discuss results:** *How do the results of the small groups differ?*

You can use the **one-minute paper** as a quick measure if you are unsure how well your students have understood or mastered the class contents. In one minute, students react in writing to a question or prompt you provide. Teachers often use the question: “*What was the most difficult or confusing part of today’s lab session?*” Have your students collect the anonymous answers for you to read.

### Continue reading

Laboratory classes (3): Activate Learning: How Is It Done? (</en/start-page/course-types-disciplines/teaching-laboratory-classes-in-the-natural-sciences/3-encourage-learning/>)

### References

[1] Gastel, Barbara. "Teaching Science: A Guide for Professional School Instructors" Phoenix: Oryx Press, 1991, 83.

### Recommended citation

Buchberger, Sonja: *Teaching Laboratory Classes in the Natural Sciences (2). During the Laboratory Class*. Infopool *better teaching*. Center for Teaching and Learning, University of Vienna, September 2020. [<https://infopool.univie.ac.at/en/home-page/course-types-disciplines/teaching-laboratory-classes-in-the-natural-sciences/2-during-the-laboratory-class/>]

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