



COOKBOOK ON SMALL CLASS TEACHING



Learning Lab

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What is the purpose of theoretical exercises and problem solving classes?

University teaching is often characterised by lectures where the course content is presented to a large group of students. At Science and Technology, Aarhus University many courses are furthermore supported by a variety of small-group teaching (in Danish: holdundervisning) doing theoretical exercises, problem solving exercises, computer labs, experimental labs, etc.

Lectures often taught by professors and senior staff are intended to scaffold the learning of the students through interactive presentations. The small-group teaching should support the lectures by providing the students opportunities to work actively with the course content and be involved in dialogue, discussions, reflections, and feedback activities.

Why small group teaching?

Small-group teaching is intended to provide some of the following opportunities for students:

- practice skills
- ask and answer questions
- communicate and discuss orally
- receive, use, and provide feedback
- collaborate and learn from peers
- reflect on own learning and progression
- perform assessments and practice for the final exam

The small-group teaching has to be planned well to be able to provide the opportunities to students listed above.

Designing small group teaching

When planning your small-group teaching start out by considering the following:

- what knowledge do students already have or what are the course prerequisites?
- what do you intend the students to learn during the small-group teaching?
- what should the students do during class (in-class activities)
- what should the students do between classes (out-of-class activities)
- how will you investigate/assess whether your students learn what you intend for them to learn?
- how are the small-group activities preparing the students for the assessments/final exam?
- how do you create a safe learning environment?
- what can you learn from previous course evaluations and discussions with TA's and course responsible?

Reference:

Race (2014). Making Learning happen. Sage, Los Angeles Integrated Course Design. Dee Fink:

http://ideaedu.org/wp-content/uploads/2014/11/Idea_Paper_42.pdf

Svinicki, M. & McKeachie, W.J. (2011) McKeachie's teaching Tips. Strategies, Research and Theory for College and University teachers. USA: Wadsworth

Becoming a reflective Teaching Assistant

Teaching Assistants at Science and Technology are recommended to participate in a teacher training course.

Teacher training course at Science and Technology

Course name	Participants	Duration	Comments
Introduction to Teaching and Learning	bachelor students, master students, DVIP	8 hours	Online course
Science teaching	PhD students at ST	5 ECTS = 150 hours	Mandatory of PhD students at ST
Teacher training course	Assistant professors, Post docs	5 ECTS =150 hours	Mandatory for assistant professors applying for a permanent position

Collaboration between Teaching Assistant and Course Responsible

The course responsible

Initial meeting

Before the Teaching Assistant (TA)/Student Teacher teach a course for the first time it is suggested to have an initial meeting between the Course Responsible/Main Lecturer and the TA. During the meeting, the Course Responsible could give a brief overview of the course.

The Course Responsible could briefly inform the TA about the overall course:

- Learning outcomes as described in the course catalogue
- Teaching methods (e.g. lectures, laboratory exercises, problems solving, project work, online activities, etc.)

- Assessments both during the course and the final examination
- Course material and the Blackboard course page
- Course evaluations and previous challenges
- Teaching staff and their responsibilities (e.g. lecturers, TA's, lab technicians, etc.)

More importantly, the Course Responsible could outline the responsibilities of and expectations to the Teaching Assistant.

Discussions regarding lessons taught by the TA could include:

- Suggestions for teaching methods (e.g. student presentations at the blackboard, group work, peer feedback, jigsaw groups, correction of assignments, etc.)
- What the students need to learn/practice (the learning outcomes) during lessons taught by the TA
- Course material used during the lessons taught by the TA
- What role is the TA expected to play? Is it to be guiding problem solving in groups or at the blackboard, challenging the knowledge of students, providing answers to their questions, planning teaching activities, organising group work, assessing, etc.)
- What are the previous experiences with student learning and their difficulties and misconceptions
- How are the lessons taught by TAs evaluated

It is important to communicate what the TA is obliged to do, and what not to do, e.g. should the TA answer questions or try to get the students to find the answers themselves; should the TA solve problems at the blackboard if no student volunteer to do this, etc.

It is important that The Course Responsible/lecturer align expectations with the TA regarding deciding how much (if at all) the Teaching Assistant can influence or is responsible for:

- Organisation and the scheduling of time during class
- Prioritisation of content during the teaching
- Development of new activities
- Feedback to students
- Feedback to the course responsible

Meetings during the course

The departments and individual courses at the Faculty of Science and Technology have different traditions regarding the collaboration between the Course Responsible and the Teaching Assistants, ranging from a brief introduction to the TA responsibilities to weekly meetings where content, teaching methods, and student progress are discussed. It is recommended that regular meetings are set up between the Course Responsible and the TA.

The TA can provide feedback to the Course Responsible as the TA will often be in close dialogue with the students and therefore be able to diagnose the misconceptions and difficulties that the students have in the course. This feedback can be used to adjust the teaching during the course and ensure that the learning of the students is supported in the best way.

Meetings during the course could focus on the following:

- Teaching challenges for TAs (e.g. unprepared students, diverse academic levels among students, etc.)
- Feedback on student progress and misconceptions to the Course Responsible
- Individual, group, or class feedback to students on their progress and difficulties
- Prioritisation of content during the teaching
- Development of teaching activities to support student learning
- Organisation and the scheduling of time during class

Teaching assistant

The Teaching Assistant in a given course is advised to prepare for the teaching in the following way

- Read the overall objectives of the course (learning outcomes, teaching methods, assessments, and course material)
- Familiarise yourself with your responsibilities in the present course (specific learning outcomes, teaching methods, assessments, and course material for TA teaching)
- Obtain an in-depth knowledge of the course content
- Acquaint yourself with methods and techniques to support student learning
- Look for information about the course evaluations from previous years
- Ask the course responsible or fellow TAs whenever you are in doubt

Before each lesson, the TA should consider the following

- Purpose and learning outcomes for this specific lesson
- Timetable and organisation of class
- Instruction to students
- Teaching methods
- Feedback to students
- Course material and prioritisation of content

After each lesson, the TA should consider the following

- Teaching: What worked well and what needs to be improved?
- Content: What was easy for the students and what was difficult?
- Feedback to students
- Feedback to the Course Responsible

Theoretical exercises and problem solving classes

The term theoretical exercises (in Danish: teoretisk øvelser) or problem solving classes refers to lessons where the students calculate, solve, or answer exercises in-class. The in-class activities typically start out with students solving exercises individually or in groups with the Teaching Assistant helping and answering questions. Often this is followed by students presenting process and/or solutions at the blackboard with the Teaching Assistant as a facilitator aiding, guiding, and elaborating on the process and the result. The student preparation (out-of-class activities) varies intentionally or unintentionally from expectations of not preparing before class to very well-prepared students.

Out-of-class considerations

The Course Responsible and the Teaching Assistants should communicate to the students if they are expected to prepare before class or not as this will influence the organisation of the in-class activities.

- To which degree are the students expected to prepare before class. Should they solve all problems, some of them, or just familiarise themselves with the problems. Are they encouraged to work individually or in groups?
- Can the students ask for help if they have difficulties solving the problems? If yes, how and where (e.g office hours, e-mail, Blackboard course page, etc.)
- Will specific exercises be assigned to individual students/student groups?

In-class considerations

The Course Responsible and the Teaching Assistants should inform the students about the organisation, teaching methods, and the role of the TA.

- What are the main objectives of the theoretical exercises (result or process, written or oral explanation, application of theory, etc.)
- How are the in-class activities organised?
- What are the specific teaching methods supporting student learning?
- How are the teaching activities preparing the students for the final exam?

- How many students go to the blackboard? Can exercises be split into minor parts to let more students present? Can more students be presenting at the same time for some of the exercises?
- How can the students be encouraged to asking and answering questions?

In a theoretical exercise class or a problem solving class, it will often be important that the students practice problem solving themselves. The Course Responsible should therefore consider informing the students about their role as active participants in the theoretical exercises and could advise the TA that her/his role is only to guide the students through the exercises and never to be solving problems at the blackboard themselves.

Organisation of student presentation at the blackboard

In courses where the students present/solve problems or assignments at the blackboard, there are several things to consider to optimise the teaching:

- What is the main purpose of presenting assignments at the blackboard? (calculation of correct result, discussion of the process, relating assignments to theory, etc.)
- Are the students that are not presenting at the blackboard active and what are they doing? (taking notes, asking questions, answering questions from presenter or TA, etc.)
- Are the students that are not presenting at the blackboard learning in an efficient way or do they need to be involved more? (asking questions, giving feedback to presenter, relating exercise to theory, etc.)
- Is it important that the TA guide the student presenting at the blackboard or could several students be presenting at the same time in smaller groups (without the TA being present all the time)?
- How long time should one student be presenting at the board? Could larger assignments be split between students to allow more students to present?

Organisation of group work

In some courses where the students present/solve exercises or problems at the blackboard, it could be beneficial to let the students work in groups. The duration of group work can vary from a few minutes to the entire in-class time. There are several things to consider to optimise the teaching:

- What are the main purpose of the group work? (assuring that out-of-class preparation is correct, calculations of results, discussion of the process, relating exercise to theory, etc.)
- How is the group work organised (timetables, prioritisation of work, group members, specific tasks)
- What is the role of TA during group work (available if needed, actively guiding or challenging groups, passive)

Group work and the follow up after group work can be organised in many different ways. See suggestions below.

Teaching activities

Gallery walk

Short description: Each group of students prepare a presentation of e.g. a mathematical proof or problem. The proof or problem is different from group to group. After the preparation time each group will present their proof/problem with focus on argumentation of each step in the proof/problem. The rest of the students walk from “artwork” to “artwork” (hence the name gallery walk), listen to the presentation and ask questions



Motivation: the students practice for an oral exam

TA:

Before: Form groups (if not already in study groups); distribute problems/proof to the groups

During: answers questions etc. from the groups, organize the “walk”

After: Reports process and results to the lecturer.

Materials: Problems/proof to present

Notes: The students can prepare without the TA being present. Some of the rooms have projectors, use them, and alternatively use paper or students’ own laptops.

Oral exam preparation

1. **Short description:** 1) Students prepare in groups of 2-3 (one of) the exam question(s) related to this period’s topic. They get 30-45 minutes to prepare for their oral presentation. 2) One student (picked by the TA) do a presentation (approx. 10 minutes) and the rest of the group take notes so that they can evaluate the presentation. 3) A couple of students (picked by TA) evaluate the presentation and gives constructive feedback. 4) The rest of the students comments on feedback and can give additional comments for the presentation 5) TA sums up and gives his/her comments and answers questions from the students
2. **Motivation for activity:** This prepares the students for an oral exam. It gives the students time to reflect on the topic (and figure out what (s)he finds most important). It supports talking about and being critical about the subject.
3. **TA:**



- a. **Before:** Reviews the exam question.
 - b. **During:** 1) Waits/helps, is available for questions (can be without TA) 2), calls on student to do the presentation, takes notes, 3) calls on students, 4) in a round robin fashion asks all students about their short comments, 5) sums up and gives his/her comments
 - c. **After:** Reports process and results to the lecturer.
4. **Materials:** Exam question(s)
 5. **Notes:** If the first part is without the instructor, the exercise must appear on Blackboard when the teaching starts (adaptive release). It is very important to create a safe learning environment.
 6. **Alternative:** The groups can be regrouped into trios where one student do the presentation and the two others evaluate

Peer feedback exercise

1. **Short description:** Students receive an exam-like exercise, which they have not seen or prepared for. They get 30 minutes to do the exercise individually. Afterwards, student exercises are collected and re-distributed in such a way that students in pairs give feedback to two other students' exercises using a model answer. The feedback can be anonymous or not. Points or grades can be given.
2. **Motivation for activity:** This is very much like the exam; an unseen exercise with time pressure. The following peer feedback session reinforces the learning in that students will automatically compare their own exercise with the one(s) they are giving feedback to and the model answer.
3. **TA:**
 - a. **Before:** Prints exercises created by the lecturer.
 - b. **During:** Distributes exercises, waits/helps, collects exercises, distributes model answers, re-distributes exercises, is available for questions.
 - c. **After:** Reports process and results to the lecturer.
4. **Materials:** Exercises, model answers
5. **Notes:** If the first part is without the instructor, the exercise must appear on Blackboard when the teaching starts (adaptive release)

Selecting relevant exercises/topics (developed by students at Science Teaching 2017)

1. **Short description:** Brief survey among students answering four questions using Mentimeter (anonymously)
 - a. Which exercise(s) did you (try to) solve?
 - b. Which exercise(s) did you find hardest?
 - c. Which exercise(s) did you find most important? (1 minute to think and discuss with another student before answering - TA follows up by asking pairs of students to comment)

Activity	To Do	Amount of time
1	Exercises	1 1/2 (12:50 - 14:00)
2	Paper Q's	1 (14:15 - 15:15)
3	Concept Map	10 min (15:30 - 15:40)
4	Ticket-to-go	<20 min

Remember breaks!

d. How much time would you like for solving exercises?

The survey is followed by making a timetable (see image), based on students' responses to c. and d. Arrange study groups where students solve exercises before presenting them to class.

2. **Motivation for activity:** Involve students in decisions regarding small class teaching (TØ) by listening to their opinion (anonymously) and by tailoring TØ to meet their needs and difficulties.
3. **TA:** Sets up questions in Mentimeter, leads discussion where relevant and creates a timetable.
4. **Materials:** A computer with [Mentimeter](#).
5. **Notes:** This activity can be followed up by asking students at the end of TØ whether they would like this activity at the beginning of each TØ.

Adjusting group work to different levels of preparation

1. **Short description:** Students are divided into groups based on preparation. E.g. three groups: A well-prepared group, a medium-prepared group, and an unprepared group.
 - a. In the well-prepared group students (taking turns) go through the exercises almost immediately and is able to reach a deeper level in the discussion. Afterwards, and if time permits, extra or different assignments can be given.
 - b. In the medium-prepared group students first have time to complete remaining exercises, to ask questions, etc. Afterwards, students go through exercises. The number of exercises is so that this group will have time to go through all or nearly all exercises.
 - c. In the unprepared group students have even more time to do problem solving and subsequently they go through selected exercises.

After the group work and if deemed necessary the TA (or a student from the well-prepared group) can follow up in a plenary session, e.g. by going through one particularly difficult exercise or by leading a plenary discussion. Alternatively, the TA produces a short video about the most difficult/important exercise.

2. **Motivation for activity:** Differentiated teaching, rewarding and motivating students for preparing for TØ, more students will go through exercises at a board.
3. **TA:** The TA has to facilitate the group work in all three groups. In the well-prepared group, the TA asks probing questions to test deeper understanding, in the other two groups the TA answers questions and gives clues to problem solving, etc. In the end, the TA decides how to follow up. This activity will work best with a pedagogically skilled TA.
4. **Materials:** None
5. **Notes:** Initially students may find this type of activity very different from what they are used to. However, many students will quickly see the advantage of it.

Jigsaw:

1. **Short description:** Students are assigned different topics/concepts/images/etc. in expert groups. Each expert group has its own topic/concept/image/etc., and students in the expert groups help one another identifying key points/results and make comprehensive explanations. This first part has a specific time frame. After this, new groups are formed with at least one representative from each expert group. In the new groups, students take turns teaching one another about their expert topic/concept/image/etc. During both sessions, students are encouraged to take notes. A plenum discussion is used to round off the activity, if deemed necessary.
2. **Motivation for activity:** This activity encourage students to prepare, as all students will be teaching other students. All students have a defined active role during the activity and teaching a given topic/concept/image/etc. is in general very beneficial in terms of learning.
3. **TA:** The TA (or the lecturer) prepares topics/concepts/images/etc. for the activity and directs the activity. Helps the expert groups to clarify issues and monitors the progress and conversation. This quality assurance is important but in most cases students will be able to correct mistakes in the groups.
4. **Materials:** None or templates to fill in depending on activity
5. **Notes:** Works very well as preparation for oral exam. Can be used on problems as well.

Out-of-the-box activity

1. **Short description:** This type of activity nurtures student creativity and focuses on generating ideas and subsequently making judgements about them. An example is to change a law of nature slightly and brainstorm implications. Another example is to design experiments to test conceptual questions. Activities often start by posing a question/problem: “How might you design ...”, “What would happen if ...”, “List different ways to modify ...”
2. **Motivation for activity:** Creativity is one of the most important skills in work life, whether it be as a researcher, teacher, or some other job. However, it is a skill rarely exercised in TØ. Introducing small activities focusing on creativity can help students practising their creativity and at the same time make teaching more diverse.
3. **TA:** The TA needs to be prepared for many and different ideas. The TA’s role can be guiding and giving feedback on ideas.
4. **Materials:** Depends on the activity.
5. **Notes:** There are many elements of the creative process including searching for information, identifying problems, brainstorming solutions, considering points of view, etc. As the creative process is known to cause angst for some students, it is advised to break the process into discrete steps. Furthermore, if students are to brainstorm well they need advice on how to do it.

Best video explanation:

1. **Short description:** 1) The students (in groups) find a YouTube video that in a good way describes and explains a central concept AND argue for why they think it is a good explanation. 2) In the team each student votes on what video (apart from the one their group found) they think is the best. 3) The TA asks each student why (s)he voted the way (s)he did.
2. **Motivation for the activity:** It is enhancing the student's ability to argue for the topic. They will see different explanations for the given topic. It will give the lecturer good indications on material to include in the course next year.
3. **TA:** Organize. The first part can be outside class hours.
4. **Materials:** Nothing special
5. **Notes:** It can be time consuming. To ensure that the students do not just search for the topic and pick the first argumentation is necessary and you can ask for a prioritized list of X videos.
6. **Alternative:** The lecturer/TA creates/finds a number of explanations, the students votes for the best AND argues for their vote.

Graphical representation of a TØ lesson:

Astrophysics 2016 (written exam) and 2017 (oral exam)

2016



Feedback exercise

Problem solving in groups, based on preparation

Follow-up and round-off in plenum

- Individual problem solving
- Group
- Student feedback
- Individual presenting
- Group
- TA presenting
- Creativity

2017



Groups presentations in a Jigsaw format

Problem solving in groups based on preparation

Follow-up and round-off in plenum

Out-of-the-box exercise