9

Naturgrundlaget 2 – activation of students in large classes

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Introduction

Traditionally, teaching at universities is often a one-way communication form where students are listening passively to the lecturer who on her part is trying to get the knowledge across to the students. According to Biggs & Tang (2007) most people learn about 20 % of what they hear and about 70 % of what they talk over with others. During a lecture the students' attention drops after 10-15 minutes, but a short rest or activity may increase attention again (Bligh 1998). With that in mind, one can ask why it is that the majority of teaching at universities is still one-way communication from the teacher to the students, knowing that the concentration drops during the lecture and that it encourages surface approaches to learning. Studies have shown that changing the lectures from a one-way communication form to a more student activating form can support deep approaches to learning (Mazur 1997, Trigwell et al. 1999). Last year, I gave my first two lectures, and I was doing it the classical way of teaching: one-way communication. Why? I have been taught in that way myself and by looking at other teachers, many are teaching in more or less the same way. It has been a great eye-opener for me to participate in the Introduction to University Pedagogy (IUP) course and I have been inspired by reading the KNUD project by Schneider (2007), Biggs & Tang (2007) and Mazur (1997). I have reflected on my teaching last year and started thinking; how can I change my lectures in such a way that students will be more active during the lecture? – based on the constructivism theory emphasizing that "learners construct

knowledge with their own activities, building on what they already know" (Biggs & Tang 2007, p.21).

Focus

The focus in this project was to try out and introduce different kinds of teaching and learning activities (TLA) in my teaching that could support the intended learning outcome (ILO), sharpen the students' attention during the lecture and support deep approaches to learning.

- How can we do that in large classes when the curriculum that has to be covered is on a basic level, and it is to be expected that the students' previous knowledge will be at different levels?
- What kind of teaching and learning activities will be appropriate leading to the ILO?

Course

I participated in teaching in the course "Naturgrundlaget 2" (Natural Resources 2 – Ecology and Biodiversity) which is a new 15 ECTS course running in blocks three and four with a written examination after each block. Before 2012 it was a 7.5 ECTS course with a focus on plant classification and identification, and vegetation ecology. These topics are still part of the new course, but the new course also includes interactions between plants and soil and overlaps with another course including written reports (in block three).

The course had 76 students. In block three, I gave three out of the eight lectures in basic ecology. In block four, I gave two lectures and exercises in vegetation ecology.

Before the teaching started in block three, I was a bit concerned about the large curriculum, the many different topics that had to be covered, several textbooks, two large written reports and many different teachers. Would it be possible for the students to overcome all that in only one block and for my part of the teaching (three-eights of basic ecology): Would the students find basic ecology relevant for their education and future employment at all? I did not have the same concern regarding block four. Block four still had many teachers, but the topics were more alike.

Teaching in block three – basic ecology (topics):
Lecture one: Photosynthesis, respiration, nutrients, fundamental and realized niche, plasticity
Lecture two: Population demography and growth models
Lecture three: Plant competition

Teaching in block four - vegetation ecology (topics):
Lecture one: Heath, grassland
Lecture two: Weed in arable land, ruderal habitats, small biotopes, roadsides, hedges

In block three, I asked the students to complete a questionnaire twice (one covering lecture one and one covering lectures two and three). In block four, they were asked to complete one questionnaire covering two lectures).

Method and teaching

With the constructivism theory in mind (Biggs & Tang 2007), my strategy was that I would start the lecture by asking the students if they knew anything about the subject of the days lecture or if they thought that they were able to explain the subject to their next-door neighbour. After that I would introduce the theory, interrupted by questions like: Why. . . ?, How. . . ?, Can you explain this figure? and so on, and small exercises. Some of the questions were (a) questions directly to the full class, (b) questions where students had to think for themselves first, then discuss their individual answers with their next-door neighbour for a few minutes, followed by a discussion in plenum (think-pair-share), and (c) questions or exercises that needed longer than a few minutes to solve and discuss, but the students were still working in groups of two to three persons, and the answers were finally discussed in plenum. The didactic game was not the same in all situations, but an example could be (Winsløv 2006, after): devolution (teacher presents the question), action (students work on their own), formulation (students discuss with their neighbour), validation (students present solutions in plenum), institutionalization (teacher presents official knowledge).

The intended learning outcome for the first part of Naturgrundlaget 2 is mainly on a low level on the SOLO taxonomy, e.g. describe or identify (Biggs & Tang 2007, Figure 5.2 and Table 5.1). I had to take that into consideration when asking questions (TLA), knowing that it does not support

deep approaches to learning. The students should be able to relate theory in ecology of knowledge in interactions between plant and soil. To support deep approaches to learning, I decided to include some questions or exercises on the relational level on the SOLO taxonomy (e.g. explain).

Apart from supporting deep approaches to learning and keeping the students awake during the lecture, another purpose of asking questions or giving exercises during the lecture was to motivate the students to take an active part in the lecture, to give the students an opportunity to work with the theory, to obtain a more relaxed atmosphere in the classroom and to create a more dialogue-based teaching. The questions and exercises gave me an opportunity to test whether the students understood the theory I had just gone through or not.

Teaching in block three

In block three, I made hands-out to each lecture where difficult theory and terminology were explained in details to (1) support the PowerPoint presentations, and (2) help the students to understand difficult topics. The working questions and exercises were handed out to each lecture. To each lecture I included three or four exercises.

I started the first lecture by asking the students if they had read the curriculum of the day – most of them had (Fig. 9.6). After that I asked if they knew what photosynthesis is about. They all nodded. When I asked them to explain photosynthesis to their next-door neighbour it was a bit more problematic. So after buzzing for a while (none of the students wanted to explain photosynthesis to the rest), I took over and explained what photosynthesis is all about and introduced three different photosynthetic pathways (C_3, C_4 and CAM) as an introduction to the first exercise. At this point in the lecture, the students should be able to work with the first exercise (Fig. 9.1), so I introduced the first of three small pre-planned exercises in that lecture.

In this exercise they should find out and discuss with their next-door neighbour which of the leaves in the figure was a C_3-plant and a C_4-plant. (Answer: Photosynthesis takes place in the chloroplast. In C_4-plants photosynthesis takes place in the mesophyll cells and in the bundle sheath cells, whereas in C_3-plants photosynthesis takes place only in the mesophyll cells (no chloroplasts in the bundle sheath cells)). The students found this exercise difficult. That surprised me because I thought that they would have found this exercise easy. Then we went on with more theory, and I introduced the next exercise to them (Fig. 9.2). Again, they should discuss with

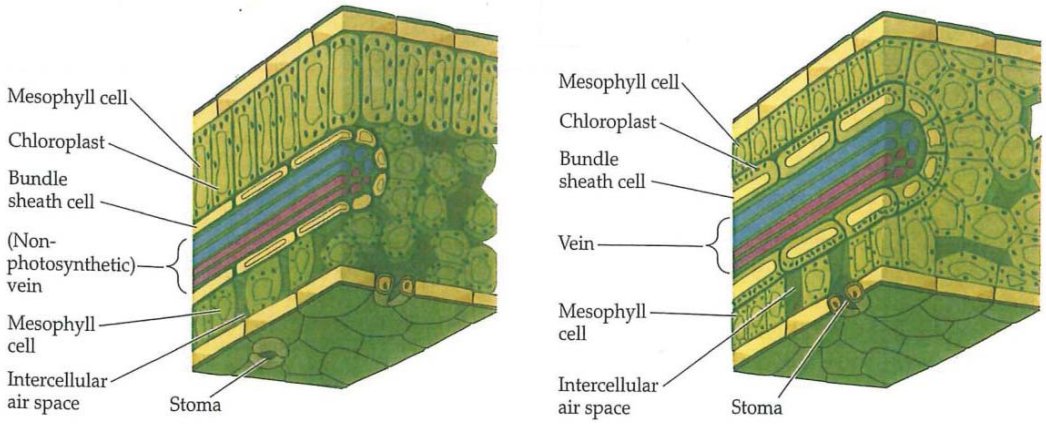


Fig. 9.1. Leaf from a C_3-plant (left) and from a C_4-plant (right).

their neighbour why (1) trees (at least most of them) are green during summer and (2) their colour changes in the autumn. This exercise was easier for the students to answer. Answer: Green in the summer because of the content of chlorophyll in the leaves. Most of the green light is reflected, and we perceive the leaves as green. In autumn the temperature is low and the light intensity reduced, and the production of chlorophyll is less than the breakdown. The red and yellow colour in autumn is caused by other pigments in the chloroplast, and these are visible when the chlorophyll is broken down.

After the lecture, I asked the students to evaluate my teaching (Fig. 9.6). About half of the students found that both the lecture and the exercises were at an appropriate level. 50 % found the lecture too difficult and 37 % found the exercises too difficult. Some of the students commented that they did not get enough instructions to solve the exercises.

The next lecture was built in the same way as the first with theory, questions and exercises. In this lecture, I had asked the students to solve an exercise before the lecture. The reason for that was to force the students to read the textbook before the lecture to be able to solve the problem and to support deep learning. To be sure that all students were able to solve this exercise (and the other exercises in this lecture), I tried hard to explain what the exercise was all about and gave them all necessary data and instructions beforehand (the exercise was about exponential growth of a population). My hope was that one-third of the students would have tried to solve the exercise at home. The original plan was to ask the students to work in small groups with the exercise. Each group should include at least one person

Fig. 9.2. Leaf colours in summer and in autumn.

who had tried to solve the exercise at home, and this person should help the rest. One day before my lecture, the students had a deadline for a written report in their other course, resulting in only two or three having tried to solve the problem. Nevertheless, I asked the students to solve the problem in smaller groups because it was a part of the planned TLA – knowing that they needed longer time than i had initially planned. The exercise was no more difficult than mathematics on the highest level in high school (which is an entry requirement for the course), however some of the students had problems solving this exercise – probably because they had not read the curriculum before the lecture. My first intension was that the students, by turns, should go through the questions at the blackboard. Because they used more time solving the problem than planned, and only a few had read the curriculum for the day, I had to go through the questions.

In the third lecture, I had tried to find some exercises at a lower level than the two first lectures. I started the lecture by asking if they knew what plant competition is about and what plants compete for. These questions were to start the dialogue and to motivate the students to take an active part in the lecture from the beginning – they came up with very good suggestions to the questions. Figure 9.3 is an example of one of the exercises from this lecture. The students were asked to plot the yield for maize grain, grown at different crop densities and levels of nitrogenous fertilizer, and discuss the influence of crop density and fertilizer level on yield with their next-door neighbour. After some time, I asked if someone would like to explain the figure to the rest of the class. The students got feedback to their answers, and finally, I explained the figure to the students.

In the end of this lecture, I had an empty slide and asked the students to review what they had just learnt. This activity was included to give the students an opportunity to ask questions and to explain, and we briefly discussed their suggestions. I wrote the points down on the slide and compared it to my own summary. There was a very good accordance between the two slides.

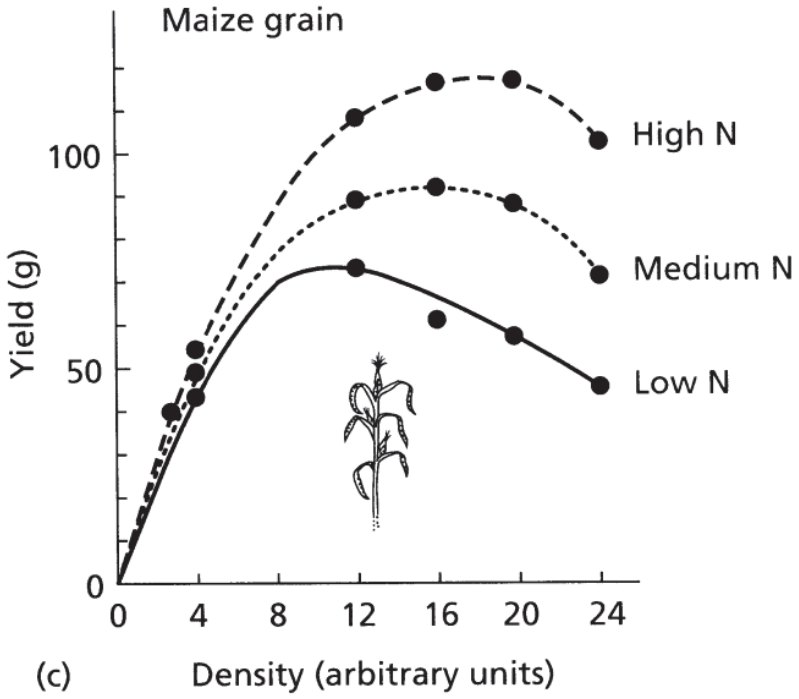


Fig. 9.3. Grain yield of maize grown at five crop densities and three nitrogenous fertilizer levels.

Teaching in block four

In block four, I supposed that the students would find the topics more relevant. In this block, the lectures were followed by exercises with the same topic as the lecture. Because of the following exercises, I had changed the teaching in both lectures from small exercises to be more dialogue based than it was in block three. In the exercise after the first lecture, the students were going to make a kind of puzzle and to identify living plants typical from the heath. In the second exercise, the students were introduced to a field experiment (relevant for the exercise), and afterwards they were asked

to collect and identify as many weed plants and plants from the hedges as possible.

In the first lecture (heath and grassland), and I started the lecture by asking the students: Do anyone of you come from Jutland? Some of the students did, and I asked them to explain to the rest what a heath is (why is a heath more common in Jutland than in the rest of Denmark, which kind of vegetation do we find and questions like that). The rest of the lecture shifted between theory and open questions and dialogue. During the lecture, the students were introduced to figure 9.4 which was a part of the following exercise (puzzle). In this exercise, the students were asked to place cards – with pictures (like figure 9.5) of the mentioned plants in figure 9.4 – in the right place (no plant names on the cards). Some of the plants were part of the examination requirements. For these plants, the students should make a list with the characteristics and the names of both the plant family and the species (ILO-TLA). At the following written examination, one of the main questions dealt with heaths and the TLA from figure 9.4.

The second lecture (weeds, small biotopes and hedges) took place at the university's research farm, Højbakkegård. I used almost the same method as the first lecture, starting the lecture by asking the students how to define weeds. Early in the lecture, I introduced the students to the field experiment in which they were going to collect weed plants during the exercise. The introduction to the field experiment was more or less case-like. The students were asked to consider the following problem: Politicians have decided to (1) reduce the use of pesticides, (2) increase the area with organic farming, and (3) reduce the emission of greenhouse gases (real goals in the Grøn vækstplan).

The case: How can we help the farmers to fulfil these goals?

Some of the slides are translated to English and listed in Appendix A. The slides were presented as open questions to the students, discussed in plenum and followed up by examples from the real world.

The rest of the lecture shifted between theory and dialogue-questions, interrupted by circulating living plant material in the class, giving the students an opportunity to see the plants we had just been talking about in real life and not only on a slide.

In the following exercise, all the plants collected from the field and the hedges should be arranged in the right plant families. Finally, the plants were gone through together with one of the teachers to be sure that all the students knew the right names of the plants.

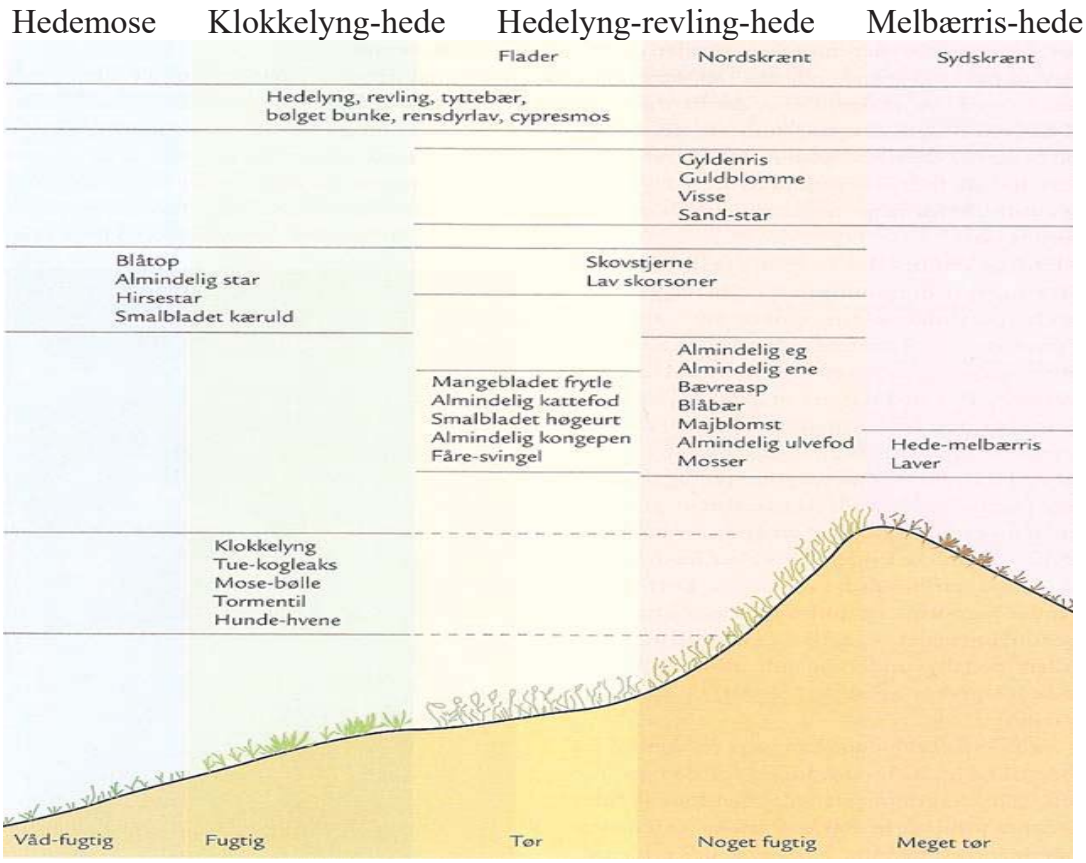


Fig. 9.4. Different plant species are related to specific areas in the heath – depending on topography and humidity conditions.

Evaluation

To evaluate and improve my own teaching, I asked the students to complete a questionnaire after some of the lectures in block three (Fig. 9.6) and after the last lecture in block four (Fig. 9.7). The evaluation includes my own reflections and comments from my departmental and pedagogical supervisors, too.

My concern before block three about the large curriculum, the many different topics, several textbooks, written exercises and many different teachers was confirmed by the following course evaluation after block three (non-official questionnaire worked out by the course coordinators), where not only these things were criticized but also the basic ecology (among other subjects).

My own evaluation after block three showed that 50 % of the students found the first lecture difficult and 37 % found the exercises difficult (Fig.

Fig. 9.5. Card example to the puzzle showing a detailed drawing of common heather (*Calluna vulgaris*) on one side and a picture on the other side of the card (no plant name on the card).

9.6). Though many students found the exercises difficult, 95 % liked being asked questions during the lecture, 74 % thought that they learnt more because they had to answer questions or exercises, but only 26 % thought they were more active because they knew that they were going to answer questions during the lecture. I had expected a higher percentage here. Some of the comments to my teaching were that I should decrease the number of slides, that I spoke too fast and not loud enough and that they needed more instruction for the exercises. For the next two lectures, I borrowed a microphone, I tried to speak more slowly, and I was very much aware of explaining what the exercises were about and to give all necessary information. According to figure 9.6, more students found both lecture and exercises easier in lecture two and three than in lecture one. I still have to work on finding the right level. A test before the first lecture, checking their previous knowledge of the topics, could have been a possibility to adjust my teaching to their knowledge. Because the students had a written report due the day before my lecture number two, only 35 % had read or looked over the curriculum for the day and only a few had tried to solve the exercise – as I had asked them to do – before the lecture. This could explain why

A. Did you read/look at the curriculum for today before the lecture?			
Lecture no	Yes	No	
1	61	39	
2	35	65	
3	27	73	
B. Did you find the lecture difficult?			
Lecture no	Easy to appropriate	Appropriate to difficult	Useless answers
1	50	50	
2	60	30	10
3	92	8	
C. Do you like being asked questions during a lecture?			
Lecture no	Yes		
1	95		
D. Do you think that you were more active during the lecture because you knew that you were going to answer questions?			
Lecture no	Yes	No	Do not know
1	26	58	15
E. Do you think that you have learned more because you had to answer questions?			
Lecture no	Yes	No	Do not know
1	74	13	13
F. What do you think about the exercises (degree of difficulty)?			
Lecture no	Easy to appropriate	Appropriate to difficult	Other answers
1	58	37	5
2	70	15	15
3	86	0	14

Fig. 9.6. Extract of some the results from the two questionnaires the students were asked to complete during block three (after lecture one (38 answered) and lecture three (37 answered)). The numbers in the table are percentage of usable answers for each question (some of the possible answers to the questionnaire are pooled (question B and F)).

15 % of the students found the exercises difficult in lecture two. Though the students had not worked on the exercise at home, they worked actively with the exercise in small groups in the class. The exercise did not turn out exactly the way I had expected. We spent more time than planned to solve this exercise, but it will not prevent me from asking students to solve exercises at home in the future. I have learnt that it is important (1) to coordinate homework, both within the course and with other parallel courses, to avoid loading the students with unrealistically high homework pressure, and (2) to include extra time within the lecture to solve the exercise (in case the students have not looked at the exercise at home).

Instead of sitting passively listening, the exercises and learning by doing did increase the students' attention because they had to work with the theory I had just gone through. Most of the students liked questions or exercises

A. Did you like the textbook (Vegetationsøkologi)?			
	Yes	No	No answer
	61		39
B. Did you read/look at the curriculum for today before the lecture?			
Lecture no	Yes	No	
1	41	59	
2	100		
C. Did you find the lecture difficult?			
Lecture no	Easy to appropriate	Appropriate to difficult	
1	100		
2	100		
D. Did you learn what you expected?			
Lecture no	Yes	No	Do not know/no answer
1	71		29
2	78		22
E. What do you think about the exercises?			
Lecture no	Number of students that made comments.		
1	13 found the exercise from good to very good, 4 found that the quality of the some of the pictures was not good enough, 2 found it difficult because they did not know so many plants, 1 would have found the exercise more relevant if it had only included curriculum species, 2 that there were too many pictures, 1 did not have time enough to the hole exercise but liked this kind of exercises.		
2	15 found the exercise from nice (cosy) to very good, 1 found it a bit boring but liked to see the research area, 3 would have liked more time, 1 that it was nice that they had the opportunity to ask questions and get answers during the exercise, 2 that it was nice to collect plants themselves, 3 liked the summary of the plant names in the end of the exercise.		

Fig. 9.7. Results from the questionnaire the students were asked to complete after the second lecture in block four (18 answered). The numbers in the table are percentage of answers for each question except question E, where it is the number of students commenting the question (some of the possible answers to question C are pooled).

during the lecture and felt that they learnt more. It is my impression that all students were active in solving the exercises and many – though not all – were active when they had to participate in the following discussions in plenum. In the future, I will continue including short exercises in my teaching to support the ILO, but I will try harder to find subjects more relevant to the students' field of activity. A challenge I see using (small) exercises during the lecture is that (1) the flow of the lecture is interrupted (which of course can be the intention, to revive the students' attention) and it can take some time to get the attention and the students back on track again, (2) in large classes it can be difficult to get around and help all groups

if you are the only teacher, and (3) students need different amounts of time to solve problems – fast students or groups can disturb or cause stress for slower working students. Offering the fast working students and groups extra questions could be a solution – the answers to be explained by the groups to the rest of the class later in plenum. This could prevent private talking, surfing on the internet and walking in and out of the class, but one should have in mind that not all students see extra questions as an advantage.

Changing the teaching from teamwork exercises in block three to a more dialogue based teaching with many open questions to the whole class in block four worked very well, and the atmosphere in the class was relaxed. It is my impression that the students found the topics easier, more interesting and relevant to them. More students than I had expected participated in the discussions. I think the reason is that none of the students found the lectures difficult in block four (Fig. 9.7) and therefore they were not reluctant to participate in discussions and in answering questions. Early in the lectures, the students were presented with the ILO and introduced to the TLA that followed later in the exercises (Fig. 9.4 and 9.5, and the case). This made a good coherence between the lectures and the exercises.

Conclusion

Introducing questions and small problems that have to be solved during a lecture does involve students more in the lecture. The strategy gives the students the opportunity to think and work with previous and new knowledge by discussing problems with other students and the teacher. It also reveals what was unclear in the lecture. I felt that the students were more active and their learning was changed from passive (surface) learning to a more active and deeper learning. A test before the first lecture in block three could have matched my teaching with the students' previous knowledge better in this block and increased the students' output of the teaching. This should ask the students to review what they have learnt during a lecture, give the students a possibility to think, reflect and explain in their own words what they think was the learning outcome for the lecture. I will definitely use this again in my lectures. I think that the students were more active than usual in this course. Despite that, I am not sure that it is realistic to believe that all students will be actively involved in all teaching during a lecture in classes with many students. The students expressed that they liked being

asked questions during the lecture and that they learnt more. My personal impression is that (1) all the students worked with the exercises though some of the exercises were a bit too difficult, (2) more students participated in discussions when the topics were easier, or they found the topics more relevant, and (3) the contact among the students were closer, and the atmosphere in the class was more positive and relaxed when the teaching was more dialogue based. My experience is that it is very important to think and reflect on which kind of TLA is appropriate in a given teaching situation and to explain in details what the exercises are about. I will continue my teaching method of switching between questions, discussions and small problems. To increase the number of students taking part in the lecture, I will start the lecture with some easier questions, and I will include more time in the lecture for students to think and work with questions and small problems.

A Case from lecture two in block four

"Case" and introduction to field experiment

"Grøn vækst plan"

Goals:

Reduce the use of pesticides

Increase the area with organic farming

Reduce the emission of greenhouse gases

→ 70 % of the pesticide use are herbicides!

How can we help the farmers to fulfill these goals?

What can the farmer do?

Heat treatment or mechanical weed control

Alternative

Increasing the competitive ability of the crop

No reduction in emission of greenhouse gases

Plant competition

Cereal crop plant advantage:

1) Crop seeds/seedlings are usually larger than weed seeds/seedlings

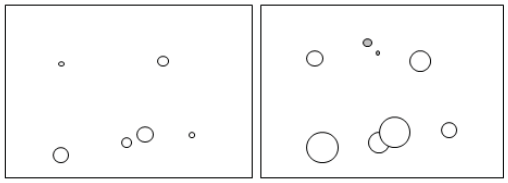
2) Crop plants normally germinate quickly after sowing

"Size-asymmetric competition":

Larger plants often have a disproportionate advantage in competition with smaller plants , i.e. that larger plants receive a disproportionate share of resources relative to their size than smaller individuals.

Plant competition

Above ground competition - light

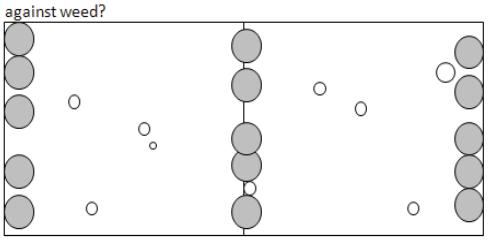


Time 1 Time 2

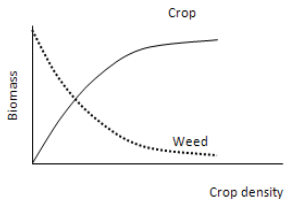
Part of a cereal crop field

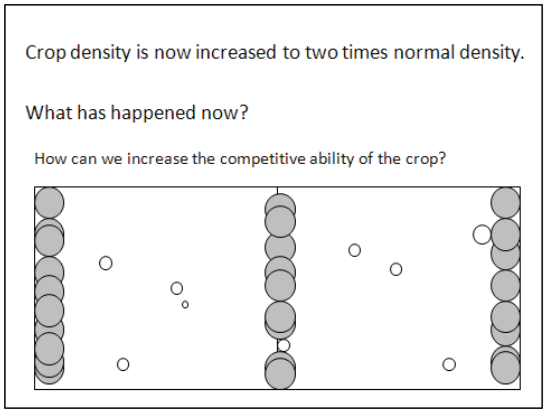
White circles are weed plants. Grey circles are crop plants sown at **normal crop density in a row pattern**.

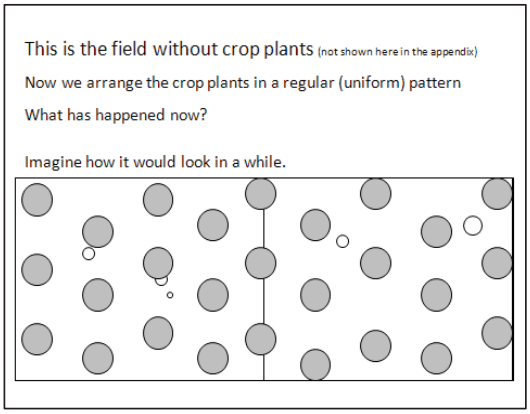
Is the crop a good competitor against weed?
What do you expect will happen if the farmer is not allowed to spray against weed?

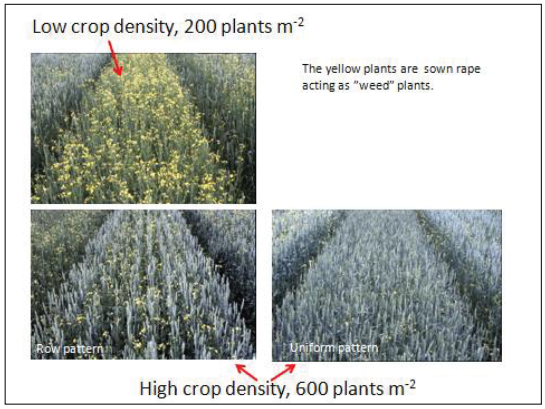


Relationship between biomass and crop density









(This is not the original slide but a combination of three slides)

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