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Activation and motivation of students in Seed Science and Technology for improved learning using interactive lecturing

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Introduction

In 2010, I taught on the Seed Science and Technology course twice; in October, my teaching was a special edition of the course designed for a group of Egyptian students and scientists (six persons). In December, I taught on the regular version of the course for a mixed group of Danish and foreign students (twenty persons).

Seed Science and Technology is a joint BSc and MSc course, where many teachers are involved. I teach the specific part called: "Maintenance of genetic purity and identity using biotechnology methods to identify gene manipulated crop (GMO) seeds". The time schedule for this part is very strict as it is composed of only three half days in which, besides lectures, a laboratory exercise has to be conducted.

Previously, I had taught the course twice, in 2007 and 2009. My general experience was that the laboratory work motivated the students to a high degree as the students were very active and dedicated during that part, but not so much during the lectures. In 2009, I designed the teaching part myself and one of my goals was to motivate and activate the students more, especially during lectures, as I felt that was needed after teaching according to the course plan that was handed out in 2007. Hence, in 2009, I incorporated a student assignment on GMO legislation in EU which led to a general GMO debate, but still only few students, typically the Danes, participated actively. So I still felt I needed specific tools to motivate the students even more to promote deep learning. After I had taken the theoretical part (KNUD) of *adjunktpædagogikum* (Higher Education Teaching and Teaching Practice Programme), I tried to apply specific pedagogical tools in the 2010 course.

Problem definition

I will try to plan the lecture as an interactive lecture. The students will have access to some background literature and some web pages concerning GMO legislation in EU in advance, to be introduced to the subject and inspired to form an opinion. When the students arrive, I will give them an outline of the day, and afterwards they will be given some small assignments that they will work on in teams. Later, the students will try to provide answers to the given questions and this will then open up for a debate. My intentions are to focus on the basic concepts and to use inspiring examples or case studies known from the media, where the students in pairs rather than groups (to increase the activity of the individual student, as it is more easy to "hide" in a group) will discuss or buzz on small topics and maybe use a quiz or take a vote as activating tools.

My vision is to make the students capable of reflecting on both the application and ethical aspects in relation to GMO seeds and plants.

Will a more interactive lecture form, e.g. group work and small assignments, increase the activity level of the students in the GMO debate?

– for whom and why?

Will the students be able to use some of the knowledge they obtained about GMO purity in laboratory work in this debate? (Is deep-learning stimulated?)

What impact will this lecture type have on the Egyptian students vs. the mixed student groups?

– will there be a difference?

Theoretical part: The interactive lecture vs. the traditional lecture as teaching form

Traditional lecture

My definition of a traditional lecture is a lecture where the teacher presents scientific facts (usually) to a larger group of students. This teaching format has for several centuries been the dominant teaching form at universities around the world. The traditional lecture is a monologue and the teacher might succeed in getting the students to learn concepts and to identify a procedure. However, it can often be very difficult for the student to get a qualitative level of understanding solely from lectures. On the other hand, traditional lectures are very time and cost efficient as a large amount of students (several hundreds) can be taught at the same time by one teacher. This fact is an important aspect when planning the teaching of a course. However, the last decades have shown that other formats of lectures might improve the students' deep learning (see below).

Interactive lecture

Before planning the interactive lecture format, I browsed the literature based on what I had learned through the KNUD course part, and the chosen theoretical aspects are discussed in the following paragraphs. Based on observations made by Eric Mazur, a teacher at Harvard University, an interactive teaching format was developed in the late 1990s (Crouch & Mazur; 2001; Mazur; 1996). One of the starting points was that Mazur tested his students and found that they relied on memory rather than understanding. Mazur then applied multiple-choice questions, the students' answers were recorded electronically by "clicking" the answers, and the total outcome of the results was shown on a screen. Afterwards, the students discussed their answers with neighbouring students that answered differently and they elaborated their answers together. Mazur aimed for a high level of understanding and stimulated the students by using student activities like discussing novel problems and application of knowledge gained from reading. Collectively, these activities should improve the students' deep learning (higher student retention rates) as shown in the lower sections of the Learning Pyramid (Fig. 7.1).

Similarly, other teachers like David Yamane were also annoyed by the inefficiencies of lecturing, as the students did not read when they were told to. Hence, he posted course preparation assignments on the course web page before the lectures (Yamane; 2006). Mazur and Yamane both experienced that the interactive lecture format stimulated the students' learning as they became motivated and enjoyed it. However, Mazur and Yamane were also aware of the potential class size limitation for using this lecture format and mentioned the limits to be in the range of 30-80 students. Another important aspect in promoting deep learning for the students is to change the teaching activities often. Bligh (1972) found that student concentration flags after approximately fifteen minutes, particularly if the teaching ac-

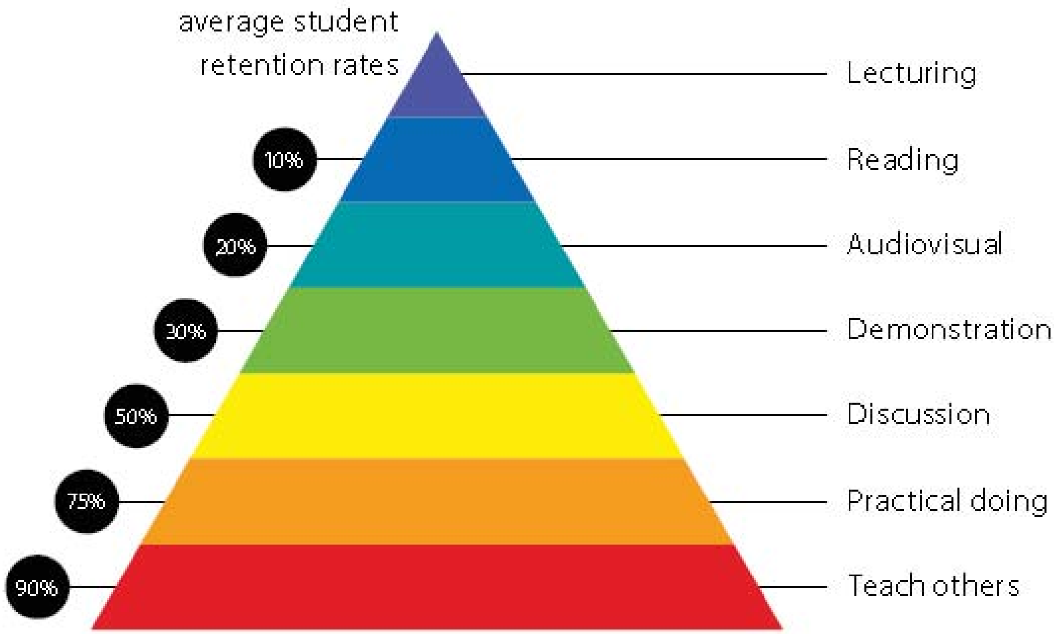


Fig. 7.1. Learning Pyramid. National Training Laboratories, Maine, USA.

tivity is listening (Fig. 7.2). The teaching activities can be changed by, for example asking the students questions, providing them a case study to work on, and letting them reflect on what they have learned, which will increase the students' focus (Fig. 7.2).

In the following scheme (Fig. 7.3), I have compared and reflected on some positive (+) and negative (-) basic aspects of the traditional and interactive lecture that I found important when I planned my lectures.

Lecture planning

Based on my abovementioned observations on how the students perceived the traditional lectures that I gave at the seed science course when I taught it in previous years and the potential theoretical benefits, I planned an interactive lecture.

My teaching part in the seed science and technology course is divided roughly equally between lectures and exercises. In order to vary the teaching type and output to keep the attention of the students, first of all, I decided to divide the exercise part into segments and separate them out on

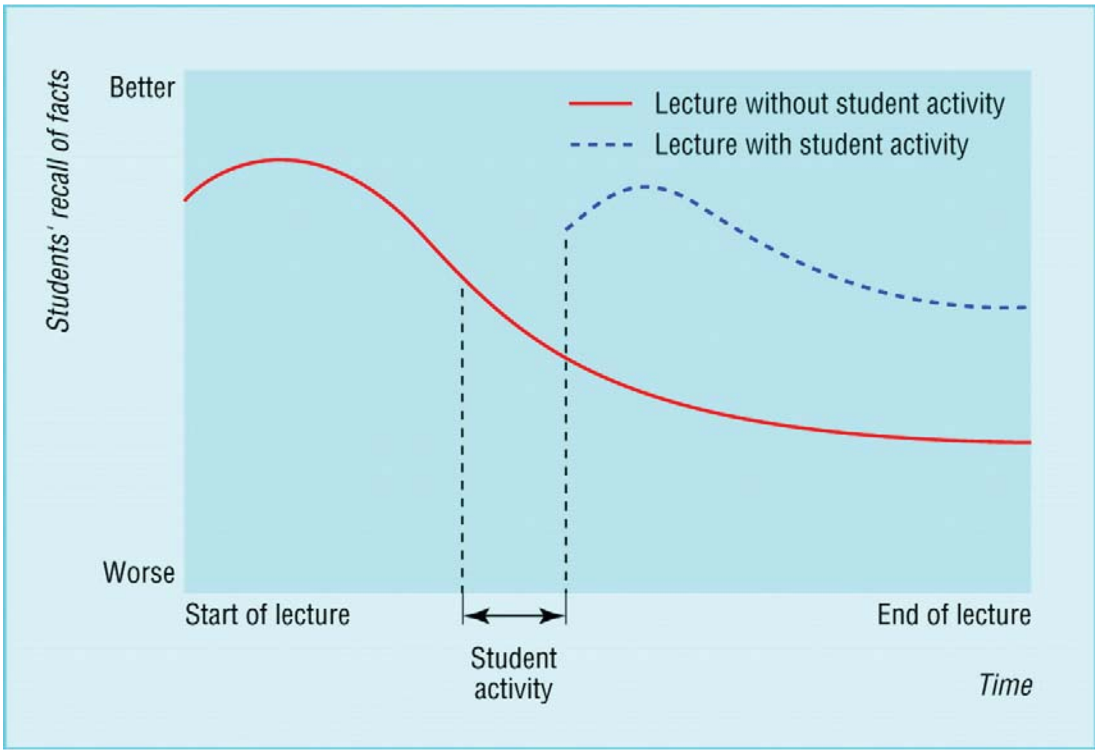


Fig. 7.2. Student learning over time and how to improve it. Modified from Bligh (1972).

Traditional lecture		Interactive lecture	
+	-	+	-
Time & cost efficient Many students can be taught at the same time			Longer preparation time for the teacher. Smaller classes
Delivery of facts and scientific concepts	No application of facts and scientific concepts	Application of facts and scientific concepts	
	Passive teaching / monologue	Active teaching / dialogue	
		Deep learning	

Fig. 7.3. Basic aspects of the traditional and the interactive lecture.

the three course days (see course part plan for the regular course in Appendix A). Next, I applied a concept gradient of my ownership of the teaching, gradually going from "hands on" to "hands off" during the time span of the lecture parts. This meant that the introduction lecture was a traditional lecture that was monologue-based. The second lecture was interactive, whereas the last "lecture" was solely based on input and presentations from the students. The planning and reflections of the three lectures will be discussed more thoroughly below.

Planning the introduction and traditional lecture

As this lecture was an introduction, it was controlled with "hands on" from my side. I felt that this would be the most efficient method to introduce the course plan and the topic itself to the students and to deliver some scientific facts and basic concepts. However, time was set aside to answer questions and the students were allowed to interrupt if they had questions popping up. Approximately one week prior to my part of the regular course, I uploaded the programme as a bulletin on the course web-page at Absalon, stating that the students should read and bring the plan for this part. Moreover, non-compulsory background literature was uploaded as well.

Planning the interactive lecture

This lecture started with an "exercise sum-up", where specific questions were given to the students in respect of what they did in the lab on the first day. After that, I presented a case study covering some of my own research on how compact potted plants can be produced by using three different GMO methods as an environmentally friendly alternative to chemical growth retardants. For each of the methods, some specific features were presented (Appendix B) and the students were asked to give an opinion regarding whether they were for or against the specific feature. To do so, the students were given green and red sheets, to hold in the air to indicate their opinion, "for" or "against", respectively. This feature was chosen as a representative for the "clickers" Mazur used, mentioned above. Moreover, the students were given time to elaborate on their answers. The case study ended with a question asking the students to prioritize the three methods which led up to a discussion if or where general ethical lines can be set (Appendix C). After the interactive lecture, a student assignment was given on EU GMO regulation (Appendix D) forming the basis for the student presentation lecture (see below).

Planning the student presentation lecture

Again, the lecture started with an “exercise sum-up”, where specific questions were given to the students in respect to what they did in the lab the last time. A student assignment was given on EU GMO regulation (Appendix D) forming the basis for the student presentation lecture, where the students were divided into teams. My idea behind the student presentation lecture was to give the students the opportunity to introduce themselves to the three phases in EU GMO application by giving them an internet link and providing them with possibilities to find answers to the questions mentioned in Appendix D. Furthermore, due to peer supervision feedback, I included a case study on “transgenic cotton” (Appendix D). In the case study, the teams were asked to provide opinions from the respective viewpoints of a biotech company, the EU and the public. The overall purpose was to see how at the end of the course the students would be able to apply their knowledge to discuss relevant aspects regarding the scientific subject with only minimal interference from me.

Results

When I started to give the introduction lecture in the regular version of the course, I experienced that it was difficult to catch the attention of all the students as some kept on talking. Hence, I deviated a bit from my plan by asking questions of the students, this caught their attention and I kept on asking short questions with an interval of some minutes. In contrast, on the Egyptian version of the course, all the students listened carefully from the beginning. The majority of the course participants at the regular version of the course had actually read the programme in advance – in contrast to other years, where I did not specifically ask them to do so – which helped their understanding of the course part. (As the Egyptian students are not enrolled at the University of Copenhagen, the programme was handed out on the first day).

In the interactive lecture, I found that the experimental sum-up was a very good idea to start with, as I quickly discovered which aspects I needed to address more thoroughly to improve the students’ understanding. During the case study part, where the students were asked to provide their opinions on specific features, I experienced that several of the students on the Egyptian version of the course were looking around sort of trying to figure out what the “right opinion” would be to that specific feature. In contrast, at the regular course the students actively elaborated on their opinions and discussions were initiated.

For the student presentation lecture, my overall feeling was that it was a bit difficult for some of the students attending the Egyptian version of the course to be able to present the essential features specific to the three GMO approval phases in EU. When the students were preparing themselves, I experienced that it sometimes was difficult for them to navigate around the various links at the homepage. However, the Egyptian students were highly motivated in presenting the cotton case study. On the regular version of the course, I found that the students were very active in both the legislation part and the case study. Several had prepared PowerPoint presentations, even though it was not mandatory.

Evaluation and conclusion

To obtain information on how the students perceived my teaching, I constructed the evaluation scheme shown in Appendix E. The answers of the Egyptian students and the regular students are highlighted in blue and pink, respectively.

As the Egyptians in their home country are only used to traditional one-way directed lectures, I felt it was very important to ask them how they perceived the interactive lecture format. Rather contrary to my initial expectations, 87% of the Egyptian students preferred the interactive lectures. However, when I discussed the interactive lecture format with the Egyptian students they elaborated and said that at first they found the format a bit annoying, but gradually they felt they gained more knowledge that way. At the regular version, most students also favoured the interactive lecture, but some also mentioned that there should be a mix between interactive and traditional lectures.

The majority of the students on both versions of the course mentioned that they had learned both the basic molecular and legislation concepts for GMO and plants. The majority stated that they liked the laboratory part best, but whereas all the Egyptians found that the lab work was most important, a large part of the students at the regular course found that the discussions were important as well.

In respect to what should be improved, their answers were more varied, but a few mentioned lectures, so I will develop these further next year.

In conclusion, the majority of the students on both versions of the course favoured interactive lecturing over traditional lectures, and it stimulated their activities and they were able to participate more actively in the discussions than what I experienced when I taught at the course previously.

Perspectives

The students at the Seed Science and Technology course are usually an equal mix of Danish and foreign students, as mentioned above. This feature often provides a good forum for interactive lectures as debates and discussions due to different backgrounds and opinions from the students are easy to initiate. Hence, it was pleasing to experience that a homogeneous group of students from Egypt also favoured this lecture format, even though they have only experienced traditional lectures. However, when comparing the Egyptian version of the course with the other times I taught at the course with a mixed group of students, I feel that certain precautions are necessary. For instance, I think that on all the courses I teach in the future I will use slightly different versions of lectures depending on the composition of the participating students, as I believe that small adjustments can improve the learning outcome without too much effort by the teacher. In the problem definition, I stated that I would let the students work in pairs rather than groups. However, the groups already formed in the course consisted of two or three persons, so I decided to keep this structure, and I experienced that the students collaborated very well within these groups.

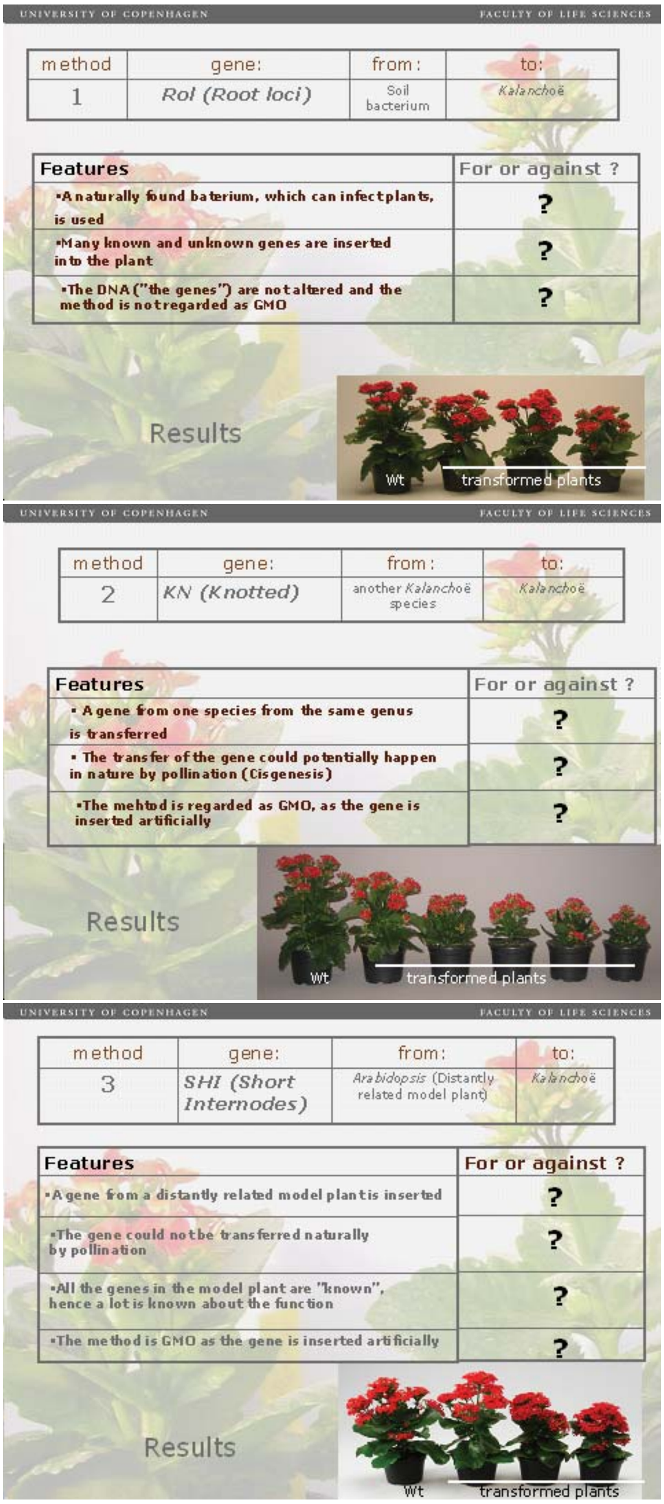
A Course part plan

Tuesday 12/10	*Programme*	*Location*
8.45-9.45	Introduction to the exercise: Extraction of seed DNA The principle behind polymerase chain reaction (PCR)	P11
9.45-10	Small break	
10-12	*Exercise:* Purify DNA from seeds using 2 extraction methods	Laboratory #15

Friday 15/10	*Programme*	*Location*
8.45-9.45	*Exercise:* Set up PCR	Laboratory #15
9.45-10	Small break	
10-11	Interactive lecture: *Molecular breeding in ornamentals as an alternative to chemical growth retardants* *Which method do you prefer and why?*	18.01
11-12	Student assignment will be given: EU GMO regulation at: http://www.gmo-compass.org/eng/regulation/regulatory_process/	18.01

Monday 18/10	*Programme*	*Location*
8.45-9.45	*Exercise:* Making gels, running gels	Laboratory #15
9.45-10	Small break	
10-11	Student presentation of the EU assignment GMO discussion	18.01
11-12	*Exercise:* Evaluate experiment	Laboratory #15

B



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method
gene:
from:
to:
1
Rol (Root loci)
Soil bacterium
Kalanchoë
Features
For or against ?
•A naturally found baterium, which can infect plants, is used
?
•Many known and unknown genes are inserted into the plant
?
•The DNA ("the genes") are not altered and the method is not regarded as GMO
?
Results
Wt
transformed plants
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method
gene:
from:
to:
2
KN (Knotted)
another Kalanchoë species
Kalanchoë
Features
For or against ?
• A gene from one species from the same genus is transferred
?
• The transfer of the gene could potentially happen in nature by pollination (Cisgenesis)
?
•The mehtod is regarded as GMO, as the gene is inserted artificially
?
Results
Wt
transformed plants
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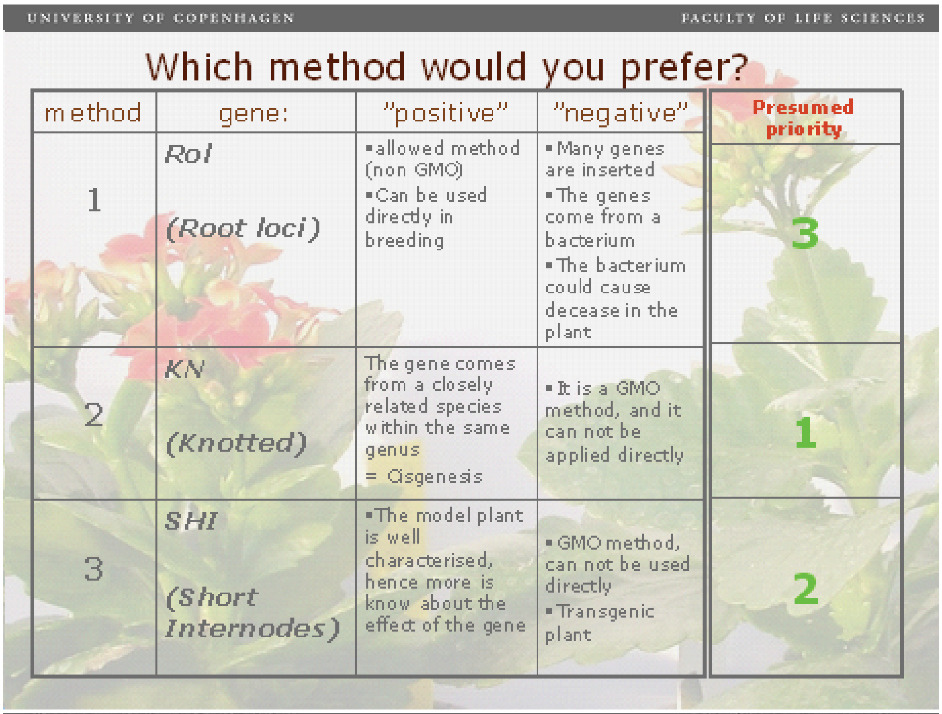
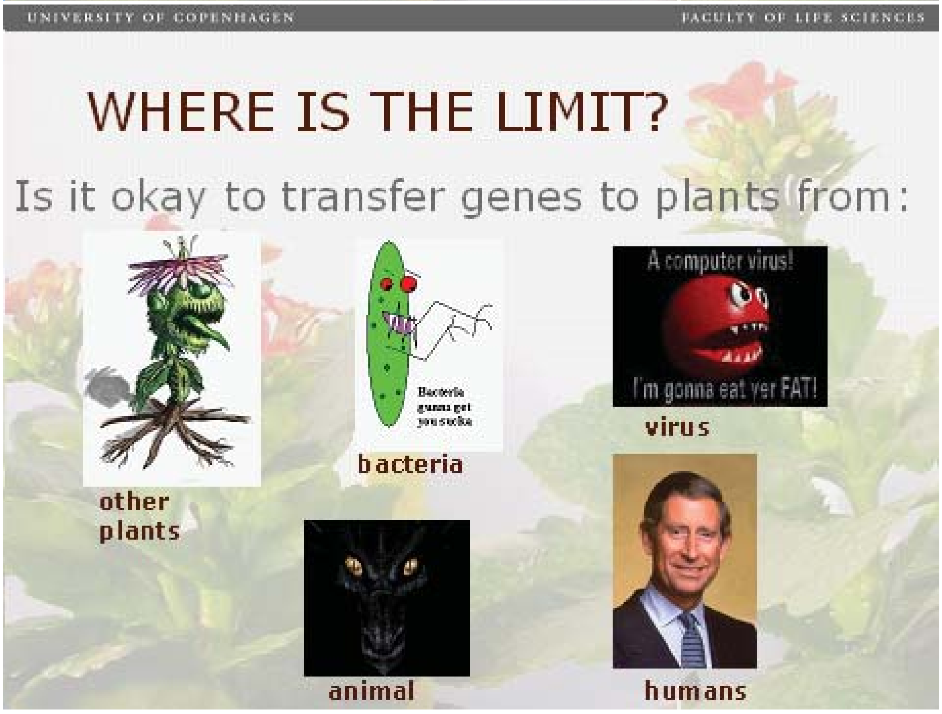
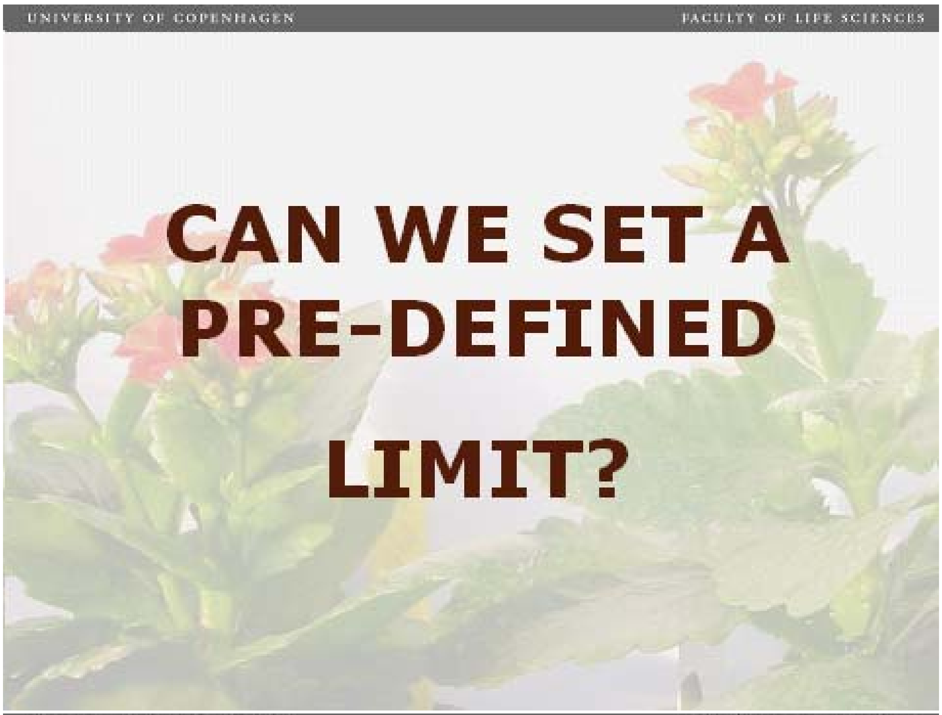
method
gene:
from:
to:
3
SHI (Short Internodes)
Arabidopsis (Distantly related model plant)
Kalanchoë
Features
For or against ?
•A gene from a distantly related model plant is inserted
?
•The gene could not be transferred naturally by pollination
?
•All the genes in the model plant are "known", hence a lot is known about the function
?
•The method is GMO as the gene is inserted artificially
?
Results
Wt
transformed plants

C



method	gene:	"positive"	"negative"	Presumed priority
1	*Rol* *(Root loci)*	▪allowed method (non GMO) ▪Can be used directly in breeding	▪Many genes are inserted ▪The genes come from a bacterium ▪The bacterium could cause decease in the plant	3
2	*KN* *(Knotted)*	The gene comes from a closely related species within the same genus = Cisgenesis	▪It is a GMO method, and it can not be applied directly	1
3	*SHI* *(Short Internodes)*	▪The model plant is well characterised, hence more is know about the effect of the gene	▪GMO method, can not be used directly ▪Transgenic plant	2

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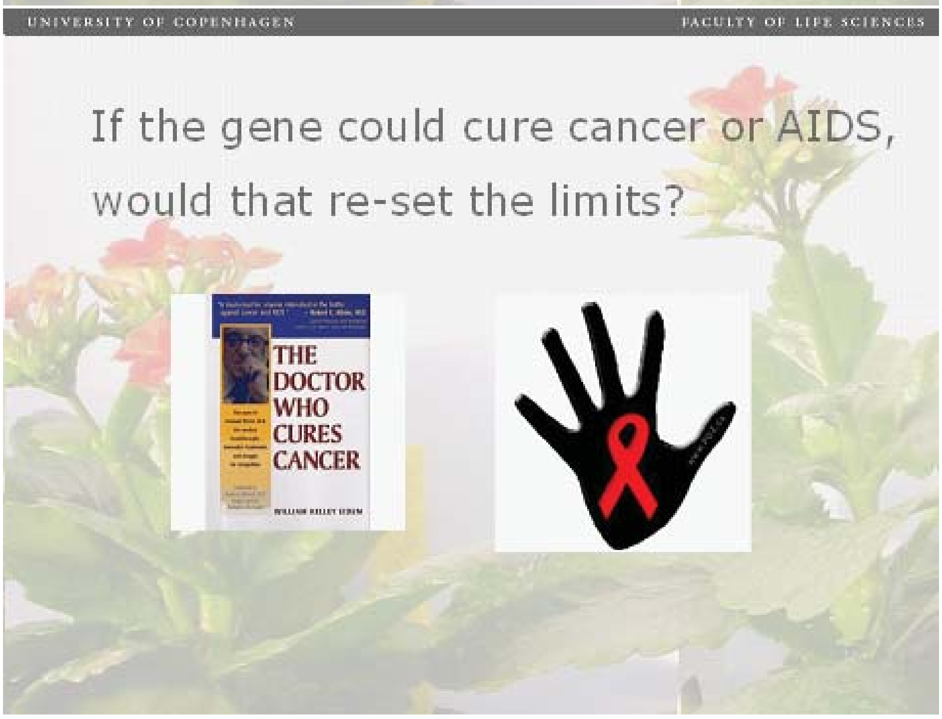
CAN WE SET A PRE-DEFINED
LIMIT?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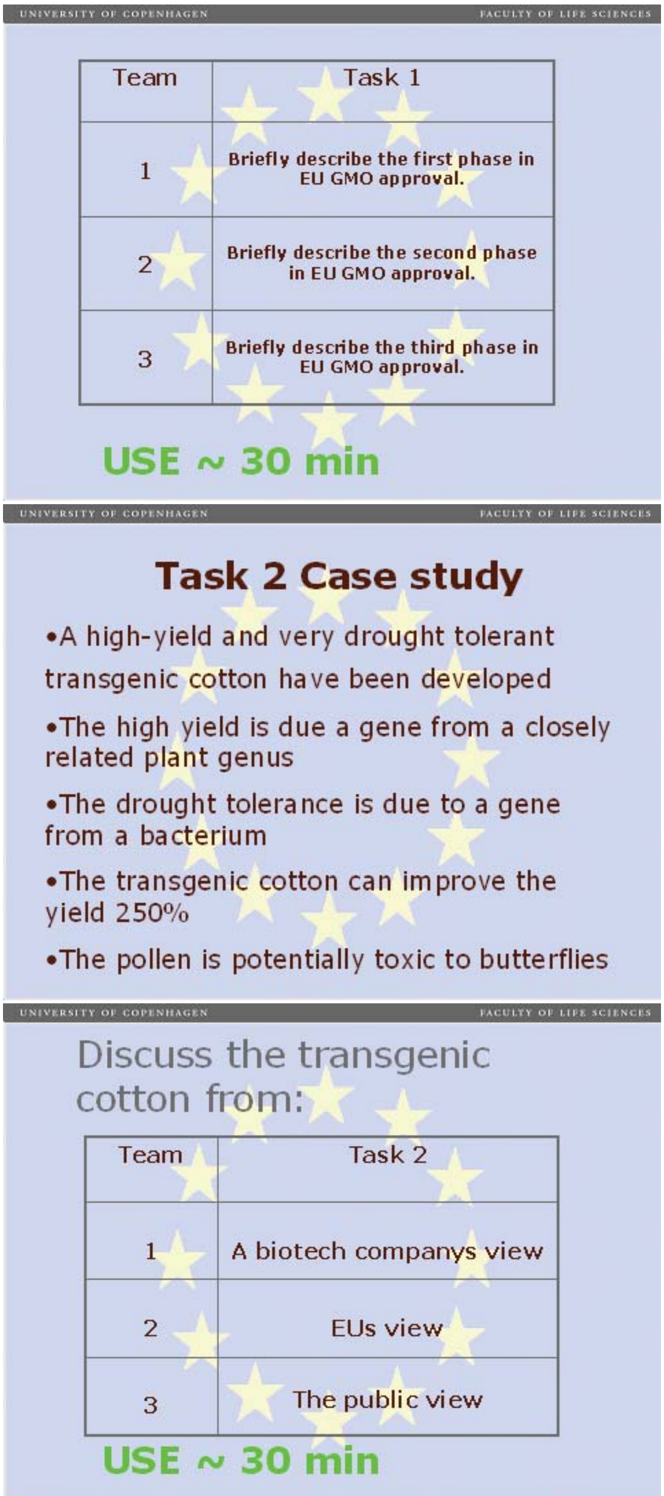
If the gene could cure cancer or AIDS,
would that re-set the limits?
THE DOCTOR WHO CURES CANCER

D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Team
Task 1
1
Briefly describe the first phase in EU GMO approval.
2
Briefly describe the second phase in EU GMO approval.
3
Briefly describe the third phase in EU GMO approval.
USE ~ 30 min
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Task 2 Case study
•A high-yield and very drought tolerant transgenic cotton have been developed
•The high yield is due a gene from a closely related plant genus
•The drought tolerance is due to a gene from a bacterium
•The transgenic cotton can improve the yield 250%
•The pollen is potentially toxic to butterflies
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Discuss the transgenic cotton from:
Team
Task 2
1
A biotech companys view
2
EUs view
3
The public view
USE ~ 30 min

E Evaluation of the GMO course part

Did you learn the basic molecular concepts for GMO and plants?
Egyptian: yes: 6/6=100%.
Regular: yes: 10/14=71.4%, no: 2/14=14.3%, did not participate all days: 2/14=14.3%

Did you learn the basic legislation concepts for GMO and plants?
Egyptian: yes: 5.5/6= 92%, no: 0.5/6=8%
Regular: yes: 12/14=85.7%, not answered: 2/14=14.3%

What did you like in particular?
Egyptian: lab work 5/6=83%, GMO legislation: 1/6 = 17%
Regular: lab wok: 10/14=71.4%, GMO legislation: 3/14=21.4%, student presentation: 1/14=7.1%

Which aspect did you find most important?
Egyptian: lab work 6/6=100%
Regular: lab work: 7/14=50%, discussions: 6/14=42.9%, not answered: 1/14=7.1%

What do you think should be improved?
Egyptian: lectures: 2/6 = 33.3%, more material: 1/6=16.6%, nothing: 1/6=16.6%, PCR protocol: 1/6=16.6%, homework and more material: 1/6=16.6%
Regular: nothing: 9/14=64.3%, nothing/really good: 1/14=7.1%, more time: 3/14=21.4%, lectures (GMO legislation), 1/14=7.1%

Did you like the interactive lecture format or would you prefer traditional lectures?
Egyptian: interactive: 5/6= 83%, traditional lecture=17%
Regular: interactive: 11/14=78.6%, a mix of both: 2/14=14.3%, only used to traditional lectures in home country, but found the interactive lecture interesting: 1/14=7.1%.

Rate the course part:

Bad	Room for improvement	Okay	Fine	Excellent
		Regular: 1/14=7.1%	Egyptians: 2/6= 33.3% Regular: 10/14=71.4%	Egyptians: 4/6= 66.7% Regular: 3/14=21.4%

Other comments:

Egyptian: none: 66.6%, more time for understanding: 16.6%, more handouts: 16.6%,

Regular: none: 11/14=78.6%, more PCR theory: 1/14=7.1%, less PCR theory: 1/14=7.1%, address organic seeds: 1/14=7.1%.

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/2010-3-1/

The bibliography can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/kapitler/2010_vol3_bibliography.pdf/