PROCEEDINGS: TEACHING@ST SPRING 2019

11 JUNE 2019

AARHUS UNIVERSITY
SCIENCE AND TECHNOLOGY LEARNING LAB

Learning Lab

Teaching@ST celebrates the end of the Teacher Training programme and the Science Teaching programme with a mini conference on teaching at Science and Technology. The purpose of the conference is to inspire exceptional teaching.

The conference is held by ST Learning Lab, the educational development centre of Science and Technology, Aarhus University.

For more information visit: stll.au.dk

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CONFERENCE PROGRAMME

13:00-14:15 **Poster presentations and discussion of teaching at ST**

14:30-15:00 **Søren Hansen, Associate Professor**
Pupil or student?

15:00-15:30 **Erik Østergaard Jensen, Head of Department of Molecular Biology and Genetics**
Mother is watching you: Study start with a visible teacher

KEYNOTE BY SØREN HANSEN, ASSOCIATE PROFESSOR

As a teacher, have you ever had the feeling that your students are inattentive because they already understand the curriculum? Heard statements like, "Why prepare at all, the teacher will explain everything nevertheless..." Or they believe that their mere presence means that they have done their part...

Sounds familiar? How about a method that turns things upside down and places students in control of the agenda, thus making them responsible for their education!?

The presentation introduces you to the basic concept of the method, how to get started, and insights into challenges and experiences.

KEYNOTE BY ERIK ØSTERGAARD JENSEN, HEAD OF DEPARTMENT OF MOLECULAR BIOLOGY AND GENETICS

The transition from upper secondary school to university can be rather overwhelming for the students. At the university, there are no class teachers that control if the students are present and have done their homework. Often the students are expected to read numerous pages before each lecture and prepare for the theoretical exercises (TØ). If a student finds it challenging to administer the increased levels of responsibility for their learning, there is a risk that they drop out.

We have decided to ease the transition for students at molecular biology by using an e-learning system that makes it possible to monitor the progress of the students, including their preparation for the lectures and at theoretical exercises. We have also allocated senior researchers for all theoretical exercises. When we combine our observations from the theoretical exercises in the classroom and the information from the e-learning system, we are at a very early stage able to identify the students that are behind schedule. These students will be contacted by the course coordinator and will be supervised to make up for lost time.

TEACHER TRAINING PROGRAMME POSTERS BY ASSISTANT PROFESSORS

Learning design/ theme	Lectures	Group work* (theoretical exercises/ TØ)	Group work* (laboratory exercises/ LØ)
Flipped Classroom	Søren Steffensen, Øget aktivitet før og efter undervisningslektionen, p. 20		
STREAM	Patrick Biller, New Learning Design for MSc Biorefining Course, p. 9 Jonas Elm, Transforming Lecture Elements into Screencasts, p. 10 Henrik Daniel Kjeldsen, STREAM'lining the Limits of Machine Learning, p. 11 Søren H. Nielsen, Understanding filters in digital signal processing, p. 15 Pernille Klarskov Pedersen, Transformation of Traditional Lectures into Online Supervision in Modern Physics, p. 16 Claus Rasmussen, Thinking Ecology, p. 19 Chris K. Sørensen, Teaching Academic Writing to Ensure Good Alignment Between Learning Objectives and Examination, p. 22 Søren Ulstrup, Lecturing in a Supplementary Subjects Class: A Learning Approach Based on the STREAM Model, p. 23	Line Andersen, Seminar om at skrive videnskabsfilosofi, p. 8 Lasse Sommer Kristensen, A New Learning Design for Improved Student Participation and Deeper Learning at the Course RNA Molecular Biology at AU, p. 12	Rikke Kristiansen, Øget forberedelse inden laboratorieøvelse for at sikre bedre udnyttelse af laboratoriefaciliteter, p. 13 Peter Bøgh Pedersen, Transformation af laboratorieøvelse for at sikre bedre læring hos de studerende, p. 17
Peer Instruction			Steffen G. Sveegaard, Training Your Lab Rats: How to Enhance Student Learning in the Lab With Edu IT, p. 21
The 5-stage Model	Vivi Kathrine Pedersen, Teaching Geologists Programming, p. 18		
Ad Hoc	Ida Thordis Mølmer, Exam Preparation with Playing Cards as a Motivational Factor for Oral Participation, p. 14		

*Also referred to as 'small-class teaching'

Seminar om at skrive videnskabsfilosofi

Line Andersen
Postdoc

Keywords: *videnskabsfilosofi; skriftlig fremstilling; teoretiske øvelser*

Pedagogical challenge

Eksamen er en skriftlig hjemmeopgave, og de studerende har typisk lidt eller ingen erfaring med at skrive filosofi.

Context/course facts

Kurset er et valgfrit kandidatkursus i videnskabsfilosofi for studerende med en bachelor i et naturvidenskabeligt fag. Der er seks studerende og fem timers undervisning om ugen. Der er ikke instruktorundervisning. Kurset vægter 10 ECTS.

Learning outcomes and purpose of learning design

Formålet med undervisningsforløbet er at træne de studerende i at skrive godt og klart og dermed blandt andet forberede dem til eksamen. Eksamen vil være meget forskellig fra, hvad de studerende er vant til. De skal skrive en opgave, hvor de fremsætter en påstand, som de argumenterer for. Derfor er det væsentligt at træne de studerende i at skrive en opgave af denne type.

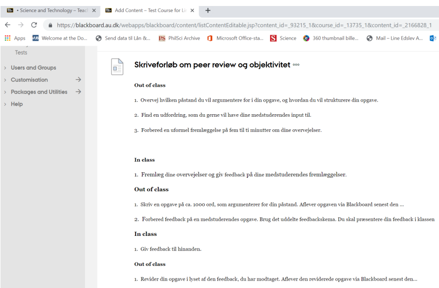


Figure 1. Skriveforløbet på Blackboard.

Learning design and Educational-IT

Skriveforløbet varede fra Uge 7 til 9 i et 14 uger langt kursus, men optog ikke al tiden i de uger. Emnet for de to uger op til skriveforløbet var videnskabelig objektivitet. Her havde de studerende læst tekster og hørt forelæsninger om ret abstrakte teorier om, hvad vi skal forstå ved objektivitet inden for videnskaberne. De studerende var også som et separat emne blevet undervist i peer review inden for forskning. Den primære opgave til de studerende var, at de skulle skrive en individuel opgave på 1000 ord, hvor de brugte, hvad de havde lært om objektivitet inden for videnskaberne til at diskutere, hvordan peer review bør indrettes. Jeg gav dem fire mere specifikke spørgsmål at vælge imellem.

Et af formålene med dette emnevalg var at illustrere over for de studerende, som enten var eller havde været studerende på et naturvidenskabeligt fag, hvordan filosofi kan være relevant for naturvidenskabsfolks praksis. Et andet formål med emnevalget var at tvinge de studerende til at springe ud i at være originale. De studerende havde læst om videnskabelig objektivitet og peer review og skulle på egen hånd forbinde de to emner.

Overordnet var forløbet indrettet på følgende måde. De studerende blev bedt om hjemmefra at overveje, hvilken påstand de ville argumentere for i deres opgave, og hvordan de helt overordnet ville strukturere deres opgave. De skulle også pege på en udfordring, som de stod over for, og som de gerne ville have deres medstuderendes input i forhold til. De blev bedt om at forberede en uformel fremlæggelse på fem til ti minutter af deres overvejelser.

I klasseværelset satte vi os alle rundt om et bord, og de studerende fremlagde og modtog kommentarer fra os andre. Dette fungerede rigtig godt. De studerende var i stand til at give brugbar feedback på hinandens oplæg, som de kun lige havde hørt. Til sidst fik de studerende et feedbackskema, som de senere skulle bruge til at give feedback på en medstuderendes opgave.

Herefter skulle de studerende skrive opgaven på baggrund af deres overvejelser og den feedback, de havde fået. Jeg delte de studerende i to grupper med tre i hver. Hver studerende blev bedt om at læse de to andre gruppemedlemmers opgaver og give grundig feedback på en af dem efter mit valg. Her skulle de bruge feedbackskemaet. Et af målene med at få de studerende til at give feedback på en andens opgave var at gøre dem bedre i stand til kritisk at evaluere deres egne opgaver.

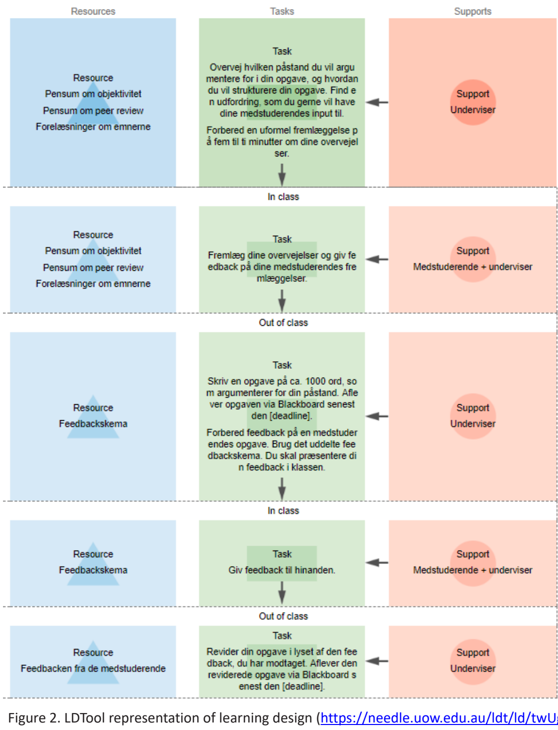


Figure 2. LDTool representation of learning design (https://needle.uow.edu.au/ldt/ld/twUgmqwj)

I klassen gav de studerende hinanden feedback i de to grupper. Der var sat 45 min. af til at diskutere hver opgave. Hvis man ville spare tid, kunne man lade de studerende give hinanden feedback gennem Blackboard.

Herefter skulle de studerende revidere deres opgaver i lyset af den feedback, de havde modtaget, og genaflevere opgaven. Jeg gav dem skriftlig feedback på den reviderede opgave og brugte samme feedbackskema, som jeg havde givet dem.

Indicators of impact

Jeg læste begge versioner af de studerendes opgaver og kunne se, at de havde revideret opgaverne væsentligt efter at have modtaget peer feedback.

EDU-IT role and benefits

Man kunne lade de studerende give hinanden feedback igennem Blackboard. Dette ville spare tid.

Lessons learned and looking forward

Næste gang, jeg skal lave et lignende forløb, vil jeg gøre mere ud af kriterierne for feedback. Jeg vil måske endda udvikle kriterierne for feedback sammen med de studerende.

New Learning Design for MSc Biorefining Course

Patrick Biller
Assistant Professor, Department of Engineering.

Keywords: *lab excercise, lab protocols, theoretical excercise, peer feedback, learning design model*

Context/course facts

The new learning design was developed for the specialization packet of **Biorefining** for the Msc students of the Chemical and Biotechnology Engineering program at the department of Engineering. There are two parallel courses running: Integrated Biorefining Technologies (theoretical) and Experimental Biorefining (lab based) . Each course is 10 ECTS and there are a total of 18 students enrolled in both courses.

Learning outcomes and purpose of learning design

The principal idea of the new learning design was a change to the current system where students chose an experiment to perform based on their interest from the lectures and following a predefined lab protocol. The new design was that the students develop a deeper interest for a specific technology by watching online videos and finding out more details of selected technologies at full scale including: biogas production, hydrothermal carbonization and hydrothermal liquefaction, ethanol production, green protein production, biomass pretreatment and biochemical production. The task set to the students is then to develop their own experimental protocol for the new lab exercise in a *flipped class room* approach. The intended learning outcomes were specifically:

- **Critically evaluate different biorefining technologies**
- **Develop experimental protocols based on theory in lectures**
- **Critically evaluate other groups' protocols**
- **Carry out lab based exercises based on protocols**
- **Present their findings to the class**

The activities carried out in order to achieve the learning outcomes are shown in more detail in Figure 1.

The basic theory of the different technologies is covered in the theoretical lectures by the instructors. A significant amount of self teaching/learning is expected from the students to get deeper knowledge on the practical side of the technologies to see how this can be translated to the laboratory. The instructors provide some initial information and sources but the students are expected to dig deeper. The initial protocols are uploaded to blackboard for peer-feedback.

Learning design and Educational-IT

The new learning design is supporting the teaching activities in a way that new elements are included such as peer feedback, self study and critical evaluation of the students own learning all found in the STREAM theme. An online activity page has been set up to support the learning design. There are two submission sections; the first one for the original protocol design which is posted on a discussion forum where each group has to provide feedback on another group's protocol. The students can then go back to refine their protocol before carrying it out in the laboratory.

The second submission is for the final protocol with the addition of videos of key laboratory steps in the exercise

.

The final part of the learning design includes the presentation of the results form the experiment and discussion of the learning outcomes in designing a new lab protocol with help from peer feedback.

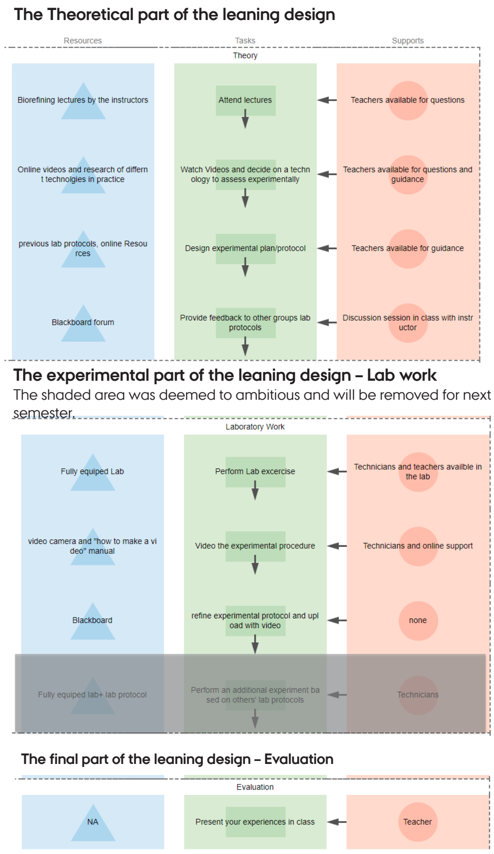


Figure 1. *LDTool representation of learning design used in Biorefining*

Indicators of impact

Close monitoring of the online activities is carried out and a lot of informal feedback is expected during the activities. The final presentations of protocols and exercises is carried out in class to evaluate the students performance and learning outcomes.

Pedagogical challenge/purpose

The idea of the new learning design was to bring the students to a higher level of understanding in their learning. Previously they followed instructions and learnt by doing. The new design is based on the STEAM model and includes online activity to help creating and designing tasks, justifying their decisions, argue their choices and reflecting on others. Thereby bringing them to a higher learning level.

Lessons learned and looking forward

The main lesson learnt was that the learning design was too ambitious to implement during one semester or more accurately in the same semester the learning design was designed. The shaded box in the learning design tool was originally included but this was decided to be too ambitious the carry out. The refined learning design does now no longer include this aspect. The instructor team is planning to implement the new learning design fully next in semester F2020 now that it has been refined.

Luckily I was able to carry out some parts of the new learning design. The students uploaded their lab reports from experiments carried out the a blackboard discussion forum for peer feedback. This worked reasonably well, the students were able to see other group's approaches to solving the challenges and commented on their differing approaches and gave valuable suggestions for improvements and changes. One problem I encountered was the low participation rate on peer feedback. Everyone submitted their protocols but only about half of them provided peer feedback. I suspect a mandatory element needs to be included. IT resources on blackboard are able to assist in this aspect for next semester.

We also carried out the presentations of experimental protocols and experiments in class with peer feedback. This part was very valuable and had a good outcome. This part of the learning design will not have to be changed.

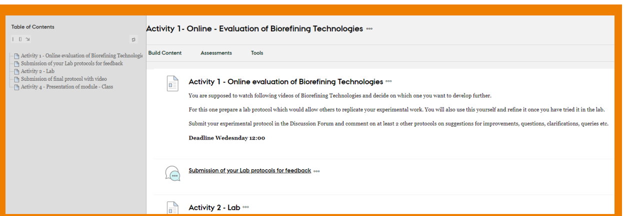
Overall the outcome of the new learning design was very positive as I believe we have a new activity to implement ready for next semester with improved learning outcomes. Rather than simply applying protocols and theory in the laboratory the students are asked to develop and design experiments which brings them to a higher taxonomical level of learning.
The two parts of the learning design tested in practice were overall very positive and received well by the students. The full implementation of the new learning design next semester is planned.

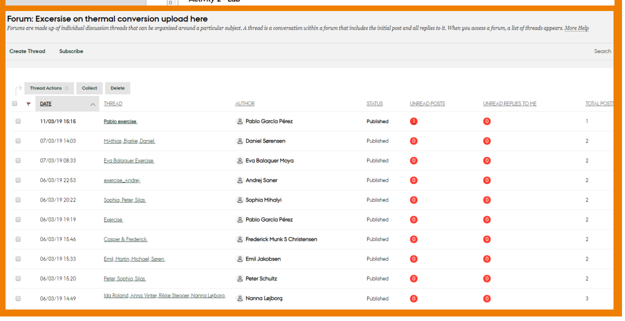
EDU-IT role and benefits

The main use of IT resources was the use of blackboard discussion forums where students could provide peer feedback to the other group's development of their protocols.

This allowed an easy and compact platform for the students to utilize and critically evaluate the protocols. The instructors were able to gather the feedback and discuss it during the presentation f protocols in class.

The second screenshot shows one of the online activities carried out where students were asked to provide feedback on their submission of other group's work. The overall outcomes was positive but a low participation rate was the main problem. A challenge I plan to fix next semester by making peer feedback a mandatory part of the leaning design.





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Transforming Lecture Elements into Screencasts

Jonas Elm
Post doc

Keywords: *Lecturing, the STREAM model, screencasts.*

Pedagogical challenge/purpose

Keeping an adequate pace when teaching chemical reaction mechanisms can be challenging. Powerpoint lecturing will inevitably be too fast paced. Old school blackboard and chalk lecturing is preferable, but leave a large stress on the students, if they attempt to take notes simultaneously.
By transforming the blackboard lectures into online screencast segments the students can follow the lectures at their own pace and without the extensive requirement of taking notes.

Context/course facts

The course "Atmospheric Chemistry and Physics" is a 5 ECTS point master level course offered by the Department of Chemistry. Each year only 5-8 students are enrolled and each week only consists of 3 confrontation hours. The confrontation hours are used on a mixture of lecturing, exercises, in-class discussions and student presentations. The exam is a 20 min oral exam with an A4 paper for notes. To qualify for the exam the students have to give two student presentations.

Learning outcomes and implementation

The learning outcome associated with the two weeks in tropospheric chemistry during the course is:

- **Explain** the principles and processes of importance for turnover of gasses in the air.

As the course content is quite heavy on chemical reactions and mechanisms the major pedagogic challenge is to ensure that the pace is not too fast. Last year I decided to use old school chalk and blackboard lectures, to ensure a slower pace. An ideal way to ensures more flexibility in both place, time and pace is to transform of the blackboard lecture into screencast segments implemented in a learning path in Blackboard. Figure 1 presents all the implemented learning path.

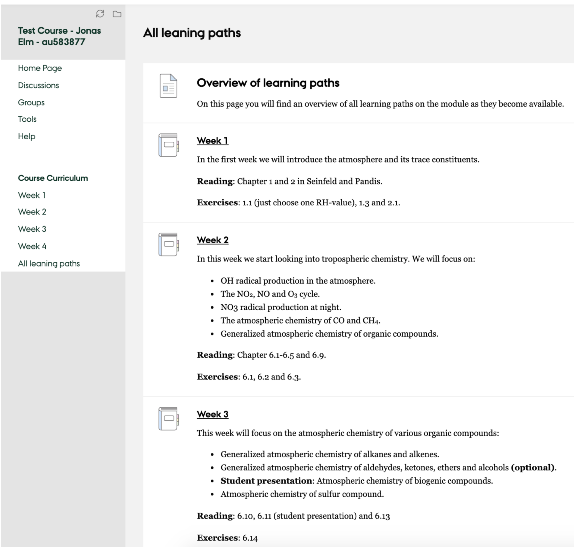

Figure 1: *Learning path implemented in Blackboard.*

Under each week in the learning path the associated material to read and exercises to solve can be seen. Each week also contains several screencast lectures on the associated curriculum, as shown in Figure 2.

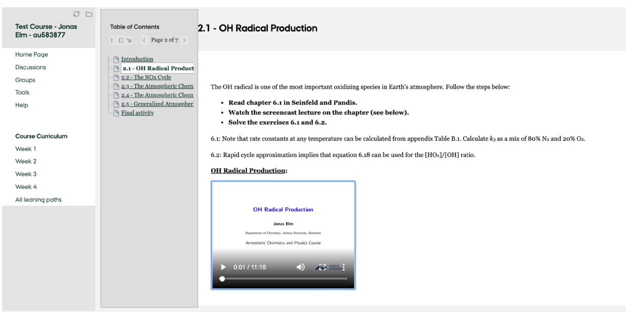

Figure 2: *Screenshot of one of the videos implemented in the blackboard learning path*

Learning design

The transformation of the lectures into screencast video segments in a learning path has been made with the ***STREAM*** model in mind. It can be viewed as an ***augmentation*** in the ***SAMR*** model, where the technology acts as a direct substitute with a functional improvement.

Before the class the students read the curriculum, solve the associated exercises and watch the screencast lectures. After the learning path for the week is finished each student answers a small questionnaire (out-of-class activity) with 5-10 questions related to what they have learned and upload the answers to their portfolio tool in Blackboard. In-class the lecture will be motivated based on what the students had difficulties with in the questionnaire. During class the students will also go through the exercises and each week one student will do a student presentation about a part of the curriculum that is not available as a screencast lecture.

The out-of-class activity serves two purposes:

- It gives me as a teacher an idea about the level of understanding of each student.
- It directly gives the student a tentative set of notes that can directly be used for the exam.

An overview of the learning design can be seen in Figure 3.

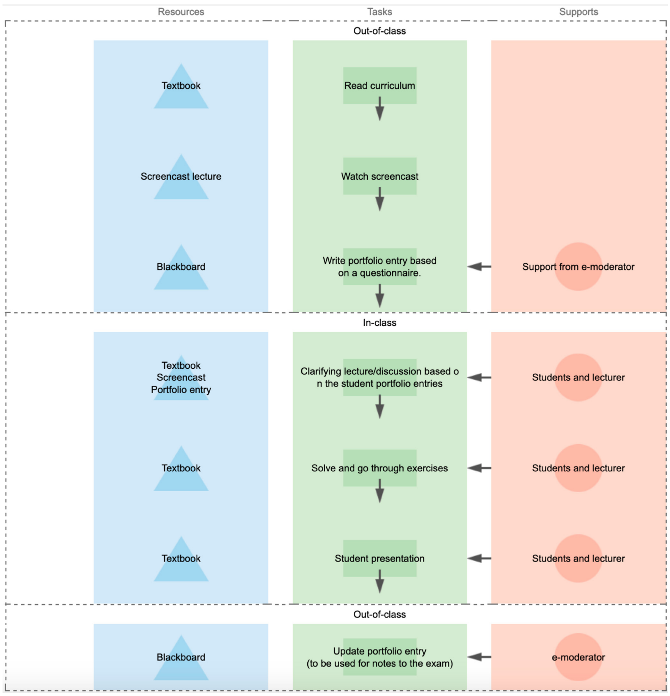

Figure 3. *LDTool representation of learning design used in the "Atmospheric Chemistry and Physics" course.*

Lessons learned and looking forward

It has been educational to produce screencast videos and implementing them into a blackboard learning path. There is no doubt that having the lectures available as online material is an important help for the students and give a large flexibility in the course.
As similar courses in atmospheric chemistry with also only few students is being offered at other Departments and Universities, in time the transformation of blackboard lectures into online learning paths could allow us to offer the course as an online course. In this case potential confrontation hours could efficiently be performed via adobe connect.

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STREAM'LINING THE LIMITS OF MACHINE LEARNING

Ing. Dr. Henrik Daniel Kjeldsen, Assistant Professor

Keywords: *machine learning; lectures, learning activities and educational-IT; STREAM; limits*

PEDAGOGICAL CHALLENGE AND PURPOSE

This learning design attempts to apply the STREAM model to part of an introduction to machine learning, which focuses on machine learning hype versus technical limits.

The motivation and rationale is two-fold, first the for the topic itself, second for the use of STREAM:

A: New students of machine learning typically buy into much of the hype presented in the media and elsewhere, and as a result have unrealistic expectations. At the same time it is difficult to realize the limitations of machine learning independently if not specifically told where to look, and in many cases even skilled practitioners are also not aware of the real-world technical limits; and as a result may take on tasks or make promises that are simply technically impossible to fulfill.

B: A previous version of the learning design did not feature out-of-class activities, and as a result many students seemed to have difficulties relating cases covered in lectures to other and new cases (part of the ILOs). The STREAM model affords out-of-class activities to strengthen this aspect, for example by way of moderated forum discussions and Mentimeter assessments for learning.

GAMMEL VIDEN STÅR I VEJEN FOR NY VIDEN

SÆRLIGT RELEVANT for MACHINE LEARNING pga HYPE og MISINFORMATION

VS

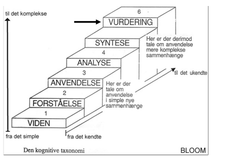
COURSE FACTS AND NUMBERS

The course facts are listed in the table.

Course name	**Machine Learning (ITMAL)**
Faculty	ST
Department	Ingeniørhøjskolen
Level	Diplom, 6/7 semester valgfag
ECTS	5
Number of students	109
Number of lecturers and other teaching staff	2 main lecturers,1 teaching assistant.
Your teaching role and responsibilities	Responsible for part of the course.
Assessments during the course	3 journal report hand-ins. Final journal is a problem-based project.
Exam/final assessment	Pass/fail assessment based on all journals combined.

INTENDED LEARNING OUTCOMES

- Define the differences between hype and technical reality in machine learning.
- Use machine learning case studies for comparison with new cases.
- Evaluate feasibility of new machine learning use cases.



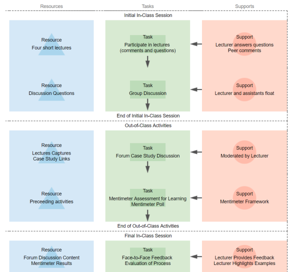
For at bibeholde konkurrencedygtighed skal der uddannes dygtige ingeniører, der ikke kun formår at anvende machine learning i praksis, men også er i stand til at rådgive og vejlede i hvor og hvornår, hvilke teknikker kan benyttes; også i forhold til hvornår givne opgaver ikke kan løses med machine learning.

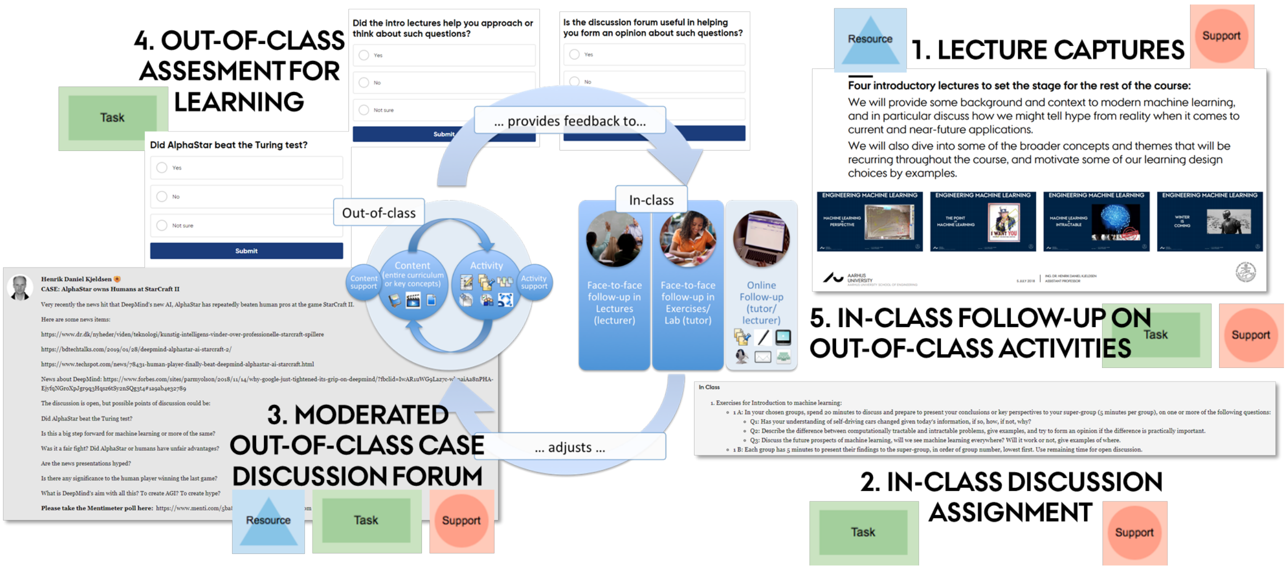
LEARNING DESIGN AND EDU-IT

- Lecture captures.
- Blackboard forum discussion.
- Mentimeter evaluations.

LDTOOL REPRESENTATION

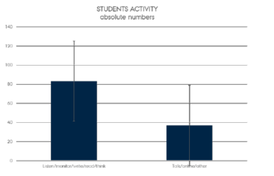
The LDTool representation specifies resources, tasks and supports for the learning design.
Alignment between in-class and out-of-class activities is achieved mainly by running evaluation and feedback as indicated in the cyclic design layout below.





INDICATORS OF IMPACT

- Discussion board activity.
- Student activity observations (see figure).
- Follow-up discussion.
- Mentimeter evaluations.
- Topic choices for final projects.



LESSONS LEARNED AND LOOKING FORWARD

- Optional out-of-classes activities sees too low activity and engagement.
- Other obligatory activities might be weighted too heavily, and as a result students down-prioritize optional activities.
- It might be beneficial to make more elements of the learning design obligatory.
- Observations and evaluations need more statistical power.

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A New Learning Design for Improved Student Participation and Deeper Learning at the course RNA Molecular Biology at AU

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Keywords: *Molecular Biology; lecture/theoretical exercises; flipped classroom; blackboard*

Context/course facts

This learning design was implemented in the 10 ECTS course named RNA molecular biology. This is a master course at the Department of Molecular Biology and Genetics (MBG) at Aarhus University (AU) with about 30 students attend each year. The final assessment is a written exam where the list of questions is given beforehand.

Learning outcomes and purpose of learning design

The learning design described here is motivated by the fact that many students currently enter the small class teaching room unprepared or poorly prepared. Specifically, students use part of the in-class time for reading the original article that is supposed to be discussed in detail during the three hours of small class teaching. Because of this, only a small fraction of the students take active part in the discussions in plenum. Therefore, valuable time spent in-class with the teacher is used on activities that might as well have been done out-of-class. As a result, students may only scratch the surface of the article and do not reach a higher taxonomic level of learning (Biggs, 2012), which is necessary for the students to be capable of extending knowledge to hitherto unseen problems. Ultimately, this is reflected in the final examination where the students are expected to be able to do just that.

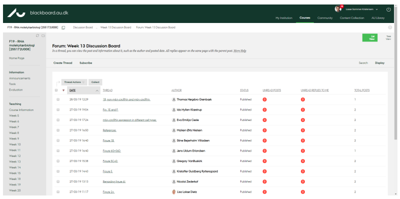

Figure 1: Discussion forum in Blackboard.

Learning design and Educational-IT

This learning design is based on the STREAM-model, which focusses on a good balance between out-of-class and in-class activities (Godsk, 2013). The teaching activities include a one-hour lecture and three hours of small class room teaching. Below, I have detailed all in-class as well as out-of-class activities.

Out-of-class
The students read a review article covering the most essential parts of the topic.

In-class teaching (one hour lecture)
First a brief mentimeter quiz to measure the students' level of understanding was done. Then the most important content of the review was covered. During the lecture, I referred to relevant knowledge covered in previous courses and incorporate small activities (e.g. think-pair-share (Goodwin, 1999)), which help to keep the attention of the students. The lecture was concluded with the same mentimeter quiz.

Out-of-class
The students read an original article (submitted version from bioRxiv.org), and did the activities described below.

Out-of-class activity 1
After having read the article, the students made a post in Blackboard highlighting a part or aspect of the article, which they felt could be improved upon.

Out-of-class activity 2
The students read all the posts of their peers and selected one to comment on. The student then either suggested how the aspect of the article could be improved or defended the authors.

In-class (lesson 1)
Activity "Jigsaw" (Goodwin, 1999): the students were divided into groups and answered one question (prepared by the instructor) per group (app. 20-25 min). New expert groups were then formed (25-30 min).

In-class (lesson 2)
Follow-up on the questions from lesson 1 in plenum (25-30 min). The group work: each group got a post with the associated comment from the out-of-class activity to discuss and elaborate/improve (20-25 min).

In-class (lesson 3)
Each group presented their elaborated/improved comment in plenum (45 min).

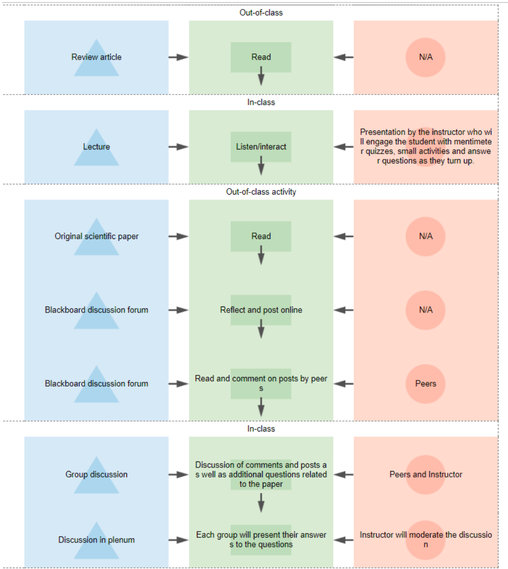

Figure 2. LDTool representation of learning design used in RNA Molecular Biology.

Pedagogical challenge/purpose

Many students currently enter the small class teaching room unprepared or poorly prepared. Specifically, students use part of the in-class time for reading the original article that is supposed to be discussed in detail during the three hours of small class teaching. Because of this only a small fraction of the students take active part in the discussions in plenum. Therefore, valuable time spent in-class with the teacher is used on activities that might as well have been done out-of-class. As a result, many students may only scratch the surface of the article and do not reach a higher taxonomic level of learning (Biggs, 2012).

Indicators of impact

I used evaluations and my own observations to describe signs or indications of results that may be used to decide if learning design is appropriate for the course.
The evaluation was done using mentimeter and consisted of 14 questions related to both in-class and out-of-class activities.

Main results/observations
All students read the article before the in-class activities, which was one of my main goals in order to achieve a Flipped-class-room situation, and the majority took part in the out-of-class activities. I observed that most students took part in the discussions, which was supported by 65% of the students answering that there was more discussion regarding important aspects of the article than usual in class. Together, this created more deep learning compared to the usual teaching approach and facilitated more peer to peer interactions. Finally, the activities were well aligned with the final exam as all but one student found them relevant in this regard. Overall, I think the new learning design and its implementation was a success.

EDU-IT role and benefits

I used a discussion forum in Blackboard for the out-of-class activities and Mentimeter for a quiz during the lecture, which created more peer-to-peer interactions and a focused learning, respectively.

Lessons learned and looking forward

The main obstacle for a successful implementation of this learning design was that I interrupted the students' weekly schedule by giving them two additional deadlines during the week. I feel that this might not have been a problem if this learning design had been used throughout the entire course. This would allow more meta-communication regarding the intensions of the learning design and its alignment with the final exam (Hattie, 2015). Finally, it might also be an idea to make the out-of-class activities count as a minor part of the final exam (Brown, 2004).

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Øget forberedelse inden laboratorieøvelse for at sikre bedre udnyttelse af laboratoriefaciliteter

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Keywords*: laboratorieøvelse; læringsdesign; holdundervisning; peer feedback;*

Pædagogisk udfordring
Erfaring har vist, at de studerende ikke møder velforberedte op, når de skal udføre en øvelse i laboratoriet. Kan dette forbedres ved at involvere de studerende i fremstillingen af protokollen til øvelsen?

Fakta om kurset

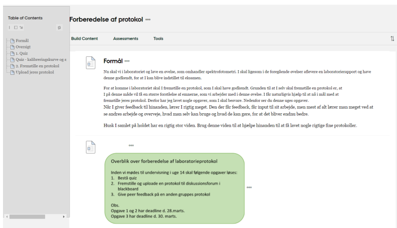
Analytisk kemi er et 5 ECTS-kursus på 2. semester for diplomingeniørstuderende på retningerne kemi (KE2ANA), bioteknologi (BI2ANA) samt kemi og fødevareteknologi (KF2ANA). Der er ca. 50 studerende på KE2ANA og BI2ANA og ca. 25 studerende på KF2ANA. Igennem kurset introduceres de studerende for grundlæggende principper inden for analytisk kemi. De studerende skal i løbet af kurset udføre 3 laboratorieøvelser. Laboratieøvelserne har til formål at give de studerende mulighed for at se udvalgte teknikker I praksis. På baggrund af de 3 laboratorieøvelser skal de studerende have godkendt 3 rapporter for at blive indstillet til den mundtlige eksamen. Eksamen er 20 min. med 20 min. forberedelse.

Læringsmål og designets formål

Læringsdesignet har til formål at understøtte følgende af kursets læringsmål:

- Udføre kemiske analyser med VIS spektroskopi og TLC
- Beskrive prøveforberedelsens indflydelse på analyseresultater
- Beskrive anvendelsen af standarder
- Diskutere optimeringer af kvantifikationsmetoder

En general erfaring er, at de studerende ikke er godt forberedt eller tager stort ansvar for egen læring, når de møder op til en laboratieøvelse, hvor de har fået udleveret en protokol. Jeg tror, at der kan være flere grunden til dette; bl.a. ser de studerende denne dette som en nem del af kurset eller de studerende forstår ikke øvelsen, når de læser den på et stykke papir, og kan derfor ikke se en grund til at forberede sig. Dette resulterer i, at de studerende anvender deres tid laboratoriet på at finde ud af, hvad de skal foretage sig frem for at forstå deres forsøg og resultater. Det overordnede mål med dette læringsdesign er dermed, at de studerende opnår dybere læring igennem dette læringsdesign (Hattie, 2015), da de igennem læringsdesignet skal deltage i fremstillingen af protokollen samt diskutere deres data i laboratoriet.



Figur 1: *Udsnit fra blackboard, som forklarer de studerendes forberedelse til lektionerne.*

Læringsdesign og Educational-IT

Læringsdesignet skal understøtte, at de studerende får en dybere læring i laboratoriet ved at sikre, at de forberede inden øvelsen og dermed aktivt kan indgå i diskussioner omhandlende data. Dette understøttes af en række aktiviteter i og uden for klassen (fig. 2).

Uden for klassen skal de studerende bestå en quiz, som skal hjælpe dem med at genopfriske den teori, som de skal anvende i den praktiske øvelse. Herefter skal de studerende fremstille en protokol. De studerende skal give hinanden peer feedback på deres protokoller, hvorved de kan få inspiration fra hinandens arbejde til at forbedre deres egen protokol.

I klassen diskuteres det input, som de forskellige studerende har opnået igennem deres peer feedback. Yderligere hjælpes de studerende desuden i gang med at udarbejde et excelark til opsamling af data. Protokollen revideres og godkendes inden laboratorieøvelsen.

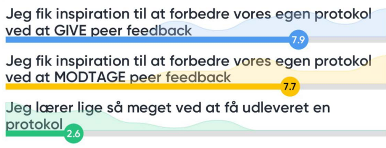
I laboratoriet er øvelsen opdelt i to delelementer. For hvert delelement skal de studerende ud fra deres protokol opsamle data og dokumentere dette i deres excelark. Inden de kan gå videre til næste delelement eller afslutte øvelsen, skal de studerende diskutere deres data med en anden gruppe på baggrund af guidespørgsmål.

Igennem aktiviteterne i og uden for klassen forventer jeg at opnå, at de studerende får et større udbytte af øvelsen, da de selv skal deltage aktivt og problemløse ud fra de retningslinjer, som jeg sætter (Biggs, 2012).

Indicators of impact

Læringsdesignet blev udført på den tredje øvelse i kurset. De studerende havde således allerede lavet to øvelser. Ved den ene øvelse havde de studerende fået udleveret en protokol. Ved den anden øvelse havde de studerende lavet en protokol, hvor de på klassen renskrev den diskussion, som vi sammen havde.

Til den sidste øvelse skulle de studerende selv være ansvarlige for udarbejdelse af protokollen. På et af holdene havde de studerende ikke arbejdet med peer feedback. Den generelle kvalitet af protokollerne var højere på de hold, hvor de studerende havde arbejdet med peer feedback. Ud fra et mentimeter blev de studerendes holdning til læringsdesignet evalueret (fig. 3).



Figur 3: *Mentimeter til vurdering af de studerendes udbytte af læringsdesignet. Uddrag af mentimeter fra BI2ANA.*

De studerende får generelt god udbytte af deres peer feedback. Jeg har desuden samlet studerendes skriftlige feedback på læringsdesignet. En studerende skrev "utrolig stor hjælp at se de andre, så man både kan se, hvad der fungerer godt og hvad der ikke fungerer ved ens egen protokol". Mange af kommentarerne indholder samme essens.

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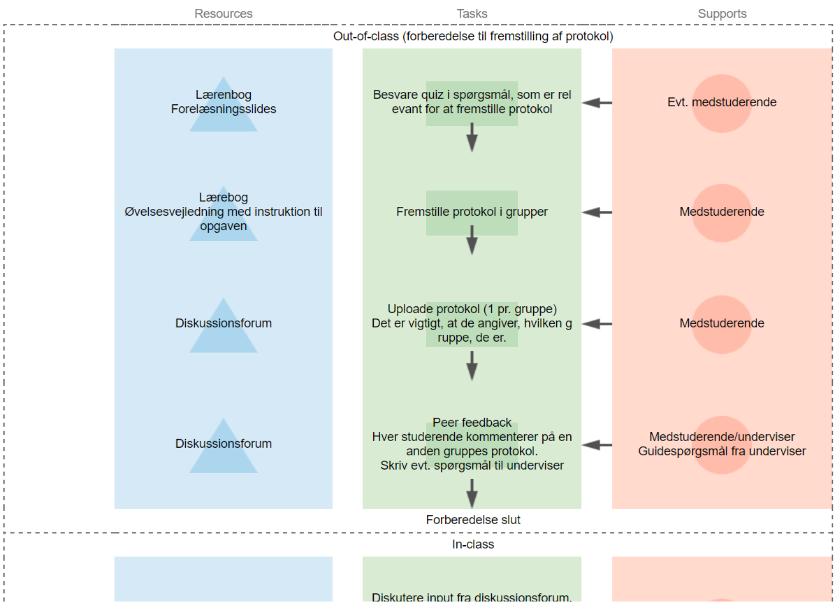

Figure 2: Udsnit af *LDTool-repræsentationen af læringsdesignet anvendt til fremstilling af en protokol I kurset analytisk kemi.*

EDU-ITs rolle og fordele
Det digitale medie blev implementeret som en del af de studerendes forberedelse. Der blev anvendt en quiz i blackboard for at hjælpe de studerende med at repetere tidligere forelæsninger samt fokusere på relevante emner ift. deres protokol. De studerende skulle give peer feedback på hinandens protokoller inden de blev afleveret til godkendelse af underviseren. Denne peer feedback gav de studerende i et diskussionsforum på blackboard for at sikre, at de studerende kunne få inspiration fra hinandens protokoller.

Erfaringer

De studerende er positive over for selv at udarbejde en protokol, da de øger deres forståelse for øvelsen og dermed dybere læring. Det blev til første hold forsøgt, at holde diskussionsforummet lukket indtil de studerende havde indgivet deres protokol. Da protokollen afleveres som gruppe, bevirkede dette, at de studerende, som ikke havde afleveret, ikke kunne se afleveringerne i diskussionsforummet. Derudover har jeg ikke indtrykket af, at de studerende søger inspiration i dette forum inden de afleverer, hvilket bevirker, at der ikke er grund til at holde diskussionsforummet lukket.

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Exam preparation with playing cards as a motivational factor for oral participation

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Keywords: *small class teaching; oral participation; competition; discussion; exam exercise*

Pedagogical challenge Several of the students are used to working jobs where they are not prompted to speak unless they know something for a fact. The didactical challenge and the aim of this activity is to combat this attitude with a behavioral method using motivational elements to force students in the right direction and at the same time preparing them for the oral exam.

Context and course description

This activity was conducted in a preparatory 1-year course in Danish A-level. The aim of the course is to provide students who lack the required education to apply to university with the necessary theoretical prerequisites for starting a diploma engineering degree.
The course is assessed by the end of the year with both a written and an oral exam. This activity was conducted in a class of 19 students.

Learning outcomes and purpose of learning design

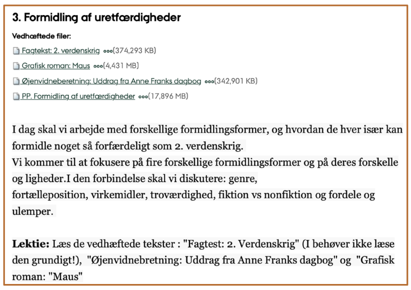
The primary goal of this project design is to create a better alignment (Biggs: 2010) between activities in class and the oral exam by normalizing oral participation in class. The learning outcomes addressed by this study focus on the students' ability to

- Express relevant ideas and reflections orally
- Argue and discuss different ideas and viewpoints

These learning outcomes are in direct relation to the requirements described in the course description: the aim is that students "acquire skills in communicating correctly, accurately, nuanced and appropriately."

Learning design and Educational-IT

This study focuses primarily on the in class activities. By pushing the students into participating orally in-class, however, they might also spend more time on their preparation out-of-class in order to be able to participate. As seen on Figure 1, the out-of-class activities in this study consist of reading short texts, which are then discussed in class.
Blackboard is used as the online platform where material is exchanged (Figure 2).


3. Formidling af uretfærdigheder

Vedhæftede filer:

Fagtekst: 2. verdenskrig (374,293 KB)
Grafisk roman: Maus (4,431 MB)
Øjenvidneberetning: Uddrag fra Anne Franks dagbog (342,901 KB)
PP. Formidling af uretfærdigheder (17,896 MB)

I dag skal vi arbejde med forskellige formidlingsformer, og hvordan de hver især kan formidle noget så forfærdeligt som 2. verdenskrig.
Vi kommer til at fokusere på fire forskellige formidlingsformer og på deres forskelle og ligheder.I den forbindelse skal vi diskutere: genre, fortælleposition, virkemidler, troværdighed, fiktion vs nonfiktion og fordele og ulemper.

Lektie: Læs de vedhæftede tekster : "Fagtest: 2. Verdenskrig" (I behøver ikke læse den grundigt!), "Øjenvidnebretning: Uddrag fra Anne Franks dagbog" og "Grafisk roman: "Maus"

Figure 2: *Use of Blackboard to provide material and reading guides.*

Activity Description

The activity is meant to force students to participate orally in class by means of a game. At the beginning of the lesson, each students will be dealt a number of playing cards. Their aim is to play their cards during the lesson which they do by participating in a discussion. The activity ran over three lessons, and they received between one and two cards depending on the lesson type. Cards which were not played were collected each time and handed out randomly as extra cards in the following lesson. To include a motivational factor, an element of competition was included. If the students played all cards before the end of the last lesson, they would win. If they did not, I would win. In this way they were one team against me.

Indicators of impact

As can be seen in my learning design (Figure 1), I guided and supervised the discussion to stay on the right path and I provided instant feedback on their contributions.
At the end of the activity, the students answered a Mentimeter evaluation. The results were generally very positive.

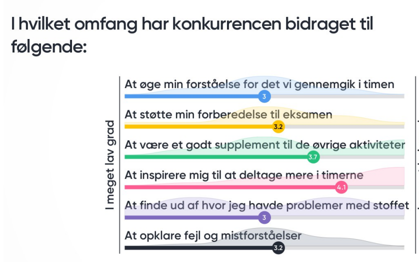


Figure 3: *Indicators of impact of learning design and the use of educational technology. 15 out of 19 students participated in the evaluation.*

My personal observations were also very positive. Several students, who usually stay quiet, participated several times even after having played their cards. Further, an unpredicted improvement of the learning environment seemed to arise when I automatically moved a lot more physically around in the classroom when collecting their cards. This seemed to engage the students and it was a great way to get even closer to the students.

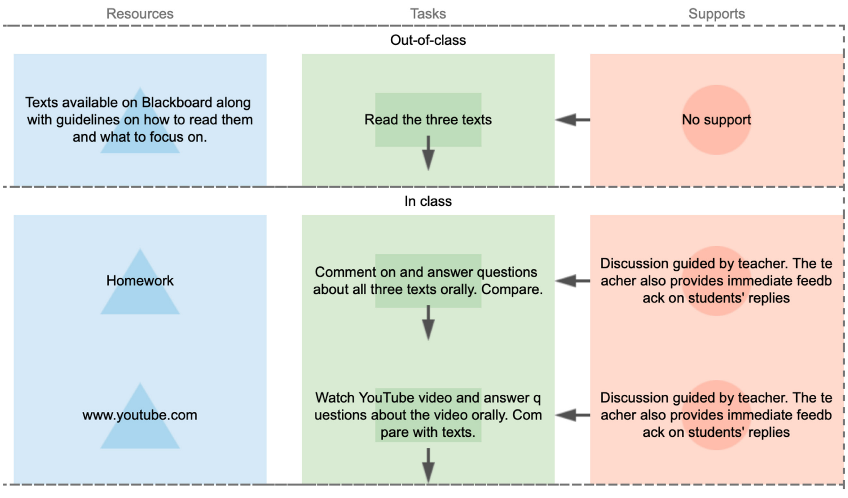


Figure 1: Selection of *LDTool representation of the learning design: structure of the in class and out-of-class activities*

Lessons learned and looking forward

The teaching design and activity outlined and explained here is a very simple version of a design which can be used in many different contexts and class rooms. It can easily be adapted to fit a given learning environment by adding more focused rules or by changing the importance of the competition.
The activity will not necessarily work in all situations and therefore it seems extremely important to make sure this adaption to the context is done thoughtfully.

Next time I will introduce the activity multiple times during a course and add more rules continuously. Pedagogically, I also think it would be interesting and possibly very fruitful to get the students to define the rules and what makes a good contribution to a discussion.

EDU-IT role and benefits

All of the out-of-class material, along with reading guides, was provided on the digital platform Blackboard (Figure 2). Finally, the activity was evaluated in Mentimeter (Figure 3). Both were simple and easy-to-use tools which the students were familiar with already.

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Understanding filters in digital signal processing

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Keywords: *electrical engineering; digital signal processing; lecture, exercises; mini-project; feedback; STREAM model; pencast; webcam; unclear impact*

Pedagogical challenge/purpose

Digital filters, in particular IIR filters, can be difficult to understand.
An important purpose of the presented learning design is to try to give an *intuitive* understanding af the workings of an IIR-filter.

Context/course facts

The course (E3DSB/EE4DSB) is an introduction to digital signal processing and the programming tool Matlab. It is 5 ECTS and placed on the 3rd semester for most students. There are 40-100 participants with somewhat varying prerequisites. The course is mainly theoretical, but with practical elements in the 4 mandatory hand-ins. There is no exam and the course grade is binary. This semester (Spring 2019), the course was shared between a collegue and myself.

Learning outcomes and purpose of learning design

The course as a whole covers an introduction to several topics in the field of digital signal processing. The lecture/topic described here covers a certain, and very widespread, type of digital filters, IIR (infinite impulse response) filters. Digital filters, in particular IIR filters, can be difficult to understand, at least for some students.
One important purpose of the presented learning design is to try to give an intuitive understanding af the workings of a digital IIR-filter, ranging from the simple fact that a digital filter is a combination of signal samples from different points in time (or space) to the more complex interaction between feedforward and feedback structures.
Emphasis is on understanding the basic mechanisms rather than the (rather complex) mathematics needed to design a filter with specific properties. One mean to convey that understanding is the use of demonstrations, as shown in Figure 1.

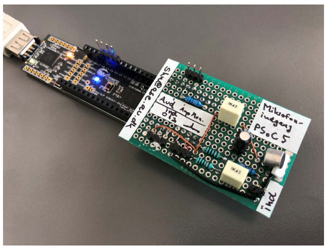

Figure 1: *A live camera is used during the lecture to show examples of relevant equipment.*

Learning design and Educational-IT

Several means are used to (attempt to) get that understanding. The learning design can be well described by the STREAM model [Godsk, 2013] with activities both in-class and out of class, see Figure 2.
The textbook offers some help, but is maybe a bit too mathematical. I make some step-by-step examples (pen on PPT) of the mechanisms of an IIR filter. Furthermore, a large Matlab example is thoroughly presented, using many graphs showing the very basic properties of IIR filters, both in time and frequency domain – and in the z-plane.
As a demonstration of using digital IIR filters for a practical task, a demonstration is shown, running on a small real-time computer the students use in other courses and in the semester project. When whisteling a tone of the right pitch, an LED lamp is turned on and off. This is shown on the projector by means of a webcam.

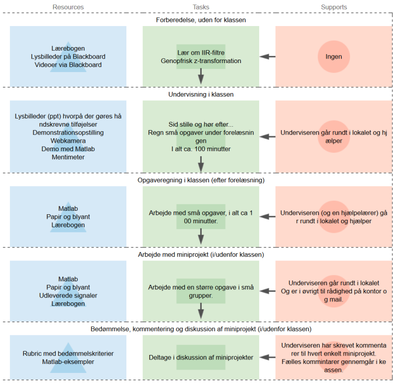

Figure 2. *LDTool representation of learning design used in lecture 9 (in Danish). https://needle.uow.edu.au/ldt/ld/UoQBcp1X*

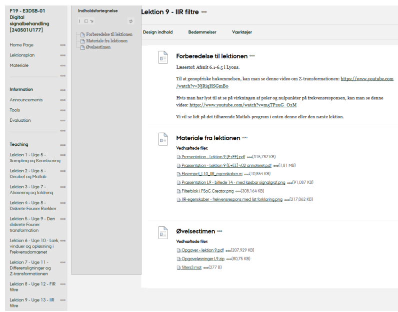

Figure 3. *Blackboard implementation of the learning design used in lecture 9 (in Danish).*

For preparation, the students are pointed to an interactive Matlab demonstration tool, illustrating properties of IIR filters in another way. This tool is briefly presented in class. All tools demonstrated in class are provided to the students, such that they can experiement themselves.
The annotated lecture notes are provided to the students immediately after the lecture. See Figure 3 for the Blackboard representation of the lecture design.
An important point here is that the technologies used must be meaningful for the teacher, and preferably also be fun and/or convenient to use.

Indicators of impact

In order to assess the impact of the learning design and the use of educational IT tools, several methods have been used: First of all, two sessions of lecture observations have been performed. Furthermore, a set of hand-ins have been examined. Also, the overall evaluation of the course by the students has been studied.
Observation of the lecture described here was made by two fellow assistant professors in March 2019. They each observed, among other things, the behavior of four students (using the observation form provided in the teacher traing course). Also, one semester ago, in the course of a mutual supervision session, two experienced collegues made observations of student behavior and interest with focus on the demonstrations made.
The results of the observations were 1) The students are generally paying attention, despite only a small degree of student/teacher dialogue, 2) I talk a lot, 3) Only few students take notes, and 4) Bringing physical equipment and making demonstrations with it (assisted by a webcam) attracts attention.
The hand-ins (mini projects) were handled entirely in Blackboard, both handing them in, assessing them and giving written feedback. After each of the hand-ins, common feedback was given in class, and there was a discussion.

Some of the students have used my demonstration programs (in Matlab) as a starting point for their work in the hand-ins. This is expected and desirable - and an indicator that this use of IT makes sense.
There has been no formal (quantitative) indicators of impact – apart from the general course evaluation. The course evaluation is made by means of Blackboard. A question of mine has been added to the Spring 2019 editions of the course. It relates to the coupling between theory and practice.
Measuring the impact of the various interventions in the course, as expressed in the general evaluations, is rather difficult due to the fact that the course page in Autumn 2018 on BB was shared between two different runs of the course (for different study programmes), by two different teachers.
For the Spring 2019 edition the topics of the course was taught by a collegue and myself. The very general questions in the course evaluation are therefore not very suitable for assesing the impact of my interventions, IT-wise and otherlf detailed assessments of learning experiments is desired, a more focused evaluation questionnaire is therefore needed. And to be comparable between different editions of the course, the questionnaires must contain a set of common questions.
When it comes to alignment between expected learning outcomes, the activities, and the evaluation/assessment of the learning outcome my impression is, that the course is well aligned. At least this is what we aim at.

Lessons learned and looking forward

From my perspective, use of some educational technologies are meaningful, even when following a rather traditional lecture format. The tools and technologies I have been using until now work well for me. However, in order to get more interaction with the students, so some changes to the learning design are desirable.

EDU-IT role and benefits

The Edu-IT used: Blackboard LMS, live camera, videos, live Matlab examples and demonstration, lecture notes before and after annotation put on BB all support the learning. They also generally ease the work burden for the lecturer – and some of them are even fun to use.

References
Godsk, M. (2013) STREAM: a Flexible Model for Transforming Higher Science Education into Blended and Online Learning. In E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 722-728). AACE.

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Transformation of traditional lectures into online supervision in Modern Physics

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Keywords: *Electrical Engineering, Modern Physics, STREAM model, Lectures, Online Supervision, Practical and Theoretical Exercises.*

Pedagogical purpose

The goal of this learning design is to transform the traditional lectures in Modern Physics into webcasts supported by exercise sessions and online supervision. This allows for more time to focus on the students learning through their activities.

Course context

The course "Modern Physics" is a mandatory second semester course on the bachelor education in Electrical Engineering at Aarhus University. The course is 5 ECTS and will run for the first time in the Spring 2020 with up to 30 students. In 2021, the intake of students will be doubled allowing for 60 students to be accepted into the program. The exam is a 3-hour written exam, while three mandatory assignments throughout the course must be approved.

Learning outcomes and purpose of learning design

This presentation concerns the part "Light as a particle and a wave" within the curriculum of the course Modern Physics, which has the duration of one week. Within this week one of the mandatory assignments has been placed. The Intended Learning Outcomes are:

- Describe the nature of light as a wave vs. a particle.
- Sketch the propagation of light through a media such as a lens with ray tracing.
- Calculate interference and diffraction patterns.

The course Modern Physics is, as many other university-level physics courses, mainly consisting of theoretical derivations of physical phenomena, which often is communicated through traditional lectures, where the teacher goes through calculations on the blackboard or slides PowerPoint slides. However, with this approach it can be difficult both to activate and engage the students as well as assessing the student's learning. On the other hand, many topics within Modern Physics do allow for a greater emphasis on experimental exercises to facilitate the underlying theory.

The purpose of this of this learning design is to transform the traditional lectures in to online webcast. This will be followed by face-to-face exercises and online supervision allowing for more time to activate and monitor the students and their learning process. The learning design presented here is greatly inspired by the video "A Day in Victor's Life" produced by ST Learning Lab, 2018, where the teacher "Klausen" has replaced his lectures with webcasts.

Learning design and Educational-IT

The learning design presented here is shown in Fig. 1 and 4. Overall, this consists of four elements:

Out-of-class preparation activities where the students work on their own with the texbook and webcasts. These evaluate the necessary theory, and their understanding of this is monitored by an online quiz, which also allows for just-in-time teaching (JiTT) at the exercise session and online supervision. Examples of a webcast and the quiz in Blackboard is shown below in Fig. 2. The students are furthermore expected to start looking at the exercises to identify which difficulties they may have in these before showing up in class.

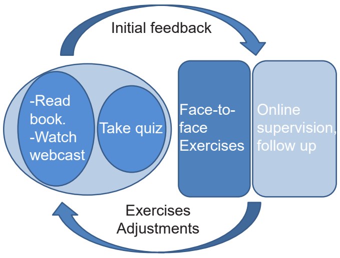

Figure 1: *STREAM model applied to wave-module in Modern Physics.*

Exercise session with Teaching Assistants (TAs) where TAs will work with the students on the theoretical and experimental exercises, where an example is shown in Fig. 3.

Online supervision where an Adobe Connect session will conclude the out-of-class work and the exercises with the TAs, and allow to follow up on difficulties pointed out by the TAs or the quiz. This also gives the students a chance to ask questions for the exercises for their mandatory assignment.

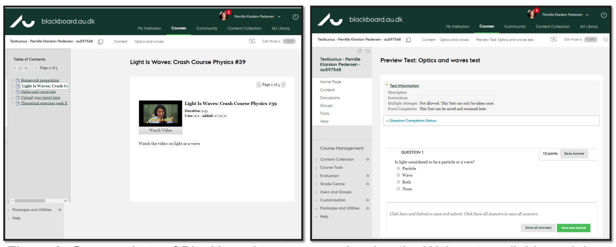

Figure 2. *Screen shots of Blackboard test course showing the Webcast available and the quiz to be taken before showing up for in-class exercises.*

EDU-IT role and benefits

The key elements of EDU-IT in this learning design are webcasts, online quizzes (see screen shots in Fig. 2), and an Adobe Connect online supervision session. Replacing traditional lectures with webcasts gives more time to evaluate the students learning and address difficulties through exercises and online supervision. The quiz takes place prior to the face-to-face exercise session, which makes it possible to monitor the student's understanding, and allows for JiTT.

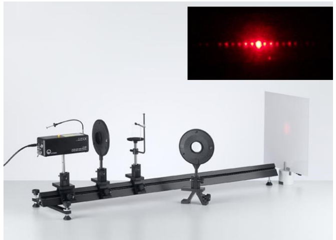

Figure 3. Exercise: *Diffraction pattern (inset) measured with a simple setup consisting of a laser and a small slit. The students will get a practical feeling for when the diffraction pattern appears, and can relate the pattern to varying sizes of the slit and the wavelength (color) of the laser, where several configurations are possible. The students will be asked to estimate either the wavelength og size of the slit from their measurements of the diffraction pattern by using appropriate theory as a part of the exercises to be submitted on Blackboard.*

Out-of-class work on exercises where the students will hand in their answers to the exercises on Blackboard. The students will be allowed to resubmit their answers after receiving feedback on their initial submission. This allows them to learn from their mistakes and provides feedback to the teachers, from which adjustments in future teaching can be done.

Substituting the traditional lectures with webcasts and online supervision sessions will not only allow me to prepare the webcasts with a greater flexibiity, but also give me more time to focus on the students learning throughout exercises and supervision. Considering the SAMR model, I hope that the EDU-IT overall will lead to a transformation by modificaton of the traditional form with lectures and theoretical exercises.

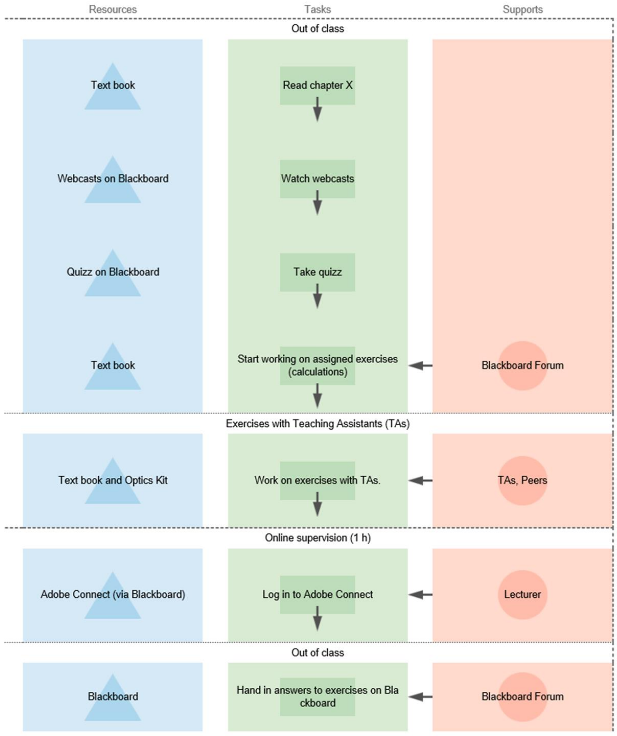

Figure 4. *LDTool representation of learning design used in Modern Physics for the curriculum about "Light as a particle and a wave".*

Lessons learned and looking forward

As the learning design proposed here has yet not been implemented, the actual impact is still to be studied in the future. From the course content in Module 2 and 3, I have been motivated by the data showing positive effects on online teaching methods. This made me reconsider why one should stick to traditional lectures when one can gain more flexibility and time to observe the students learning by replacing these with elements of EDU-IT.

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Transformation af laboratorieøvelse for at sikre bedre læring hos de studerende

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Ingeniørdocent

Keywords: *laboratorieøvelse, læringsdesign, holdundervisning, peer feedback, SAMR-model, STREAM-model*

Pædagogisk udfordring

Erfaring har vist, at de studerende ikke møder forberedte nok op, når de skal udføre en øvelse i laboratoriet. Kan dette forbedres ved at transformere øvelse med fokus på data til fokus på forståelse af måleprincip?

Fakta om kurset

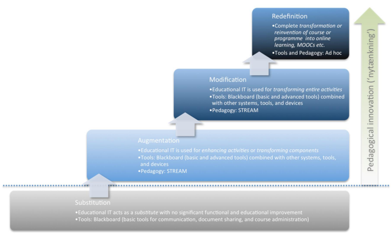
Introducerende Kemiteknologi er et 5 ECTS-kursus på 1. semester for diplomingeniørstuderende på retningen kemi (KE1INT). Der er ca. 60 studerende på holdet. Kurset er tilrettelagt, så de studerende introduceres for syv forskellige kemiteknologi og ingeniørmæssige faglige områder, for at give de studerende et indtryk af, hvad det vil sige at være kemiingeniør. Alle de syv emneområder linker op til kommende kurser på studiet.
De studerende skal indenfor hvert emneområde igennem en laboratorieøvelse med de formål at linke teorien op på en praktisk del. Derudover kommer de studerende på et virksomhedsbesøg, som har relevans for de kemiteknologiske processer, der gennemgås. Der udarbejdes en rapport på baggrund af besøget.
Kurset bestås ved at alle otte rapporter godkendes.

Læringsmål og designets formål

Den transformerede øvelse tager udgangspunkt i den reviderede SAMR-model (figur 1) og benytter STREAM-modellen som basis (Figur 2). Øvelsen har til formål at højne den studerendes taksonomiske[1] niveau fra at genkende og respondere på et instrument til måling af lysabsorption til at kunne:
Udføre korrekt måling af lysabsorption.
Vurdere egen og andres forståelse af princippet bag måling af lysabsorption og udførsel af måling.

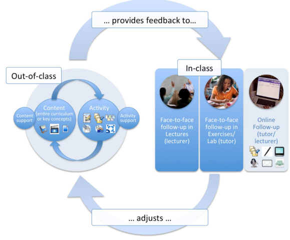
1 Revised Bloom taxonomy (Bjælde, 2014).

Erfaringsmæssigt møder de studerende ikke forberedte nok op til laboratorieøvelserne, når de får udleveret en protokol. I underviser-teamet er vurderingen, at den studerende enten 1) ikke forstår øvelsen/beskrivelsen, når de endnu ikke har set instrumentet, 2) tænker, at den udleverede protokol indeholder en "opskrift", som de bare kan gå frem efter og derfor ikke behøver at sætte sig ind i øvelsen på forhånd. Begge dele blokerer for den studerendes læring og ønskes mindsket så meget som muligt. Konkret betyder det også, at den studerende bruger sin tid i laboratoriet på finde ud af, hvad der skal ske fremfor at forstå og reflektere over opnåede data og resultater.
Ved modifikationen af måden, hvorpå øvelserne afholdes, afhjælpes implikationerne af den manglende forståelse og/eller forberedelse af øvelsen. Med læringsdesignet tilskyndes den studerende til at opnå dybere læring (Hattie, 2015), da fokus rettes mod forståelse af måleprincipper og iterativ gennemgang af teori og gennemførelse.



Figur 1: *Revideret SAMR-model. Den transformerede laboratorieøvelse vil indgå på Modifikations-trinnet.*

Out-of-class skal de studerende se en introduktionsvideo af brugen af instrumentet (fx SpectroVis) og læse teori fra lærebogen om emnet. Herefter skal de studerende gruppevis i online-diskussionsforum med egne ord forklare teorien for de øvrige grupper. Underviseren faciliterer dette.
Det er vigtigt, at videoen viser den specifikke øvelse i lab planlagt af underviseren. Inkluderet i dette skal indgå formål med øvelsen, forklaring og visning af brug af instrumentet og dataudtræk/databehandling, således at den studerende er klædt på til selv at gå i gang med de følgende opgaver.
De studerende skal nu internt i gruppen planlægge optagelsen af en ny (forbedret) video, hvordan de vil designe udførelsen, hvilke forklaringer der skal med, osv. De skal liste fordele og ulemper ved deres valg i et lukket gruppediskussionsforum – underviseren har adgang hertil og kan komme med input.
Når denne del er godkendt af underviseren skal de studerende selv gå i lab og foretage øvelsen mens de filmer 2-4 min video – gerne bare med en mobiltelefon. Videoen skal indeholde formål med øvelsen, teori, brugen af det specifikke instrument, og visning af, hvordan data evalueres. Videoen uploades i åbent diskussionsforum.
Hver studerende skal nu 1) stemme på, hvilken video er bedst og 2) argumentere for, hvorfor det er den bedste video inde i diskussionsforummet. Hermed flyttes fokus fra personerne i videoen til, hvad der rent faktisk siges og leveres af information.
In-class samles op på øvelsen og baseret på argumenterede stemmer vælges den bedste video. Videoen gøres tilgængelig online for hele holdet og for kommende studerende, som skal lave øvelsen fremadrettet, som introduktionsvideo.



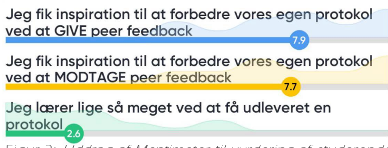
Figur 2: *STREAM-modellen*

Læringsdesign og Educational-IT

Læringsdesignet understøtter en dybere læring for de studerende, i det de er mere forberedte inden selve laboratorieøvelsen. Dermed øges deres taksonomiske niveau og de får overskud til at indgå i diskussioner omhandlende data allerede i laboratoriet, hvor der er tid til at rette op, hvis der er brug for det. Læringsdesignet understøttes af en række aktiviteter i og udenfor in-class undervisningen.

Indikatorer på virkning

Øvelsen med at lave egen video-protokol er en didaktisk forlængelse af "Lav din egen protokol". Øvelsen er endnu ikke foretaget, da kurset ligger i efterårssemesteret. Øvelsen ligger dog tæt op af den anden øvelse, som blev udviklet som en modificeret øvelse og afholdt her i foråret af en kollega.
Baseret på erfaringerne fra "Lav din egen protokol" er der store forventninger til øget læring hos de studerende.



Figur 3: *Uddrag af Mentimeter til vurdering af studerendes udbytte af læringsdesign til "Lav din egen laboratorieprotokol". Lav din egen video-laboratorieprotokol bygger på samme princip og forventes at give tilsvarende evaluering.*

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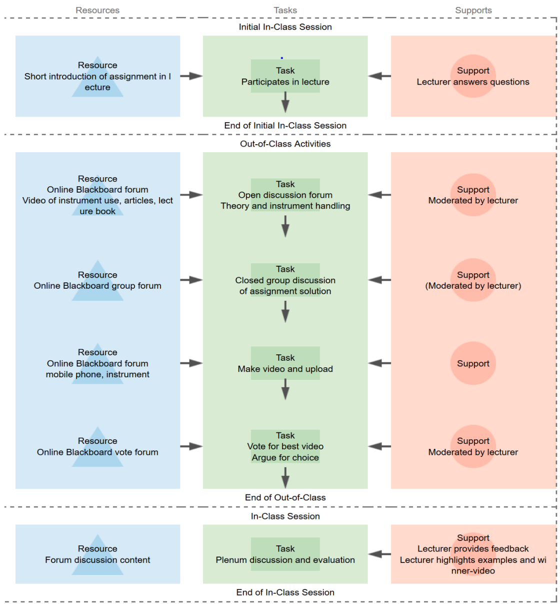

Figur 4. *Udsnit af LDTool-repræsentation af læringsdesign anvendt til fremstilling af video-protokol i kurset Introducerende Kemiteknologi*

EDU-ITs rolle og fordele

Det digitale medie er blevet implementeret som en del af de studerendes forberedelse. Mentimeter, Kahoot, og quiz i Blackboard er anvendt til repetition af lektioner samt til fokusering på relevante emner.
Det digitale medie åbner for muligheden for at introducere peer feedback på hinandens video-protokoller for de studerende inden de afleveres til godkendelse hos underviseren. Dette kan bl.a. gøres i et diskussionsforum i Blackboard, hvor de studerende giver hinanden peer feedback og således henter inspiration i hinandens protokoller.

Erfaringer

Baseret på indledende omstruktureringer af afholdelse af laboratorieøvelserne er de studerende positive over for selv at udarbejde protokol til brug i laboratoriet, da det efter eget udsagn øger deres forståelse for øvelsen og dermed den dybere læring.
Set fra underviserens synspunkt glider øvelserne bedre, da de studerende er hurtigere i gang og der arbejdes meget mere effektivt.
Set i det lys vil øvrige laboratorieøvelser blive evalueret med det formål at undersøge muligheden for at ændre øvelserne. Der skal her indskydes, at der selvfølgelig er et tidsaspekt set med den studerendes øjne, som der skal tages hensyn til, da det er en klart mere tidskrævende form for læring.

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Teaching geologists programming

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Keywords: *Geoscience; numerical methods; lectures/small-class teaching; 5-stage-model; promoting self-efficacy and peer-interaction*

Pedagogical challenge

Because this course is subsidiary compared to the main interests of many students, it is a challenge to keep them engaged. In addition, there is a large span in student level, which makes it challenging to keep them all occupied while giving the necessary feedback.

Context This learning design was used in *Numerical Methods* (8 weeks, ~5 ETCS), which is part of the obligatory 2nd year course *Geoelektromagnetism and Numerical Methods* at the Department of Geoscience, AU. Roughly 20 geology/geophysics students attend each year. The course includes theory and hands-on exercises, and consists of a combination of lectures given by an instructor (2x2h/week) and theoretical exercises supervised by a teaching assistant (3h/week). The final assessment is an oral exam where the list of questions is given beforehand.

Learning outcomes and purpose of learning design

By the end of this course, the students should be able to:

- Calculate algebraic expressions numerically, including interpolation, differentiation and integration, as well as solve equations.
- Produce curve and surface plots of mathematical functions and observed data in regular grids, read and write data on disk files, and fit analytical expressions to such data.
- Write, debug and apply elementary Matlab code in connection with the above-mentioned learning goals.
- Solve simple differential equations numerically.
- Combine and relate these electromagnetic and numerical methods for solving geoscientific problems.

With this learning design, I would like to help the students to a smoother entry into programming and give the students a positive experience with this topic that is unfamiliar and subsidiary to most of them. Developing their self-efficacy is key in order to ensure that they will continue to use and develop their skills in this course and in their future studies and work life (e.g. Lassesen, 2011).

The learning design includes out-of-class activities in order to give the students the time for hands-on experience they need in order to develop their programming skills, while still having time to develop their understanding of numerical methods in class. In addition, the out-of-class activities will be used for in-class student-led repetition. This should facilitate a deeper learning and increase the alignment in the course, by having learning activities that prepare the students for the oral exam (e.g. Biggs, 2012).

Finally, I see these out-of-class activities as a good way of coping with the diverse group of students, as they can work in their own pace at different levels, while it still facilitates peer-interaction.

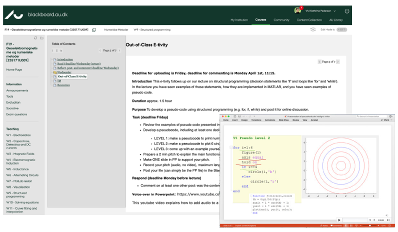

Figure 1: *Screen dumps of learning path with online e-tivity example, and an example of student*

Learning design and Educational-IT The online activities have followed the 5-stage model by Salmon (2002), to facilitate a successful online learning experience for the students. In the first weeks of the course, the online e-tivities focus on stage 1) familiarize the students with the digital learning tools (blackboard discussion board, screencast), and 2) promote interaction between students (high degree of scaffolding). The following weeks have e-tivities on stages 3) information exchange, 4) knowledge construction, and 5) development (with a lesser degree of scaffolding on student-student interaction).

The in-class student-led repetition was done in small groups of 2-3 students. Here they quickly summarized their solution to the online e-tivity, followed by a discussion of additional dimensions of the problem (based on a set of given questions). The group work was followed up by a short consensus discussion with the whole class. As an example, the students have implemented a numerical method in MATLAB (e-tivity), and they then compare their implementations and discuss further the limitations of this method in the small groups.

The described learning design was tested in the teaching experiment performed during module 2 of the teacher training program.

Indicators of impact I have evaluated the learning design using student reflections on course expectations and progress, that they have formulated in a portfolio tool (first week, later week), in combination with a short survey with specific questions on the student's preparation before class and engagement in online learning activities. Both were followed up by a general discussion in class.

The majority of the students (>90%) have found the weekly learning paths useful (Figure 1A), and in addition, many students (>60%) find that the online activities were helpful for the learning process, although half of these say that they do not have the time to make them (Figure 1C). Despite that the students found the online e-tivities helpful for their learning process, only a small number prioritised to upload them each week. This made it difficult to use the e-tivities for student-led repetition in the following week, and I have often had to come up with alternative repetition exercises.

A Do you find that the learning paths for each week gives a good overview of the content and learning activities?

Answers	Per cent Answered
Yes	91.666%
No	8.333%
Unanswered	0.00%

B Do you prepare before class by reading in the book?

Answers	Per cent Answered
Yes	25.00%
No	75.00%
Unanswered	0.00%

C Do you find the online e-tivities helpful for your learning process?

Answers	Per cent Answered
Yes, they are helpful	33.333%
Yes, but I do not have time to make them	33.333%
no, they are too easy	8.333%
no, they are too difficult	8.333%
none of the above	25.00%

Figure 3: *Selection of results from the student survey (12 responses).*

Lessons learned and looking forward I consider reducing the number of online e-tivities, to reduce the workload slightly. The students were really happy with the online MATLAB tutorials we had during the first weeks in particular, while they didn't prioritise the e-tivities in the following weeks.

I will continue with student-led repetition in order to prepare the students for the oral exam. However, I will add this student-led repetition in the end of each lecture, immediately after presenting the theory, so the students can test their understanding immediately.

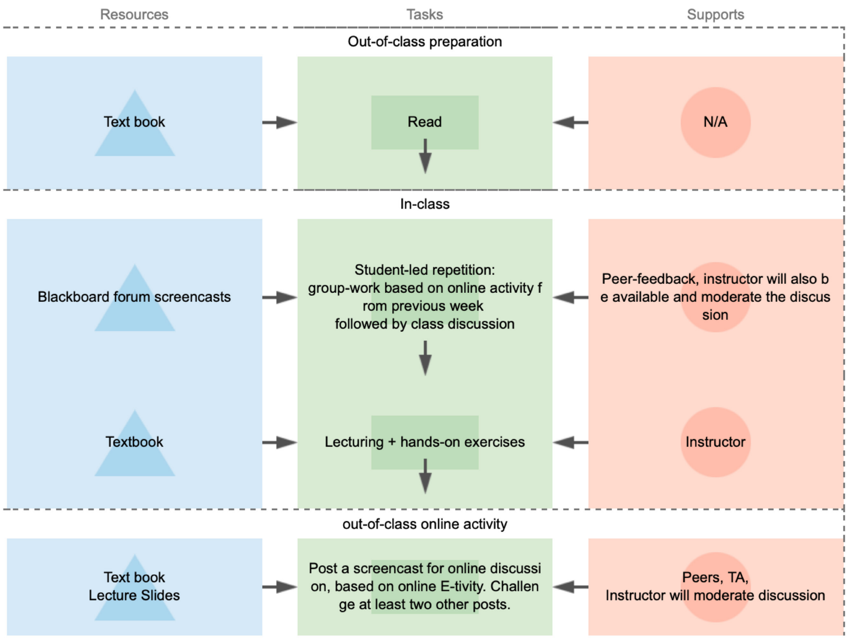

Figure 2: LDTool representation of learning design used in in this course: ***URL:*** *https://needle.uow.edu.au/ldt/ld/pLpwD3of*

EDU-IT role and benefits

I have used EDU-IT for out-of-class e-tivities. Here the students have prepared screencasts and posted them for online discussion (figure 1). Many of the e-tivities require that the students develop and implement their own ideas, based on the knowledge and skills they have acquired in the course. This use of EDU-IT facilitates i) a higher level of student activity, ii) a new component of peer-interaction that promotes peer-feedback, and iii) that the students engage at a high taxonomical level, which makes deeper learning more likely (Biggs, 2012).

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Thinking Ecology

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Keywords: *STREAM, lecture, supporting theoretical exercises, learning design model*

Context/course facts

Ecology is a 10 ECTS compulsory course for second year biology students. The aim of the course is to give participants an understanding of the principles that control the distribution of species, interactions of populations, community structure of animals and plants, and the organization and functioning of ecosystems. The number of students varies from around 85 to more than 100.

Learning outcomes and purpose of learning design

Within my section of the ecology course, students are expected to able to:

- Explain the important factors for the geographical distribution of species.
- Extrapolate population growth by using age and lifestage-structuring matrices
- Predict population growth and the outcome of interactions between species by applying simple theoretical models

Activities are a mix of lectures, presenting examples and relating the sections. Lectures are supported by lab exercises in the form of real-life or close to real-life data that students analyze and interpret using models and knowledge from the text book and lectures.

Learning design and Educational-IT

The learning design inspired by Godsk (2013), as outlined in my LDTools figure 2, provides an example of how I approached the lecturing topic, Carrying capacity. Here students prepare by reading the textbook, receive lectures, and apply knowledge in TØ/theoretical exercises. In addition I provided two online Blackboard quizzes (figure 3).

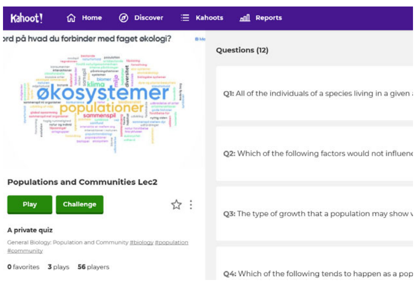

Fig. 1. Kahoot during initial lecturing to learn about students background and expectations to the course.

As I did not want students to share correct answers, they did not receive feedback on the test until everybody had finished. However, I did want students to discuss Ecology and they were allowed to take these test anytime during a period of three days and they could do this in groups where they would discuss their findings and results. I would then use the beginning of the next lecture to go over those questions that caused problems for the majority of the students, or, that some of the students were tricked by.

Figure 3. Example of quiz during the course. Both multiple-choice and several other set-ups were used.

Pedagogical challenge/purpose

My approach to lecturing is very classical. A professor presenting text-book material. The challenge is the attention to, and retention of, lecture material decline as a function of time. Therefore I attempt to break lecturers into smaller segments, by adding activitie,ssuch as think-pair-share, Kahoot (figure 1) and Mentimenter, or by breaking the information flow into smaller segments, by change of speed, voice, topics.

Indicators of impact

Other than my Kahoot, Blackboard tests and think-pair-share communication during lectures, I receive no other feedback. The grading and percentage or mistakes in the tests does provide a clue about the students learning outcomes during the semester.
Some of this feedback come to late to be incorporated into the teaching, whereas direct – en vivo – communication with think-pais-share and Kahoots provide instant response that I can use on the fly to focus, explain or maybe even refer to sections in previous lectures or in the text books that should be consulted again.

Lessons learned and looking forward

The technology provides several new paths for effective teaching and – in concert with classical lecturing – I have learned to implement and will use them more in the future. I will likely limit the amount of activities during lecturing, as time is limited, but compulsory out-of-class activities, at the pase of the students will provide a more flexible learning environment.

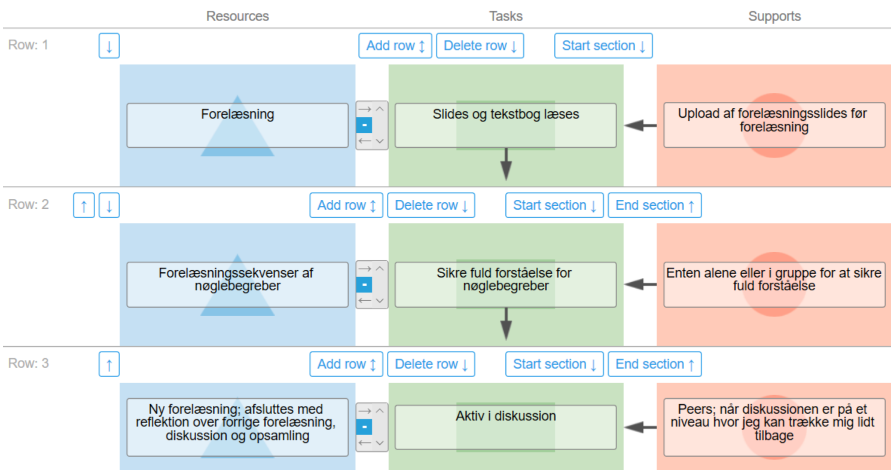

Fig. 2. LDTool representation of learning design used in Ecology; this particular approach to explain the carrying capacity 'K'

EDU-IT role and benefits

During lectures Kahoot, Mentimeter, and others have been incorporated, not only for testing and practicing, but also as in the above case, to learn about the students expectations, and their prior knowledge about the course. With more than 80 students in the class, it is difficult to have many one-to-one interactions, but such excercises does provide an idea about the students motivation and academic background. This helps me direct and relate what I teach to something they are comfortable with. Developing more quizzes will benefit the teaching by better monitoring the students progress, and, to emphasize which sections needs to be revisited.

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Øget aktivitet før og efter undervisningslektionen

Søren Steffensen
Adjunkt

Keywords*: Dynamik; læringsdesign; holdundervisning; web-cast; peer feedback*

Pædagogisk udfordring

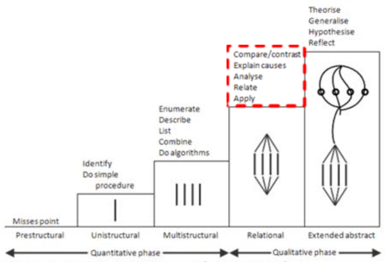
Grundlæggende er de studerende gode til at arbejde med opgaverne og teorien samt at give peer feedback i forbindelse med undervisningslektionerne men det opleves samtidig, at de sikke altid er aktive mellem undervisningslektionerne. Kan dette forbedres ved at ændre måden der følges op på opgaverne?

Fakta om kurset

Dette learning design er delvist prøvet anvendt i *Dynamik* (M3DYN), som er et obligatorisk 10 ECTS-point kursus for maskiningeniørstuderende på 3. semester. Kurset introducerer de studerende for grundlæggende principper inden for kinematik og kinetic af partikler og stive legemer samt vibrationer. Undervisningen er en blanding af forelæsning og problemløsning (2x3 timer per uge).
Eksaminationen består i en 20 minutters mundtlig eksamen uden hjælpemidler, hvor de studerende på baggrund af kendte opgaver, skal udvise at de opfylder læringsmålene. Opgaverne har de studerende selv lavet i grupper i forbindelse med undervisningen.

Læringsmål og designets formål

Læringsmålene for kurset er i den kvalitative ende af Biggs SOLO taksonomi (Biggs, 2012) med aktive verber som ***analysere, redegøre, forklare*** og ***anvende*** (Figur 1).



Figur 1: Biggs SOLO taksonomi (Biggs, 2012).

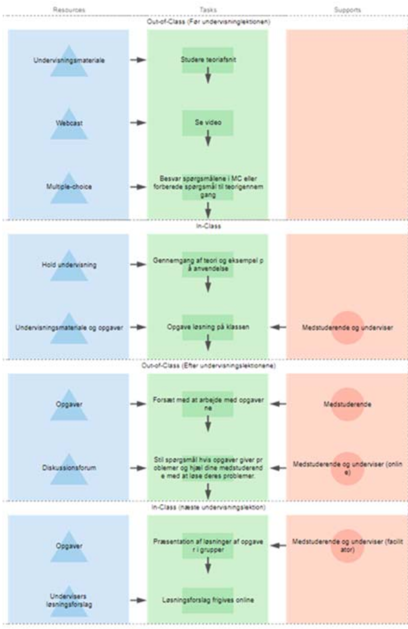
Der ligges specielt vægt på, at de studerende skal kunne anvende den teori de lærer, fremfor at skulle kunne teoretisere, udlede osv. Derfor er der i undervisningen lagt stor vægt på, at de studerende skal arbejde aktivt med løsning af opgaver, hvilket der bliver afsat en stor del af konfrontationstiden til. Baseret på spørgsmål fra de studerende i forbindelse med undervisningslektionerne, fremgår det også meget tydeligt, at det først er når de aktive og arbejder med opgaverne, at de begynder at forstå teorien.
Der stilles flere opgaver en de studerende har tid til at lave i forbindelse med undervisningslektionen, hvorfor det er vigtigt at de studerende er aktive mellem undervisningslektionerne, for at når at lære teorien i dybden. Det er dog ofte tilfældet at de ikke er aktive, hvilket ses tydeligst ved, at de ikke lærer teorien i dybden inden næste undervisningslektion, hvor der typisk bygges videre på teorien fra forrige undervisningslektion. Det medfører at det gentagende gange er nødsaget at repeterer allerede gennemgået teori.

Det ses ligeledes at de studerende ikke møder velforberedte op, hvorfor der bruges unødig meget tid på teorigennemgang, hvilket tager tid fra den del af undervisningslektionen, hvor de studerende kan være aktive med opgaverne og få feedback fra underviseren.

Dette læringsdesign har til formål at aktivere de studerende mere mellem undervisningslektionerne, hvorved de opnår en mere dybdegående forståelse for teorien løbende, som de kan bruge i forbindelse med anvendelsen af denne. Det skal ligeledes frigive mere tid i forbindelse med undervisningslektionen, hvor de studerende kan være aktive i forbindelse med opgaveløsning.

Læringsdesign og designets formål

Læringsdesignet er opbygget omkring en række aktiviteter før, i og efter undervisningslektionen, der skal sikre at de studerende møder velforberedte op til undervisningslektionen og at de arbejder aktivt med opgaver efter undervisningslektionen (Figur 2).
For at sikre at de studerende møder velforberedte op (studerer teoriafsnittet), indføres der før undervisningslektionen en aktivitet der gerne skal aktiverer den studerende til at forberede sig. Alt efter det pågældende emne, er dette enten en multiple-choice quiz eller at de skal forberede spørgsmål til den teori som vil blive gennemgået i undervisningslektionen. Spørgsmålene som de forbereder skal de før undervisningslektionen upload på enten et Blackboard forum eller ved brug af Mentimeter. Dette tjener både det formål at de studerende reflekterer over det de har læst i undervisningsmaterialet samt at underviseren for indblik i, hvilken del af teorien de studerende har svært ved at forstå og har mulighed for at lægge vægt på dette i forbindelse med teorigennemgang i undervisningslektionen. (Denne del er endnu ikke afprøvet i undervisningen!).
De studerende har flere gange, både i forbindelse med undervisningen og i kursusevalueringerne, givet udtryk for, at de finder det svært at studere teorien før undervisningslektionen. Det skyldes at de finder teorien svær men også at de synes det er svært at forstå sproget i undervisningsmaterialet. Derfor er der en proces i gang, hvor der løbende laves små Webcast som de studerende kan se i forbindelse med deres forberedelse til undervisningslektionen.
I videoerne udledes små beviser eller der gennemgås et eksempel som de studerende kan bruge til at forstå teorien. Videoerne er meget lavpraktiske, og foregår ved at filme ned på et stykke papir hvor beviset udledes.


Figur 2: LDTool-repræsentation af læringsdesignet.
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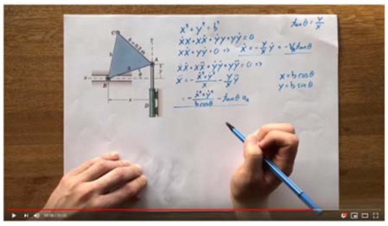
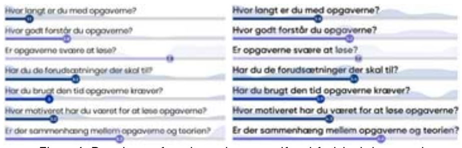

Figur 3: Screendump fra Webcast "[5/3] Plan kinematik af stive legemer - Absolute bevægelse"

Videoerne er meget korte og præcise, og der gives ikke længere forklaringer, hvorfor de ikke kan stå alene.
For at forøge de studerendes aktivitet efter undervisningslektionen, er der i dette læringsdesign indlagt en øvelse i næste undervisningslektion, hvor de studerende skal præsentere og give peer feedback på hinandens løsninger af opgaverne i grupper. Dette er gjort både for at motiverer de studerende til at arbejde aktivt med opgaverne men også for at der er bedre overensstemmelse mellem hvad vi laver i undervisningslektionerne og måden hvorpå de studerende bliver eksamineret.
For at de studerende ikke er efterladt uden hjælp mellem undervisningslektionerne, er der oprettet et diskussionsforum på Blackboard hvor der studerende kan poste i forbindelse med spørgsmål. Her kan de studerende hjælpe hinanden og underviserende kan ligeledes give support i det omfang det er nødvendig.

Indikationer på virkning

I forbindelse med modul 3 i Adjunktuddannelsens grundforløb "Holdundervisning", har jeg arbejdet med et eksperiment omkring at motivere de studerende til at være mere aktive mellem undervisningslektionerne.
Grundlæggende gik eksperimentet ud på at ændre den måde der følges op på opgaverne. Fra at ændre opfølgningen til en mulighed for at stille spørgsmål, til som det er implementeret i dette læringsdesign, at de skal præsentere for hinanden og give peer-feedback, steg motivationen for at løse opgaverne og være aktiv mellem undervisningslektionerne markant. I forbindelse hver type opfølgning på opgaverne, bliv de studerende stillet en række spørgsmål hvor der var tydelig fremgang at spore på samtlige parameter.



Figur 4: Resultater fra eksperiment udført i forbindelse med Modul 3 "Holdundervisning"

Erfaringer

Udover det der er direkte mål i eksperimentet, giver de studerende udtryk for, at de sætter stor pris på den hjælp de får i de små Webcast i forbindelse med deres forberedelse til undervisningslektionen. Det er ligeledes min erfaring, at hvis de studerende har den mulighed for at se en webcast, at de så er bedre forberedte, hvilket frigiver mere tid i forbindelse med undervisningslektionen til, at de studerende kan arbejde aktivt med opgaverne.

Omkring en tredjedel af de studerende bruger de diskussionsforum der bliver lavet i forbindelse med at de løser opgaver mellem undervisningslektioner. De studerende der benytter sig af dem, giver udtryk for at de får meget ud af det men for at få resten af de studerende til aktivt at benytte sig af disse diskussionsforum skal der ydes en større indsats fra underviserens side.

EDU-ITs rolle og fordele

Jeg har anvendt Webcast, Mentimeter, diskussionsforum i Blackboard og Multiple-choice quizzer for at øge de studerendes motivation for at forberede sig til undervisningslektionerne og arbejde aktivt med opgaver mellem undervisningslektionerne. Brug af EDU-IT har frigivet mere tid i forbindelse med undervisningslektionerne til, at de studerende kan arbejde aktivt med løsning af opgaver.

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Training your lab rats: How to enhance student learning in the lab with Edu-IT

Steffen G. Sveegaard
Assistant Professor

Keywords: *Biotechology; engineering; lab exercises; STREAM; peer-instruction; Just-in-Time Teaching; small class teaching*

Pedagogical challenge/purpose

How the combat students that have not read or understood the lab protocol prior to entering the lab? How do you enhance the students' understanding of the exercise they just performed in the lab? In the learning design presented, these challenges are attacked with Edu-IT as the weapon of choice

Context

The learning design has been implemented in the first semester course Introduction to Biotechnology in the academy profession programme (Biotechnology). The course is a 5 ECTS course, and there is typically 55-60 students enrolled in the course. The purpose of the course is to introduce some of the content they will meet during their education and is heavy in laboratory exercises.

Learning outcomes and purpose of learning design

It has been seen historically that the students are difficult to get to prepare for the lab exercises. The students are handed a lab protocol to read prior to the lab exercise, but many fail to do so. The results is that many students read the protocol during the lab hours, wasting time that was allocated for the experiments. The end results is that the students become so busy actually doing the experiment that they fail to see the idea of the lab exercise. Further, the lab note they are to hand in in groups after each lab experiment are filled with errors and often rejected (in average 4 times).
The learning outcomes I pursue in this particular learning design is that the students reach a deeper learning (Biggs 2012), they have a better reflection over their work in the lab (Biggs *et al.* 1982), and understanding of the task at hand is enhanced.

Learning design and Educational-IT

In this learning design, educational IT is a pivotal point of its success. To enhance the deep learning of the students prior to the lab work, an activity must be in place to engage the students in exploring the lab protocol and the video and text material given for preparation. An online quiz was made to challenge the students' own understanding of the material. The quiz must be answered at least 90% correct, but they can take as make trials as needed. The teacher and TAs can from the quiz results and number of retakes obtain an idea about which areas are hard to understand, and use this to enhance the lab exercise on the lab day or in the future. This follows the STREAM methodology (Godsk 2013), where the teaching initiatives are updated based on active or passive feedback from students.
After the lab exercise, the students are to peer review other groups' lab notes by using Peergrade. This allows the students, via rubrics, to reflect on their own efforts and understandings of their lab work, as well as receiving feedback from their peers. A final draft after initial corrections is then submitted to the teacher.

Indicators of impact

I could not test the learning design at hand, because I had no teaching duties in the period of the teaching experiment. However, a method to monitor the outcome of the described experiment would be as follows. The pre-lab quiz will give information about how many errors and how many retakes are necessary. In-class, there is expected a much more fluent progression of the laboratory experiment, saving time and improving understanding. And lastly, the quality of the lab notes are expected to increase drastically, only resulting in a few rejections (Figure 3).

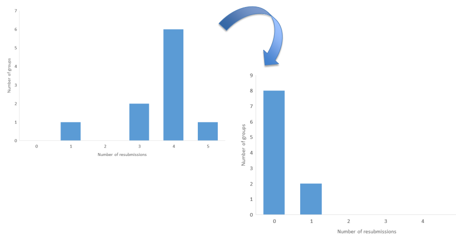

Figure 3. The expected result is that the number of resubmissions is reduced from 4 in average.

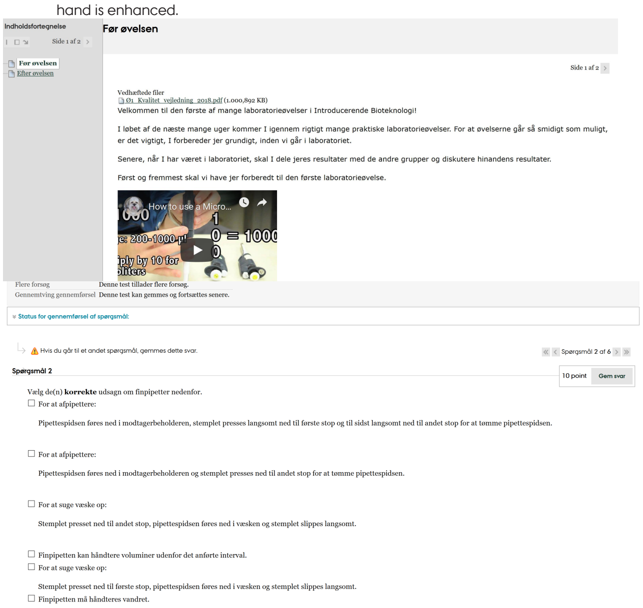

Figure 1. The learning design implemented in Blackboard. Here the tasks prior to the lab work are presented. Top: The lab protocol and an instructional video. Bottom: The pre-lab quiz.

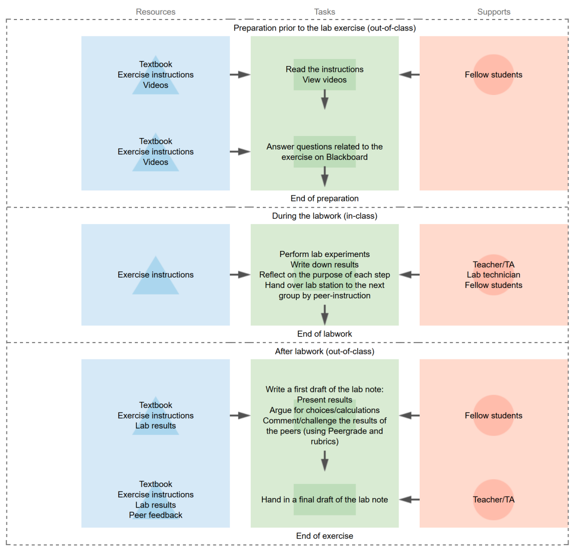

Figure 2. LDTool representation of learning design used in the course.

EDU-IT role and benefits

The educational IT tools used in this project had the primary role to align the theoretical material with the lab exercises, mainly by enhancing the students' understanding of the lab exercise, the theory behind it, and the practical aspect of the exercise. The educational IT tools used are online quizzes on Blackboard (for out-of-class preparation) and peer-feedback with rubrics on Peergrade (for out-of-class preparation of the lab note).

Lessons learned and looking forward

The main lesson learned in this project is that educational IT can enhance the alignment of laboratory exercises. Care is to be taken not to overburden the students, as the learning then is in danger of declining, leaving too little time for reflection.
Educational IT is a versatile tool, and I expect to include it more often in my courses and developing my teaching practices. The end goal is efficient use of both the students' and the teachers' time, lessening the stressful environment we currently find ourselves in.

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Teaching academic writing to ensure good alignment between learning objectives and examination

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Keywords: *Academic writing, Life science, Plant microbiology, STREAM model, Peer and teachers feedback,*

Pedagogical challenge/purpose

Many students don't have much experience with academic writing when they first enter the university. Despite of this students are met with different types of written assessments almost right from the beginning. The challenge is to increase the students awareness about assessment criteria for written examination and to make sure that students are capable of writing in accordance with these. This also includes enhancing the students confidence about writing.

Context

This learning design was developed for the bachelor course "Plant microbiology" at department of Agroecology. The design was used for the first time in spring 2019. Plant microbiology is a 5 ECTS course offered at the fourth semester and about 10-20 students attend each year. The course has 3 connected hours of lectures two times a week for seven weeks. Examination is a written essay on a topic chosen individually by the students.

Learning outcomes and purpose of learning design

The bachelors program in Agrobiology has the aim to teach students basic academic skill like doing literature searches, giving presentations, writing in an academic style etc. The teaching of these skills are spread out on several courses where each course has a main focus on a single skill. Plant microbiology focuses on academic writing and therefore the examination is a written essay given as a home assignment. The students chose the topic of their essay early on and will get feedback on their progress throughout the course. In previous years feedback was mainly given in class and primarily by the teachers with only limited introduction to the students of academic writing.

The design presented here can according to the SAMR model (Puentedura 2010) be seen as an augmentation of previous years teaching where out-of-class activities combined with in-class follow ups are expected to increase the students awareness and confidence about academic writing to make learning more visible (Hattie 2015).

With this design I hope to encourage deep thinking through teacher guided activities and thus ensuring that all students are able to write on higher taxonomic levels in accordance with the course assessment criteria (Biggs 2012).

Learning design and Educational-IT

The organization of activities in this learning design closely followed the STREAM model (Godsk 2013). Out-of-class activities prepared for on-class exercises and discussion. The design consisted of three loops which were all planned to feed into the students work with their written home assignment. A loop was organized around a single theme. Themes covered :

- **The structure of academic essays and text taxonomy**
- **Writing good problem statements**
- **The process of writing: how to get started and move forward.**

Each loop followed a general structure as described below:

Out-of-class:
A teacher guided exercise was given to students who were then expected to upload an answer online. Following their answers students were expected to give feedback to the answers of peers based on teachers instruction and own reflections.

In-class:
The teacher summarized the results of the out-of-class activities and facilitated a discussion where students could substantiate their thoughts on the topic of the exercise and on their feedback to peers.

For two of the loops, the in-class activities included students presenting their progress on the home assignment followed by teachers and peers feedback.

All out-of-class activities were organized on the Blackboard learning management system. Activates were presented on the course web site (figure1), and student answers and peer feedback uploaded in discussion forums (Figure 2). An example of the connection between out-of-class and in-class activities are presented in figure 3.

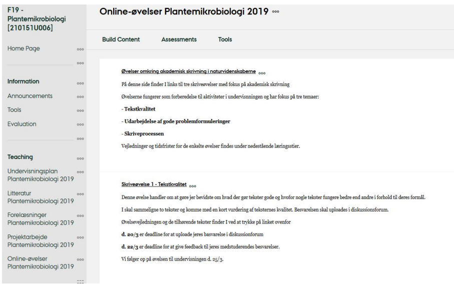

Figure 1. Presentation of activities on the course web page on Blackboard.

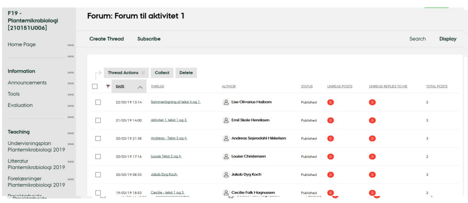

Figure 2. A discussion forum on Blackboard where students upload answers to exercises and give peer feedback.

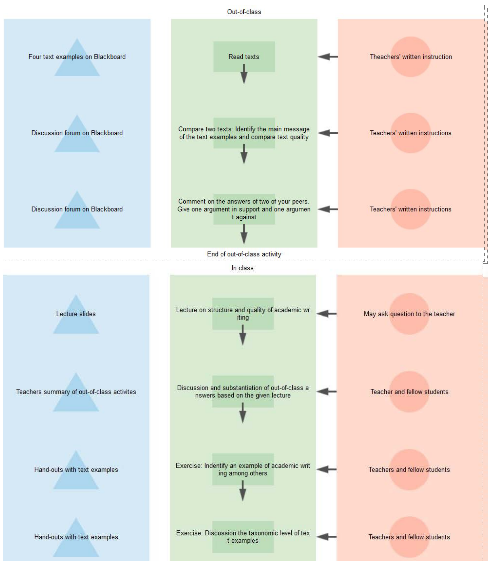

Figure 3. An example of the connection between out-of-class and in-class activities in this learning design presented with the LDTool. .

Indicators of impact

I closely monitored the student discussions on the blackboard to follow student progress and to identify any general problems or lack of participation. Only seven students participated in the course this year but all students showed a strong interest in the presented activities, both in and out of class. All students contributed with highly relevant input during feedback sessions.

During in-class discussions I often asked students about their view on the exercises. All students mentioned that they found the activities highly useful, not only for the course assignment but as a general support for other courses as well. Most students also expressed that they found it very inspiring to follow the answers and feedback of their peers on blackboard.

The teacher who has been responsible for the course through out the years mentioned that students showed a faster progress on the home assignment compared to previous years.

In the anonymous final course evaluation several students expressed a high level of satisfaction with the online exercises. The students had not yet handed in their home assignments at the time when this poster was made. So the final impact of the learning design was not yet available.

EDU-IT role and benefits

I have used Blackboard discussion forums for out-of-class activities and few mentimeter quizzes' embedded in on-class lectures as a part of this learning design. Blackboard activities were used to facilitate and prepare students for on-class discussions and exercises. Students expressed a strong motivation for participating in Blackboard discussions. They found it particularly useful to follow the answers and feedback provided by their peers online. Mentimeter was used as a tool to engage students in on-class discussions by taking onset in their answers.

Lessons learned and looking forward

I see the teaching of academic writing through guided activities and discussions as a forceful way of making students engaged in deep learning. Although I think it is of high importance that activities are followed up by significant amount of feedback for a successful outcome. It was my impression that the students confidence grew both by receiving and giving feedback. I therefore tend to focus more on feedback instructions in the future.

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Lecturing in a supplementary subjects class: A learning approach based on the STREAM model

Søren Ulstrup
Assistant Professor

Keywords: *Physics; lecture, peer discussions, problem solving; STREAM model/Blackboard learning paths; transforming student learning*

Pedagogical challenge:

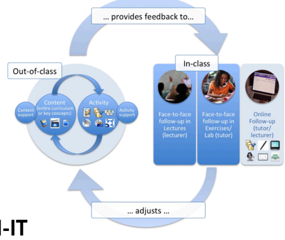
How to ensure balance between student preparation and learning out of class and activating students during lectures in a small class

Context/course facts

The course is called "Statistical Physics and Solid State Physics for Supplementary Subjects", it is typically followed by 2-6 students and run as a mix between lectures, study groups and problem solving. The work load corresponds to 5 ECTS points, and the course is assessed via 8 take-home exams that are given throughout the duration of the course.

Learning outcomes and purpose of learning design

The learning design in this poster documents the transformation of two weeks of the course to involve online learning via learning paths in Blackboard. The main challenge has been to activate students in a Physics course when this is not their main subject. There is not enough time in lectures to include student activities and to go through the harder topics in enough detail that helps students to meet the intended learning outcomes.
I decided to transform some of the more challenging aspects of this course about quantum statistics to online learning in accordance with the STREAM model [1]. This ensures out-of-class learning with the possibility to obtain peer feedback and to account for the student learning in the following in-class activities. Based on the online activity the students were asked to give presentations in class, discuss their studies with peers and provide a guideline for the lecture on which topics to focus on in the lecturing parts.



Learning design and Educational-IT

The learning design corresponding to a week of the course is presented in Figure 1 and the complete learning path in Blackboard is shown in Figure 2. The students were given assignments as a study guide and asked to upload written hand-ins in a Blog and give peer feedback. Finally, they gave 20 minute presentations in class to summarize the results of these exercises.

Figure 1. *LDTool representation of learning design used in "Statistical Physics and Solid State Physics for Supplementary Subjects". The learning design represents a week in the course.*

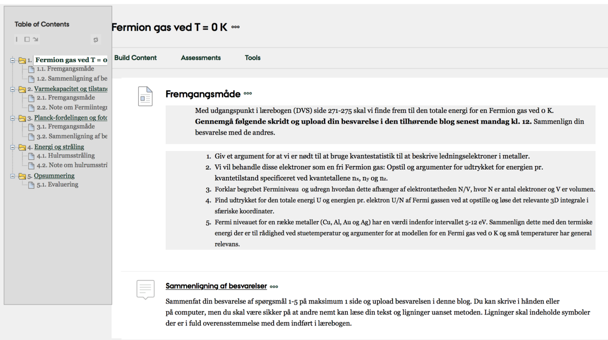
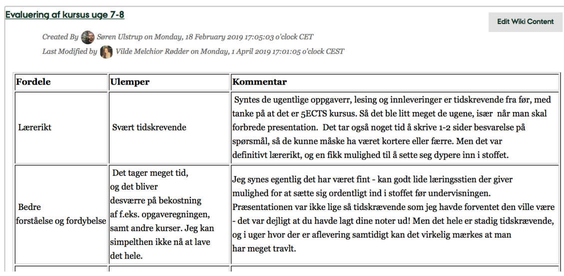


Figure 2. *Learning path in Blackboard. This was structured over 2 weeks of the course and contained a mix of reading, hand-in exercises and peer feedback in blogs. Future versions of the course are envisioned to include pencasts with more background material and to facilitate complete transformation of the course.*

Indicators of impact

The students were asked to evaluate the activities based on the learning paths in Blackboard. The outcome of the evaluation was discussed in class and will be used to improve the students learning experience in the course. The evaluations are shown in Figure 3.



Evaluering af kursus uge 7-8

Edit Wiki Content

Created By Søren Ulstrup on Monday, 18 February 2019 17:05:03 o'clock CET
Last Modified by Vilde Melchior Rødder on Monday, 1 April 2019 17:01:05 o'clock CEST

Fordele	Ulemper	Kommentar
Lærerikt	Svært tidskrevende	Syntes de ugentlige oppgaverr, lesing og innleveringer er tidskrevende fra før, med tanke på at det er 5ECTS kursus. Så det ble litt meget de ugene, især når man skal forbrede presentation. Det tar også noget tid å skrive 1-2 sider besvarelse på spørsmål, så de kunne måske ha været kortere eller færre. Men det var definitivt lærerikt, og en fikk mulighed til å sette seg dypere inn i stoffet.
Bedre forståelse og fordybelse	Det tager meget tid, og det bliver desværre på bekostning af f.eks. opgaveregningen, samt andre kurser. Jeg kan simpelthen ikke nå at lave det hele.	Jeg synes egentlig det har været fint - kan godt lide læringsstien der giver mulighed for at sætte sig ordentligt ind i stoffet før undervisningen. Præsentationen var ikke lige så tidskrævende som jeg havde forventet den ville være - det var dejligt at du havde lagt dine noter ud! Men det hele er stadig tidskrævende, og i uger hvor der er aflevering samtidigt kan det virkelig mærkes at man har meget travlt.

Figure 3. *Snapshot of evaluation of learning paths in Blackboard.*

EDU-IT role and benefits

Learning paths in Blackboard have provided the students with an online study guide and it provided a method to collect and make hand-in exercises available to peers and teachers. This facilitated discussions and peer feedback, and has also provided the teacher with intermediate feedback on student learning experience.

Lessons learned and looking forward

The online learning paths demanded more time from the students but they indicated that they learned more using this approach. By balancing this with other course elements in the future the students may find this is more time efficient and less stressful compared to the typical course work load.

References

[1] Godsk, M. (2013). *STREAM: a Flexible Model for Transforming Higher Science Education into Blended and Online Learning*. In T. Bastiaens & G. Marks (eds.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2013, (pp. 722-728). Chesapeake, VA: AACE.

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SCIENCE TEACHING COURSE POSTERS BY PHD STUDENTS

Discuss and disseminate
- Conquering Chaotic Chemistry in Pairs

Learning Lab

Abstract: The course 'Organisk Kemi I – Reaktioner og Funktionelle grupper' contains a plethora of exciting and exotic reactions, functional groups and conversions. However, many students never uncover the magic of organic chemistry, as the curriculum is by all means overwhelming and confusing to many students, and the pace is high. In this exercise this is approached by extracting essential reactions and concept and having students discuss them in pairs, and subsequently disseminate their knowledge to their peers. The students received the exercise well, and would have liked a short exercise like this every week.

COURSE FACTS

- Course name: Organisk Kemi I – Reaktioner og Funktionelle Grupper
- Level: Bachelor, 1st year
- ECTS credits : 10
- Language: Danish
- Number of students: 12
- Your role: TA in Theoretical Exercises

TEACHING IN PRACTICE

1. Identifying a problem

In the course, students often struggle to keep an overview of the many reactions, reagents and functional groups, and how they are related. The exercises given do not necessarily cover all topic systematically, sometimes limiting the *understanding* of the curriculum, which, in my opinion is the most important goal! The reduced understanding prevents some students form mastering the course and performing well at the exam.

2. Planning a teaching activity

The goal of the implemented teaching activity was to systematize a curriculum that appears as messy and overwhelming to many students. By relating certain compounds to specific functional groups, students may be better equipped to systematize and use various reagents and reactions, something which is highly relevant for the written exam. Also, by not only listening, but actively telling fellow students about the curriculum I hope they learn and remember more.

3. Trying it out in practice

The structure of the exercise is sketched in Figure 1. Briefly, the exercise was introduced , and students were paired. Certain organic functional groups and reagents were shown on a PowerPoint, and students were given a short time to discuss reactions specific to the group, and how the functional group could be converted to other compounds. Students then turned around to another partner, and told them the results of the initial discussion. This was repeated several times, covering three different functional groups.

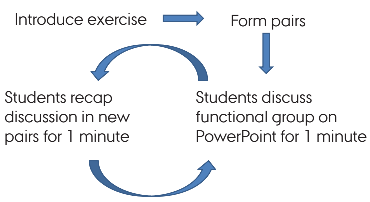


Figure 1: Schematic of the teaching activity format.

By asking the students to not only review the curriculum but also *tell* other students their findings, the students have to understand the chemistry, and they become active disseminators, rather than passive listeners.

Student learning was assessed by a 'Ticket out the door' method, by having students fill out a short questionnaire. The responses are summarized in figure 2 and 3.

MAIN POINTS

1. **Main problem/challenge:** Chaotic and overwhelming curriculum
2. **Teaching activity**: Discuss key concept and disseminate in pairs
3. **How did it go?** Students expressed that they would prefer an exercise like this every week.
4. **What to do next?** Use this exercise each week during the course if I teach it again.

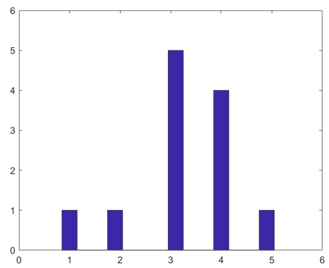


Figure 2: Student responses to the question "Did the exercise improve your understanding and give you an overview of the curriculum?" where 1 is not at all and 5 is yes!

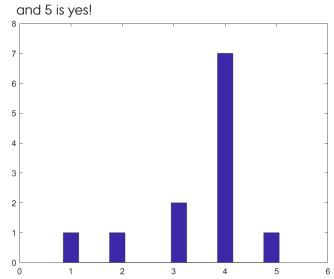


Figure 3: Student responses to the question "Would you like to have more exercises like this?" where 1 is not at all and 5 is yes!

4. Looking forward

I think that the combined initial discussion followed by the dissemination to fellow students worked very well. Also, many students expressed that this exercise should be included in every TØ session during the course, to enhance their overview of the curriculum. I will definitely do this, if I get to teach the course again. To get a better assessment of students' learning, I will include a short wrap-up session in plenum were students briefly present a functional group or a reaction. Their presentations will give me an impression of their learning.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Asger Holm Agergaard
iNANO and Dept. of Chemistry

STRUCTURED PROBLEM SOLVING

- How to differentiate mechanisms

Learning Lab

Abstract: **Students in organic chemistry have trouble differentiating mechanisms. Using structured problem solving by developing a flowchart actively with the students. This provides them with a tool on how to approach the problem. Ticket out of the door with two assignments showed that 95% of the students were able to solve two exams questions in short time.**

COURSE FACTS

- Course name: Organic Chemistry I
- Level: First year students
- ECTS credits : 10
- Language: Danish
- Number of students: 18
- Your role: Theoretical TA

TEACHING IN PRACTICE

1. Identifying a problem

Students in first year organic chemistry have difficulties differentiating between 5 common mechanisms, S_N1, S_N2, E1, E2 and E1cb, that can occur in organic reactions. The mechanism can be found by looking at the molecules involved and the conditions used. It is difficult for the student to find a general to approach the problem.

2. Planning a teaching activity

To engage the students, the flowcharts will be made as a collective effort on the blackboard. The main way of differentiating the mechanisms is by analysis of the two reacting molecules. First by looking at the number of carbon-carbon bonds for one of the reactive center, followed by analysis of reactivity of the other approaching molecule. The analysis of the second approaching molecule can be troublesome due to a variety of properties that effects the mechanism. By making a flowchart the students only have to consider one property at a time thus making the problem less overwhelming.

3. Trying it out in practice

The activity was initiated by briefly going through the theory of each mechanism for the students to remember the problems and being able to discuss it. Then the TA started forming the flowcharts giving the conditions and the students were then answering by raising hand and explaining their reason. In the end three flowcharts were made, each for a different starting structure in the reaction.

Figure 1: Showing the three generated flowcharts

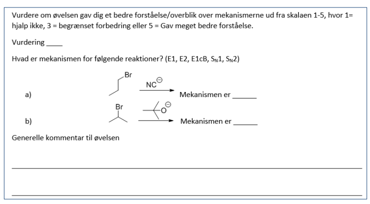
The TA then solved 3 reactions on the blackboard to show how to approach the problems. The flowchart is simplified and a short discussion about the limitation was done. The class was then split into 4 groups and then each group had to solve one problem using the flowchart and present briefly for the class. In the end of the exercise, the students were giving a ticket out the door for assessment.

MAIN POINTS

1. **Main problem/challenge:** Problems with differentiating between 5 mechanisms
2. **Teaching activity:** Structured problem solving combined with Ticket out of the door
3. **How did it go?** The evaluation gave positive results and the students were able to solve problems given.
4. **What to do next?** Implement earlier next time teaching the course.

4. Assessment

To access the activity, a ticket out the door was performed. Here the students individually and anonymous had to rate how they felt the exercise helped them (from 1-5, 5 being best). This was followed by two exercises to elucidate the mechanism of reactions to empirically evaluate if the activity helped. The average satisfaction of the exercise was 4.6 and all students except one solved the two reactions correct. The comments were all positive, with the main complain that the activity should have been implemented earlier.


Vurdere om øvelsen gav dig et bedre forståelse/overblik over mekanismerne ud fra skalaen 1-5, hvor 1= hjalp ikke, 3 = begrænset forbedring eller 5 = Gav meget bedre forståelse.

Vurdering ____

Hvad er mekanismen for følgende reaktioner? (E1, E2, E1cB, S_N1, S_N2)

a) Mekanismen er ______

b) Mekanismen er ______

Generelle kommentar til øvelsen

Figure 2: Ticket out the door to assess the activity

4. Looking forward

The evaluation clearly indicate the activity was a success. 95% of the students were able to solve the two problems given in the end correct and they felt the activity was satisfying. The activity will be implemented earlier next time teaching the course so the students will benefit earlier.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Casper Barløse
Organic Chemistry
Department of Chemistry

Overcoming student inactivity

- Increased participation through matrix groups.

Learning Lab

Abstract: To increase the degree of participation and practice oral presentation of key concepts in the curriculum, a teaching activity based on matrix groups was implemented for 2. semester bachelor students. To align the activity with the final oral evaluation of the course, the students all had to both prepare and execute a presentation. Both of these parts took place in small groups to more efficiently engage the students and the basis of the presentations was a set of concept heavy discussion questions. This succeeded in increasing the degree of student participation during the activity. Further benefit might be achieved by ending the activity with a discussion of what the students found difficult.

COURSE FACTS

- Course name: Mechanics and modern physics for chemists
- Level: 2. semester
- ECTS credits : 10
- Language: Danish
- Number of students: 23
- Your role: TA in theoretical exercise classes

TEACHING IN PRACTICE

1. Identifying a problem

The main challenge is that the current format of the exercise sessions, that I mediate, tend to only engage a small number of the students present. The goal of the activity is therefore to increase the degree of participation so more students benefit from the session.
In addition, the final evaluation of the students is an oral exam focused on the main concepts in the curriculum. To increase alignment, the teaching activity should therefore also aim at enhancing conceptual understanding as well as their ability to orally explain these these.

2. Planning a teaching activity

In this teaching activity, the key method to motivate the active engagement of more students will be to split the students into smaller groups, for each to have more room in the discussion. The activity should also feature some sort of oral presentation for all students of part of the material included in the activity. This has the benefit of both enhancing oral presentation skills as well as motivating active participation by the prospect of having to present to other students.
Finally concepts in physics are often best understood and explained with a good figure. It should therefore be mandatory to draw at least one figure as part of the preparation and presentation of the activity material. The activity is carried out in an ordinary exercise session and should therefor not take up more than half an hour as other material has to be covered as well.

3. Trying it out in practice

The activity relies on the matrix group method and consists of two parts. In the first part, students are separated into groups and each group is given a different set of questions each dealing with a particular subject in the curriculum. In these groups, they are given 10 minutes to prepare a 2-3 minute presentation of their answers to these questions.
In the second part of the activity, the students are split into a new set of mixed groups of people having dealt with different questions. In these groups they will take turns presenting their answers.
During the activity I, the TA, will help and observe the students. A pitfall I observed was that misconceptions are like to occur even tin the groups. It is therefore especially important for the TA to be vigilant in the preparation part of the activity, to catch these.

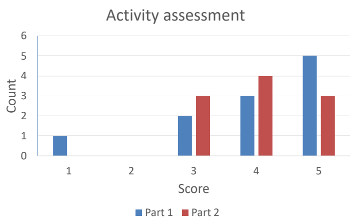


Figure 1: Students evaluating the benefit of the two parts of the activity relative to the traditional format for exercise sessions. With 1 being much less and 5 much more.

The main goal of the activity was to increase to level of student participation. This goal was assessed by asking the students how much they benefitted from the two parts of this activity compared to the same amount of time spend in a traditional exercise class.

MAIN POINTS

1. **Main problem/challenge:** Low active participation in normal exercise session format.
2. **Teaching activity**: All students prepare and execute presentation in small matrix groups.
3. **How did it go?** Increased participation observed and positive student feedback.
4. **What to do next?** Consider how to ensure that all misconceptions are caught and

As indicated by the survey, the students themselves felt a large benefit from this type of activity, with practically all students assessing it to be at least as beneficial as the traditional format. My own observations confirm that a much greater fraction of the students, and often all, was active during the activity.
A challenging aspect is that not all groups will handle the questions equally well. I generally spend more time with the most challenged groups, but it might also help to take care when constructing the groups.

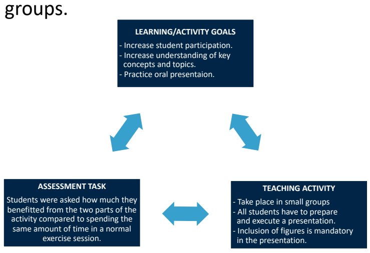


Figure 2: Constructive alignment.

4. Looking forward

The activity was clearly a success in terms of student participation both from the perspective of the students as well as my own. However there are still aspects to improve. Firstly I had a hard time monitoring the discussions of all the groups to a degree that I am sure to have corrected all misconceptions. Secondly, it might be beneficial to further discuss the parts of the material that the students found particularly difficult. Both of these challenges might be partly handled by ending with a class discussion where the students share the what they found most difficult/unclear.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Malthe Kjær Bisbo

Active discussions using JIGSAW groups

- Encouraging active participation and alignment

Learning Lab

Abstract: In the course Statistical physics and solid state physics, there is a poor alignment of the learning outcomes related to the higher taxonomical level. This activity will try to encourage active participation and help with the alignment by using JIGSAW inspired discussion sessions. The activity has yet to be implemented.

COURSE FACTS

- Course name: Statistical Physics & Solid State Physics
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: 16-20
- Your role: Theoretical TA

TEACHING IN PRACTICE

1. Identifying a problem

In the solid state physics part of the course, there is more of a focus on being able to explain and discuss central topics [1]. This is somewhat reflected in the discussion questions at the start of each TØ (theoretical exercise) session, but the problem is getting every student to participate actively in the discussion. Also, the exam is a multiple choice test, and thus there is an alignment problem in the higher taxonomy learning outcomes.

2. Planning a teaching activity

The plan is to encourage active participation in the discussion questions through the use of JIGSAW groups. This helps train the students in discussing the curriculum and thus helps directly with course alignment, which is presently lacking. The students are put into four groups of four and then asked to answer and discuss a couple of semi-related question each. Then, four new groups are made, each with one person from each of the previous groups. Here, the students will teach to the others what they discussed previously.

3. Trying it out in practice

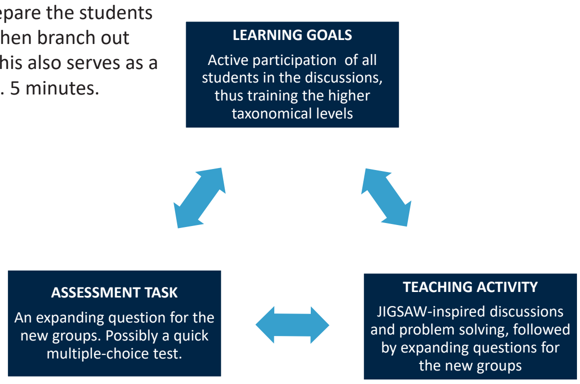
Unfortunately, I have not had the chance to try it out in practice, so instead a detailed step-by-step description follows:

1. The students are divided into four groups of four (assuming 16 students in total). Each group receives two / three questions, which they will discuss among themselves. 5-10 minutes.
2. The students are divided into four new groups, each with one member from each of the previous groups. The students will, one by one, present their questions from before and what they discussed previously The teaching assistant here has an important job to ensure the quality of the discussions. 5 minutes per student, 20 minutes in total.
3. Follow-up questions to the new groups, which connects and builds on questions from all of the students. The groups will discuss these internally and will then answer it to the whole class. A possible way to do this is to use multiple choice questions (e.g. Mentimeter) to prepare the students for the exam, and then branch out into a discussion. This also serves as a kind of assessment. 5 minutes.

MAIN POINTS

1. **Main problem/challenge:** Ensuring course alignment and active student participation in the discussion sessions.
2. **Teaching activity**: JIGSAW-inspired discussion groups encouraging active participation in the discussion.
3. **How did it go?** Unfortunately not implemented in practice yet.

Evaluation is performed in each group, who are given a piece of paper and writes whether they liked the activity, whether they think it was beneficial to their active participation and learning, and if they would like to do the activity again. Furthermore, the teaching assistant evaluates and notes during the activity the quality of the discussions and the amount of active participation, and by that also assess the student learning outcome.



4. Looking forward

The discussion question could be taken from the weekly notes, since these are often well connected to the curriculum and nicely interrelated. This activity could then possibly sometimes replace the usual way of going through these questions.

References

[1] https://kursuskatalog.au.dk/en/course/93251/Statistical-Physics-and-Solid-State-Physics

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Thomas Bækkegaard
AU Superconducting Circuits
Department of Physics and Astronomy

Why learn without motivation?

- Concept maps as a tool for increasing motivation.

Learning Lab

Abstract: Is it possible to learn without motivation? Perhaps, but it is a lot easier if motivated. For students on early semesters it can be difficult to see how a course connects to their degree and this can be demotivating often resulting in poor work ethic. To combat this my teaching activity has the students study a text describing how the concepts covered in the course can be used to analyze the interaction of a drug molecule with a protein, and based on this make a concept map. In this way the students explore the connections between the different fields. The activity was well-received from my students, but would be better if it required less preparation from the students.

COURSE FACTS

- Course name: Mechanics and Modern Physics for Chemists
- Level: 2nd semester
- ECTS credits : 10
- Language: Danish
- Number of students: 10
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

My students are medicinal chemists and have not always shown too much motivation for studying physics. Considering they are only on their 2nd semester it can be difficult for them to understand why they need to learn the topics covered in the course. How is it spending a lot of time working on exercises, assignments and exam questions in physics will help them become proficient medicinal chemists?

2. Planning a teaching activity

My teaching activity was not designed to teach the students a specific topic, but rather to help them realize the connections between physics and medicinal chemistry and how they might be able to use this understanding in their studies and eventually in their careers.

By showing them a concrete case of physics being applied to a problem in medicinal chemistry and having them explore the connections with a concept map, the value of the course should become more clear to them.

References

[1]: R. N. Santos, A. D. Andricopulo, *Physics and its interfaces with Medicinal Chemistry and Drug Design, Braz. J. Phys, 2013.*

3. Trying it out in practice

At the previous TØ-session the students were handed an excerpt of an article describing how the cancer drug Taxol works, specifically the text describes how to analyze the binding between the drug molecule and a protein[1].

In this text 35 words, many of which had been covered in the course, had been highlighted (such as Hooke's Law and Coulomb potential) and the students were instructed to make sure they understood these words, e.g. by googling.

During the activity the students were divided into groups of 5 and asked to discuss the text they had read for a few minutes and then instructed to make a concept map with the highlighted words as the focus.

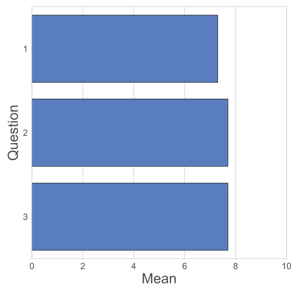


Figure 1: Questionnaire results: Students were asked to answer three questions after participating in the activity on a scale from 1-10.
Q1: How relevant is the course for your education?
Q2: Has the activity made the relevance more clear?
Q3: Do you expect to use the physics you have learned in the course in the remainder of your education or when you have finished?

MAIN POINTS

1. **Main problem/challenge:** Making sure the students understand why they spend time and energy on this course.
2. **Teaching activity**: Concept map based on article excerpt.
3. **How did it go?** The students enjoyed the activity and drew a lot of connections.
4. **What to do next?** Try it again next year, reduce amount of student preparation.

After spending about 20 minutes working on their concept maps, the two groups presented their concept maps to each other.

In order to asses If the activity had been a success (besides observing their work and the presentations) the students answered a few questions about their opinions on the relevance of the course and whether the activity had an impact on that opinion.

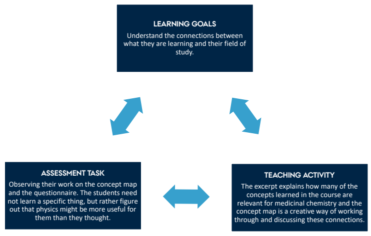


Figure 2: Constructive alignment

4. Looking forward

I think having the students work on the concept map went well, but only few of them had actually read the text a head of time, so sometime had to be spent in class on that. As a next iteration perhaps I could arrange for someone to give a short presentation on a similar subject as an alternative to supplying reading material that it is difficult to make sure they prioritize reading. The assessment could be improved by doing a questionnaire before the activity and by asking more qualitative questions.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Mads-Peter Verner Christiansen
Machine Learning in Quantum Chemistry
Department of Physics and Astronomy

Pure science and LEGOs

- Piquing the interest of outsiders in 10 minutes

Learning Lab

Abstract: For detail-oriented topic-immersed scientists (like ourselves) dissemination of "what we actually do" to outsiders is incredible challenging. Connecting pure science (which is not focused on specific outcomes by definition) to the prior knowledge of a wide variety of people in all ages and backgrounds and piquing their interest requires a well-thought-out strategy, extensive around-science knowledge and a few props. Here, LEGOs functioned as the common ground for an introduction into membrane proteins, neurons and encouraging a dialogue about disease, actual size or whatever caught their interest. The result; four hours of incredible diverse dialogues, creative LEGO-protein builds and a rediscovery of my own subject seen through the eyes of others.

COURSE FACTS

- Course name: Forskningens døgn
- Level: Open for all
- ECTS credits : does not apply
- Language: Danish
- Number of students: 50
- Your role: facilitator/communicator

TEACHING IN PRACTICE

1. Identifying a problem

Pure science is complex and confusing even from a scientists approach. Finding the right tools for communicating and piquing the interest of non-scientist on something like membrane proteins is a challenge, which is often abandoned due to complexity. At the "Forskningens Døgn" event science is celebrated and we need to find the best way to make pure science relatable and intriguing to a wide variety of audiences and also providing a milieu where all questioned are allowed and dialogue is the main goal. Previous years has highlighted the need for a new approach, which is more focused on discussion and more flexible to the wide variety of people attending.

2. Planning a teaching activity

Membrane proteins in neurons are far from the everyday-life thoughts of most people,. The overall plan for the teaching activity is focused on connecting with people through something "known", here LEGO, and using it to make the actual subject more digestible. In this manner the roles are less "expert" vs "novice" and rather two people talking about LEGOs (or really membrane proteins through LEGOs) which creates a more open milieu and hopefully opens up for more questions.

The stand was designed with the LEGO building station as the natural starting point, which was combined with a "neuronal" circuit which was lit up when it could communicate with other neurons. This would only happen when a correct LEGO membrane protein was inserted (see figure 3+4). Further 2 posters functioned as talking guides about proteins and neurons respectively. Altogether making the setup very flexible, dependent on the person attending.

3. Trying it out in practice

Based on the described stand we invited people to learn, discuss and build their way through our stand. Some went straight for the LEGO (old as young) while others were more fascinated by the posters. While occupied with the LEGOs it was easier to start a relaxed conversation about our science, and invite peoples questions. For some kids the sheer number of proteins/cell (1-2 billions) suddenly made them aware of how small they had to be to fit, while their parents asked questions about mutations or disease. This approach of visitor-guided-teaching and -learning worked well in the setup and enabled us to disseminate on very different levels from conversation to conversation.

Some of the participants were asked to mark on a action potential, if they felt their interest had been piqued after visiting the booth. It turned out to be interpreted very differently, but functioned well as a starting point for further qualitative evaluation and discussion about the subject in general, rather than a cut-and-dry fact evaluation, which was a lot more rewarding and valuable from a dissemination point of view.

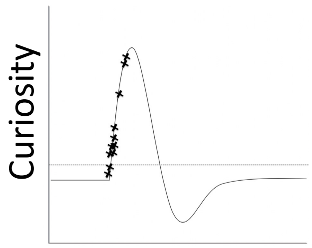
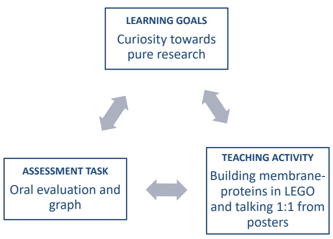


Figure 1: **Conversation starter evaluation**
Participants were ask to rate is their curiosity was piqued by visiting the stand. It was mostly used as a tool to talk to them about their experience.



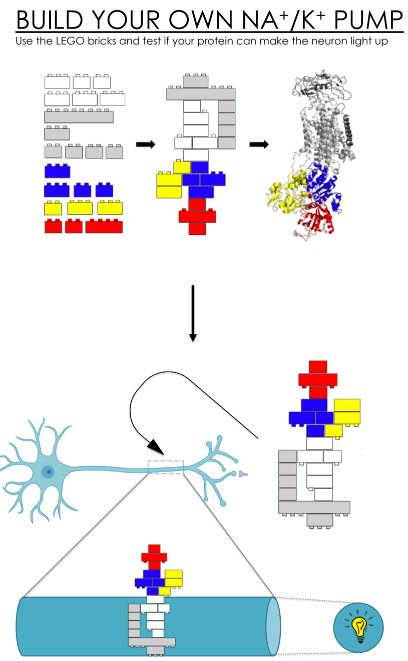


Figure 3: **Build a membrane protein setup**
Participants could build their own membrane protein based on a guide and insert it into a neuron to light a lamp which simulated action potentials.

Figure 4 (above): **Experimental setup**
LEGO and instruction setup with 3D printed sodium potassium pump for inspiration.

Figure 2 (left): **Summary of teaching**
Alignment visualization based on the project and thoughts behind the design of the project.

4. Looking forward

As the event hosts people from kindergarten to care home residents this flexible design of the stand made sure that there was something for everyone, which was a vast improvement and made it easier to disseminate. For next time the posters could be upgraded to make them more interactive, so people were more engaged in the process, instead of in some cases primarily listening. In addition we're considering if the LEGO portion can be expanded, as it seemed to make matters a lot more relatable to the visitors.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

LineMarie Christiansen
Poul Nissen lab
Molecular biology and genetics

Practice via presentations

- A matrix group approach

Abstract: A common problem within teaching is how to motivate the students to prepare and present their work. In the course Mechanics and Modern Physics for Chemists, I implement a matrix group approach that engages the students in preparing and presenting a given topic with focus on theory and concepts. Training oral presentations will help them during the exam and be a valuable tool they can use afterwards. An evaluation revealed that they were overall fond of the teaching activity.

COURSE FACTS

- Mekanik of moderne fysik for kemikere
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: 18
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

Theoretical exercises (TE) mainly focuses on problem-solving with a specific results in mind. However, there is a miss-alignment in the course since the oral exam mainly focuses on explaining concepts and ideas. A regular approach to TE is to select a volunteer student to present the results to the others. Here, there is a lot of inactivity from the other students, especially those who do not typically volunteer.

2. Planning a teaching activity

Based on the problems outlined in section 1, I will plan a teaching activity that aim to both engage all students and to a larger extend focus on the theory i.e. ideas and concepts of the course. I have chosen the matrix-group approach to tackle these problems. The concept is illustrated in Figure 1, with a class of nine students (here the names a fictive). First the students are divided into the horizontal groups where they will prepare a presentation of a given topic. Then they will be divided into the vertical groups where they will take turn presenting. For instance Emmy will first prepare a presentation with John and Alex, then she will present to Thomas and Antony. This activity will help them practice presentations.

3. Trying it out in practice

As different topics I chose three exam questions, which the lecturer had assigned us to discuss. There were eleven students showing up, so four students had to be assigned as two. I briefly explained the concept to them and they were given 45 minutes to prepare a 7 minutes presentation. During this presentation I went around and helped them if they had any questions. Once they were presenting I kept time with a stop watch so they did not went over time.

	1	2	3
a	John	Elisa	Phillip
b	Emmy	Thomas	Antony
c	Alex	Theresa	Ann

Figure 1: An illustration of the matrix group approach. First the students are divided into the horizontal groups 1, 2, and 3 where they will make a presentation of a given topic. Then they will be divided into the vertical groups, where they will take turn presenting.

In order to evaluate the session, I used the ticket-out-of-the-door approach. Here they were given a piece of paper with some basic questions regarding the session. The statistics can be seen in figure 2.

Overall I conclude the teaching activity went successful and actively combated the problems identified in section 1. Next time the lecturer gave a similar assignment, the students actively requested that we repeated the matrix group approach.

MAIN POINTS

Main problem/challenge: Engage more students and practice oral presentations.

1. **Teaching activity**: Matrix groups
2. **How did it go?** Overall it went well. They evaluated the overall activity with a score 4.09/5.0.
3. **What to do next?** Improve the learning during the listening phase.

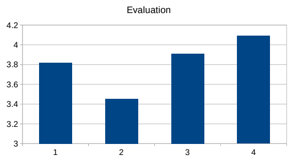


Figure 2: Evaluation of how much they have learned: from presenting (1), from listening (2), from preparing (3), and overall evaluation of the teaching activity respectively (4). They were asked to evaluate on a scale from 1 to 5.

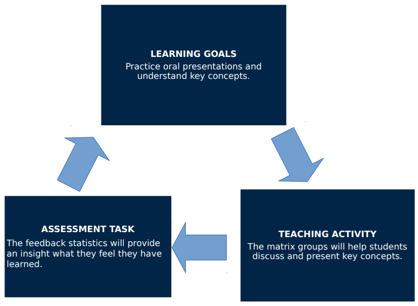


Figure 3: **Constructive alignment**
The teaching activity was chosen to achieve the learning goals. The feedback will gain inside of how much the students learned. From the feedback the learning goals can be reviewed.

4. Looking forward

Overall I conclude the teaching activity went well based on their engagement during the activity and their feedback. As the feedback showed the largest weakness was learning from hearing other present on a given topic. Perhaps this could be improved with given the students a question scheme they should answer during the presentation.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Mogens Dalgaard
Quantum measurements and control
Department of physics and astronomy

How to Read a Scientific Paper

-Developing a teaching method to help summarise the key points of a study

Learning Lab

Abstract: **Reading papers, understanding papers and summarising papers are key skills needed during a science career. This teaching task aimed to help students pick out information that is important to take on board when analysing research. The time provided was not enough to complete the task, but the task promoted good discussion in the groups, and it was clear the students really got to grips with understanding what is necessary to know to understand the paper and what can be ignored when summarising. The presentations the students did after I used this teaching activity were of a greater standard compared to previous years where I did not use this teaching activity.**

COURSE FACTS

- Course name: Advanced Population genetics
- Level: Final year Bachelors
- ECTS credits : 10
- Language: English
- Number of students: 60
- Your role: TA and lecturer

TEACHING IN PRACTICE

1. Identifying a problem

A scientific paper can be long, information loaded and confusing as to what the take home message should be. From personal experience, having many papers to read for a class can be daunting. Identifying the key points can be hard with these points being lost amongst words that can essentially be ignored.

2. Planning a teaching activity

This activity aims to guide the student in identifying key information from a paper and be able to say why that information is important. Small, 10 minute presentations are required a lot during a science degree, so not all the paper's information can be included. By providing the students with extracts from a paper from the course, some essential extracts and some 'space fillers', the students will discuss in groups which extracts they believe are important enough to be included in a presentation. They will therefore develop their skills in constructing a short presentation summarising the key points of a paper (figure 1).
Using the paper layout double triangle (figure 2), students will also learn how the layout of their presentations should be.

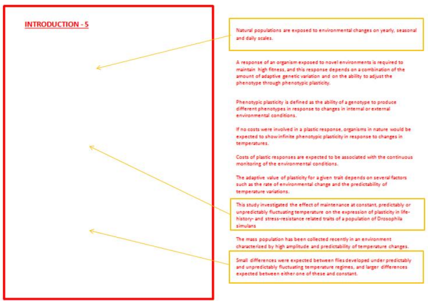


Figure 1: To begin with, the students will be given extracts from the paper. Some are very important and some not so much for a summary presentation of 10 minutes. The students will pick which points they think should be included and discuss why.

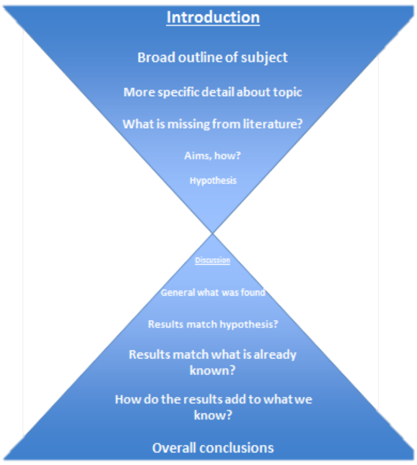


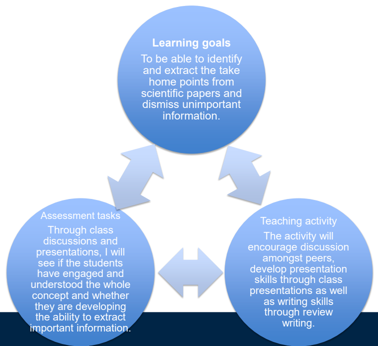
Figure 2: Paper layout double triangle. Broad to specific, specific to broad.

MAIN POINTS

1. **Main problem/challenge:** Extracting the main points and take home message from a scientific paper.
2. **Teaching activity**: Filtering out important points from a paper for a summary presentation or review.
3. **How did it go?** A little more time was needed in order to read the extracts, but overall went well.
4. **What to do next?** Find ways in saving time and making the activity a little easier. In future I will provide the paper before hand.

3. Trying it out in practice

During the exercise the activity encouraged the students to discuss the contents of the paper. As they progressed it was made clear they could see pieces of information were not needed for a summary presentation. It also promoted good discussion and debate.
Having taught this course for a few years, seeing the difference in quality of presentations when this teaching activity was used proved to me that is it a worthwhile exercise to do. The presentations were better organised and I received less questions from the students concerned with how to format their presentations.



4. Looking forward

I believe the whole concept of the teaching activity is a very good idea. From experience, it's very rarely teaching is focused on how to read scientific papers and you are just expected to know how. Developing different ways of assessing and how the discussions should take place is what I will look at to really make this task as effective as possible. Whether group presenting to class, individual presenting to groups or writing reviews are the best ways possible to measure progression as well as get the most out of this teaching concept.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Lucy Rebecca Davies
Genetics, Ecology and Evolution
Bioscience

Simulating a two level atom

- Matrix formalism of quantum mechanics and Pauli matrices

Learning Lab

Abstract: The main objective of this course is to familiarize the students with the matrix formalism of quantum mechanics, especially Pauli matrices and use it to simulate simple systems like a two level atom. A code was developed with the students that solves a known problem using matrix formalism and the results were analyzed and compared with their solutions from Bloch equations.

COURSE FACTS

- Course name: Atomic & Molecular physics
- Level: B.Sc.
- ECTS credits : 5
- Language: English
- Number of students: 25 approx.
- Your role: T.A

TEACHING IN PRACTICE

1. Identifying a problem

The students attending the atomic and molecular physics course are required to have knowledge of basic quantum mechanics, which they study in the previous semester. However, the course curriculum is condensed and the students have difficulty in understanding the difference between the two formalisms of quantum mechanics- the wave formalism and the operator formalism. This extra course was to motivate them to use operator formalism, which is much easier for realistic systems and also for simulation purposes.

2. Planning a teaching activity

The students recently had an exercise on the dynamics of a two level atom on the application of various pulses using the optical Bloch equations. Hence they have studied and solved the problem using one formalism. I plan to use this opportunity to introduce the matrix formalism and show them that the same thing can be solved both analytically and numerically using operator formalism, which is more intuitive and easy to follow. Since they already know the results with one method, it would be easy for them to understand and relate.

References

Introduction to Quantum Mechanics, Griffiths

Quantum Mechanics, N Zettlii

3. Trying it out in practice

The first 30 minutes were used to revise and remind them the Pauli matrices which they have learned in their previous semester.

In the next 30 minutes I showed them how the Pauli matrices can be used to represent a two level atom and apply various types of pulses.

Finally, once the basic theoretical part was complete, a code in Python was developed. I myself wrote the code to make the process faster. The problem was solved numerically and it was shown how both the analysis were equivalent.

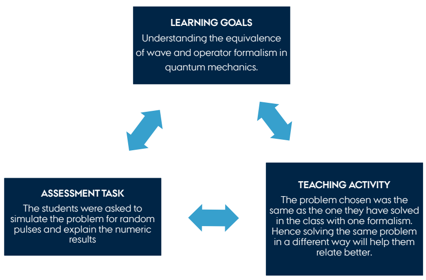
The students were NOT asked to write the program since the program for the optical Bloch equations in previous exercise session was also supplied to them with the material. I also found that it would be difficult for them to write the code and understand the physics in one hour.

Since this was not directly part of the curriculum but was rather used as a supplement to boost their understanding, a direct evaluation was not involved. Instead, they were asked to simulate things they have done with the optical Bloch equations previously and report any inconsistencies with the new formalism.

As a small evaluation of their understanding, I simulated the system with random parameters and pulses and asked them to explain the observed results.

MAIN POINTS

1. **Main problem/challenge:** To help boost their previously acquired understanding of operator formalism of quantum mechanics.
2. **Teaching activity**: Identifying a problem the students are well acquaint with and solving it using the new formalism. This would help them relate better.
3. **How did it go?** The session was pretty interesting and it turned out that the students could easily relate with the problem.
4. **What to do next?** If time permits, it would be better to ask them to solve some problems by their own using the matrix formalism.



4. Looking forward

The teaching activity went very good. The students responded well. However as a next step they should be asked to solve some problems by themselves and also be given the chance to write their own code for better understanding.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Kamanasish Debnath
Quantum optics
Physics and Astronomy

Six Thinking Hats: six tips for effective presentations

- A mimic of a real academic conference

Learning Lab

Abstract: first year physics students have the possibility to take additional challenges beyond those they already face during their bachelor. These challenges are offered in the Challenge Track program, which includes in its offer a numerical simulation module. One of the challenges proposed by this module is to give a presentation in English about the projects developed by the students. However, they do not have a broad expertise in this area. Thus, the aim of this teaching activity is to teach the students how to convey a message in a clear and concise way and which aspects are essential to include. This will be done during the presentation session, where six thinking hats will represent an essential aspect that a presentation should include. The students' response was positive, since they participated actively and communicated that they now know which information should they include. As improvement, more time should be given to the activity and component that boost their confidence at presenting could be added.

COURSE FACTS

- Course name: Challenge Track Module 3: Numerical Simulations
- Level: First year
- ECTS credits : 2-3
- Language: English
- Number of students: 4
- Your role: TA

TEACHING IN PRACTICE

1. Identifying a problem

As part of the Challenge Track there is a module focused on Numerical Simulations, in which the students have to build a numerical model of a real system. Then, they are asked to present their results in a presentation session at the end of the module. However, I realized in previous Challenge Track modules that this is difficult for first year students. Thus, the aim of the activity is to help them prepare an effective academic presentation, by letting them know which sections should they include and how to convey the message concisely.

2. Planning a teaching activity

The activity will be divided in two parts: in part A, the students will be asked to make a 12—minute presentation about their projects using a mind map format, which should include the categories represented by the hats in Figure 1, inspired by [1]. Part B will take place at the presentation day, in which I will assign 2 different hats per student, per presentation, and they will have to evaluate those aspects in the current presentation. This with the aim of letting them know first, what is essential to include in a presentation and, second, to identify how precise and concise the information should be conveyed. The learning outcome will be to improve their presentation skills.

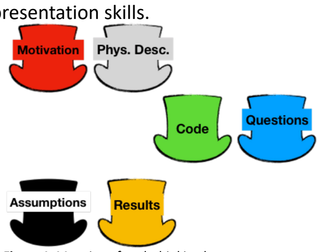


Figure 1. Meaning of each thinking hat.

3. Trying it out in practice

The presentation session was carried out as a normal academic workshop. At the beginning I gave a copy of the agenda to each student and printed versions of the evaluations they would do, based on the 6 thinking hats. This document had examples of the questions they might answer in each category. I assigned 2 different hats to each student per presentation, meaning that they all had the opportunity of "wearing" all the hats. There were 4 12-minute presentations (Figure 2) with a 3-minute Q&A session per presentation, in which the students participated actively, even though not all of them had to ask a question. At the end of the session the students evaluated the activity in a numerical scale and with comments, stating that it was useful for them to know which contents are truly important to include in a presentation. Some of them also though that the mind map format helped them to convey the message in a more concise way. As a suggestion, they all agreed that the presentations should be longer. Average grade was 4/5.

In my opinion, I was impressed by the active role of the students during the activity. They used the mind map format creatively and provided a very constructive feedback for their peers.

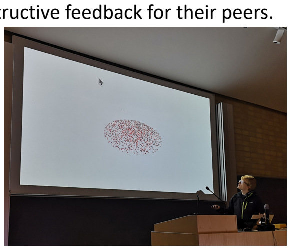


Figure 2. Student presenting one of the results of his project.

MAIN POINTS

1. **Main problem/challenge:** boost the students' confidence when giving academic talks by letting them know how to structure an academic presentation.
2. **Teaching activity:** Group investigation. Stage 5: presenting.
3. **How did it go?** The final evaluation showed that the students liked the Six Thinking Hats activity and the mind map format helped them to include only the relevant information in their presentations.
4. **What to do next?** Repeat activity next semester by giving more time for presentations and add component to boost confidence at presenting.

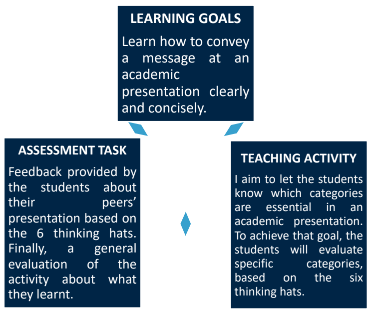


Figure 3: Constructive alignment

4. Looking forward

Based on the students evaluations the activity was very well received, since they agreed that they were able to realize how to structure a good presentation and which categories should be included. They also stated that the mind map format was to some extent useful to limit the amount of information they wanted to show. As suggestions, they all agreed that more time for the presentation would be desirable, i.e. 15 minutes. Thus, it would be interesting to incorporate this activity in the regular Challenge Track modules and include a section to boost confidence at a presentation.

References: [1] Memeiros, I. (2015, December 10) Six Thinking Hats. Retrieved from: *https://es.slideshare.net/designative/six-thinking-hats-56004525*

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Luisa Fernanda Rodríguez Díaz
Stellar Astrophysics Centre - SAC
Department of Physics and Astronomy

Adapting Structured Problem Solving

For understanding the Life Cycle Assessment methodology

Learning Lab

Abstract:

Using the Life Cycle Assessment (LCA) methodology as a framework for the examination reports is challenging for students. Most of them find it difficult to carry out LCA studies as they do not understand the relationships between certain steps in the methodology and the required calculations. For this reason, an adapted "structured problem solving" activity was implemented to help the students have an overview on the LCA thinking for livestock systems. The students were divided in groups of 2-3. They were asked to discuss the first two steps of a LCA for milk and the calculations that are required to perform in relation to those. A plenum discussion was held in the end for clarifications. The teaching activity was evaluated by using "ticket-out-of-the-door" activities and by analyzing the examination reports. It was found that the activity represented a good start for understanding LCA. Similar sessions could be introduced at the end of lectures in the future.

COURSE FACTS

- Course name: Organic Agriculture (theme 2)
- Level: Master
- ECTS credits : 10
- Language: English
- Number of students: 19
- Your role: TA giving a lecture

TEACHING IN PRACTICE

1. Identifying a problem

Life Cycle Assessment (LCA) represents the framework for the examination report (for theme 2). LCA is also a very complex concept, which implies following a series of pre-defined steps and carrying out a multitude of calculations related to different fields (in this case the environmental and the agronomic fields). In the previous years of the course, this proved to be challenging for the students as many of them are not familiar with both fields. For this reason, they found it very difficult to carry out simplified LCA studies. More importantly, the relationships between the aim of an LCA study, a certain step in its methodology and/or the required calculations are not understood properly. Given all the above, it is important to increase students' learning in relation to LCA.

2. Planning a teaching activity

"Structured problem solving" activities are perceived as good tools for providing logic approaches for problems to students. Thus, an adapted version of a "structured problem solving" activity was introduced at the end of the introductory LCA lecture, followed by a plenum discussion. The learning goals for this activity were:

- To understand the LCA thinking in relation to livestock production systems;
- To identify relationships between the aim of a LCA, a certain step in the analysis and the required calculations.

3. Trying it out in practice

After the introductory LCA lecture, the students were divided in groups of 2-3 in order to work with the first two steps of a LCA (goal and scope definition and life cycle inventory) for a milk production system (that was introduced to the students in the previous lecture and recapitulated in the beginning of the lecture). The students were not asked to perform calculations, but to discuss what calculations are needed for each step and their implications. Several groups were asked to present their views. A plenum discussion was held in the end for clarifications.

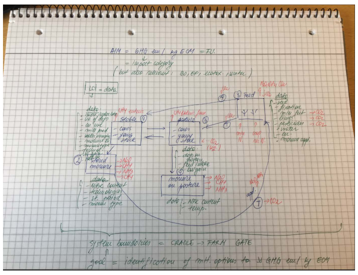


Figure 1: Example of students' views for LCA of milk

The teaching activity was evaluated in the last session of the theme by using a "Ticket-out-the-door" activity. It was considered that its helpfulness can be better assessed by the students at the point when they have also finalized must of their work on the report (with LCA framework). Their reports were also compared with the reports from the previous years in relation to the learning outcomes.

Overall, the students considered that the activity contributed to the understanding of the concept. They noted that it represented a good start in understanding LCA and that it gave them an overview on the expectations for the examination report. Some of them also mentioned that they would have liked to spend more time on this activity and to discuss the whole four steps of a LCA. It has to be noted that, in general, the students thought that LCA is a very challenging topic.

MAIN POINTS

1. **Main problem/challenge:** Using LCA methodology in the examination reports is challenging for students
2. **Teaching activity**: Structured problem solving, plenum discussions
3. **How did it go?** Overall, the students found the activity useful for understanding the LCA concept. That was also proved by their examination reports.
4. **What to do next?** Given the students' feedback, it could be beneficial to have similar sessions at the end of lectures, where to discuss the implications of that day's work on the overall analysis.

Based on the examination reports, it was observed that most of the students were able to perform the LCA analysis. Compared to the previous years, the reports were much better. However, that can also be correlated with other factors (e.g. students' background).

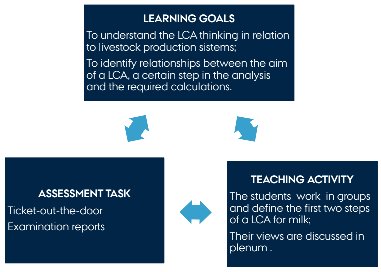


Figure 2: **Constructive alignment**

4. Looking forward

Discussing the relationships between the overall aim of a LCA and specific steps proved to contribute to increased students' learning. In the future, it could be beneficial to have similar activities after completing each lecture.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Teodora Dorca-Preda
Agricultural systems and sustainability
Department of Agroecology

Genomic Assisted Breeding

- Think-group-share to support student's learning

Learning Lab

Abstract: Using statistical software to conduct breeding program analysis and comprehending the meaning of the results can be a challenge for many students. After the theoretical lecture, students are asked to think and gather their thoughts on how to conduct the statistical analysis and then to share their ideas with the rest of the group. This teaching activity aims to provide students different perspective of thinking and the ability to consider and appreciate the different viewpoints of their peers. Students found the activity very useful, but I will consider to improve the material for the analysis and the student evaluation.

COURSE FACTS

- Course name: Plant Biology and Technology
- Level: MSc
- ECTS credits : 10
- Language: English
- Number of students: 10
- Your role: TA

TEACHING IN PRACTICE

1. Identifying a problem

It is essential in science to be familiar with data analysis in order to read correctly the obtained results. When students started the course most of them had very little experience with data analysis. Students were asked to analyze two small data sets with a different number of molecular markers (1000 SNPs vs. 100 SNPs) in order to verify and understand the differences in the outcomes. The aim of the teaching activity is to assist students to analyze and interpret data for the first time.

2. Planning a teaching activity

My teaching activity was planned to help students in analyzing a genetic data set, firstly, giving them a theoretical lecture followed by a simulation of a genomic prediction.
The idea behind presenting a simulation is to provide an opinion to the students about the topic without getting into laborious analysis and theory.
Then, I planned to have the **think-group-share** to help students to better understand the topic, develop ability to form their own idea and share their thoughts. During the activity they consulted "step by step" instructions.
The given materials together with the group activity are organized to create a "safer" environment especially for those students new to the topic.
The learning goals are:

- **Define** genome-assisted breeding;
- **Apply** the methods for the analysis;
- **Interpret** the different obtained output.

3. Trying it out in practice

The theoretical lecture and the data analysis simulation using Tassel software (Figure 1) gave a broad overview of the subject to all the class and in particular, opened numerous discussions that elucidated the difficult steps of the analysis.
During the exercises, students were divided into two groups (5 people each): the group A (Figure 2) received a data set of 100 molecular markers, while the group B one of 1000 molecular markers. Both the groups had the same "step by step" protocol where they were asked to modified some variables according to the size of the input data.
They had 10 minutes to think individually on the approach that they would use to conduct the analysis. After this, all students shared their ideas with the rest of the group for 20 minutes and then, they finally started the analysis while the TA was monitoring and helping them.
After 40 minutes both groups presented (orally) the obtained results for each trait (Table 1) in order to have a batter understanding of the variation in the output.
A final brainstorming with each group helped the TA for the assessment of the teaching activity.

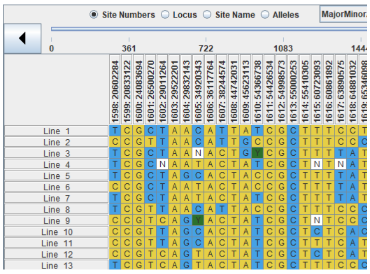


Figure 1: Snapshot of the input data used for the analysis on the TASSEL software.

MAIN POINTS

1. **Main problem/challenge:** Lack of experience in data analysis
2. **Teaching activity**: Analysis of small data sets
3. **How did it go?** According to the students' feedback, they understood the concepts
4. **What to do next?** I will implement the teaching material.

Figure 2: PhD students discussing the adjustment for the protocol.

Mean Prediction Accuracy		
GROUP-A	trait	GROUP-B
0,37	GPC	0,36
0,20	T-kW	0,19

Table 1: Example of output that the 2 groups of students were asked to calculate and compare; GPC: grain protein content, T-kW: thousand-kernel weight. The mean prediction accuracy values, and the rest of the results were reported on the blackboard from the two groups, followed by a discussion.

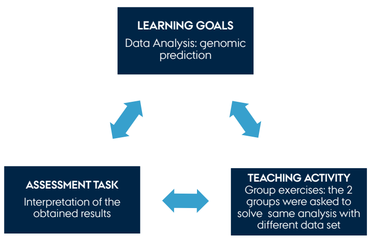


Figure 3: **Constructive alignment**

4. Looking forward

The students found the simulation very useful to understand the correct approach for a data analysis experiment. They also agreed that the group work helped them in collaborating and sharing their own knowledge.
In the future, I will consider using a protocol for the analysis with more obstacles that they have to solve in order to mimic a more realistic scenario. I will also consider to use mentimeter.com for the student evaluation.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Mattia Fois
Crops Genetic and Biotechnology
Molecular Biology and Genetics

Real time PCR assay for fungal pathogen diagnosis

- From theory to practice by online and printed tools

Learning Lab

Abstract:

A real-time PCR is a very tricky procedure, which has to be done precisely, and avoiding contamination. Repetitions, visual tools and laboratory practice could build up the main structure on which the students will develop manual skills and confidence to perform this delicate task as the molecular detection of microorganisms in plant specimens. Moreover, group discussion and paper material that the students can take home and go through if necessary should help to fix the main concepts of the technique.

COURSE FACTS

- Course name: Diagnosis of plant disease
- Level: Bachelor
- ECTS credits : 5
- Language: English
- Number of students: 14
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

A real-time PCR is a very tricky procedure, which has to be done precisely, and avoiding contamination. It is important for the students to learn what that means and how to perform it at its best as soon as possible because it is one of the milestones in molecular biology.

2. Planning a teaching activity

a. **"Repetita iuvant" (Repeating helps):** what has been given in the pre-course will be re-proposed during the lecture and tested afterwards in order to verify and fix the main concepts of the real time PCR.

b. **Schematic, colourful and visual material** like videos and flyers will help the students to remember the main steps and will give tips which are not usually found in literature. Of course practicing several times is the best way to learn this delicate and complex procedure.

c. **The practical work** will be done in groups and with my help. There will be a waiting time which will be used for questions and the start of the report writing.

Learning goals:

1. Understanding of how a qPCR works.
2. Learning and start building up manual skills for executing the assay.

3. Trying it out in practice

a. **Prior to the course**: reading of a paper and links on videos about qPCR. I will upload on the blackboard also flyers about practical tips for PCR execution.

Figure 1: Examples of material will be provided for student learning prior the class.

b. **First day of the course**:

- Short **theory** introduction on qPCR principles and short test in groups (4-5 people each) by "**Flash review**" technique. It will be give to the students a list of 10 questions into a PowerPoint slide. In pair (or in three) they have to discuss the questions and afterwards share the answers with the group and the class.
- **Practical assay** (start working on compulsory report during waiting time) and data retrieving. During the waiting time to the students will be also asked, with a **short questionnaire,** if the teaching activity has helped them to better understand the technique and if they think they have assimilated the main concepts. Possibly getting some comments on what was clear and was not.

Plate no. ....

Date ....

	SC	Sample number			SC	Sample number			SC	Sample number		
	1	2	3	4	5	6	7	8	9	10	11	12
A	-RT	Sample 1	Sample 9	Sample 17	-RT	Sample 1	Sample 9	Sample 17	-RT	Sample 1	Sample 9	Sample 17
B	NTC	Sample 2	Sample 10	Sample 18	NTC	Sample 2	Sample 10	Sample 18	NTC	Sample 2	Sample 10	Sample 18
C	0.016 ng	Sample 3	Sample 11	Sample 19	0.016 ng	Sample 3	Sample 11	Sample 19	0.016 ng	Sample 3	Sample 11	Sample 19
D	0.08 ng	Sample 4	Sample 12	Sample 20	0.08 ng	Sample 4	Sample 12	Sample 20	0.08 ng	Sample 4	Sample 12	Sample 20
E	0.4 ng	Sample 5	Sample 13		0.4 ng	Sample 5	Sample 13		0.4 ng	Sample 5	Sample 13	
F	2 ng	Sample 6	Sample 14		2 ng	Sample 6	Sample 14		2 ng	Sample 6	Sample 14	
G	10 ng	Sample 7	Sample 15		10 ng	Sample 7	Sample 15		10 ng	Sample 7	Sample 15	
H	50 ng	Sample 8	Sample 16		50 ng	Sample 8	Sample 16		50 ng	Sample 8	Sample 16	
	Ref.				GOI1				GOI2			

Figure 2: Material provided during the class. Real time PCR plate example with standard curve implementation and sample location. Ref. : reference gene, GOI x: Gene of Interest number x, SC: Standard Curve.

c. **Out of Class**: use of **blog** and **wiki tools** to work individually or in groups to think of a way to analyse the data.

d. **Second day**:
Data analysis and **interpretation** previously from one responsible for each group and after by me

MAIN POINTS

1. **Main problem/challenge:** Real time PCR understanding and performance.
2. **Teaching activity**: Small lecture with "Flash Review" assessment and practical essay with data analysis.
3. **How did it go?** Still to perform.
4. **What to do next?** Possibly improve the practical part (time for each step execution and student group organization) .

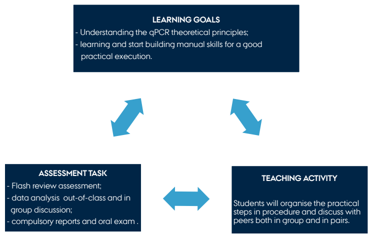


Figure 3: Constructive alignment

4. Looking forward

Since I have not conducted the teaching yet I do not have an outcome.
I can speculate that might be issues in the practical part which depending on how the students will respond I could fix for next course running.
I think what instead could work with very minor troubleshooting is the theoretical part and the small first assessments.

References
- Active learning and adapting teaching techniques (from Toronto University).
- Posters from previous running Science Teaching courses.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Flavia Pilar FORTE
Crop Genetics and Biotechnology
Dep. of Molecular Biology and Genetics

Error Analysis in Practice

- Learning how to use statistical tools in an experimental context.

Learning Lab

Abstract: Students showed difficulty understanding statistical concepts introduced in the course, and how to use them in their error analysis in the experimental part of the course. To address this issue, I have designed an activity to encourage discussion among the students, based on specific experiments encountered earlier in the course. The activity is designed to ensure a safe environment and encourage open discussion.

COURSE FACTS

- Course name: Experimental Physics and Statistical Data Analysis
- Level: First year
- ECTS credits : 10
- Language: Danish
- Number of students: 22
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

In this course the students are given problems to address experimentally. They have to plan and (in a limited way) design their own experiment. The second part of the course is a theoretical statistical course.
The course teaches them about basic statistics and how to apply this when doing error analysis in an experiment. This is the first time the students meet statistics and error analysis in a formal way.
The course in pass/fail, which leads to very limited engagement from the students. This leads to the problem that most of the students are having difficulty understanding the statistical concepts and how to apply them in the experimental exercises.

2. Planning a teaching activity

This teaching activity aims to help the students apply their theoretical statistical knowledge on a specific problem they have encountered earlier in the course. This activity is held towards the end of the course, when they have already encountered the concepts at least once, which will help them in understanding the connections between the course elements.

The pressure of speaking openly and presenting in front of many people, is reduced by having the class split into small groups.

3. Trying it out in practice

The first part of the activity is the discussion phase. The class is split into four groups with approximately four students in each. Each group is the given a unique discussion question, that they have 30 minutes to talk about. The questions are based on an experiment they have conducted previously in the course, and some statistical concept introduced in the course. The question will encourage them to think about how to their statistical knowledge to solve/analyze a practical problem.
After the first phase, the groups are mixed into 4 new groups, as shown in figure 2.
Each member of the group is then expected to be able to give a 3-5 minute presentation of the question.
The groups have 15 minutes to discuss each question, so this presentation should encourage further discussion.
During both phases, the teaching assistant is participating in the discussions by asking elaborating questions.
The teaching activity and student learning will be evaluated with a small questionnaire before and after the activity.
The questions are designed to also illustrate to the students what they have learned during the activity.

MAIN POINTS

1. **Main problem/challenge:**
2. Difficulty understanding theory, and not being able to apply it experimentally.
3. **Teaching activity**:
4. Discussion session in groups with small presentations.
5. **How did it go?** Has not yet been implemented
6. **What to do next?** Implement the activity

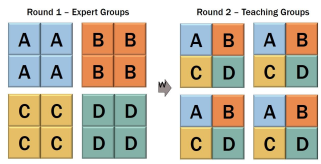


Figure 1: **Jigsaw Groups**
(left) Groups in the initial discussion phase.
(right) Groups are mixed in the presentation phase.

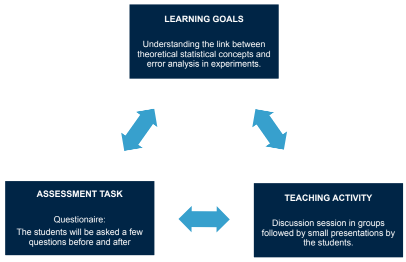


Figure 2: **Constructive alignment**
Illustration of the connection between learning goals, teaching activity and assessment task.

4. Looking forward

I am looking forward to implement the activity in an actual teaching setting. Depending on the feedback from the students, this activity would be nice to implement in the end of the course as a brush-up of what they have learned.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Andreas Gad
Aarhus Subatomic
Department of Physics and Astronomy

A quiz for assessing student understanding of genetic concepts

Learning Lab

Abstract: A common problem in teaching is the identification of the most difficult material. By having students solve a quiz with questions about fundamental topics, both the students and the teacher get information about their level of understanding. I made a quiz and gave to students. I also asked the students to write two concepts that they find most difficult in the whole course and made a mind map from the results. The students reported that the quiz activity was helpful for their learning. The results of the quiz can be used to select material to cover in more detail in the future.

COURSE FACTS

- Course name: Genetics
- Level: BSc
- ECTS credits : 5
- Language: English and Danish
- Number of students: 12
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

A common problem in teaching is that it can be difficult for a teacher to identify material that students find the most difficult. If there is lack of communication between students and teacher, the teacher does not spend time in the most efficient manner. If students lack understanding of basic concepts, then they will not have understanding of more advanced concepts. This includes in genetics fundamental things, such as defining genotype, inbreeding, linkage of genes, recombination and genetic drift. Being able to work with these concepts is part of the learning outcomes of the course, on which the students are assessed in a written exam. The aim of this activity is to increase student and teacher awareness of which concepts are most difficult for students.

2. Planning a teaching activity

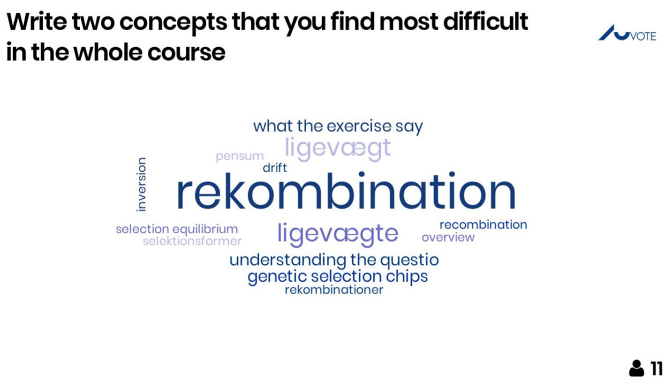
By answering a quiz, the students become aware of their own understanding of the subject. The questions were not made to be difficult, but to cover most basic concepts, which are part of the course learning outcomes. Teachers of the course can use the results of the quiz for their own preparation for teaching. The students can use their own results to focus on the areas they are lacking in.

3. Trying it out in practice

I made a menti quiz to identify concepts with which students struggle. The quiz contains 11 questions about fundamental genetic concepts and takes about 15 minutes to complete. After the questions, I asked the students to write two concepts from the course that they found most difficult. The results were used to make a mind map. Students overwhelmingly reported that recombination and selection equilbrium are the most difficult concepts of the course. At the end, students were asked if the quiz was helpful for their learning. The students were positive about the activity: eight out of 12 students agreed that the quiz was helpful for their learning.

MAIN POINTS

1. **Main problem/challenge:** Identification of the most difficult material.
2. **Teaching activity**: A quiz on fundamental topics and a mind map.
3. **How did it go?** The students reported that the activity was helpful for their learning.
4. **What to do next?** Use the results of the quiz to emphasize the most difficult material in teaching.



A mind map of the concepts that students found most difficult in the course.

4. Looking forward

The activity engaged the students and gave them and the teacher information about their level of understanding. The next step is to use the information gathered to modify teaching emphasis. A quiz such as this one could be made regularly during the course, e.g. each week or every other week.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Egill Gautason
Center for Quantitative Genetics and Genomics
Department of Molecular Biology and Genetics

Twisting TØ Into Exam Preparation

- A good way to recap and give students confidence as the end of the course is near

Learning Lab

Abstract: In the course, where the content can be abstract and hard to grasp, and where a low number of lectures are smeared out over a semester, much of the central content do not seem to stick with the students. As the exam approaches, it was decided to dedicate a TØ session to look at some of the exam questions, by having the students presenting answers to exam questions to each other. The purpose was to have the students reach a higher level of understanding of the content already covered in the course. The assessment carried out before and after class showed an increase in "how ready they feel for the exam", and the general feedback was positive.

COURSE FACTS

- Course name: Atom and molecular physics
- Level: 2nd year
- ECTS credits : 5
- Language: English/Danish
- Number of students: 10
- Your role: TA

TEACHING IN PRACTICE

1. Identifying a problem

This course is a 5 ECTS course, which used to fit in nicely in the old quarter structure with lectures twice per week and TØ once per week. With the new semester structure there is only one lecture and one TØ session per week. Combined with that the course is fairly hard and contains abstract elements, it means that much of the content covered in the beginning of the course, seem to be forgotten by the students late in the course. Hence, several students often have a hard time later in the course, and they of course worry about the exam.

2. Planning a teaching activity

The plan is to dedicate a TØ session to preparing exam questions for the oral exam. Only questions that can be answered with the content covered so far will be considered. The questions are very broad and are meant to be used as a starting point for discussing the curriculum. The students should prepare answers to 3 random questions beforehand and present them to each other in small groups. Hence, they will have to review content covered earlier in the course, and they will come out more prepared for the exam. An example of a question could be: "Discuss the coherent interaction between atoms and light using the Bloch vector formalism. Give an example for experiment which can be described using the Bloch vector."

3. Trying it out in practice

Only a few students turned out to have prepared more than one question in advance. To some extent the exercise became more about preparing the questions in groups rather than presenting to the group. The students formed 2 groups of 5. Before and after the session the students were asked to indicate on a scale from 1 to 5 how "ready they felt for the exam". 1 being "not at all", 5 being "totally ready".

Figure 1: Group of students got their attention caught by a good point made by the other group

One group worked quite independently, while the other group asked several question. The focus on the questions was mostly on the curriculum rather than the exam questions. It turned into a good discussion with multiple students being involved. The students also discussed with each other. It was my impression that we caught several misconceptions and clarified a few things. The group that worked more independently saw multiple examples of presentations of exam questions. They could perhaps have benefited from being in a smaller group.

MAIN POINTS

1. **Main problem/challenge:** Content covered earlier in the course does not seem to stick
2. **Teaching activity**: Exam preparation in groups
3. **How did it go?** Increase in how well the students feel prepared
4. **What to do next?** Have a Q&A session before the exam in the exam period

With 1 being "not at all ready for the exam", and 5 being "totally ready" the students responded that the before the TØ session were 1.7 on average, while they after the session were 2.6 on average. One students in particular liked the session saying that she "had improved more in this TØ session than any of the other sessions during the year". Several students expressed that they were happy with the class

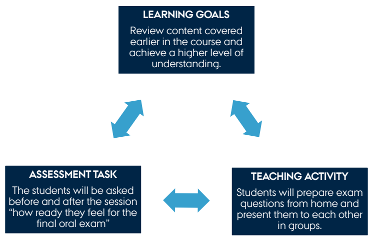


Figure 2: **Constructive alignment**
How the learning goals, the activity and the assessment support each other.

4. Looking forward

The discussion with the students in smaller groups worked very well. It is different from normal TØ in the way that the content is not new to the students. We will be doing something similar a few days before the exam, when the students have has time to prepare. One could consider to spend more time on reviewing previously covered content in future courses, since the students seem to benefit significantly from a second iteration.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Peter Granum
The ALPHA Collaboration - CERN
Aarhus University

Sequencing the procedures

- an easy and active way of learning laboratory procedures

Abstract:

Laboratory analyses can in many cases be overwhelming and too comprehensive to keep a sense of the perspective. However, understanding them and how they are set up is extremely important. In animal science, laboratory analyses are often used as models for describing animal physiology. In the current example, should describe a laboratory analysis through the teaching activity "Strip sequencing". The activity will help familiarizing the students with procedure, understand the purpose of the procedure, and prepare them for what can be discussed during the exam.

COURSE FACTS

- Course name: Quantitative Animal Nutrition and Physiology
- Level: Master
- ECTS credits : 10
- Language: English
- Number of students: 25-30
- Your role: Teaching Assistant

TEACHING IN PRACTICE

Introduction

The course aims at enabling the students to quantify and discuss digestion of nutrients (e.g. NDF) and subsequently predict production responses on basis of a given feed ration. Students will be assessed continuously through assistance during group work and a written report on the specific subject. At the exam, students will individually engage in a discussion on the subject with the examiner.

1. Identifying a problem

Evaluating the nutritional value of feedstuffs is vital in the present course. In doing so, the procedure for determining fibre (NDF) degradation characteristics in ruminants must be understood thoroughly and interpreted correctly enabling the student to sufficiently describe the methods and their applicability. However, the procedures are comprehensive and it can be extremely difficult to keep a sense of the perspective. The aim is to logically familiarize the students to the procedure for NDF degradation and discuss its interpretation by means of the activity "strip sequencing".

2. Planning a teaching activity

Students will be able to sufficiently describe a method for quantifying digestion of a nutrient and concurrently discuss why the method is designed as it is. Furthermore, this enables the students to better engage in a discussion during the exam and explain a specific method using their own words.

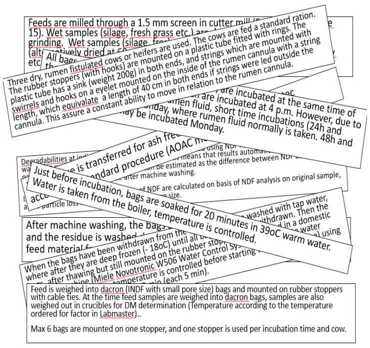


Figure 1: Example of strip sequences

3. Trying it out in practice

Before the lecture, students will have read about the procedure. During the lecture, images from the procedure will be shown in chronological order for a limited time. Emphasis will be put on the following activity and the discussion among themselves. Groups of 5-6 students will be made, teaching material (Figure 1) will be provided, the concept of the activity will be described, and 8 minutes are given to solve the problem in the groups. A joint discussion between students and TA in the end will sum up results from the activity.

MAIN POINTS

1. **Main problem/challenge:** Difficult to keep sense of the perspective when using comprehensive laboratory analyses
2. **Teaching activity**: "Strip sequence" – sequencing a procedure
3. **How did it go?** Has not been implemented yet
4. **What to do next?** Implement activity

Assessment of student learning

The students learning will be assessed during the activity as the TA will be wandering around among the groups and be at their disposal for questions. To support the student's learning, feedforward is provided after the joint discussion by emphasising on what they should improve before the final exam.

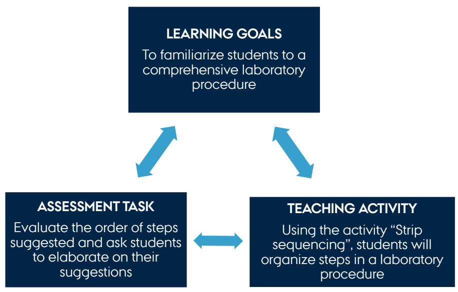


Figure 2: **Constructive alignment**

4. Looking forward

The teaching activity has yet to be implemented. However, the efficiency of the activity could be evaluated based on a simple hand rise before and after the activity. The question would be to ask how many feel confident with the procedure. A future improvement of the activity could be to bring equipment from the laboratory for inspiration in the discussions. Furthermore, my awareness will be put on which elements of the activity seems to be too time consuming compared to how much they contribute to the students' learning.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Nikolaj Hansen
Animal Science

Fill-in a cell

Putting general biochemistry and molecular biology into context

Learning Lab

Molecular biology and biochemistry consist of a broad spectrum of disciplines. This requires extensive knowledge of many different organelles and processes in the cells of the human body. The course 'General Biochemistry and Molecular Biology' covers a variety of biochemical processes, but the theoretical exercise (TE) material lacks relation to the "bigger picture" in the broad curriculum on molecular biology. The list of course learning outcomes are all on the lowest level of taxonomy. In our experience, the students' ability to describe the processes increase when they put them into context, thus increasing the level of taxonomy. This activity is a mixture of a mind map and a strip sequence that puts the curriculum into context of the human body and the cell. The activity resulted in rich discussions among the students, who were very engaged. From the evaluation it is clear that the students were pleased with the activity, since they reported that the activity supported their learning, and that they will use it for their exam studies. In conclusion, the activity was success and fulfilled the aim.

COURSE FACTS

- Course name: General Biochemistry and Molecular Biology
- Level: Bachelor 1st year
- ECTS credits : 10
- Language: Danish
- Number of students: 2x15
- Your role: Teaching Assistant (TA)

LEARNING GOALS

The students learn to recall, localize, describe, relate, and discuss biochemical processes from the course curriculum.

ASSESSMENT TASK

In a classroom discussion, the students asses each others work. Furthermore, the students self report in a *mentimeter* questionnaire if the teaching activity worked.

TEACHING ACTIVITY

Students fill out a modified mind map and discuss in pairs. In groups they present focus areas and help each other in a classroom discussion.

Figure 1: **Constructive alignment**

TEACHING IN PRACTICE

1. Identifying a problem

This course deals briefly and superficially with a lot of different biochemical processes in the human body. During the course, the TE material does not include assignments on the relation and context of these processes. In our experience, the students' ability to describe the processes increase when they put them into context. Thus, the aim of this activity is to improve the students' capability of quickly relating subjects from the course at the exam, where they are tested in relating and understanding ~~of~~ the entire curriculum.

2. Planning a teaching activity

The activity is a mix of a modified strip sequence and a mind map (figure 2). It is focused on teaching the students to relate the different course-topics by placing these in context to each other within a human body and within the cell. Furthermore, the students are asked to describe the biochemical processes and the regulation hereof. The course learning outcomes are all defined as "describe …", which is the lowest level of taxonomy. The primary aim of this activity is not to improve the students' ability to describe the different biochemical processes. Rather, the goal of the exercise is to provide the students with a possibility to get a better overview of the course curriculum and a tool to support and improve their exam studies through higher taxonomy.

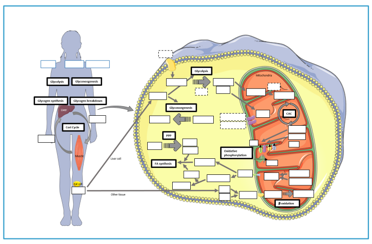


Figure 2: **Teaching activity**. The figure shows the scheme which was handed out to the students along with a word list (not shown here).

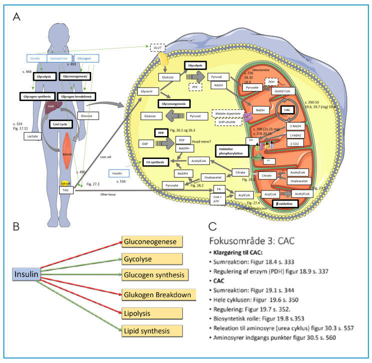


Figure 3**: Students' solution**. The figure shows three examples of how the students chose to solve the assignment in the activity (A, B and C).

3. Trying it out in practice

We handed out a sheet with a zoom on a cell in the human body and a word list with the biochemical processes that the students have learned to describe during the course. The students had to recall and localize the words from the list in the correct organelles of the cell. In pairs, they discussed and elaborated the scheme by drawing arrows and adding comments (figure 3). The pairs were grouped in groups of four, who got a focus area of the scheme, and they made a classroom presentation. The students compared, discussed, and corrected each others solutions in this classroom discussion.

Overall, the students were engaged in the activity, and it resulted in fruitful discussions both in pairs, groups, and in the classroom presentations. Furthermore, the activity was evaluated by the students with a *mentimeter* (mentimeter.com) questionnaire, which informed the TA if the activity supported student learning. The evaluation showed that the students found the activity useful, it supported their understanding and learning, and they reported that they would use the activity as a template for their exam-studies (figure 4).

As the overall aim of this teaching activity was to improve the students' overview of the very broad curriculum, we believe that the activity was a success and supported student learning in the intended way.

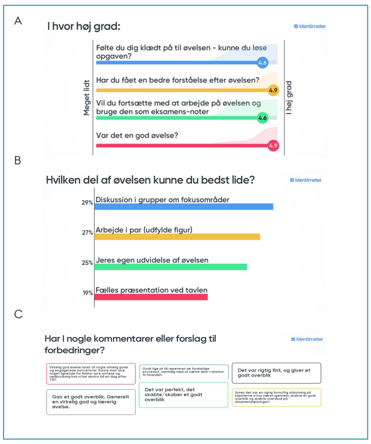


Figure 4: **Evaluation of teaching activity.** The figure shows the evaluation which was carried out in *mentimeter*. Figure 4A, B and C shows results from the questionnaire, where the students were asked to both evaluate the entire activity, the different parts of it, and give general comments and ideas for improvement.

4. Looking forward

The activity was implemented in every class by other TAs (13 classes), and it was successful. The evaluation shows that the classroom presentation needs improvement. We believe that the time frame for the presentations was too tight, and this was partly solved by handing out an USB stick with the empty scheme for the groups to fill in before presenting, opposed to filling in the scheme while presenting.

In conclusion, the course lecturer was satisfied with the activity and wish to develop a similar assignment for the rest of the curriculum to implement in future TE material.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Sara Basse Hansen and Josephine Dannersø Nissen
Poul Nissen-group
Molecular Biology and Genetics

Practical Machine Learning

Learning how to do a real world machine learning project in several steps

Abstract:
During the practical courses, the students need to do some exercises and link their practical project to what they have learned from the lectures and exercise sessions. This teaching activity tries to motivate the students to attend the exercise sessions actively, facilitates the peer feedback and gives them the chance to improve their final project gradually during the semester by chunking the project into three smaller parts and using Kaggle website as teaching material. This teaching activity should be implemented from the beginning of the semester by designing a good project and related exercises. It can be evaluated based on the students' feedbacks and their projects' performance.

COURSE FACTS

- Course name: Computer Vision and Machine Learning
- Level: Master
- ECTS credits : 10
- Language: English
- Number of students: 30
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

The goal of this course is to teach the students to get insight into the computer vision and machine learning methods for real world signals analysis. During the exercise sessions, the students are intended to do some programming exercises to understand how different methods work and get some practical experience to do a final project. The problem is that the students don't take part in TA sessions actively, because the solutions are available to them before the class. Therefore, their final projects lack good performance and they don't have any chance to improve their project during the term.

2. Planning a teaching activity

The teaching activity is meant to motivate the students to take time in doing the exercises (not just reading the solutions) to find out if they have understood the course contents properly and get experienced for doing a larger project. Moreover, it helps them to learn how to give peer feedback on a project and analyze the results. They will also have the chance to improve their project during the semester using received feedbacks from other students.

3. Trying it out in practice

This teaching activity consists of two parts which affect each other. The first part is about the project and the second part targets weekly exercise sessions.

- I define the final project as a Kaggle competition (a popular website for machine learning online competitions) on a real world dataset and chunk it in to three parts. The students are intended to submit an implementation and a short document for each part of the project on the Kaggle website. The submissions are ranked based on the results on a leaderboard. In the next step, I will ask all the students to give feedback on one of the peers' project in the Kaggle forum. This is a mandatory part of their project, because they should learn how to analyze the results, how to give feedback and also how to apply others' feedbacks to improve their own project. I will also give them feedback. Accordingly they will have the chance to improve their projects for the next deadlines.

- For the each weekly exercise session, again I create a Kaggle forum for sharing the codes and solutions. The students don't have the solutions before the class. In each session, I first explain the exercise, then the students start doing programming individually. They can discuss together about their theoretical and technical issues. I walk through the class to answer their questions and have one to one discussions. At the end of each session, I will ask the students to upload their code on the Kaggle forum. The submissions are ranked based on the results performance. I will ask the first one on the leaderboard to come to the board and present his/her results. I ask related questions from other students and encourage them to get involved. At the end, I will complete the explanations if necessary.

As a result, since the students have short deadlines to submit their mandatory project and they know that they can get some practical experience in the weekly TA sessions, they will be more motivated to take part in the class actively and think on exercises.
The teaching activity would be assessed during each session. I can find out if the students have understood the course by analysing their presentations in the class and also the questions and challenges they have in doing exercises. Besides, when they submit each part of the project, I will analyse their codes, reports and peer feedbacks. In this way, I can decide to make some changes in the weekly exercises if necessary.
To evaluate the activity, I will make a structured questionnaire about the impact of weekly exercises on doing project and ask the students to write their responses anonymously. I can do it after each project deadline and it gives me some information about the quality of weekly exercises.

MAIN POINTS

1. **Main problem/challenge:** The students don't take part in TA class actively, so probably they don't have good performance in the final project.
2. **Teaching activity**: Chunking the project into smaller parts, using Kaggle competition website for involving the student actively in doing the exercises/project and giving peer feedback.
3. **Supporting student learning:** This activity will allow the students to get experienced to do the final project better and improve their project during the term from peer feedbacks.
4. **What to do next?** Evaluate whether the teaching activity is relevant by assessing the students presentations in the class and their performance in final project.

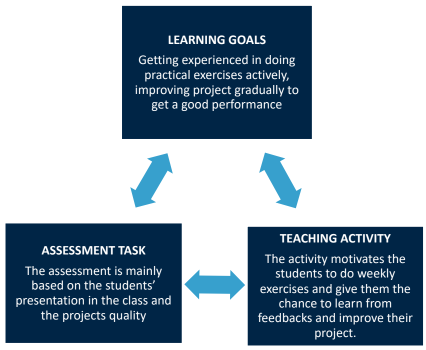


Figure 1: **Constructive alignment**
Illustration of the connection between learning goals, teaching activity and assessment tasks.

4. Looking forward

This teaching activity will be implemented in the next semester. First of all a comprehensive project should be defined and then a set of relevant weekly exercises should be designed for each session. This teaching activity can be evaluated based on the students' feedbacks on doing project and also I can evaluate this activity by measuring the projects performance and their improvements compared to this semester.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Negar Heidari
Computer Engineering
Department of Engineering

Identifying Fragmentation in EI-MS

- How to help the students to identify and apply reaction mechanism for molecules undergoing fragmentation in an Electron Ionization Mass Spectrometer

Learning Lab

Abstract: An important part of Spectroscopy in Organic Chemistry is for the students to learn how to identify and apply fragmentation mechanisms of molecules in EI-MS. However, the students often have trouble identifying the correct mechanism. To counter this problem an exercise sheet containing an incomplete reaction pathway was given to the students, who solved the exercise sheet during class with the TA available for help. The exercise was evaluated by the students, and the results give suggests that the exercise sheet helped the students understand the reactions. Furthermore, the exercise sheet allows for further development by gradually increasing the difficulty of the sheet.

COURSE FACTS

- Course name: Structural Chemistry IIa: Spectroscopy in Organic Chemistry
- Level: Bachelor, 4th Semester
- ECTS credits : 5
- Language: Danish
- Number of students: 47 (22+25)
- Your role: TA in Theoretical Exercises

TEACHING IN PRACTICE

1. Identifying a problem

A focus of the course is to have the students learn how to obtain a molecular structure from different spectra and do a confirmation check of the structure. The confirmation check of the EI-MS spectra troubles the students, where they must identify and apply reaction mechanisms for the molecule undergoing fragmentation in EI-MS. Furthermore, the reaction mechanisms differ from the regular reaction mechanism, which is problematic for students. As these fragmentation mechanisms are part of the examination, both as an confirmation check of a structure, but also as a separate exercise, it is important for the students to be able to identify and apply these reaction mechanisms.

2. Planning a teaching activity

The learning outcome of the teaching exercise is to help the students learn how to identify and apply the different fragmentation reactions of a molecule. To help the students learn how to identify and apply the frag-mentation reactions, an exercise sheet containing incomplete reaction pathways for the fragmentation of a molecule is created. This exercise helps the students by providing a direction. The intend of this exercise sheet is then to be handed out in class for solving in pairs thereby giving opportunity for the students to observe and discuss the reaction mechanism. In the end a class discussion of the exercise is to be made, thereby giving examined which parts the student will find difficult.

By being given a direction for the sequence, as well as discussion of the sequence, it should help the students toward being independently able to identify and apply fragmentation reactions. An example of an incomplete pathway can be seen in Fig. 1.

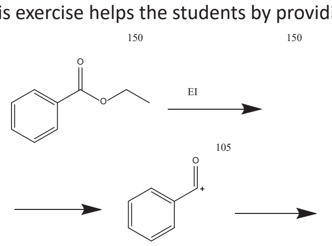


Figure 1: **Example of incomplete reaction pathway**
A possible incomplete reaction pathway of the Ethyl benzoate molecule. Within this example all masses of the fragments are given, while two fragments as well as all reaction types and mechanisms are lacking.

3. Trying it out in practice

The practical part of the exercise was done as described in section 2:

- Handing out the exercise sheet
- 20 minutes of exercise solving
- 5 minutes discussion of the found solutions
- 3 minutes of Mentimeter evaluation

Throughout 20 minutes of exercise solving, the TA was walking around the class room, either helping the students or observing the student's progress.

Part of assessment of the student was done throughout the observing, as it gave a clear indication of how well the students were able to identify and apply the different reaction mechanisms. Furthermore, the class discussion also contributed to the assessment as it gave an indication of which parts the student found difficult and easy

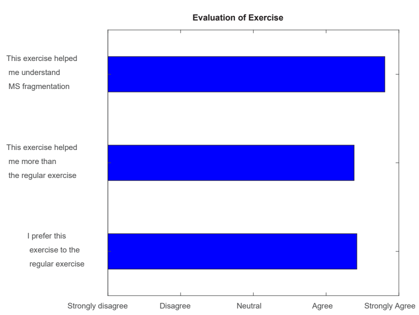


Figure 2: **Evaluation of the exercise**
Data obtained on the opinion of the exercise of the students done through the use of Mentimeter after the exercise session. From the data, I can be seen, that in general the students prefer this exercise over the regular exercise of finding the correct reaction pathway by themselves.

MAIN POINTS

1. **Main problem/challenge:** Students having trouble adjusting to new reaction mechanisms in EI-MS
2. **Teaching activity**: Students are given an unfinished reaction pathway to complete
3. **How did it go?** The students seem to have an easier time identifying and understanding the reactions
4. **What to do next?** Improve the reaction pathway to make it gradually harder until the students can solve the reaction by themselves

The exercise was evaluated in the end through a Mentimeter questionnaire, where the students was given three different statements, and requested to state on a scale from 1 to 5, how well the statement matched their opinion with 1 corresponding to strongly disagree and 5 to strongly agree. The results are shown in Fig. 2 and in general there was a good agreement on the teaching activity being preferred over the regular way.

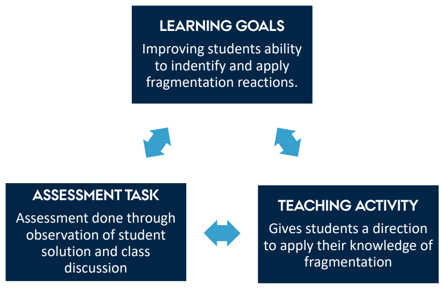


Figure 3: **Constructive alignment**
The correlation between the learning goals, the teaching activity and the assessment task is showcased in the figure. The learning goal of improving students ability is reached giving the student a direction of applying their knowledge. The students are assessed through observation during the solving and the classroom discussion.

4. Looking forward

The exercise seemed to be the preferred way to learn the fragmentation reactions for the students, suggesting further development of the exercise to be the way to go. A possible direction to improve this exercise, could be to create a series of exercise, which gradually becomes more difficult, thereby allowing the students to slowly become more independent applying the fragmentation mechanisms.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

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Femtolab
Department of Chemistry

Quiz on prior and new knowledge

- Students knowledge and your knowledge on them

Learning Lab

Abstract:

Knowing your students level in the subject you are going to teach is crucial for the success of the lecture. This is why it is a good investment to prepare and execute a well designed teaching activity that can help with that. A quiz on both prior and new knowledge is designed as a teaching activity. This teaching activity gives both the students and the teacher important insight to the level of the course and the level of the students. By knowing where the students are, it is much easier to understand where to focus the teaching and the first try in practice proves the success of the teaching activity. The teaching activity was implemented with great outcome for both students and the teacher, but the questions could be more sharp to improve the learning.

COURSE FACTS

- Course name: Structural Mechanics and Dynamics of Wind Turbines
- Level: Master
- ECTS credits : 5
- Language: English
- Number of students: 8
- Your role: Guest lecturer

TEACHING IN PRACTICE

1. Identifying a problem

Knowing your students level in the subject you are going to teach is crucial for the success of the lecture. Even though, the course prerequisites should ensure that the students know everything needed for a specific course, this is often not the case. Starting at a level just a little higher than the students current level might make them fall behind and not get the full planned outcome.

2. Planning a teaching activity

This teaching activity is designed to help the students access their prior knowledge by refreshing math and physics they should know. The students will also get a primer on the new knowledge presented through the lecture and enable them to solve the exercises given at the end. Lastly, the teaching activity acts as an icebreaker when the students are asked to discuss their answers with peers and on the class. The teaching activity aims to align the expected level of the students with the actual level before starting the lecture. Future lectures can also benefit from this teaching activity by having data from previous semesters.

3. Trying it out in practice

The teaching activity starts with a set of questions with multiple answers handed out to the students. The students will first answer the questions alone and thereafter share and compare with a peer. Finally the answers will be noted down by the teacher by raising the hand and the relevant questions will be discussed on the class. The overview of the teaching activity is seen in figure 1.

After implementing the teaching activity, the experience is that the formulation of the questions is very crucial. Some questions were too easy to figure out the wrong answer although the students did not know why and others were hard to interpret. But for the specific teaching, it also became clear that the students missed a basic understanding of some fundamental math that was used extensively through the lecture afterwards. The questions were a hidden mix two categories of prior and new knowledge. For the presumed prior knowledge, the students answered right on average 61% of the questions. From the new knowledge, many students answered blank on the unknown topics which was also intended. Some questions were easy to answer by ruling out the wrong answer and therefore these questions were not beneficial for statistics, but gave a good discussion afterwards. The whole thing took 30 min and this was mainly due to the amount of questions (10 questions).

MAIN POINTS

1. **Main problem/challenge:** Knowing what the students know in order to focus the teaching on the relevant topics.
2. **Teaching activity**: Quiz on the topics supposed to be covered and the topics to be introduced.
3. **How did it go?** The students were more active and engaging and as a teacher, I knew better where to focus my teaching.
4. **What to do next?** Fewer questions and maybe make the questions as an online homework before class to save time.

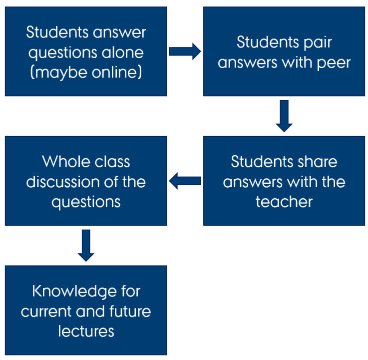


Figure 1: **Overview of teaching activity**

4. Looking forward

The teaching activity worked well and gave a good discussion and activated some of the more shy students. The discussed topics from the questions they did not understand was helpful to know when to elaborate on specific parts. The session took 30 min in total, but could be made shorter by limiting the number of questions from 10 to 6. The quality of the questions seems to be more important than the quantity and good discussions can come from few well thought out questions. Another way of getting a similar knowledge about the students knowledge might be to implement the questions in BlackBoard and then only use time in class to share with a peer and discuss on the class during the lecture.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Christian Elkjær Høeg
Computational Methods
Civil and Architectural Engineering

Repetition Using Matrix Groups

- Allowing All Students to Present

Learning Lab

Abstract: Usual theoretical exercise often only allows one student to present at a time, preventing the remaining students to get the learning experience from presenting. This challenge was met using matrix groups as a repetition exercise. In the matrix groups the students worked with question sheets on their topics, and afterwards they presented in new small groups. This method also allowed to enhance the students understanding of a few central topics. The student evaluations showed a very satisfactory learning outcome, but if the activity is implemented again, the material on the question sheets must be reduced.

COURSE FACTS

- Course name: Mechanics and Modern Physics for Chemists
- Level: Bachelor (first year)
- ECTS credits : 10
- Language: Danish
- Number of students: 19
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

In theoretical exercise classes one student often present a problem while the rest of the class listen, more or less actively. Since it can be expected that the student learning the most is the one presenting, this is not necessarily ideal.

Another challenge is to ensure a basic understanding of some key concepts in the course.

The teaching activity described here is planned to meet these two challenges by allowing the students to present in small groups.

2. Planning a teaching activity

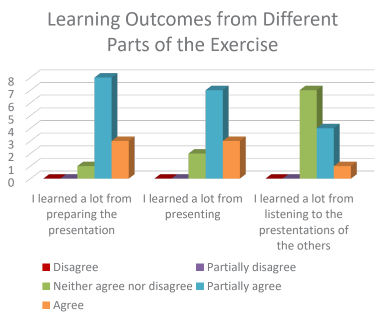
The teaching activity used here is a repetition exercise using matrix groups which is an activity where each group works with a different topic, and afterwards the students regroup and present in new groups. This allows more students to present at the same time, and since all students have to present something, all the students will get the learning experience from presenting course material.

Matrix groups is also a good way to go through a lot of material quite quickly, and hence allowing the students to recap several central concepts. The topics to recap were Gauss' law, circular motion, center of mass, and energy.

3. Trying it out in practice

Twelve students showed up for the session where the activity was implemented. The session followed the plan

- Introduction of the exercise
- Division of four groups at random
- Work in groups with the topics for 20 minutes. Sheets with questions were handed out for this.
- Pairing into new groups.
- Presentations in the new groups of 4 minutes per group member.
- A minute for the students to assess their own performance or grasp what they just learned.
- Follow up in plenum.
- Evaluation using an evaluation sheet.



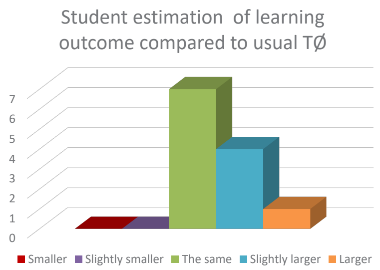


Figure 1: Student answers of the evaluation questions regarding the learning activity.

MAIN POINTS

1. **Main problem/challenge:** Activation of all students.
2. **Teaching activity**: Matrix groups.
3. **How did it go?** The students learned the same or more compared to usual theoretical exercise classes.
4. **What to do next?** Reduce the number of questions.

A stop watch on the projector was used to keep track of time during preparation and presentations.

During the preparation and the presentations the teaching assistant (TA) walked around the class. This gave the TA a chance to help (during preparation), but also to some degree assess the student learning, and find out if it was necessary to follow up on something specific afterwards.

The evaluation consisted of four questions regarding student learning. The results of these are shown in Figure 1. The results showed that the students felt the students learn the same or more compared to the usual theoretical exercise classes. Furthermore, the data indicates that the student learned more from preparing the presentations and presenting than by listening to presentations. The students could also write comments. They showed that in general they felt that they did not have enough time. It was also my feeling that there were too many question at least in two of the question sheets.

4. Looking forward

This exercise turned out to work well to activate all the students, and to ensure that all of them got a chance to present. Furthermore, the student evaluations of their learning were very satisfactory. However, if it shall be used again, the exercise must be reduced, so the time frame is more appropriate.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Ole Aae Iversen
maQma
Department of Physics and Astronomy

Cookbook for setting up integrals

- A structured approach using matrix groups

Learning Lab

Abstract: According to a mentimeter survey, many of my students struggle with correctly setting up integral expressions in the Electrodynamics course. This type of exercise accounts for large portions of the course curriculum and poses an immediate problem. To help this, I created a "*Cookbook for setting up integrals in Electrodynamics*" along with a supplementary teaching activity based on matrix groups that puts emphasis on a structured approach. The activity provided a low-stakes environment for discussion among the students, and a significant increase in the number of active participants was observed. According to the ensuing mentimeter survey, the students were very satisfied with the learning activity. Future improvements include another writing iteration of the *Cookbook* to better fit the assignments. The *Cookbook* also well received by the course lecturer, who will employ it in the course next year.

COURSE FACTS

- Course name: Electrodynamics
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: 16
- Your role: Instructor

TEACHING IN PRACTICE

1. Identifying a problem

Many exercises in the Electrodynamics course involves solving integrals. However, more than half the battle is in simply setting up the integral correctly i.e. in adapting a general integral expression to the specific geometry at hand. When asked in a mentimeter survey what the most difficult part of the exercises was in a particular session, about 2/3 of the answers was related to setting up the integrals. One student wrote "*understanding how exercise 1 should even be set up*". These findings are consistent with my own experiences. I attribute this student learning problem to the lack of a structured approach in solving this type of exercise.

It is an important issue in the context of the written exam, where correctly setting up integrals will likely account for at least half the points allotted for a particular question.

2. Planning a teaching activity

In the light of constructive alignment it is therefore natural to address the identified problem with a teaching activity. In pursuit of promoting the structured problem solving skills in the students I created a "*Cookbook for setting up integrals in Electrodynamics*". This 6 page document outlines the general steps and considerations necessary to analyze a geometry and set up the corresponding integral successfully. Particular emphasis is put on common pitfalls and how to avoid them. The document concludes with two worked examples of previous exercises and a list of further problems to which the document could be applied.

To maximize the student learning, I designed a supplementary teaching activity using matrix groups. The activity highlights active participation by all students. The agenda for the activity was:

- 10 m: Introduction
- 5 m: Example from cookbook by instructor
- 5 m: Assignment into initial matrix groups
- 30 m: Group problem solving
- 5 m: Prepare short presentation
- 5 m: Re-shuffling into final matrix groups
- 35 m: Assignment presentations
- 10 m: Wrap up and mentimeter survey

In summary:

1. **Learning goal**: Improve student ability to correctly set up relevant integrals.
2. **Teaching Activity**: Matrix groups to enhance discussions and active participation from all students.
3. **Assessment**: Mentimeter survey and by listening to the students working and presenting.

3. Trying it out in practice

At the beginning of class, the students received the following handouts:

- The *Cookbook* itself
- A detailed agenda
- A list of things to keep in mind during the activity.

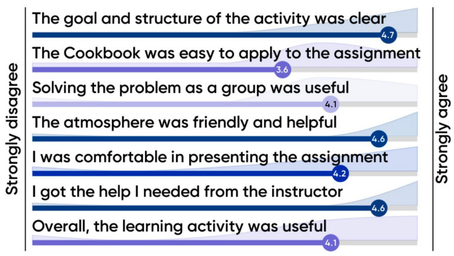
Most items on the latter attempt to reduce performance anxiety by e.g. highlighting the focus on methodology rather than results and puts emphasis on the group aspect of the activity.

After the Introduction and Example, the 12 students present were split randomly into 4 initial matrix groups of 3. Each group was supplied a whiteboard to promote discussion. 3 out of 4 groups used it and found it useful. During the problem solving phase, I regularly visited each group to make sure progress was made and answered questions.

MAIN POINTS

1. **Main problem/challenge:** Setting up integrals correctly
2. **Teaching activity**: Cookbook for setting up integrals using matrix groups
3. **How did it go?** Very well
4. **What to do next?** Iterate the material and hand over to course lecturer

All groups worked in a focused manner and managed to finish their assignment. The students were then given a handout of my solutions to the assignments and were invited to use it during their presentation if they desired. This was meant to reduce anxiety and put focus on discussion rather than taking notes.
The matrix groups were re-shuffled into 3 groups of 4. All groups managed to get through 3 presentations, leaving out the 4th one due to time constraints. I visited each group and provided help or clarification as needed. The low-stakes environment of the small groups clearly increased the overall level of discussion and number of active participants compared to our normal classes. Finally, the students took a mentimeter survey. Shown below are some of the results, which indicates that the learning activity was a success.



4. Looking forward

Based on the mentimeter survey, the learning activity worked very well. The answer distribution clearly reflects the majority of the students enjoyed the activity. One student wrote "*It was very useful, and would have been good to introduce early in the course.*" However, it is also clear that the *Cookbook* could use another writing iteration to better fit the assignments. Additionally, a single student seems to have not enjoyed the activity at all.

I have handed over the material to the course lecturer who will continue to use it next year. I recommend introducing the students to this type of activity as early as possible.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Jesper Hasseriis Mohr Jensen
Quantum Measurement and Manipulation Group
Physics and Astronomy

Evolution of morphological traits

- Tools for deeper understanding

Learning Lab

Abstract: Active learning is an important component in student learning, and while the zoology course already employs active learning methods, it is not used to its full potential. A modified strip-sequence learning activity was developed to aid students in fully understanding how certain morphological characters are defining specific groups of animals. While this teaching activity is yet to be implemented in the teaching, it has potential to help students learn about evolutionary mechanisms defining the different branches on the tree of life, and serves as a helpful teaching activity for ensuring alignment between learning outcomes and final assessment.

COURSE FACTS

- Course name: Eukaryotes | Zoology
- Level: Bachelor
- ECTS credits : 10
- Language: Danish/English
- Number of students: 200
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

During lectures, students are presented with a "tree-of-life" approach, depicting what morphological characters define certain group of organisms. Each week they deal with a different phylum of animals. They never actually get to play with and understand the characters through practice, only from a listener's perspective, which limits their understanding of the different branches on the tree of life. They should be allowed more time to train these skills, enabling a broader understanding of the mechanisms separating the groups, which is a part of the learning outcomes and final exam.

2. Planning a teaching activity

Each week students will be presented with a phylogeny of major clade names concerning the phylum of the week. They will also be given a set of small cards with morphological attributes written on them. As such, the teaching activity is a modified "strip sequence", where students in pairs map the right morphological attributes to the correct groups. They will spend 10-15 minutes on placing the morphological characters in the right places at the beginning of every lab exercise, after which a walkthrough, clarifying any potential confusion, is carried out by the teacher and the teaching assistant.

References
Edgecombe, G.D., Legg, D.A. 2014. Origins and early evolution of arthropods. Frontiers in Palaeontology 57 (3), 457-468. https://doi.org/10.1111/pala.12105.

3. Trying it out in practice

This teaching activity was never implemented in the teaching. The teacher believes it is a good idea to try it out, and we will try to implement it in the coming semester. We hope that allowing students extra time to delve deeper into understanding what characters define each group will make them better suited for their final assessment in the course, which would ensure better alignment from learning outcomes to assessment.

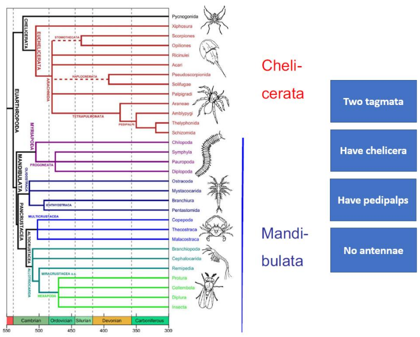


Figure 1: Illustration of the modified strip sequence approach the students would have to perform for each new phylum presented. On the left, a phylogeny of arthropods (Edgecombe and Legg, 2014). On the right, attributes pertaining to chelicerates.

4. Assessing the teaching activity

After the first trial of the concept, students will be asked for feedback on what they thought of the exercise and if it helped them better understand the branching of groups of organisms. We will hand out a questionnaire which we will use to evaluate how we can improve the exercise and to what extent it should be implemented in future teaching of the zoology course.

MAIN POINTS

1. **Main problem/challenge:** The students are only presented with morphological characters defining groups of organisms in lectures, and do not actively work with the features separating the groups in question.
2. **Teaching activity**: A modified strip-sequence approach allowing the students to critically think about what morphological characters define the branches on the tree of life.
3. **How did it go?** The teaching activity was never implemented, but will hopefully be introduced on a trial-basis in the coming semester.
4. **What to do next?** Implement the teaching activity, and evaluate what can be done to improve the exercise and to what extent the activity should be implemented in future teaching.

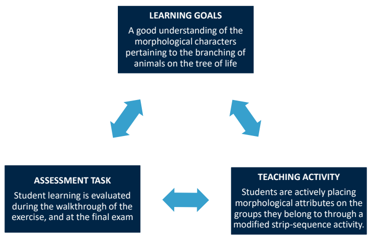


Figure 2: Constructive alignment

4. Looking forward

The next step will be to implement the teaching activity and try it out in practice. Hopefully it will enable deeper learning of what morphological characters are important for defining the different groups of organisms in the animal kingdom. After testing the teaching activity, student feedback on the exercise will aid us in deciding how to improve and to what extent we should implement the teaching activity in future teaching of the course.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Mads Reinholdt Jensen
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Department of Bioscience

Fake it till you make it

- Mock-exams as a tool to internalize learning outcomes while practicing oral exams

Learning Lab

Abstract:
The expectations and evaluation of an oral exam is often internalized by the experienced teacher and insight on how to be successful is likely to go undiscussed with the students. Furthermore, new students also need to learn how to decode the learning outcomes and apply these skills to anticipate the exam questions, i.e. the learning goals. This poster presents an attempt to make a mock-exam in which students can practice an oral exam situation while simultaneously relating each question to a course specific learning outcome. The goal is to enable students to anticipate relevant exam questions, i.e. the learning goals, by actively working with the learning outcomes.

COURSE FACTS

- Course name: Soil Science
- Level: BSc
- ECTS credits : 5
- Language: Danish
- Number of students: 7-15
- Your role: Provide lectures with some theoretical exercises

TEACHING IN PRACTICE

1. Identifying a problem

Information concerning exam evaluation is often internalized by the professor and is likely to go undiscussed with students. This creates a need among students to better understand the expectations of the teacher during final oral examinations. This need is particularly relevant for both undergraduate students and foreign students with little to no experience in decoding the learning outcomes and participating in oral exams. A mock-exam exercise will specifically imitate an oral exam, thus giving the students knowledge that can be applied in other courses.

2. Planning a teaching activity

The exercise comprise of a set of mock-exam questions handed out to predefined groups of students together with the learning outcomes of the course. Additionally, a exam grading rubric, which is based on the learning outcomes, is also handed out. After a given preparation time, the teams are randomly asked to answer the questions in a simulated exam dialogue, which may include supplementary questions. Meanwhile, the other students are asked to grade the mock-exam according to the rubric and thereby relate the questions to the learning outcomes. Once the questions have been answered, other groups are given the opportunity to provide feedback on the scientific content and how the questions related to the learning outcomes. The goal is to enable students to anticipate relevant exam questions (learning goals) by actively working with the learning outcomes.

Assessment of student learning is gained during the discussions in the activity, as well as watching the students while they are preparing the mock-exam questions.

Evaluation of the teaching activity will be done using a ticket out of the door, which will ask about what went well and what can be improved..

3. Trying it out in practice

Since the course is taught in the fall, the activity has yet to be implemented in an actual teaching situation. However, the teaching activity was first tested during role play on course day 2. It was observed that the teaching activity was significantly more time consuming than originally planned and it was decided to extend the timeframe of the activity to one lecture (45 min). Peer-feedback also highlighted that the in-class preparation time was a good possibility to assess students comprehension of specific topics covered in the questions.

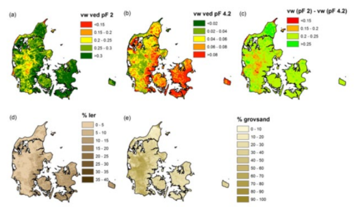


Fig. 1.|

Figure 1a and b depicts the variation of the volumetric water content in the A-horizon (θ [cm3/cm3]) in Denmark at two soil-water matric potentials: a) pF 2 (−100 cm H_2O) and b) pF 4.2 (−15500 cm H_2O). Figure 1c depicts the difference in values between Figure 1a and b. Figure 1d and e depicts the variation of clay and coarse sand, respectively, in the same horizon.

1) Account for the definition of the soil water contents at these matric potentials

2) Explain the variation in figure 1c in relation to the texture parameters in Figure 1d and 1e

3) What influence does the soil organic matter content have on the soil water content?

4) What does the variation in the above figures impact the soils ability to perform as a growing medium?

5) Describe a farming activity that may affect figure 1c

Figure 1: Example of questions for the mock-exam

MAIN POINTS

1. **Main problem/challenge:** Enable students to practice an oral exam situation and apply the learning outcomes actively
2. **Teaching activity**: Oral mock-exam with peer-feedback.
3. **How did it go?** The activity was first tested during role play on course day 2 and the time allocated to the exercise was expanded significantly. The teaching activity has yet to be implemented in an actual teaching setting.
4. **What to do next?** Implement the teaching activity in an real setting.

Grading category	Exemplary performance	Capable performance	Lacking performance with notable flaws	Lacking performance with significant flaws	Inadequate performance
Explain [soil function] and how it affects the soils role as a medium for plant growth					
Describe how **[soil property]** affects the soil's role in the surrounding environment					
Describe the soil physical and chemical properties that affect **[soil function]** and **explain** how they may be affected by land management					

Figure 2: Generic grading rubric where questions are assigned to a course-specific learning outcome and graded according to how well they cover the topic and learning outcomes.

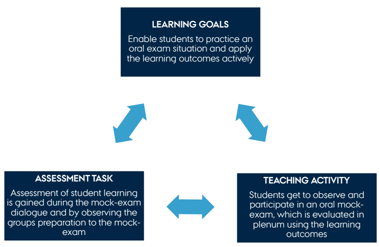


Figure 3: Constructive alignment

4. Looking forward

The teaching activity will be implemented in the fall 2019, and if successful, implemented in other courses with an oral exam. The reasonable next step would be to create mock-exam questions and for other topics when the course starts.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Peter Weber Jensen
Soil physics and hydropedology
Agroecology

Teaching and discussion amongst peers on biocontrol organisms

- A fast paced jigsaw group activity

Learning Lab

Abstract:

To improve the ability of students to characterize microbes and nematodes used in biocontrol in terms of their biology and practical use, a fast paced jigsaw group activity was carried out. Through mixing groups with different knowledge students presented to and discussed with their peers to increase their motivation to learn the different organisms. The fast pacing kept students engaged and motivated throughout the activity and they were positive about the activity when asked afterwards (in plenum). For future use of activity an exercise manual and more precise questions for the students to answer should be considered.

COURSE FACTS

- Course name: Biological Control
- Level: Master
- ECTS credits : 5
- Language: English
- Number of students: 18
- Your role: Giving a lecture (and instructing in lab)

TEACHING IN PRACTICE

1. Identifying a problem

It is a challenge for students to characterize microbes and nematodes used in biocontrol in terms of their biology and practical utility. This is an important skill in understanding the use of these organisms in biocontrol.

Therefore, this activity aimed to improve student learning in this subject by making them describe/teach and discuss important traits of the organisms with each other.

2. Planning a teaching activity

By answering specific questions using a template, the students will actively work with the distinctions between the organisms and their use in biocontrol. The students will be able to discuss and explain the organisms to their peers ("teach" their peers), thereby strengthening the learning potential. After the activity, the students will have get a "cheat sheet" (correctly filled out template) that will serve as a important tool when studying for the exam, or looking searching for specific information later on.

3. Trying it out in practice

The teaching activity I implemented was an "Jigsaw" group exercise. In this, I divided the students into four expert groups, each focusing on one group of organisms (15 minutes). Then split the groups into new groups, with one expert in each (10 minutes). The expert in each group then had to explain his/hers organism group to the rest of the group. Finally, the original expert groups were put together again (10 minutes) and tasked to present (5 minutes) an organism group that is was not their initial "expertise" to the rest of the class.

The activity was performed in 50 minutes (incl. 5 minutes intro), so the pacing between segments was fast which kept the students engaged.

Microbial agent	Bacteria	Nematodes
Host range		
Mode of entry		
Speed of kill		
Stability		

Figure 1: Cut-out of the template the students used to fill in information about the different organisms

I corrected and discussed each oral presentation briefly in plenum to clear out misunderstandings. Furthermore, the students received a "cheat sheet" with the correct answers at the end of the exercise.

The students initial response to the teaching activity was positive when asked in plenum afterwards. I felt the students were motivated and cooperative throughout

There was some confusion about the splitting and mixing of groups. This part could have been made clearer with a "exercise manual" that the students could confer with when in doubt about the process. The students had trouble narrowing in on the parts of each organism relevant to biocontrol and occasionally answered to broadly.

MAIN POINTS

1. **Main problem/challenge:** Characterization of microbes and nematodes used in biocontrol.
2. **Teaching activity**: Jigsaw group work.
3. **How did it go?** Overall good. Good engagement and discussions.
4. **What to do next?** Create an exercise manual. More specific/narrow questions.

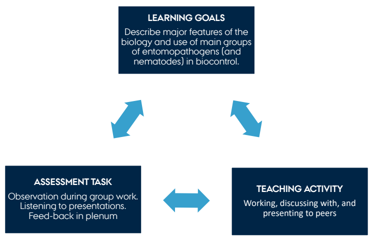


Figure 2: **Constructive alignment**

4. Looking forward

The students were engaged in the activity and motivated to complete the task. The relatively fast pacing of the activity kept the students attention. Students were actively engaged in discussion amongst their peers and everyone were more or less active throughout. There were some confusion to the structure of the exercise. This could have been presented more clearly, and furthermore a exercise manual that the students could confer with would have helped. The questions of the template could be made clearer and even more focused for another time. All in all, I think the teaching activity was a success.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Rasmus Emil Jensen
Entomology and Plant Pathology
Department of Agroecology

Identifying the Unidentified

- An application of muddiest point in spectral analysis

Learning Lab

Abstract: Alignment of the skills of students and the challenges they are presented is of high importance to the outcome of a class. The students stated anonymously the elements in spectral analysis which they found most difficult. By utilization of Muddiest Point, an exercise was designed which included those elements. Following interactive clarifications, the students were enabled to correctly establish the molecular structure from spectral data through the techniques they did not previously understand.

COURSE FACTS
- Course name: Organic Chemistry I: Functional Groups and Reactions
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: 15 (on my team)
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

The principal goal of a teaching assistant is to teach students. However, if the limitations of the students are not known, moving those boundaries will be difficult. Teaching material which is too simple can feel like a waste of time; Too difficult exercises can be demotivating for the students. It is therefore very important for the teaching assistant to identify the limitations of their students in order to contribute to their pool of knowledge. The technique of Muddiest Point gives the TA a unique opportunity to visit topics that are especially challenging for the students. Spectral analysis has many complex "rules" and is therefore also a fitting topic for Muddiest Point.

Figure 1: Identification of unknown elements.[1]

2. Planning a teaching activity

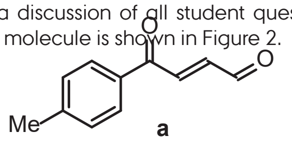
The students were to anonymously state which topics in spectral analysis they found most difficult. In this way, it is communicated to the TA which aspects to put more focus on.

Then, based on the relevant topics, a "secret" molecule would be chosen for analysis. Through the elucidation of the molecular structure with the help of spectral data, a discussion of all student questions would naturally follow.

3. Trying it out in practice

The students all handed in 1-2 anonymous paper slips the week prior detailing their biggest hurdles in spectral analysis. Student questions included the following topics:
- Nuclear magnetic resonance (NMR) chemical shifts (including *ortho*-, *meta*- and *para*-substituted aromatics
- Coupling patterns (e.g. double doublets)
- Coupling constants as well as roofing effects
- Distinguishing carbonyl classes
- Discriminating between useful and un-important information
- Finding molecular fragments
- Assembling fragments into final structure

Based on these topics, a molecule **a** was chosen for analysis which would allow for a discussion of all student questions. The molecule is shown in Figure 2.



a

Figure 2: Compound **a** which was to be identified by analysis of spectra

MAIN POINTS
1. **Main problem/challenge:** A lack of transparency in student comprehension of a given topic
2. **Teaching activity**: Muddiest Point and joint identification of compound **a** (figure 2)
3. **How did it go?** All major student questions were addressed and the compound was identified
4. **What to do next?** This activity might benefit from dividing the scope of questions in one session into smaller segments, e.g. only questions regarding

During the exercise, the students were made to describe the importance and meaning of the given spectral information. They were able to postulate the correct structure of **a** utilizing the techniques they themselves found difficult before this exercise. Student explanations of e.g. coupling patterns and chemical shifts were given which serves to indicate that this activity helped clear up the "muddy" points in spectral analysis.

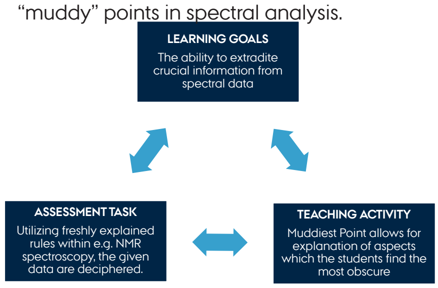


Figure 3: **Constructive alignment**
Information which is relevant both to the student questions and to the solution of the given exercise serves as a link between learning goals and the outcome.

4. Looking forward

A very important consideration when planning teaching activities is whether or not the usefulness of a teaching activity justifies the time it consumes – time which might be better spent. Here, a teaching activity which does not consume much time has been deliberately chosen. It is assessed that the teaching activity was beneficial to the students, both because it touched subjects which was very confusing to the students but also because it added some variation to an otherwise monotonous four-hour session. However, the subject "spectral analysis" is perhaps too broad to efficiently cover with 1-2 muddiest points. Segments (e.g. H-NMR) could perhaps benefit from individual sessions/exercises dealing only with that particular topic.

References

[1] *Diablo II*. Blizzard North, Blizzard Entertainment, 2000

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Nicolaj Inunnguaq Jessen
Group 109
Dept. of Chemistry

A Stakeholder Meeting

- Pros and Cons of Suggested Advice for Pollination

Learning Lab

Abstract: In order to guide the students to think critically with comprehensive perspectives, a within-group stakeholder meeting will be implemented as a teaching activity for students (with assigned stakeholder roles) to discuss the pros and cons of the advice suggested by the agricultural stakeholders. The plenum discussion will be followed as the teaching activity assessment. Evaluation of the teaching activity will be based on the mentimeter tool. This teaching activity may also be implemented for other courses that contain different stakeholders.

COURSE FACTS

- Course name: Field Crops and Environment
- Level: Bachelor
- ECTS credits : 10
- Language: English
- Number of students: 20
- Your role: TA giving a lecture

TEACHING IN PRACTICE

1. Identifying a problem

There will never be only one simple solution for a problem in agroecosystems (e.g., lack of pollination for seed crops). In a small class teaching, the challenge is to guide the students to think the pros and cons critically for the agriculture advice suggested by different stakeholders, which also requires a comprehensive understanding of the related background knowledge with a variety of perspectives.

2. Planning a teaching activity

A stakeholder meeting is a case-based teaching activity that is highly relevant to the lecture topics and provide a positive learning environment to the students. Students will think the problem in a critical way and get inspired by each other during the within-group discussion. In the following plenum discussion, TA will discuss with students and exchange the ideas. Figure 1 shows the constructive alignment .

Students will be placed into a "real-life" scenario and assigned with different stakeholder roles, which may also be beneficial for their future employment (e.g., seed growers, agriculture advisor) or further education (e.g., master degree programs).

3. Trying it out in practice

Scenario: in a stakeholder meeting organized by the local seed growers, different stakeholders gave advice on how to improve pollination for the clover seed production.

After the TA giving the lecture about pollination in agroecosystems, a **30-min** teaching activity will be conducted:

- **2-min**: teaching activity introduction.
- **3-min**: students are divided into 4 groups with assigned roles. Each group will include one agriculture advisor, one beekeeper, one agroecology scientist, and one or two local seed growers. The assigned roles have their own handouts as teaching materials (Figure 2).

Agriculture Advisor

Add early-flowering wild flower strips near the clover field to attract pollinators.

Agroecology Scientist

Use less chemical pesticides to protect wild pollinators.

Beekeeper

Put more honey bee hives in the clover field during the flowering season.

Local Seed Grower

You may consider pest problems; natural pollinators (other than honey bees); integrated pest management.

Figure 2: **Handouts for different stakeholders.**

- **10-min**: within-group stakeholder meeting.

  3-min: representatives (advisor, beekeeper, and scientist) will take turns presenting the advice.

  2-min: seed growers will ask questions to the representatives (may use the hints in Figure 2).

  5-min: within-group discussion on formulating the pros and cons of suggested advice. TA will move through the class and remind the time of the teaching activity.

	Agriculture Advisor	Beekeeper	Agroecology Scientist
Pros	Habitats Food source Biodiversity	More pollinators	Pollinator protection Environment
Cons	Habitats Food source for pests	Competition (honey bees and wild bees)	Pest problems
		More advice?	

- **15-min**: plenum discussion for the teaching activity assessment. Each group will present the pros and cons of the advice, and TA will write down the key words at the blackboard and have further discussions (Figure 3). Evaluation will be conducted by using the mentimeter.com. Student will "vote" the best pollination advice and evaluate both the lecture and teaching activity anonymously.

Figure 3: **Template for the plenum discussion at the blackboard.**

MAIN POINTS

1. Main problem/challenge:
How to guide students to think critically with comprehensive perspectives?

2. Teaching activity:
A Stakeholder Meeting

3. What to do next
To be implemented (autumn 2019)

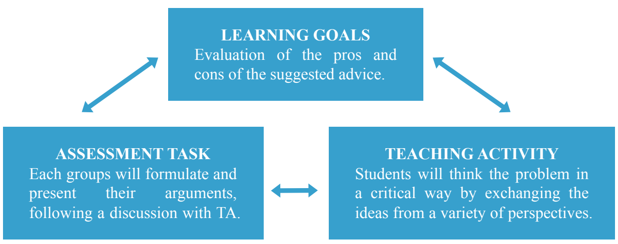


Figure 1: **Constructive alignment**

4. Looking forward

In autumn semester 2018, I gave one lecture with the same topic, but without conducting the teaching activity. In the following autumn semester 2019, I expect to implement the teaching activity. As a TA, I am looking forward to receiving feedbacks from both the lecturer and the students to improve the designed teaching activity.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Shuxuan Jing
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Department of Agroecology – Crop Health

Do-Think-Pair-Share

- Combining a small classroom based practical exercise with Think-Pair-Share

Learning Lab

Abstract: As part of the high school outreach program, AU FOOD offers a course in the processing and assessment of cheese, called "Fra Mælk til Ost". High school students are offered both a day for the full class, and then a day for a few interested students, called "ambassador day". At this ambassador day, the students learn about the cheese production, and cheese sensory attributes. Furthermore, they prepare a practical exercise they will perform with their classmates after the "ambassador day". To illustrate the difficulties of describing sensory attributes, and to make the students aware of how our senses work in practice, a short practical exercise was combined with the well-known Think-Share-Pair learning activity. The activity have not been performed ye.t.

COURSE FACTS

- Course name: Mælk til Ost (High school outreach)
- Level: High school
- ECTS credits : NA
- Language: Danish
- Number of students: ~10
- Your role: Organizer and instructor

TEACHING IN PRACTICE

1. Identifying a problem

The teaching session where the teaching activity will be implemented, aims at preparing the students for a later the practical exercise. Here, the students are going to perform an exercise about describing the tastes and odours of cheese samples at their own school. Earlier, there have been a focus on lecturing the methods the students will use in the later practical exercise.
The problem then is, that the students find it difficult to relate the theory to how we actually perceive foods.
Thus, the teaching activity aim to implement a small practical part to make the gap between theory and practice smaller.
The teaching activity should both combine the practical part with the theoretical part, and engage the students to take active part in the teaching activities.
Therefore, the idea is to incorporate a practical element to the Think-Share-Pair tool.

2. Planning a teaching activity

The teaching activity will be a simple practical exercise, where the students gets five of aromas and have to figure out the aroma descriptor. This is then combined with a Think-Pair-Share, where the students will discuss their results alone, in pairs, and in plenum.

By getting practice in describing aromas, the students get an understanding of the process of descriptive analysis. Furthermore, it is illustrated how difficult it is to describe aroma sensations.

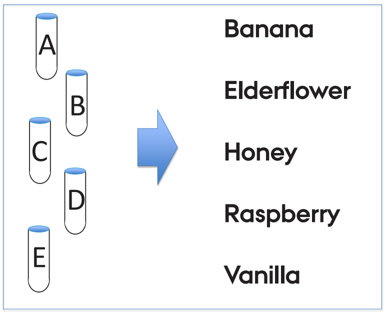


Figure 1: Design of the practical exercises, the "Do"-part of the Do-Think-Share-Pair. Five tubes with different aromas marked with letters, and their respective descriptors

3. Trying it out in practice

The students will get five common food aromas in tubes labelled A, B, C, D, and E (see Figure 1).
First, they will try do identify the odours by themselves, and after that in pairs.
Then they will get the five aroma descriptors, and have a few minutes to try, in pairs, to combine aromas and letters.
Lastly, the aromas and descriptors will be discussed in plenum, with students sharing their opinions.
As the outreach was not performed this spring due to lack of enrolled, I have not had the possibility to try out this teaching activity yet.

MAIN POINTS

1. **Main problem/challenge:** Too long from theory to practical exercise. Students show difficulties in identifying tastes and aromas
2. **Teaching activity**: Think-Share-Pair combined with a practical exercise
3. **How did it go?** Have not been performed yet
4. **What to do next?** In order to evaluate the activity it should be performed.

It is difficult to predict how it will work in the real setting, but there have earlier been quite a large jump from the theory to the practical exercises, that I think will be reduced with this exercise.
This exercise will increase the practical part of the course thus hopefully increase the student understanding of the link between sensory theory and their own food perception

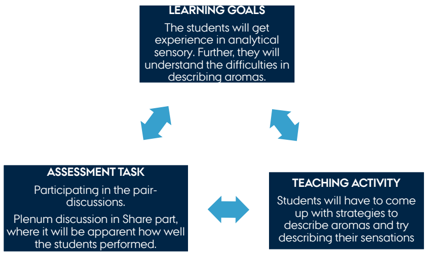


Figure 2: Constructive alignment in the teaching activity

4. Looking forward

The exercise have not been performed yet. I think the students will like getting a practical part into the teaching early in the lecture.

How big the actual learning outcome will be might be the biggest of my concerns. So, looking forward, I will have this challenge in mind when performing the activity, so I can evaluate whether this is actually the case.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Jonas Yde Junge
Food Quality, Perception and Society
Department of Food Science

Fill in the _______

- Improving student ability to interpret experimental results

Learning Lab

Abstract: Each year there is a big difference between individual groups on how well they are able to interpret their experimental results. To succeed, each group needs proper understanding of the underlying theory and protocol. This teaching activity will address this problem by challenging students to solve a “fill in the blank” and “strip sequence”. Solving these activities require understanding of simple but important concepts in the theory and protocol. The teaching activity was not tested in practice, but has the potential to better a recurring problem.

COURSE FACTS

- **Course name:** Molecular Processes in the Cell
- **Level:** 3rd year Bachelor
- **ECTS credits:** 10
- **Language:** Danish/English
- **Number of students:** 90-120
- **Your role:** Laboratory TA

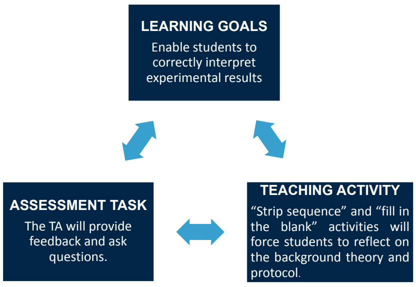


Figure 1: Constructive alignment

MAIN POINTS

1. **Main problem/challenge:** Lack of proper understanding of the underlying theory during and after the laboratory course.
2. **Teaching activity:** “strip sequence” and “fill in the blank”.
3. **How did it go?** The teaching activity was not tested in practice.
4. **What to do next?** Test in practice and refine materials.

TEACHING IN PRACTICE

1. Identifying a problem

In both 2017 and 2018 I have been a laboratory instructor in the course Molecular Processes in the Cell. After the laboratory work the students have to hand in a written report on the experiments they have carried out. Each year there is a big difference between groups on how well they have understood the exercise and their own results. Proper understanding of the theory is necessary to make sense of the protocol and for correct interpretation of the experimental results.

2. Planning a teaching activity

This teaching activity aims at improving the student’s ability to interpret experimental results. The teaching activity will consist of a “strip sequence” and ”fill in the blank”. The ”strip sequence” will challenge students to couple questions about specific protocol steps with the correct answer. This forces the students to reflect on important protocol steps. In the activity ”fill in the blank” students will be asked to couple vectors used in the experiment with cellular phenotype. Student will only be able to solve this activity if they have read and understood the theoretical background. Combined, these activities should enable students to draw conclusions from own experimental results as stated by the course learning outcomes.

3. Trying it out in practice

During the experiment there are several protocol steps with waiting time. The activity will be presented to each group during these periods. Each group will get 3-5 minutes to solve the activity (figure 2). The TA will stay in proximity to monitor the progression.

After a group has finished the TA will ask the group to go through their solution. The TA will provide feedback and ask questions. If there are any misconceptions about the protocol or theoretical background the TA will know and be able to clarify.

When confident that the group understands the background and purpose of the experiment the TA will present a barcode for a Mentimeter survey (figure 3). The purpose of the survey is to evaluate if the students themselves think they learned something from the activity.

When finished with the survey the group will be allowed to continue with the experiment.

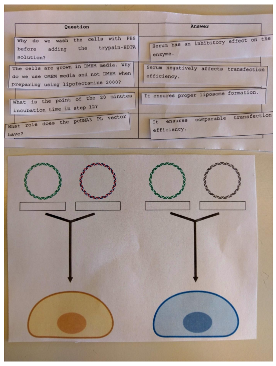


Figure 2: The “strip sequence” and “fill in the blank”.

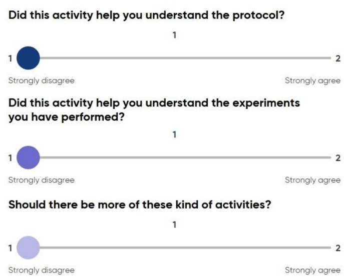


Figure 3: Mentimeter evaluation of the teaching activity.

4. Looking forward

As the teaching activity was not tested out in practice this will be the first thing to do. Depending on how the activity is received refinements might be needed. Maybe two activities is too ambitious for a short period of ~5 minutes. Therefore, removal of the “strip sequence” activity could be considered.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Andreas B. Kamstrup
Department of Molecular Biology and Genetics

Match your methods!

- Activate your students through reviews and problem based teaching!

Learning Lab

Abstract: After a whole semester of acquiring new theories and methods it can sometimes be a puzzle for the students to figure out which theory or method that fits to a specific problem. Method matching is mixing flash review with group based solving of exam questions and is very well suited as an activity performed before the final assessment as it reviews all important subjects of the course and aims to make the students discuss the best road to solving specific exam questions. The students was pleased with the activity and felt better prepared for the exam.

COURSE FACTS

- Course name: Electromagnetism Waves and Optics
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: 14-18
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

Courses in physics ending in a written assessment have a huge focus on problem solving with a specific path in mind. Students often find themselves in situation where they cannot find the correct physical principles and methods to solve the problems. Throughout a semester students acquire a lot of new knowledge which at the end of the semester can be difficult both to remember and put in correct order. It can therefore be a good idea to revisit what have been taught during the semester, to help them organize the new knowledge and give them easy access to identifying the best methods for a specific problem.

2. Planning a teaching activity

As a TA it can vary a lot how much time you have to do specific teaching activities. This teaching activity is designed to be easy for scaling up or down depending on the needs of the TA.

The activity should focus on brushing up on knowledge learned throughout a course, this should be done close to the end of the semester (maybe also halfway through). A quick review of the most important topics should help the students get an overview of their knowledge of the course.

An effective way of learning is through use of what you have learned. Therefore the students should be presented to problems after the review to use some of the refreshed methods to solve the problems and hopefully gain a better understanding. Thereby getting an overview of the course.

3. Trying it out in practice

The activity starts out by splitting the students in two groups and placing them in two lines standing in front of each other so that each have a partner with whom they will have short discussion. The TA will then show them a relevant method for the course (or theory). This can be done with a slide show where also pictures can be inserted to stir up the memory of the students if they do not remember the method. The students will then have a minute to discuss the method and what it can be used to. When the one minute have passed one of the lines are asked to take one step to the side so that they get a new discussion partner.

When all the topics have been covered the students are mixed in small groups (3-4) and then each group is presented with an old exam question (every group gets different problems) that they have to solve in the group. Finally, they will then have to present their solution in front of the class. After the presentation the TA can give the correct solution if needed

A flowchart of the activity can be seen in Fig. 1. In the end the activity was about a 2 hour class but can be varied depending on demands for TA (or next time).

In general the students really liked the activity, and the activity in itself went without problems. Most of the students said that they felt more confident in their own ability to solve exam questions after the exercise. Also the fact the activity made them review all the important theories throughout the course also gave them a better understanding of the course in general and a better overview.

MAIN POINTS

1. **Main problem/challenge:** To remember methods and theories that have been taught throughout the semester and to correctly use these for problem solving.
2. **Teaching activity**: A flash review followed by solving exam related problems in small groups.
3. **How did it go?** The activity gave generally good feedback from the students, and also mentioned that this would be good for as an activity close to the exam in the pre-exam question class.
4. **What to do next?** Based on the feedback tune the topics of reviewing, also to consider developing it as a pre-exam activity for the students.

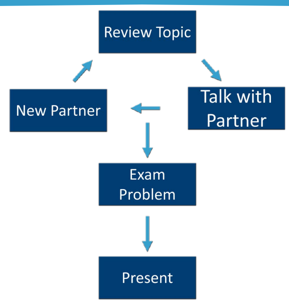


Figure 1: **Method matching – Theoretical exercises.** A flowchart of method matching with a problem solving focus. First the student pair up, then they get shown a related method for the course and are allowed to talk wither their partner for 1 min. Afterwards they switch partner and get a new topic to discuss this is repeated until all topics of the day is covered. Then the students are split into groups and get a specific problem that they then have to present.

4. Looking forward

The majority of the students was pleased with the activity and gave them a better feeling and overview of the course and in general felt better prepared for the exam. Therefore it could be interesting to implement this next year halfway through the course and in the end.

Problems of some students being inactive during the activity was especially observed during the group work and could be helped by making the presentation more group focused with everyone presenting the same amount. The activity shows good promises but improvements are still to be considered.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Christian Karlsson
Biomedical interfaces
iNANO

Amino Acid Jeopardy

- I'll take constructive alignment for $500

Learning Lab

Abstract: In many courses, students are assessed on their ability to memorise complex information by heart, a task many students find daunting - especially when the manner in which the course is taught does not align with the way the students are assessed. One way to memorise a complex curriculum is through repetition and active learning, so in order to support student learning, I designed an amino acid jeopardy game in order to align the theoretical exercises more with the final assessment.

COURSE FACTS

- **Course name:** General Molecular Biology and Biochemistry
- **Level:** Bachelor
- **ECTS credits:** 10
- **Language:** Danish
- **Students:** 20-30
- **Your role:** Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

One of the challenges faced by the students in this course is that they must learn a broad curriculum by heart. The students need to memorise a vast variety of different biomolecules and biomolecular pathways that they will be tested in at several "screening exams" throughout the course, as well as at their final exam. The current structure of the theoretical exercises (T.E.), however, does not factor in the rote learning and it is thus up to the individual student to practice this outside of class – a task many students find daunting on top of the already extensive theoretical curriculum.

2. Planning a teaching activity

To aid the students in memorising different aspects of the amino acid curriculum and align the theoretical exercises more with the learning outcomes of the course, I designed an amino acid jeopardy game. The game is intended to expose the student's to parts of the course material in a fun way - hopefully helping the students pass the screening exams.
As an additional benefit, the teaching activity will, hopefully, create a friendlier classroom atmosphere, which I have found both makes the students more likely to participate actively in class, but also making them more likely to explore any incomprehension regarding the curriculum, they might have.

3. Trying it out in practice

The teaching activity consists of a game of Jeopardy with questions about amino acids. The students will be divided into 4 - 5 groups and compete against each other in questions of varying difficulty addressing different parts of the amino acid curriculum, such as structure, side-chain properties etc. (See fig. 1).

Figure 1: **Amino Acid Jeopardy** Layout of the amino acid game with the different categories. Questions and categories can easily be changed.

The students will be informed that they need to review the curriculum concerning the amino acids one T.E. in advance and during the following T.E. the games will commence. An estimated 30 minutes will be used on the teaching activity on the day. As a motivating factor, a small bag of sweets will be purchased for the winning group.
In order to assess whether the teaching activity was succesful, I will be observing the students' answers to the questions, to see whether there are any areas that need extra attention in the upcoming T.E.s. Furthermore, I will also be asking the students to give oral feedback on the teaching activity.

MAIN POINTS

1. **Main problem/challenge:** Students need to memorise large curriculum by heart.
2. **Teaching activity:** Amino Acid Jeopardy game
3. **How did it go?** Expected to align the students' learning with course's final assessment.
4. **What to do next?** Implement and improve.

The students will be asked whether they feel the time could have been spent more productively and whether it helped them acquire the curriculum. One caveat of oral feedback is that it is not anonymous, and a bias could thus be introduced.
Unfortunately, my teaching period for the semester was over before I had a time to implement the teaching activity – the plan is to implement it next year.

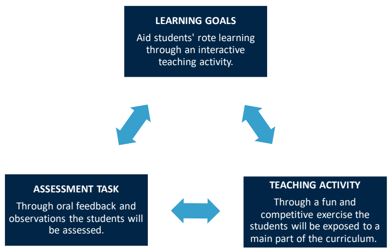


Figure 2: **Constructive alignment** Through my teaching activity I attempt to align the learning goals of the students with how they are assessed on their final examination.

4. Looking forward

The teaching activity has not yet been implemented, so many variables remain unknown (e.g. is time-allocation sufficient?). The strength of the teaching activity is that it can easily be modified to contain less/more categories or questions. Furthermore, the questions can be designed to focus on other parts of the curriculum as needed. The teaching activity can also be provided on blackboard as a template, allowing the students themselves to design questions and compete outside of class, further aiding them in acquiring the curriculum.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Peter Kerwin
Anne Von Philipsborn Group
Molecular Biology and Genetics

Comprehending Western Blot

- Learn how to interpret own protein expression results with a modified Strip Sequence activity

Learning Lab

Abstract: For inexperienced students at the beginning of their molecular medicine studies, laboratory protocol can often be hard to understand as they lack necessary hands-on experience and theoretical understanding. So in a method such as Western Blot it can be difficult to identify the right bands on the membrane and interpret the results.
In the laboratory exercises of Western Blot, a common confusion arises when the students have to detect several antibodies on different membranes. To prevent this, the students were presented with a modified strip sequence activity designed to help them understand the methods to analyze proteins works, and make them work on their own results. The teaching activity was generally evaluated as helpful by the students.

COURSE FACTS

- Course name: Molecular Cell Physiology 1
- Level: 2nd year Molecular medicine
- ECTS credits : 10
- Language: Danish/English
- Number of students: 33
- Your role: Lab instructor

TEACHING IN PRACTICE

1. Identifying a problem

The students participating in the laboratory course have a basic understanding of the molecular mechanism of Epithelial-Mesenchymal transition (EMT), but have no general experimental practice or practical experience with initiating EMT in vitro and detecting EMT markers (proteins) with Western Blot. It is essential for interpreting the results from Western Blot correctly to understand the technique itself, predict the size of the proteins of interest beforehand and how the expression of these proteins should theoretically change in cells that have undergone EMT.

2. Planning a teaching activity

Based on the identified challenge described, a teaching activity consisting of a modified strip sequence was developed. The learning goals of the activity is to 1) make the students reflect about their EMT experiment and apply their theoretical knowledge 2) get an understanding of the Western Blot technique. After completing the teaching activity, the students will be well prepared to interpret their results consciously.

3. Implementing the teaching activity

The students will pair in their respective lab groups and discuss with one another what they expect to observe on their Western Blot membrane, loaded with protein lysates from cells stimulated with TGF-B to undergo EMT. Each group will then have to fill in bands (intensity and size) on a printed "membrane" *(Figure 1)* provided by the instructors. After finishing the exercise, the instructors will ask for volunteer groups to come to the blackboard and present for the rest of the class. Each presentation will be followed by a discussion in plenum.

To solve this exercise they need to read and learn about the particular proteins they are working with, which they also have time to do when the exercise is going on. Additionally, they have to make some predictions of protein expression levels during different conditions. So if the students can solve the exercise they show an understanding of the technique as well as the molecular mechanism behind EMT.

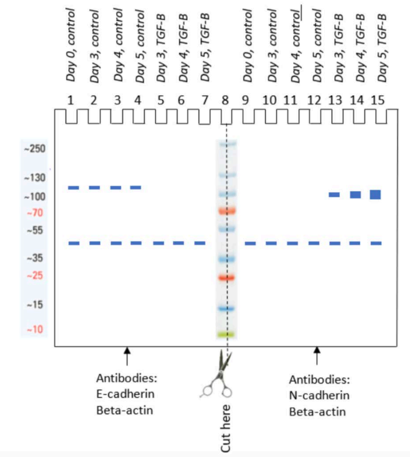


Figure 1: Western Blot membrane with "filled in band" illustrating the theoretical expression of E-Cadherin, N-Cadherin and loading control Beta-actin 3, 4 and five days after TGF-B treatment, as well as controls.

MAIN POINTS

1. **Main problem/challenge:**
Lack of practical and theoretical experience with Western Blot

2. **Teaching activity**:
Modified strip sequence to predict protein band sizes and intensities of EMT markers

3. **How did it go?**
The activity was successful and helped the students to interpret their own results

4. **What to do next?**
Consider preparation time for future use of the exercise

4. Evaluation and future directions

A week after the lab course we had a follow-up class were the students were asked to give oral feedback on the teaching activity. Generally, the students found the activity helpful and it is our impression that the learning goals were achieved for the vast majority of students. They specifically found the discussion, after the group presentation, informative. Some students found that they had insufficient time to solve the exercise, as they had to do some research on the different proteins. For future use of this exercise the students could be asked to look up and read about protein changes in EMT beforehand.

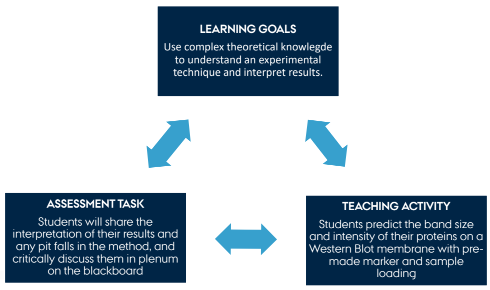


Figure 2: Constructive alignment of the teaching activity

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Marie Lorans and Sara Kobberø
UAØ and CO lab
Department of Molecular Biology and Genetics

Matrix grouping

- A Jigsaw inspired teaching activity

Learning Lab

Abstract:

Group presentations are a great way for students to dig into the literature, discuss it with fellow students and obtain a greater knowledge of the individual topics of a certain course. The problem arises when the students only have time to focus on their own presentation and forgets or do not have time to study the others. This results in an inactive classroom. To comprehend this a matrix-grouping activity was made to mix up the separate expert groups and task them to go though all of the days presentations, this activates the students and everyone obtains the same level of knowledges.

COURSE FACTS

- Course name: Microbiology (Molecularbiology)
- Level: Bachelor (2nd semester)
- ECTS credits : 5
- Language: Danish
- Number of students: 3 classes of 20-23 students
- Your role: TA

TEACHING IN PRACTICE

1. Identifying a problem

TØ purpose: The theoretical exercises in this course are used as preparation for the oral exam. A class of 20-22 students are divided into 4 permanent groups. The groups are assigned a certain topic which they have to present to the rest of the class. While one group is presenting the remaining students should prepare questions.
The problem: Almost non of the students have any questions, because they only have been focusing on their own presentation, therefore not having any knowledge of the other groups topics.

2. Planning a teaching activity

To tackle the problem of having a inactive classroom consisting of groups of students with different background knowledges to reach the same level of understating a jigsaw inspired activity was designed.
The activity: Each class consisted of 4 expert groups. After the mandatory presentations the groups were mixed so at least 1 expert from each group was present in the newly formed groups (figure 1). Here they were tasked to go though all of the days presentations, discuss them, ask questions to each other and think of what questions they might be asked during the oral examination (20 minutes).
After the group discussion, selected students will be asked to share what they had discussed with the rest of the class.

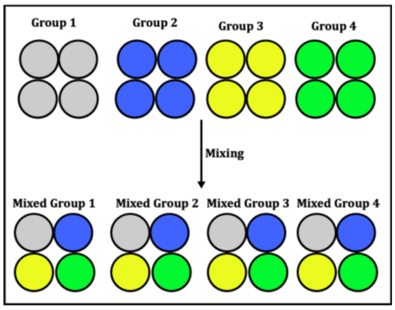


Figure 1: **Overview of group paring**
Top: Expert groups. **Bottom:** Groups after being mixed.

3. Trying it out in practice

After the presentations the mixed groups were formed and a short introduction to the activity was given. The students were allowed to leave the classroom to find a quite place to discuss the days presentations. Meanwhile I walked around listing to the discussions and answered questions if they had any.

After the group discussion all the students were gathered in the classroom and the students were asked what they had discussed. In the beginning the students were a bit shy, but after a few students shared their thoughts everyone pitched in and we had a nice discussion going on the days topics. Based on what was discussed I could clearly hear that most (if not all) of the students had identified the main key points of each topics and were able to ask and answer questions. Thus eliminating the inactive class room and ensure that everyone is on the same level.

MAIN POINTS

1. **Main problem/challenge:** Inactive students
2. **Teaching activity**: Group discussion
3. **How did it go?** Based on the feedback it went well and the activity was used whenever we had time for it.
4. **What to do next?** I will used the activity if I have to teach something similar.

To evaluate the teaching activity I prepared a mentimeter vote, as can be seen in figure 2. The students enjoyed the teaching activity. They felt that they had learned something during the teaching session (8.1 of 10) they felt that the activity was useful (7.7 of 10) and they would every much like to continue this type of exercise (8.6 of 10).

Furthermore, the students indicated that more time for this activity would be appreciated.

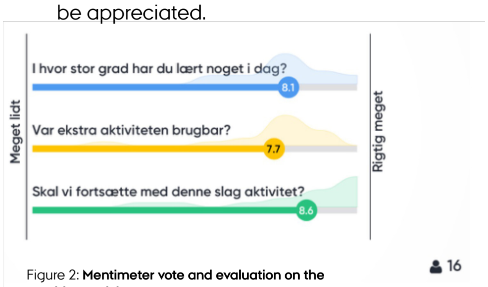


Figure 2: **Mentimeter vote and evaluation on the teaching activity.**
16 students out of 20 students voted. An overall score of around 8 out of 10 concludes the activity as successful.

4. Looking forward

Based on the mentimeter evaluation of the teaching activity the students enjoyed this activity and most important of all – learned something. Personal feedback suggest that the students will need more than 20 minutes to discuss and talk about the presentations/topics in the mixed groups as it felt slightly rushed. This is something I will keep in mind.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Benjamin Smed Korsgaard
Center for Electromicrobiolgy. Thomas Boesens lab
Department of Bioscience & Department of Molecular Biology and Genetics

Internalization of the nitrogen cycle

- Using "Connect the Concepts" with a ticket out the door

Learning Lab

Abstract:

The aim of this teaching activity is to make the basics of the nitrogen cycle in cropping systems back bone knowledge for all types of student learners. This is a good opportunity to internalize these processes which the students are faced with later in their studies and work life. The exercise gives the students an chance to discuss and share with their peers in a way that will increase understanding of how things are connected.

COURSE FACTS

- Course name: Plant Nutrition
- Level: Bachelor
- ECTS credits : 5
- Language: Danish
- Number of students: 10-15
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

In this course the students will be presented to the nitrogen cycle. Learning about the nitrogen cycle is a very useful thing for the students to master in both in terms of future courses and future work opportunities. I wish for the students to work a little more intense with the cycle in order to make it backbone knowledge that they will remember even after the exam is over.

2. Planning a teaching activity

Students have to know the differences between sources of nitrogen, how the nitrogen is transformed in the soil and how it can be potentially lost to the environment. This subject will be covered in the teaching activity, it will be assessed as a ticket out the door and in their exam

The teaching activity will focus on the first learning goal of this lesson: the basics of the nitrogen cycle in cropping systems. The students will have to make a 'connect the concepts' map exercise in which they are supposed to fill out arrows and verbs in the nitrogen cycle. This will make the students visualize the system in another way and thus remember it better. It will help the students that are not very good at note taking. They will also learn to communicate the subject to their peers.

3. Trying it out in practice

The exercise have yet to be carried out in a real class room setting.
The students will be split up in three groups and introduced to the "verbs": (1) uptake of nitrogen by plants from the atmosphere, (2) uptake of ammonium and nitrate by plants from soil and water, (3) ammonification, (4) nitrification, (5) denitrification, (6) nitrate immobilization by soil sorption, (7) nitrate leaching, (8) release of ammonia (NH_3), gaseous nitrogen and nitrous oxide to the atmosphere. They will then have to use these to connect the concepts: nitrogen in the atmosphere, nitrogen organic matter in the soil, nitrate, nitrite and ammonium. They are then supposed to share between groups by making one volunteer give a resume. This will be done in the first third part of the entire lesson and they will also get a ticket out the door after the last session to see if they remember.

The student learning will be observed by listening in on the group work and interrupted if it seems necessary. Furthermore the ticket out the door is evaluated by the TA and available for the students to see their individual evaluation on Blackboard. If they have any questions they can comment on the evaluation.

4. Looking forward

I hope that the teaching activity will help the students learn and remember in another way that they are used to. If the activity works it can be implemented on any other important basic knowledge concept in any other course.

MAIN POINTS

1. **Main problem/challenge:** Making the nitrogen cycle backbone knowledge
2. **Teaching activity**: connect the concept mapping and ticket out the door
3. **How did it go?** The teaching activity is yet to be implemented
4. **What to do next?** Implement the exercise

The teaching activity will be evaluated by a mentimeter survey by the end of the course day, and focus on how well the exercise was able to increase clarity of the subject and if the TA's communication about the exercise was sufficient. Questions could include: (1) On a scale from 1-10 how well did the exercise contribute to your learning? (2) on a scale from 1 to 10 how well did the TA explain the exercise? (3) On a scale from 1-10 how relevant were the exercise?

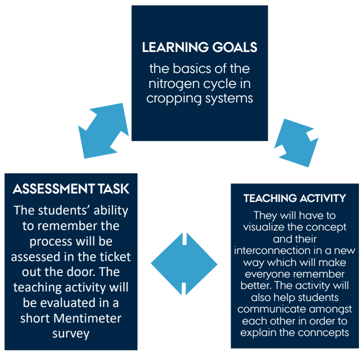


Figure 1: **Constructive alignment**

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Your name: Rebekka Kristensen
Research group: Soil fertility
Department: Agroecology

Revisiting EvoGen

- How to make evolution and genetics stick

Learning Lab

Abstract:

Uneven participation in small class teaching is a continuous issue, an issue I try to accommodate by adding a small easily implementable activity, such as theoretical terms notes featuring the theoretical terms of the day.
Students were encouraged to take a moment to gather their thoughts, before explaining the term to their group. The whole class participated actively and the notes worked as a nice break in the flow of the class session. The "theoretical terms" notes can be directly implemented in almost any teaching activity.

COURSE FACTS

- Course name: **Genetics and Evolution**
- Level: **2nd year**
- ECTS credits : **10**
- Language: **Danish**
- Number of students: **80 in total, 20 per class.**
- Your role: **Teaching assistant**

Figure 1: **Exercise notes with theoretical terms**

MAIN POINTS

1. **Main problem/challenge:**
   Uneven participation
2. **Teaching activity:**
   Theoretical terms notes 'quizzing'
3. **How did it go?**
   Students participated and discussed eagerly.
4. **What to do next?**
   Implement theoretical terms notes more, in multiple settings.

TEACHING IN PRACTICE

1. Identifying a problem

Even in group work, engaging all students can be a challenge. Especially 'shy' students may hide and let the 'strong' students do the talking. This may lead to a learning inequality in favor of the 'strong' students. It is therefore important to improve student participation in order to ensure learning for everyone. I try to accommodate this by introducing theoretical terms notes, for each person to explain to their group.

Thus, the aim is to ensure participation from both 'shy' and 'strong' students, so learning is improved and terms will stick better for all.

2. Planning a teaching activity

To make sure all group members partake in the discussion, I made notes with relevant technical terms. The idea is that each person draw a note (or multiple, see fig. 1), and subsequently get a minute to gather knowledge on the term (if needed), before explaining the meaning of the term to the rest of the group.

Thus, the goal is for all students to participate, and improve understanding of the technical terms, needed for the written exam.

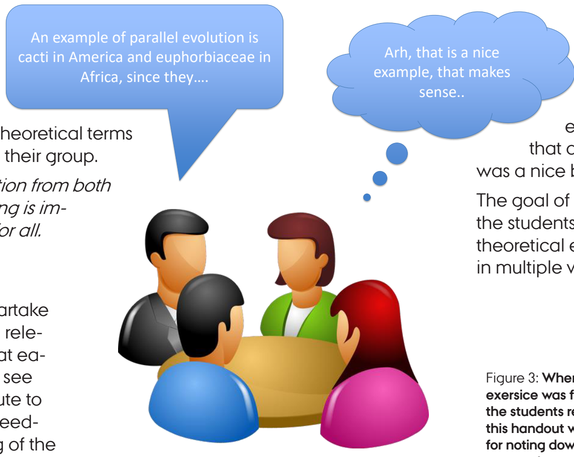


Figure 2: **An illustration of the discussion environment the theoretical terms exercise was carried out in.**
http://getdrawings.com/group-discussion-icon#group-discussion-icon-75.png

3. Trying it out in practice

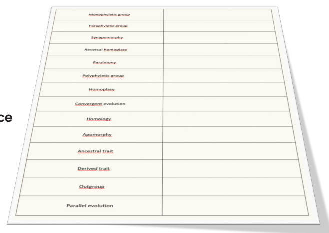
During the 3h theoretical exercise, I handed out the notes, and had the students explain the terms to one another. The strongest students used them to immediately quiz each other, while the 'shy' ones often took a minute to look at notes or lecture slides before explaining the term.

A list of all the theoretical terms was handed to them afterwards (see fig. 3), and can be used for recollection closer to the exam.

The effect of this exercise was evaluated in class by listening and ensuring that also the shy students spoke out loud. There was a nice buzzing.

The goal of a more even participation was met. Some of the students told me it was nice with such "breaks" in the theoretical exercise sessions and that revisiting the terms in multiple ways improved their learning.

Figure 3: **When the exercise was finished, the students received this handout with space for noting down notes next to the term.**



LEARNING GOALS
The students should **master the technical terms**, and be able to **communicate** their meaning **verbally**, as it improves understanding needed at the exam.

ASSESSMENT TASK
Listen to students explaining terms to one another.
Ask the students whether the exercise aided their understanding.

TEACHING ACTIVITY
Students will **explain and discuss** technical terms.
Ensure more **even participation** in group work.

Figure 4: **Constructive alignment, featuring notes on the specific exercise in the Genetics and Evolution course.**

4. Looking forward

The theoretical terms notes worked really well, and got all students involved in explaining the terms. They are useful for both stronger and more shy students. This is an exercise that is easily implementable in almost any class or even laboratory exercise if there are some terms/concepts that may be difficult to understand.
The exercise can relatively easily be varied and turned into jeopardy or interactive multiple choice, however, then I most likely loose the "shy" students again.
Handing out the lists also gives the students a tool for additional recollection when the exam is approaching.

The students evaluation of their benefit could be improved markedly. A fun and measurable way to evaluate the students learning (or perception of their own learning) would have been to use e.g. mentimeter, and let the students answer questions such as: "Do you think this exercise makes your understanding of the theoretical terms better than a 'usual' session?" That will be used next time I invent and implement new exercises.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Anne Aagaard
Spiderlab
Genetics, Ecology and Evolution
Bioscience

Thinking, Linking, and Rethinking!

- Managing a large classroom with multidisciplinary participants

Learning Lab

Abstract:

This learning activity is developed in the context of courses with a significant number of attendants where alignment between learning objectives and actual learning outcomes becomes a counterintuitive and and time-consuming task. The activity addresses various methods to sparkle one's active thinking, allowing them to link the theories to a familiar practical case, and helping them to gain confidence by rethinking some difficult problems from previous sessions. Thinking, Linking, and Rethinking!
A large classroom management approach that requires joint efforts from the TAs ☺

COURSE FACTS

- Course name: Applied Linear Algebra
- Level: AU summer school 2019
- ECTS credits : 5
- Language: EN
- Number of students: ~ 100
- Your role: TA for TØ

TEACHING IN PRACTICE

1. Identifying a problem

The main challenge of the course is to find an efficient and reliable way to boost students' learning outcomes to a satisfactory level in alignment with the learning objectives given the considerable number of course participants.

The current observation is that students are tempted to simply flicker through the solution sheets rather than trying to solve problems hands-on and some consider the need of raising questions to the TA as a potential threat to one's autonomy.

2. Planning a teaching activity

We propose a learning activity to stimulate students' active learning by giving them partial exercise solutions so that they will have to complete the missing puzzles which are often keys to the problem. In this way, they will enhance their newly acquired concepts and learn to apply them in a theoretical setting without major frustration.

They will also be given opportunities to:

- Apply the methods to a concrete case relevant in one's field of study
- Revise and test their previous knowledge, gain insights or rectify potential fallacies from taking a step back

3. Prospects of implementation

On course day 10, the students are given a set of theoretical exercises along with problems extracted from past chapters and exam questions that were difficult. Partial solution sheets are available to help them getting started. The TA shortly explains the agenda, the tasks, and the purpose of this special form of the TØ session.

The students work in pairs or small groups. The TA provides them with tips and advice, but also checks on individual involvement and group progress.

Half hour before class dismissal, students enter the questions they found the most confusing to a Mentimeter survey and the TA clarifies the most voted ones in plenum teaching. The complete solutions are then uploaded to Blackboard.

Then the students are invited to think of a real-world application in their individual domain of expertise and try to tackle it in the light of the new methods. Volunteers are welcome to shortly present their rough ideas to their classmates without detailed computation or calculation.

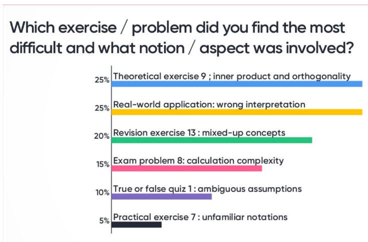


Figure 1: Mentimeter survey for students' inputs on difficulties and related domains (realistic layout but simulated result)

MAIN POINTS

1. **Main problem/challenge:** *Large classroom management to maximize participants' learning outcomes*
2. **Teaching activity**: *Alternating active thinking, theory & practice, and prior knowledge*
3. **How would you evaluate it?** TA's observation, students' feedbacks, online anonymous surveys, etc.
4. **What to do next?** *Customize the activity to students' need together with the lecturer*

After the class, the students fill in a survey in the form of tickets-out-the-door[1] to reflect upon the following items:

- What did you learn?
- Which knowledge did you reinforce?
- Which fallacies did you correct?
- How do you see the link of theories to the practical world?
- How was your learning experience?
- How do you evaluate the activity?
- …

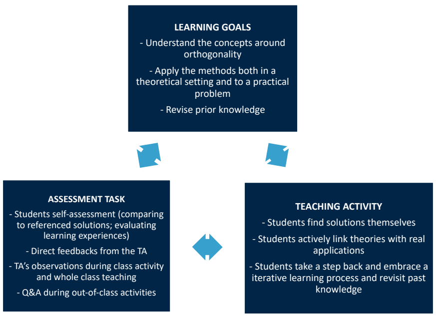


Figure 2: Constructive alignment

4. Looking forward

The evaluation of this activity will be based on:

- Attendance ratio
- Number of raised questions compared to previous sessions
- Evaluation surveys reflecting students' perceived learning outcomes, satisfaction level, attitude towards the new form of TØ
- TA's perceived strengths and weaknesses of the activity
- The acceptance of theoretical and revision questions indicate an possible optimum for combining the two

References

(1) University of Toronto. Active learning and adapting teaching techniques.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Beidi Li
Cyber-Physical System
Department of Engineering

Comprehending Western Blot

- An interactive learning activity

Learning Lab

Abstract: For inexperienced students at the beginning of their molecular medicine studies, laboratory protocol can often be hard to understand as they lack necessary hands-on experience and theoretical understanding. So in a method such as Western Blot it can be difficult to identify the right bands on the membrane and interpret the results.
In the laboratory exercises of Western Blot, a common confusion arises when the students have to detect several antibodies on different membranes. To prevent this, the students were presented with a modified strip sequence activity designed to help them understand the methods to analyze proteins works, and make them work on their own results. The teaching activity was generally evaluated as helpful by the students.

COURSE FACTS

- Course name: Molecular Cell Physiology 1
- Level: 2nd year Molecular medicine
- ECTS credits : 10
- Language: Danish/English
- Number of students: 33
- Your role: Lab instructor

TEACHING IN PRACTICE

1. Identifying a problem

The students participating in the laboratory course have a basic understanding of the molecular mechanism of Epithelial-Mesenchymal transition (EMT), but have no general experimental practice or practical experience with initiating EMT in vitro and detecting EMT markers (proteins) with Western Blot. It is essential for interpreting the results from Western Blot correctly to understand the technique itself, predict the size of the proteins of interest beforehand and how the expression of these proteins should theoretically change in cells that have undergone EMT.

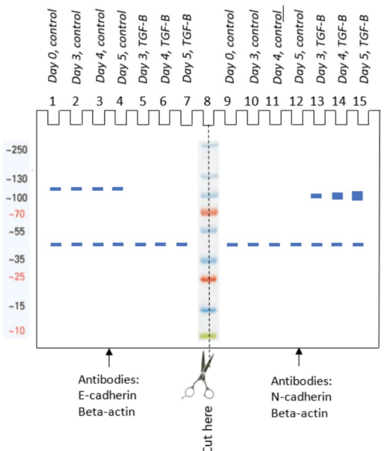


Figure 1: Western Blot membrane with "filled in band" illustrating the theoretical expression of E-Cadherin, N-Cadherin and loading control Beta-actin 3, 4 and five days after TGF-B treatment, as well as controls.

2. Planning a teaching activity

Based on the identified challenge described, a teaching activity consisting of a modified strip sequence was developed. The learning goals of the activity is to 1) make the students reflect about their EMT experiment and apply their theoretical knowledge 2) get an understanding of the Western Blot technique. After completing the teaching activity, the students will be well prepared to interpret their results consciously.

3. Implementing the teaching activity

The students will pair in their respective lab groups and discuss with one another what they expect to observe on their Western Blot membrane, loaded with protein lysates from cells stimulated with TGF-B to undergo EMT. Each group will then have to fill in bands (intensity and size) on a printed "membrane" *(Figure 1)* provided by the instructors. After finishing the exercise, the instructors will ask for volunteer groups to come to the blackboard and present for the rest of the class. Each presentation will be followed by a discussion in plenum.

To solve this exercise they need to read and learn about the particular proteins they are working with, which they also have time to do when the exercise is going on. Additionally, they have to make some predictions of protein expression levels during different conditions. So if the students can solve the exercise they show an understanding of the technique as well as the molecular mechanism behind EMT.

MAIN POINTS

1. **Main problem/challenge:** Lack of practical and theoretical experience with Western Blot
2. **Teaching activity:** Modified strip sequence to predict protein band sizes and intensities of EMT markers
3. **How did it go?** The activity was successful and helped the students to interpret their own results
4. **What to do next?** Consider improvements for future use of the exercise

4. Evaluation and future directions

A week after the lab course we had a follow-up class were the students were asked to give feedback on the teaching activity. Generally, the students found the activity helpful and it is our impression that the learning goals were achieved for the vast majority of students. They specifically found the discussion after the group presentation informative. Some students found that they had insufficient time to solve the exercise, as they had to do some research on the different proteins. For future use of this exercise the students could be asked to look up and read about protein changes in EMT beforehand.

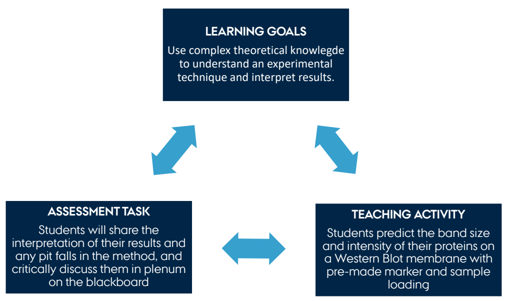


Figure 2: Constructive alignment of the teaching activity

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Marie Lorans and Sara Kobberø
UAØ and CO lab
Department of Molecular Biology and Genetics

A Show of Laboratory Etiquette

- Learning about the rules can be fun!

Learning Lab

Abstract: Laboratory teaching is a vital part of any course in molecular biology, since many concepts can be difficult to grasp without hands-on activities to support them. In fact, there is also a lot to learn about the Laboratory itself, since safety and correct handling of reagents and equipment are the key to not only a successful experiment, but also to a brilliant scientific career. Instead of reading about the rules, the students were shown a video about Bad Behavior. This teaching activity showed that students know most of the rules, but they appreciated seeing the video as a reminder before the course.

COURSE FACTS

- Course name: Fundamental Molecular Biology
- Level: 1st semester
- ECTS credits : 10
- Language: English
- Number of students: 180
- Your role: Lab instructor

TEACHING IN PRACTICE

1. Identifying a problem

Before every lab course, the students are introduced to lab safety rules. However, reading the rules beforehand might not be enough to keep every important thing in mind during the course. This is even more true for students, that are in the lab for the very first time. Having a quick and catchy reminder of the important safety rules acts firstly as an icebreaker and, more importantly, makes the students aware of the hazards and the good practices of handling them.

2. Planning a teaching activity

Based on techniques and rules that apply for a wide range of courses, we designed a script for a video, showing the misconduct of lab etiquette in a comical and exaggerated manner. The students attention will be drawn to finding all the obvious and hidden examples of bad behavior.
After showing the video, the students are asked to work in pairs and list all the mistakes they saw in the video.
After the video and discussion, the students are more aware of how to work in the laboratory. This activity helps achieve learning outcomes, by supporting the successful conduct of experiments in a safe environment.

3. Trying it out in practice

As the students are settled in their work stations and the introduction begins, the students will be shown the 3-minute video. After the video, the students are asked to discuss in pairs and then comment in a whole-classroom discussion. For the discussion, we prepared a presentation with screenshots from the video (Fig 1). The more obvious points (i.e lab coat, gloves) were easily identified, but some less familiar points had to be commented by the instructors.

Figure 1: **Instructional video.** Screenshot from the video, showing a mistake often made in laboratory – not keeping the enzymes on ice.

After the course ended, the students were asked to give feedback on the teaching activity and suggest improvements.

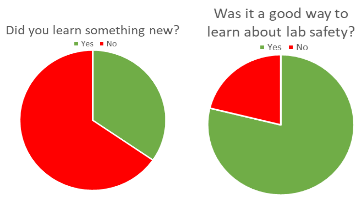


Figure 2: **Students' feedback.** Students were asked to evaluate the teaching activity – if they learned new information; if they thought the video is an effective way to learn.

MAIN POINTS

1. **Main problem/challenge:** Learning the rules of Lab Safety in an effective way
2. **Teaching activity**: Watching a video, working in pairs, classroom discussion
3. **How did it go?** Students liked the funny video, but were mostly familiar with the rules
4. **What to do next?** Improve the conduct of the teaching activity, by handing out rules, adding captions to the video

Most of the students were already familiar with the topics discussed in the video (Fig 2). The majority also agreed that the teaching activity acts as a good reminder of the rules, but might not be sufficient as a first source of learning.
The students mostly agreed, that the activity could be improved by handing out a Set of Rules at the end, which they could keep on their desks throughout the course.

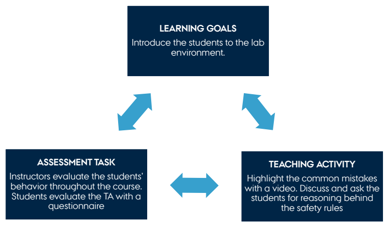


Figure 3: **Constructive alignment**
The aim of this teaching activity (TA) was to remind the students of the Lab Safety Rules. Students' learning was evident from their behavior in the lab. In addition, students gave feedback to the teaching activity.

4. Looking forward

Applying this teaching activity showed that students are mostly prepared before the lab courses. However, the activity is perfect as a reminder of the rules and acts as an icebreaker to open students for discussion.
Depending on the lab course, the teaching activity could be modified to include more/less discussion. In the future, I would like to include a Set of Rules, that would be handed out to the students at the end of the activity.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Johanna Luige
Molecular Biology and Genetics
Authors of the Teaching Activity:
Peter Kerwin, Line Marie Christiansen, Josephine Dannersø Nissen, Marie Lorans, Johanna Luige

Making main points stick!

- A teaching activity that aims to make all students remember fundamental concepts from curriculum.

Learning Lab

Abstract: In the lab part of the "Experimental Physics and Statistical Data Analysis" course, all of the students work in groups and the hand ins are also made in groups. It is therefore hard for the TA to know whether each individual student learns the required. The goal of the teaching activity is to solve this issue by exposing the students to a Flash Review where they have to answer questions based on fundamental concepts from the curriculum of the lab part of the course. The teaching activity will be implemented next time the course runs.

COURSE FACTS

- Course name: Experimental Physics and Statistical Data Analysis
- Level: 1st semester
- ECTS credits: 10
- Language: Danish
- Number of students: 24
- Your role: TA in lab part of the course

TEACHING IN PRACTICE

1. Identifying a problem

The students work in groups during all the laboratory exercises. The lab books that they have to hand in based on the conducted lab exercises are also made in groups. This work form makes it possible for some of the group members to do more of the work than other group members and as a TA it is therefore hard to estimate whether everyone learns the required since there are no individual assignments. The aim of the planned teaching activity is therefore to give all of the students an extra opportunity to become acquainted with some of the fundamental concepts that they should have learned during the course work.

2. Planning a teaching activity

As mentioned above, the learning goal of the teaching activity is to give students an extra opportunity to become familiar with some of the fundamental concepts that they should have picked up through the lab exercises conducted throughout the course. This will be done by carrying out the "Flash Review" activity where students will have to answer questions based on the curriculum belonging to the lab part of the course. After the activity has ended, we will go through the questions together in class so that everyone knows the answers to them.

3. Trying it out in practice

The "Flash review" activity will be based on a power point show consisting of slides with questions for central parts of the curriculum. Each slide takes 2 minutes, with one question on each slide, during which the students write down an answer. The students will sit together in groups of 2-3 persons so that they can discuss the answers to the questions together during the exercise. After the slide show, the TA walks around the class room and talks to the different groups to get an impression of how well the students did and what questions were the most difficult to answer and to assess the learning goal. In the end, the TA goes through all of the questions on the slide show together with all the students to make sure that everyone knows the answers to the questions. The teaching activity will take around 30 minutes and be carried out in the end of the class to help prepare the students for the next class.
The teaching activity will be evaluated by the students during the next class by passing around pieces of paper to each of the students where they have to answer whether the teaching activity made them feel more prepared for the following laboratory exercise. The teaching activity will be carried out next time the course runs.

Figure 1: Group work and discussion with TA [1].

MAIN POINTS

1. **Main problem/challenge:** It is hard to be sure that each of the students learn the required since all the assignments are made in groups.
2. **Teaching activity**: Flash Review.
3. **How did it go?** The activity will be carried out next time the course runs.
4. **What to do next?** This will be decided once the activity has been carried out.

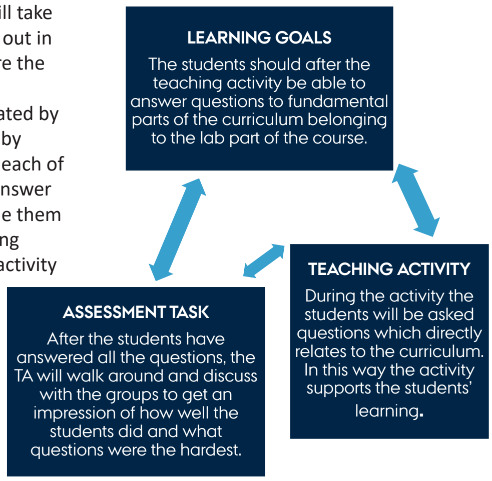


Figure 2: Constructive alignment.

4. Looking forward

I expect that the part of the exercise where we go through the answers to the questions all together will work well. Here the students will figure out which part of the curriculum they know the least about and hopefully this will be fixed by us going through the answers. It will be interesting to see whether this is true when the teaching activity has been carried out.

References

[1] http://clipart-library.com/group-work-cliparts.html

Henriette Elisabeth Lund
Department of Physics and Astronomy

Environmental models
- Rarely right, but sometimes useful

Learning Lab

Abstract: Scientific models can be an abstract concept. During the course River basin analysis and management the students will get acquainted with different models for predicting nitrate leaching. This is activity is a thought experiment, which seeks to increase the student's understanding of model limitation and uses.

COURSE FACTS

- Course name: River basin analysis and management
- Level: Master
- ECTS credits: 10
- Language: English
- Number of students: 8-12
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

During the course the students are taught about modelling and modelling concepts. Based on conversations with the students I made the observation that the students had some misconceptions about the limitations of environmental models. Another common problem occurs when one have been working with setting up and running a model for a long time. The user have forgotten that the model merely is a simplification of reality.
The students have to setup and interpret a model to complete exercises and the final report. The activity seeks to clarify what models are and guide the students into "model thinking".

2. Planning a teaching activity

The activity is a collective problem solving exercise. I want the students to solve a thought experiment by making a model. I will continuously ask questions and do a bit of explaining to guide them to the right path and introduce them to some of the worst pitfalls when creating a model. The problem solving involves minimal calculations and focuses on introducing thinking like a modeller and the limitations of models.

The problem I give the students is "How many tennis balls fits into a bus". This question was constructed to work with objects that everyone is familiar with.
They start out by giving their own estimate and I ask them about what kind of considerations they had in the process. We then devise a simple model by going through the steps in figure 1 and I continuously ask questions to make them think about what they are during. Example questions:

- What simplifications did we make and how do you think they affect the outcome?
- What data can we collect to improve the model?

3. Trying it out in practice

I have not had the opportunity to try out the teaching activity in practice as I am not teaching at the moment, but I made a detailed plan of the activity and it should take no more than 1 hour.
I did present my idea to a few people who does a lot of modelling and were predominantly positive in their responses. I am excited to try it out next year when I am a teaching assistant.
If it is a success I could use the method to explain some of the other subjects in the course.
I will asses the activity with a 1 minute assay at the end of the class. Herein the student will write about the most important points they gained through the activity.

MAIN POINTS

1. **Main problem/challenge:** Students are uncertain the concept of modelling
2. **Teaching activity**: Group and class discussion to solve a problem.
3. **How did it go?** Has not been implemented
4. **What to do next?** Implement it

If these do not match my intentions then I will have to revise my activity. The modelling work they do for their own report will also reveal if they got into "model thinking". But the competences displayed in the report does not necessarily come specifically from this activity, but could be gained from the rest of the course.

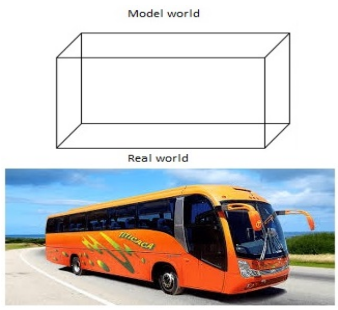


Figure 2. An attempt to illustrate differences between model world and real world. An important thing to remember when modelling.

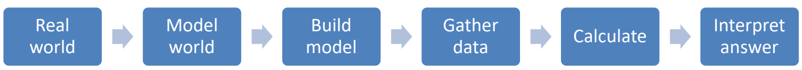


Figure 1. A schematic overview of how a model is created. The illustration is actually a model in it self. It is a conceptual model of the modelling process.

4. Looking forward

Modelling is only a simplification of the real world and is not going to give the answer in the back of the book. This is one of the most important lessons and I hope this will be one of the things that the students take with them from this teaching.

References

Doherty, J. (2011), Modeling: Picture Perfect or Abstract Art?. Groundwater, 49: 455-455. doi:10.1111/j.1745-6584.2011.00812.x

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Kim Schwartz Madsen
Climate and water
Agroecology

"Speed-dating" and problem solving

- Think, discuss, solve!

Learning Lab

Abstract: Biofabrication is a 10 ECTS point course that is divided in theoretical lectures and practical lab-exercises. In the end the students are going to plan and carry out a project under supervision of the TA. During Biofabrication the students are presented to a lot of different methods in the field of biomaterials. Furthermore, the students are presented to different biomaterials (natural, synthetic, etc.). In the end it might be difficult for the students to relate the different biomaterials, methods, etc. Finally, the students are on different levels in regards to both understanding the theory and in lab-experience. It can therefore be difficult to make sure everyone is on the same page before going to the lab. The teaching activity *"Speed-dating and problem solving"* is set out to minimize this issue! Here, the students are presented to a *flash-review* session (speed dating) followed by problem solving in groups.

COURSE FACTS

- Course name: Biofabrication
- Level: Master of Engineering
- ECTS credits : 10
- Language: English
- Number of students: 16
- Your role: TA/lab supervisor

TEACHING IN PRACTICE

1. Identifying a problem

Biofabrication is a course taught at the Department of Engineering at ST. The course is gaining more and more students every semester.

The lectures in Biofabrication is divided between theoretical lectures and practical lab-exercises. The students should hand in assignments after each exercise in the lab. Furthermore, the students have to plan and carry out a project in the end of the semester.

This means the students should have a good overview of the methods and biomaterials that has been mentioned during the course. The students should also learn how to behave in a lab and how to prepare for the lab exercises.

This can give rise to multiple problems: That not all students are active and the students will not be able to relate and discuss the topics. Furthermore, that the students are not prepared for the lab-sessions. Finally, that the student levels are so different that neither groups will gain knowledge from the lectures/sessions.

The aim is to establish a teaching activity that will allow all students to participate and gain knowledge. Furthermore, to ensure that the students can relate and discuss different methods in the field. Finally, the same teaching activity can also be used to prepare students to go into the lab.

2. Planning a teaching activity

The planned teaching activity will help activate all students. A *flash-review* will be implemented to make sure that the students will be able to identify methods and materials or steps in a protocol. This will ensure that all students have some level of knowledge about the given topic and can apply this knowledge, when writing assignments, planning projects and carrying out experiments. The students with a "deeper knowledge" will learn how to explain and communicate their knowledge to other students, while the students struggling with the topics will gain knowledge.

After the *flash-review* the students will be divided into groups, where they will be discussing given problems. Based on the topic, the problems will be related to the application of methods/biomaterials or solving a *strip-sequence* with the steps of a lab protocol. Finally, groups will be selected to present their answers.

Depending on the follow-up to the flash-review the teaching activity can be implemented in the beginning of a course (*strip-sequence* with lab-protocol) or in the end of a course (*problem solving* in regards to application of methods/biomaterials).

3. Trying it out in practice

The teaching activity will be carried out as described in section 2: "Planning a teaching activity". Whether the students have benefitted from the teaching activity will be observable, when supervising the problem solving, when they are handing in assignments and when they carrying out lab-experiments.

The teaching activity will be evaluated by the students to ensure they benefit from the activity. If not, the teaching activity will be revised. A way to assess the teaching activity is using a ticket-out-the door approach, where the students have to answer questions about the teaching activity.

Example: Rank the following statement(s) from 1-5 (1 being the lowest, 5 being the highest)

I found the teaching activity useful.

1. 2. 3. 4. 5

MAIN POINTS

1. **Main problem/challenge:** Getting the students to relate and discuss different methods and biomaterials. Furthermore, to make sure the students are all on the same page before entering the lab!
2. **Teaching activity**: "Speed-dating and problem solving" (Flash-review and think-pair-share/strip sequence in groups)
3. **How did it go?** I have not been able to implement the teaching activity yet.
4. **What to do next?** Implement the teaching activity and get feedback from students.

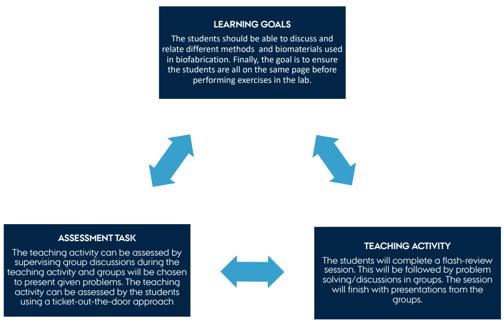


Figure 1: **Constructive alignment**

4. Looking forward

The teaching activity described on this poster will be implemented in Fall 2019. Biofabrication is a course that is growing and every year more students are following the class. After the implementation of the teaching activity the students will be asked to evaluate the session. The evaluations will help us understand if the students benefitted from the activity or if a change is needed. Based on the student evaluations the teaching activity will be optimized for future use (potentially with a larger class).

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Sara Seidelin Majidi
Nanofiber Technology and Cellular Engineering
Department of Engineering/iNANO

Getting theoretical concepts out of the classroom & onto the farm – Application of principles governing mechanical weed control.

Learning Lab

Abstract:

Many on-farm variables influence the implementation and efficacy of mechanical weed control strategies. For example, it is impactful which crops the farmer grows, whether the farm is conventional or organic, if soils are clay-based or sandy, if the farm has herbicide-resistant weeds, and if problematic weeds are perennial or annual, deeply-rooted or shallowly-rooted, grass or broadleaf species. It is essential that Agroecology students not only learn about the theoretical principals influencing mechanical weed control in the classroom but that students also understand how to apply this information in real-world situations. A teaching activity is proposed, in which groups of students will be given a fictitious on-farm scenario; students must work together to resolve the farm's weed management problems while relating to and referencing new information they have learned about in assigned readings and during lecture. The teaching activity will be implemented in the Autumn semester of 2019. Improvements will be made to the activity based on teacher observations and student feedback.

COURSE FACTS

- **Course name:** Crop Pest Biology and Management
- **Level:** Master
- **ECTS credits :** 10
- **Language:** English
- **Number of students:** 10-30
- **Your role:** Teaching Assistant (TA) responsible for giving a lecture on the topic of: Mechanical Weed Control.

TEACHING IN PRACTICE

1. Identifying a problem

The prevailing methodology used to teach new information is through lecturing and the assignment of relevant readings. We know, however, that when students practice applying and relating to new information, their understanding of concepts is strengthened.

It is easily argued that in the field of Agroecology, active application of key concepts is especially important. The on-farm experience of students is often limited, but it is critical that students relate to and understand the real-world challenges faced by farmer constituents.

We aim to improve course alignment and student learning by getting students to applying theoretical concepts to resolve real-world on-farm challenges relating to weed management.

2. Planning a teaching activity

Throughout this course, students are typically asked to memorize theoretical principals influencing weed biology and management. During the final exam, students must recall and recite learned information, apply concepts they have learned, assess theoretical situations, and consider the risks and benefits associated with different weed management strategies.

By implementing a teaching activity where students actively apply the new information we aim to: (i) improve student's understanding of those key concepts governing mechanical weed control, by having them relate to what they've learned; (ii) have students gain a better understanding of those the challenges farmers face when integrating mechanical weed management practices in on-farm situations; and (iii) improve student's performance during the final exam by aligning in-class activities with the assessed learning outcomes.

3. Trying it out in practice

Following a lecture on mechanical weed control, the TA will organize students into groups of three. A fictional farm profile will be distributed to each group of students. Farm profiles are deliberately crafted to characterize different weed problem scenarios, relevant to the application of those theories and principals addressed in the course day's reading and lecture. The farm profile will include the following information: those crops grown on the farm, the biology of their problem weed species, and the farm's existing weed management plan.

Students will be instructed to first think individually about how the mechanical weed control strategies discussed may be applied to better control for those problem weed species on their farm, thus improving the farm's existing weed management plan. After thinking independently, students will be asked to share their ideas within their group. Groups will be instructed to work together to come up with a collective plan for integrating mechanical weed control strategies on their farm. Groups will later share their plans with the class. During group work, the TA will travel among groups, providing feedback, and fielding questions. When students share their plans with the class, other groups, and the TA will be allowed to ask follow up questions and make additional suggestions.

MAIN POINTS

1. **Main problem/challenge:** Students rarely have the opportunity to apply theoretical information to resolve real-world on-farm problems.
2. **Teaching activity:** Students will think-group-share about how to best integrate new mechanical weed control practices into existing weed management plans.
3. **How did it go?** The teaching activity will be implemented in the Autumn of 2019.
4. **What to do next?** Improve the teaching activity based on teacher and student assessments.

4. Student and Teacher Assessment

After the activity, the TA will provide a brief oral assessment on their perception of how the teaching activity went. To end class, students will also assess the teaching activity and the TA, by completing a quick survey that they will hand over to the TA on their way out of class. This assessment will serve as each student's "ticket out the door" (Figure 1).

TICKET OUT THE DOOR

(i) Did you enjoy today's activity, and did you find it to be a helpful learning activity? Please explain your answer; your comments will be used to improve the class.

(ii) Do you have any remaining questions about mechanical weed control that were not answered during today's class? If so, please list them here, they will be addressed next class.

Figure 1. **Ticket out the door.**

5. Looking forward

This teaching activity will be implemented during the Autumn semester of 2019. After the activity has been implemented, the TA may choose to make improvements by altering materials or the activity's structure. Teacher observations and student feedback will be used to improve the teaching activity for future applications.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Margaret McCollough
Department of Agroecology
Crop Health Section

Spectra skill level

- An identification of theoretical experience.

Learning Lab

Abstract: A part of doing organic chemistry is to solve spectra. To ensure that students are solving spectra correctly, it is necessary find their level, and build on top of their knowledge. This was solved by implementing Jigsaw Reading in class. Following, the learning activity was evaluated by the ticket out the door activity and student feedback. The learning activity resulted in a better basic knowledge of spectral methods, which was illustrated by the answers on the tickets and the students' approach to solve spectra.

COURSE FACTS

- Course name: Organic chemistry I
- Level: Bachelor course
- ECTS credits : 10
- Language: Danish
- Number of students: 18
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

Knowing your students' level in the topic you are going to teach is essential for the success of the teaching. Even though, the course prerequisites should ensure that the students have the relevant knowledge, this is often not the case.
Therefore, doing this teaching activity the students' spectra skill level will be identified, so more knowledge can be added over time.

2. Planning a teaching activity

The course learning outcomes request the students to describe and interpret spectra. This activity should help the students to understand basic theoretical principals of NMR, IR, and MS. This will facilitate the interpretation of experimental data. Thus, the purpose of the activity is to ensure that everybody in the class is familiar with these basic principles.

To obtain the goal a Jigsaw Reading is prepared. This learning activity requires that everybody participates, and thereby results in a high activity level among the students.

To asses if the students have learnt something, a ticket out the door, concerning the discussed topics, will be handed out and collected in the end of the class.

Thus, the whole activity will be evaluated by considering; the students' work, their answers on the tickets and their personal opinion. The constructive alignment of the teaching activity is illustrated in Figure 1.

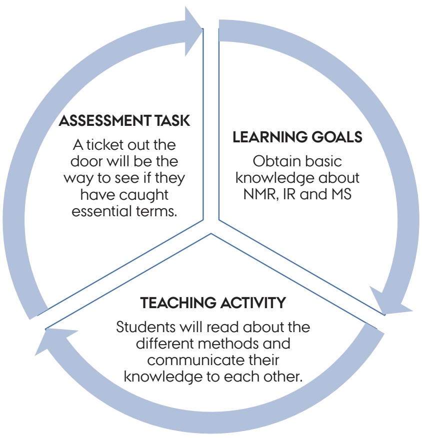


Figure 1: **Constructive alignment**

MAIN POINTS

1. **Main problem/challenge:** Identify the students' skill level
2. **Teaching activity**: Jigsaw Reading
3. **How did it go?** The students was really positive about the exercise and the activity went successfully.
4. **What to do next?** As I have identified the students' level of knowledge I will be able to build on top of it.

3. Trying it out in practice

The teaching activity consisted of Jigsaw Reading and a ticket out the door (Figure 2).
The class was split into groups of 4. Then each group was provided with information about a specific topic. Each group had 40 min, to read and discuss the topic. Following new groups were formed and they had 5 min each to present the methods for each other. Half trough the teaching students were given a ticket with two questions related to the topics. To get out of class they had to answer these.

From listing to the talks around the tables and reading the tickets it was clear that they got a better understanding of how spectra look as they do. However, some students only answered shortly on the questions. In general, the activity was quite successful.

4. Looking forward

The student met the challenge with an open mind. Everybody participated, as they had to become experts. In general, the activity worked out as it was supposed to do. To optimize the activity more focus should be put on NMR, as few MS spectra are used. This will align the teaching with the overall learning goals. Furthermore, some of the questions on the tickets should be modified as several students only gave short answers. By optimizing these parameters this activity can be used for future organic chemistry teaching.

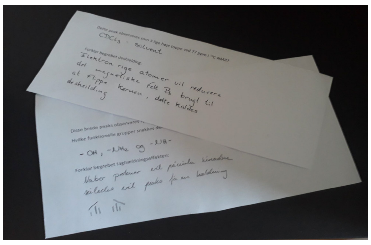


Figure 2: **Tickets out the door**

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Ditte Juhl Mogensen
Ogilby group
Department of Chemistry

AquaCrop and Climate Change

- A mind-map of acquired knowledge

Learning Lab

Abstract: In order to predict the variables in an agricultural system, it is crucial to assess different climatic scenarios. Modelling with AquaCrop, as a simple water balance model, is the perfect tool to implement different scenarios and to analyze the output during the "Climate Change Science" course. The course was divided in 2 main parts of theory and practice. Prior to the hands-on exercises, it was crucial to understand the students' background and acquired knowledge in the specific subject during the theory part of the course. To meet the need, mind mapping was chosen as the teaching activity which was highly beneficial and useful. Students were able to organize all their knowledge and come up with keywords and later connected them to create a mind map, which also helped the teachers to arrange the exercises and form the suitable groups.

COURSE FACTS

- Course name: Climate Change Science
- Level: PhD
- ECTS credits : 5
- Language: English
- Number of students: 25
- Your role: Facilitator

1. Identifying a problem

A course that has twenty five students with many different backgrounds, makes it hard to find an efficient way of designing the practical or hands-on modelling exercises. This part, highly depends on their previous knowledge and background as well as what they acquired during the theoretical part of the course. Furthermore, it is essential to assess their knowledge right before the hands-on part of the course in order to form right groups with at least one student who has more information and to recap what they have learned during the lectures.

2. Planning a teaching activity

In order to collect all the previous knowledge from the students and to assess if they remember the most important factors in crop modelling and climate change, mind mapping is the best teaching activity that needs the active participation of students and would emphasize the essential points.
In this activity the students will be asked to form groups of five and they will be given an A2 paper and different color markers. Everyone needs to come up with one word which could be an important concept or factor in climate change modeling and they should connect these words on the paper. Later each team will present the mind map.

3. Trying it out in practice

Based on a suggestion from the students, in order to save paper and to create an environmental friendly mind map, all the groups worked on their own design in PowerPoint, which also made it easier to present afterwards. Most of the groups created two different mind maps under the umbrellas of "climate change" and "AquaCrop" separately. Groups were assessing each other's mind maps and were providing feedback right away which enabled the teacher to interact and fill the missing points.

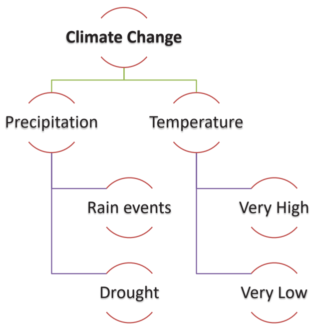


Figure 1: A mind map for the concept of Climate Change created by PhD students.

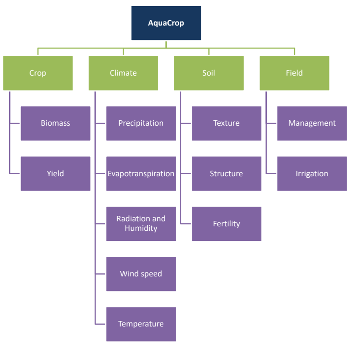


Figure 2: A mind map for the concept of AquaCrop created by PhD students.

MAIN POINTS

1. **Main problem/challenge:** Understanding the background and acquired knowledge of students prior to the hands-on exercises
2. **Teaching activity**: Mind mapping
3. **How did it go?** It was beneficial for both the students and the teachers to assess the effectiveness of the theoretical part of the course
4. **What to do next? A** feedback session from the practical part

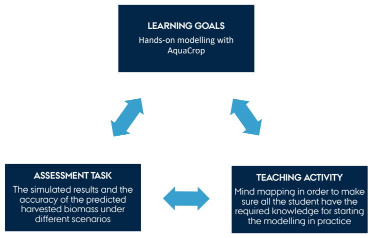


Figure 3: **Constructive alignment**
Based on the teaching activity, it was obvious that the students learn a lot during the theoretical lectures and are ready to implement their knowledge in practice. At the end of the course, the students should have been able to simulate the yield under different climate scenarios and to predict the harvested biomass. Evaluation of the results shows a very high accuracy which indicated the success of the used teaching method and activity.

4. Looking forward

Based on the results of the simulations, the teaching activity helped the student to generate the most important concepts in modelling. It would be very important to gather the feedback in order to signify the strength and weaknesses of the course according to the students' point of view.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Saghar Motarjemi
Agroecology

From data to microbial growth

- Essential MS Excel skills to quantify metabolic growth

Learning Lab

Abstract:

Quantifying microbial growth is essential in microbiology. Bachelor students often have limited experience with data analysis in Excel and do not know how to transform data to visual results. Therefore, students will use a written tutorial to train this skill. Once implemented, the tutorial will give the students more time to reflect on the interpretation and discussion questions related to the laboratory exercise. Feedback can ensure that students are provided with the necessary tools to conduct basic microbial experiments, analyse and interpret the results in a broader biological context.

COURSE FACTS

- Course name: Microbiology (Bioscience)
- Level: Bachelor
- ECTS credits : 5
- Language: Danish
- Number of students: 50-60
- Your role: Laboratory assistant

TEACHING IN PRACTICE

1. Identifying a problem

The majority of bachelor students have limited experience with data analysis in Excel. The imposes a big challenge for them as one of the major learning outcomes is that they have to learn how to describe microbial growth using empirical data obtained from the laboratory.

Several attempts have been implemented since I first started teaching the course, such as the implementation of an “Excel bootcamp” and time is allocated to help the students with data analysis. However, in spite of the this, my experience is that not all students are reached and they still have difficulties analysing the data.

I would like to improve this by making a tutorial, where I go through the calculations and functions in Excel. In this way the students can “scroll” back and forth and take the time they need to understand the calculations.

2. Planning a teaching activity

The teaching activity is a written tutorial that will help students analyse the microbial data obtained from the laboratory exercise. The tutorial will give the students the necessary tools to obtain the figures describing microbial growth and metabolism.
The implementation of the tutorial will give the students more time to discuss and interpret the results while at class instead on merely focusing on getting the correct figures for the report.

3. Trying it out in practice

The students are given a brief introduction on how to analyse the data where after they work with the data themselves in groups. At the end of the first class the students are asked to evaluate by dot query on the black board based on three levels of understanding (See figure 1).
Prior to the second class the tutorial is uploaded to blackboard and made available for the students. The students are given time to work with data and are encouraged to discuss and interpret the results in relation to the discussion questions related to the laboratory exercise. At the end of the class the students are again asked to evaluate the learning outcome using the dot query scoring system.

A final evaluation is also provided based on the quality of the reports and will be scored based on whether the students improve their ability to:

1) Obtain the correct figures (See figure 2).

2) To answer discussion questions related to results.

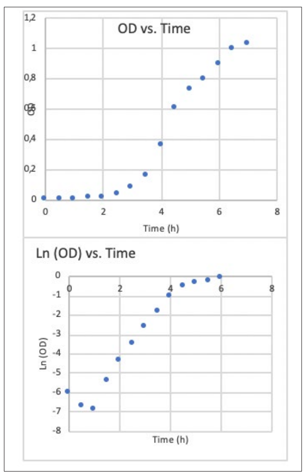


Figure 2: Microbial growth over time

MAIN POINTS

1. **Main problem/challenge:** Students have limited experience with data analysis in Excel.
2. **Teaching activity**: Written tutorial
3. **How did it go?** Not implemented yet.
4. **What to do next?** Implement teaching activity and evaluate learning outcome based on dot query and report quality.

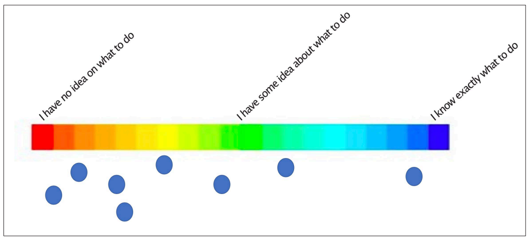
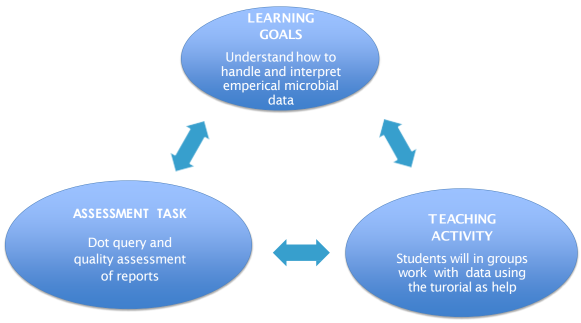


Figure 1: Dot query evaluation system



4. Looking forward

The teaching activity is still to be implemented, but since I have taught this course three time I am certain that the tutorial will work. I expect that the students will perform better and produce reports of better quality, as they would have more time for reflection and critical thinking.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Seven Nazipi
Section for microbiology
Department for Bioscience

CUDA Programming
- Connecting the Concepts

Learning Lab

Abstract:
The interplay between hardware architecture and how a program is written has a large impact on performance when writing CUDA code. This is very different from CPU coding and a challenge students have to overcome and master. A mindmap exercise is developed to help the students practice this interplay and let them observe CUDA programming from a birdseye point of view.

COURSE FACTS

- Course name: CUDA programming
- Level: Master/PhD
- ECTS credits : 0
- Language: English/Danish
- Number of students: 1-20
- Your role: Lecture

TEACHING IN PRACTICE

1. Identifying a problem

The interplay between hardware architecture and how a program is written has a large impact on performance when writing CUDA code. This is very different from CPU coding and a challenge students have to master to reach maximum performance of their GPU.

2. Planning a teaching activity

To help students get an overview of how to take hardware architecture into account when writin code, a mindmap exercise is developed. The students will be given the connections as verbs and will have to find nouns to be connected by their given verbs. They will have to connect the different hardware types, but also connect code bits with the hardware type that affects the given code the most.

3. Trying it out in practice

As the course is starting in september I have not performed the exercise yet. Before performing the exercise I will be producing the connections and the code bits that will be given in the exercise.
When doing the class is divided into groups where each group will produce a mind-map. I will be circling the room and observe/give feedback on the progress. When the mind-maps are finished we will share the maps between the groups and discuss the solutions and what they might have missed

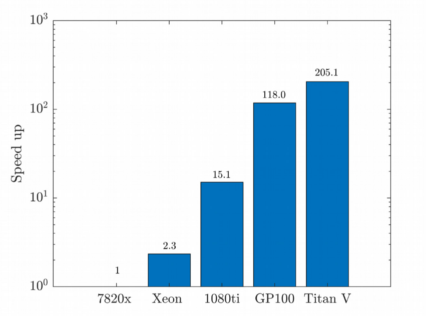


Figure: Speedup of different GPU's and CPU's running the same code

LEARNING GOALS
Learning how to write CUDA code which utilizes the hardware of the GPU to achieve maximum performance

ASSESSMENT TASK
We will be reviewing solutions to problems each week and also by doing the exercise twice and comparing mind-maps.

TEACHING ACTIVITY
The students will get a birds-eye view of the concepts and connecting code and hardware that has an impact on the code bit.

MAIN POINTS

1. **Main problem/challenge:** Take into account how hardware affects GPU performance
2. **Teaching activity**: Mind-Map exercise
3. **How did it go?** Not yet implemented
4. **What to do next?** Implement it

4. Assesment

Students will solve problems each week during the course which will be reviewed on class together. Looking at the solutions we will be able to see the progress.

By doing the exercise early in the course and one again later, we will also be able to compare the early minc-map and the later one, which might help the students see their own progression.

4. Looking forward

I am looking forward to implementing the exercise and I think that doing the exercise twice and let the students watch their own progression will be interesting.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Christian Flohr Nielsen
CERN-NA63
Physics and Astronomy

Relating concepts across topics

- Recapping curriculum and interconnecting the course material

Learning Lab

Abstract: Relating concepts across different topics is often a challenge when topics are covered on a week-by-week basis throughout the course. In this exercise I tried to encounter this using student discussion and presentation. Evaluations were mixed tilting to the positive side, but alternative approaches should be tried.

COURSE FACTS

- Course name: Fundamentals of Organic Chemistry
- Level: 1st year bachelor
- ECTS credits : 5
- Language: Danish
- Number of students: 85
- Your role: TØ instructor

TEACHING IN PRACTICE

1. Identifying a problem

In this course we cover a new topic within basic organic chemistry every week. Topics could be naming and identifying compounds, reactions of aromatics, or resonance structures. A challenge is that students often miss how the different topics are inter-connected.

2. Planning a teaching activity

With this teaching activity I have tried to solve part of this problem, by highlighting some key concepts. Five slides were prepared each showing two key concepts. For each slide the students discussed for 3 minutes in groups of 3-4 people, how the two concepts were related. For 2 minutes after that one or two group presented their answer to the class.

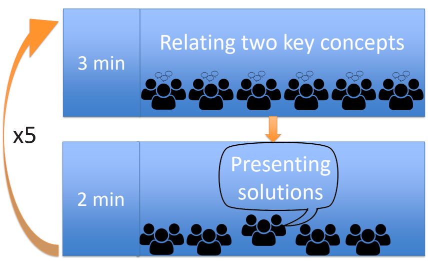


Figure 1: **Structure of the Teaching activity**
Quick figure showing the basic structure of the teaching activity.

3. Trying it out in practice

The teaching activity was easy to conduct though the students often needed hints to get started. This sometimes conflicted a bit with the format of discussing in small groups as I couldn't help all groups in the short three-minute time span. The exercise can easily be extended or varied to fit different topics, by simply changing the slides.

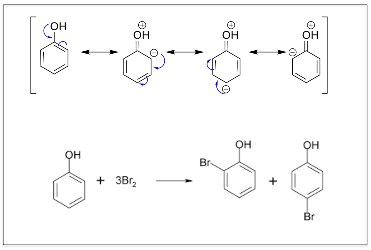


Figure 2: Slide example. Find the connection between the resonance shapes of phenol, and its orto/para directing.

4. Student evaluation

Students evaluated the exercise on a simple three-step axis as shown on the right, and they were encouraged to leave comments on the ticket-out-the-door slip. Examples of most common comments:

"The exercise was good. It is easier to see the connection between things now" – Student 1

"Good idea, but it could have been done by just explaining it" – Student 2

MAIN POINTS

1. **Main problem/challenge:** A new topic is covered each week, but students often miss how different topics are related.
2. **Teaching activity:** Two concepts from different weeks was shown on a slide and students had to work out in small groups how they are connected.
3. **How did it go?** Students figured out how concepts are related. That was popular, but many pointed out that we might as well have just talked about it, or done it as a recap lecture.
4. **What to do next?** Keep the end-of-semester recap, but consider if the format is the best one.

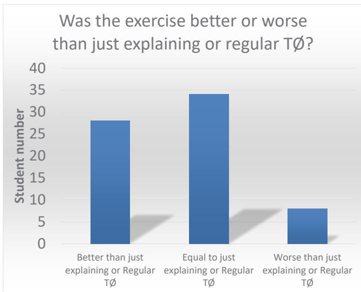


Figure 3: **Evaluation result**
This figure Shows the result of the three-step ticket-out-the-door evaluation.

5. Looking forward

This exercise was a success as an end-of-semester recap and fun exercise. However based on student comments it should be considered if this is the best format. Many commented that it would be easier to just present the correlation between topics, or give hand-outs explaining the relations that the teaching book is missing.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Jonas Palle
Biological and Bioinspired Materials Group
iNANO

The *One-sentence-summary* challenge

Abstract: During laboratory exercises, the students are putting most energy in executing the lab-protocol step-by-step and have little mentally surplus to comprehend new theoretical knowledge or to reflect upon the analytical steps during the exercises. The presented teaching activity handles this particular obstacle via *One-sentence summary*, which challenges the students to answer questions related to the principles of technique, and ultimately provides the students an opportunity to expand their levels of reflections when doing lab-work. The final outcome is then a self-defined One-sentence-summary of the applied analytical technique, by which the students combine theoretical knowledge and practical work.

COURSE FACTS

- Course name: Fødevarer på molekylært niveau
- Level: Bachelor
- ECTS credits : 10
- Language: Danish
- Number of students: Varies (last year 10)
- Your role: Teaching Assistant in lab

MAIN POINTS

1. **Main problem/challenge:** Learning students about theoretical principles behind analytical methods during lab-exercises
2. **Teaching activity**: Combined Think-pair-share and One-sentence summary of the applied technique following both a short lecture and practical experience
3. **How did it go?** Not implemented yet

TEACHING IN PRACTICE

1. Identifying a problem

The tunnel-sight

During laboratory exercises, some students have their sole focus on **finishing and completing the exercise as soon as possible**. The **students utilize** most of their **attention** on just **following the instructions on the protocol**. However, in order to enhance the students' understanding of a topic, they must be able to **relate theoretical knowledge to laboratory work**. The lab-minded tunnel-sight can therefore **counteract the students learning capacities** when executing the protocols.

To combat this as a teaching assistant, one can create time for student reflections via *One-sentence-summary* - constructed of inherently curious questions beginning with *What does what to whom, When, Where, How, Why*?

2. Planning a teaching activity

The **goal** of this teaching activity is to force the students to reflect on a specific topic, combine the theoretical knowledge with practical work and finally communicate their understanding via **a simple reflective activity**.

Students are **first** introduced to theoretical knowledge, **then** introduced to practical experience in the matter, and **lastly** forced to reflect upon what has just been introduced to them and the practical work in order to construct a One-sentence-summary. **Ultimately, the tunnel-sight of the students is obviated**.

Expected learning outcomes of teaching activity

To understand the principles behind the analytical technique applied to a relational level (Figure 1)

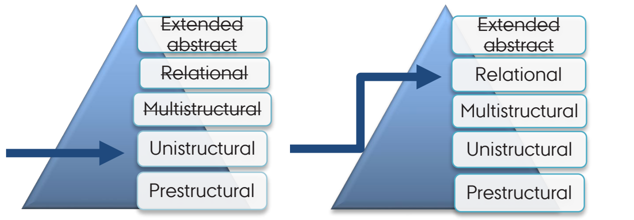


Figure 1: Left: Students' level at SOLO taxonomy during laboratory exercises beforehand, Right: Learning goal for student understanding after laboratory exercise and teaching activity

3. Trying it out in practice

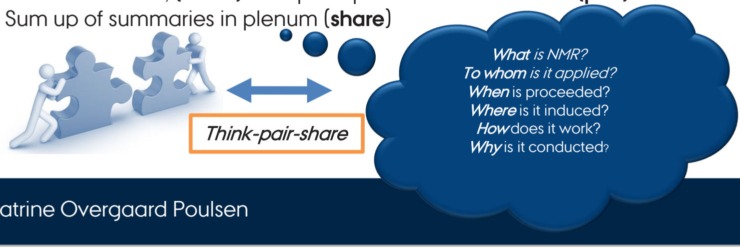
This activity has not been implemented yet

The teaching activity consists of One-sentence-summary and Think-pair-share. Generally, this activity is a **versatile**, **flexible and easy-go-to activity** during lab exercises.

The activity proceeds as followed:

Teaching activity

1) Having the usual lecture for the students during lab-exercises (here specifically on nuclear magnetic resonance, NMR)
2) Letting the students continue to the NMR exercise
3) Implementing a *One-sentence-summary (OSS)* exercise while waiting for analysis. This is constructed as *Think-pair-share*, where the students first construct an OSS, (**Think**) then pair up with another student (**pair**)
4) Sum up of summaries in plenum (**share**)



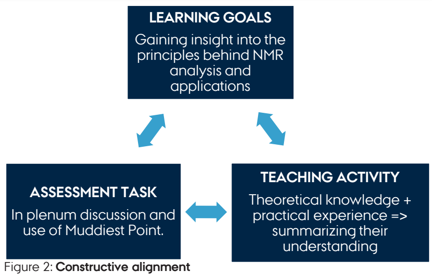


Figure 2: **Constructive alignment**

4. Looking forward

What ifs....

- Some students are not able to comprise principles in One-sentence summary?

⇒ *Allow for longer sentences, work out a shared summary on class*

- Some students missed the point?

⇒ *Discuss possible pit-falls and encourage them to elaborate when answering the Muddiest point (Fig. 2)*

Katrine Overgaard Poulsen

Method Matching

- Get a quick overview before the oral exam

Learning Lab

Abstract: At oral exam you are expected to demonstrate a broad overview and be able to relate the different topics to one another. However, the lectures and problem solving often focus on one topic at a time and therefore you do not practice this skill. This challenge will be addressed in method matching, which involves: i) Students do a flash review of relevant topics, ii) TA poses a broad problem that involves several aspects of the course, iii) Students have to asses how each topic can be applied to the problem, iV) Class discussion of solutions. The students really enjoyed the exercise and found it useful for when they have to prepare for the exam on their own. In there future, it could be used for the Q&A session with the instructor. 25/26 students felt that had gained a better overview of the course!

COURSE FACTS

- Course name: Structural Chemistry IIb: Biophysical Chemistry
- Level: 4th semester
- ECTS credits : 10
- Language: Danish
- Number of students: 16 and 10
- Your role: TA in problem solving

TEACHING IN PRACTICE

1. Identifying a problem

In this course, you will learn about many techniques – up till 5 techniques per week. At the exam, you do not need to know all the details. Instead the focus is on seeing the bigger picture and relating the techniques to each other. Because of these many techniques, it can seem daunting for students to gain this overview. This activity aims to help the students gain an overview of the techniques and practice relating them to each other.

2. Planning a teaching activity

Starting from this problem, we wanted to develop a teaching activity that 1) Does a quick recap of each of the techniques and 2) Create a setting where students can practice relating the techniques to each other to solve a problem.
In the first part, the students do a flash review where they only get one minute per technique. In this way, they cannot go into too much detail, but are forced to just state the most important points. Afterwards, the students split in groups of four and are given paper strips with each of the techniques. The TA will then pose a broad question on the next slide, and the students now have to asses whether the technique can be used for this particular problem. Finally, one group presents their solution which is discussed on the class together with other possible solutions.

3. Trying it out in practice

In the first part of this teaching activity, the students are asked to stand on two lines facing each other. They will be presented with a powerpoint that contains one slide per technique. They have one minute to discuss the technique. The TA will have a stopwatch to monitor the time. When time is up, the TA asks the last student in one row to move to the back of the row and thereby everyone gets a new partner for the next discussion. The slide changes to the next technique. This continues until all the techniques have been discussed (Figure 1).

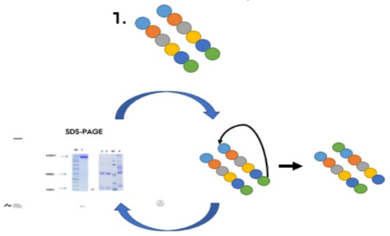


Figure 1: An overview of the first part of the teaching activity with an example of a slide from the powerpoint. Each of the circles represent a student.

Then the students are split in groups of four and given paper strips with the names of the techniques together with headlines "Can be used" and Cannot be used". The next slide will provide a simple example of how to use the headlines and paper strips (Figure 2). The last slides contain some broad questions were it can be difficult to place the paper strips in one or the other category. In this case, the students are encouraged to put them between the two categories and argue for why and why not it can be used. Finally, one group presents their solution and it is discussed on the class.

MAIN POINTS

1. **Main problem/challenge:** To get and overview for the oral exam.
2. **Teaching activity**: Flash review and assessing the relevance of the techniques for a particular problem.
3. **How did it go?** Good. The students felt they got a better overview and want more of it.
4. **What to do next?** Maybe use it for Q&A before the exam.

EXAMPLE

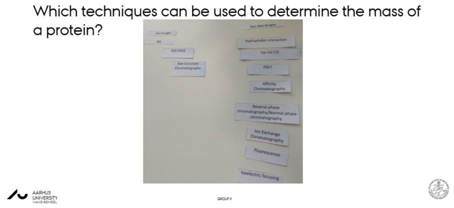


Figure 2: An example of a question using paper strips.

The activity was assessed using "ticket out the door". The students really liked the exercise. It did give them a better overview, as it set out to do, and they would like to have more of this kind of exercise (Figure 3).

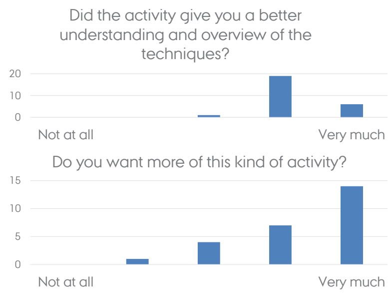


Figure 3: Student evaluation of the teaching activity.

4. Looking forward

The students really liked the activity and felt that they got a better overview of all the techniques, which was the primary goal when designing the activity. As all students had made their own solution in groups they were more willing to question the presented solution and come up with counterarguments, which gave rise to a very good class discussion. In this semester, we will do the activity again for the Q&A as an alternative way to go through the most important techniques and understand their applications.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Helena Østergaard Rasmussen
Soft matter group
iNANO

Encouraging passive students to involve in plenum discussions
- Fish bowl technique

Learning Lab

Abstract: It has been identified that some students often do not engage in active discussions regarding the unclear concepts and exercises in the class. The fish bowl activity provides a safer background for shy, passive students to ask questions from their peers and TA and to receive feedback. It is especially useful in larger classes having intensive exercises, as there is higher probability for passive students to be left behind. This activity promoted student participation in critical questioning, peer discussions and feedback which was obvious through students' final feedback/evaluation of the activity.

COURSE FACTS

- Course name: Quantitative Animal Nutrition and Physiology
- Level: MSc
- ECTS credits : 10
- Language: English
- Number of students: 25
- Your role: Teaching assistant

TEACHING IN PRACTICE

1. Identifying a problem

There is a higher probability for active learning students to dominate in the class, due to heavy workload and limited time. Therefore, the issue would be to motivate the passive students to be engaged learners, without compromising the opportunities available for the already active students. The aim would be to ensure that both groups of students have the similar opportunities in giving and receiving feedback.

2. Planning a teaching activity

The activity will promote the active engagement of the passive students in discussions. The students would be divided into 5 groups and they have to write questions arising from lecture and exercises and deposit in a bowl. These questions will be discussed among students and TA. At the end student assessment will be done using minute papers. Teaching activity will enhance questioning, critical thinking and reasoning of course material.

Figure 1. Fish bowl technique allows students some anonymity while providing them with an opportunity to receive feedback from TA

3. Trying it out in practice

After a short introduction to the lecture, few minutes were spared to explain the intended teaching activity – **Fish bowl** technique. Students were offered with **index cards** and a bowl for each group. After the lecture students had ten minutes to write their questions. Thereafter, they started with group exercise (i.e. case study) while the TA read their questions. After 40 min of group exercise a break was given. After the break 25 min were used for discussing the questions arouse from fish bowl. First, these questions were forwarded to the students and created opportunity for **group discussions**. TA involved in the discussion, if students' interpretations were wrong. At the end of class **minute papers** were used to assess student understanding on intended learning outcomes. As a last effort, the students were asked to evaluate the activity by answering different questions through **mentimeter.com.**

MAIN POINTS

1. **Main problem/challenge:**
   - ❖ The course structure is very intensive hence passive students could be left behind
2. **Teaching activity**:
   - ❖ Use of fish bowl technique to increase student participation in group discussions and active learning
3. **How did it go?**
   - ❖ It worked fine according to increased student participation, minute papers and final evaluation
4. **What to do next?**
   - ❖ Adjust and implement the teaching activity during future lectures of this course.

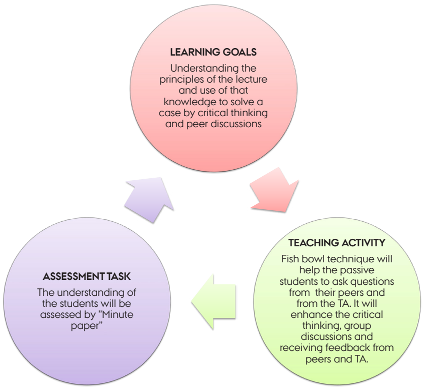


Figure 2: Constructive alignment of the teaching activity

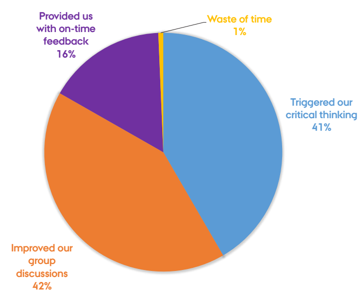


Figure 3: Final evaluation/feedback from the students, regarding the usefulness of the teaching activity to improve their knowledge

4. Looking forward

The student participation in discussions was high, probably due to the anonymity in asking questions and the opportunities for peer feedback. Minute papers indicated that student understanding on targeted concepts were increased. However, this teaching activity seemed time consuming. Therefore, prioritized, limited number of questions were discussed in the class and the remaining questions had to be posted as discussion threads in the blackboard. The next step would be to combine this with an activity like structured problem solving, in order to promote critical thinking and presentation skills.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Bhagya Samarasinghe
Animal nutrition and physiology
Department of Animal Science

Accessing scientific literature

- From being puzzled to solving the puzzle

Learning Lab

Abstract: Especially for students it is important to learn, how to systematically dissect and understand scientific articles. Within a Journal Club jig-saw-reading was implemented to form students group focusing on a article section each and discussing their findings. The discussions were active and the article's key points were presented to their overarching peer group and discussed openly. The students were able to improve their reading of publications, although in future use, the applicability for their own laboratory projects could be improved.

COURSE FACTS

- **Course name**: Molecular Microbiology
- **Level**: M.Sc.
- **ECTS credits** : 10
- **Language**: English
- **Number of students**: 14
- **Your role**: leading the Journal Club

MAIN POINTS

1. **Main problem/challenge:** insufficient understanding of scientific publications
2. **Teaching activity**: jig-saw-reading
3. **How did it go?** students enjoyed it, understood the article and discussed actively
4. **What to do next?** Ensure better preparation and manifest in future use

TEACHING IN PRACTICE

1. Identifying a problem

In former Journal Clubs, students were either not well prepared or did not understand the articles in depth during class. This resulted in **insufficient critical reflection on scientific literature**. The learning outcomes of the course include producing their own lab project, for which it is necessary to reflect on and apply the methodology from literature as well as writing a report on this project scientific article format, for which understanding existing articles is a good preparation.

2. Planning a teaching activity

To reach the course aims, this class aims at **improving the students' understanding of scientific literature first.** Therefore, I utilized the concept of a **jig-saw reading** session on a complex article. By splitting it in "puzzle pieces", the groups working on one of them could focus and go into depth more. This helps them reflecting their understanding more critically by discussing with their peers and testing their knowledge when reporting back to a bigger group – "solving the puzzle". Furthermore, teamwork often is a high motivator to tackle the otherwise overwhelmingly complex and dense scientific literature.

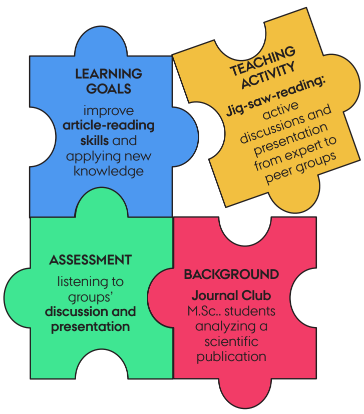


Figure 1: **Constructive alignment.** This puzzle illustrates the alignment between the students' background (red), the learning outcomes (blue), the teaching activity (yellow) and evaluating the students' learning success (green).

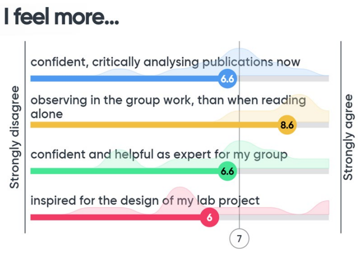


Figure 2: **Evaluation results of TA.** After 2h of teaching activity, the M.Sc. Students their confidence in their skills (blue, 66%), value of group work (yellow, 86%), value of expertise (green, 66%) and new input (red, 60%) on mentimeter.com

3. Trying it out in practice

The students were split in 4 "expert" groups (3-4 students) for the article's sections (introduction, materials & methods, results and discussion). To assess these sections thoroughly, the "experts" had 20 min. for individually reading their section and then discussed and agreed on the key points for 10 min jointly. Afterwards the students formed two larger "collaboration" groups to report their new specific knowledge back to.

Each section "expert" explained their key findings in 5 minutes, trying to clarify all incoming questions. Then, the "expert" groups presented and reasoned their findings on the overhead-projected article, in open discussion with all students and professors.

No lecture or evaluation material was produced during this session, but the final discussions as well as having listened to their expert group activity served me as assessment of their learning progress. Alignment of the activity setup and the aim of understanding the publication was achieved due to the focus the groups enabled them and trying to reply critical questions of peers (Fig.1).

The students evaluated the activity (Fig. 2) and rated the teamwork as **very helpful** for achieving the learning outcomes, while the activity did not fully help them in applying the knowledge for their own lab work.

LOOKING FORWARD

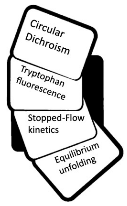
The students discussed actively, showed motivation to systematically explore the topic and explain it to their peers, asking critical questions. The activity worked well, as the evaluation shows, too, despite using more time on discussions and presentations than planned. So for a next session, a clear time-frame is needed and a clear communication on what part of understanding to focus on. Improvement is needed on how to utilize this knowledge on their lab projects, for example by utilizing different active learning tools for this part as well.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Maria Scheel
Biogeochemistry in Arctic Ecosystems
Bioscience

Put the cards on the table

Using strip sequences to discuss relevant techniques for investigation of proteins



Abstract: When students are introduced to a number of advanced techniques within protein biophysics, they may tend to focus too much on the individual techniques rather than on how these techniques can be combined to help answer some of the fundamental questions about proteins. This teaching activity helps to solve this issue: The students revise the techniques and then discuss how the techniques can be combined to solve particular problems. The teaching activity has not been performed in practice yet but it is expected to help the students to get a better overview and connection between the fundamental concepts of proteins and the techniques we can use to study them.

COURSE FACTS

- Course name: Proteins and Their Interactions
- Level: Bachelor, 4. semester or later
- ECTS credits : 10
- Language: Danish
- Number of students: 25
- Your role: Teaching Assistant

TEACHING IN PRACTICE

1. Identifying a problem

During the first weeks of this course, a number of fundamental concepts and theoretical aspects about protein biophysics are introduced to the students. Even though all this early information can be difficult for the students to grasp we steadily move on and introduce them to new topics and advanced techniques to study proteins and their interactions. It can sometimes be difficult for the students to properly relate the concepts and technique between relevant topics. The students may tend to forget some of the fundamental concepts from the first weeks of the course. The overall goal of this teaching activity is to help the students to get a better overview and connection between the topics and subjects.

2. Planning a teaching activity

The aim is to help the students to think about how some of the advanced techniques can help to answer some of the fundamental questions about proteins and their interactions. The teaching activity will contain two parts. In the first part, the students will talk briefly about the techniques they have learned about in the course as a sort of a "warm-up" for the second part which is a more in-depth discussion about how the techniques can be used to solve particular problems. The exercise should help the students to think critically about the strengths and weaknesses of certain techniques.

3. Trying it out in practice

The two parts of the teaching activity is carried out as follows:

Part 1: The students are positioned in an inner and outer circle. The students in the inner are facing the students in the outer circle. Student pairs are formed by one student from the inner circle facing another student from the outer circle. A particular concept or technique is shown on a power point slide. The students have 1 min to review and discuss the concept/technique. After one minute, the outer circle rotates, such that new student pairs are formed. A new concept/technique is shown and the students review and discuss it for one minute. This process repeats for ~10 min.

Part 2: The students are split into groups of 4 people. A number of problems are handed out and each group discuss how the concepts/techniques revised in part 1 can be used to solve the problems. The students use strip sequences to sort the concepts/techniques according to how relevant they think the particular techniques are for solving each particular problem. By sorting the concepts/techniques using the Strip Sequence, the students get a good overview of concepts/techniques and a required consider each concept/technique and discuss it. This will make them well-aware of potential shortcomings in their understanding of the concepts. The duration of the problem solving session can be from 10 min and longer depending on the number of problems that are handed out to the students.

Assessment and evaluation:
While the students are solving the problems in part 2 of the exercise, I will walk around in the classroom and assess the students' answers and discuss them with the individual groups. For evaluation I will ask the students to fill out an evaluation of the teaching exercise ("ticket out the door").

MAIN POINTS

1. **Main problem/challenge:** Linking fundamental concepts to advanced techniques
2. **Teaching activity**: Pair-Share and Strip sequences
3. **How did it go?** I have used parts of the teaching activity in my normal theoretical exercises which has worked well
4. **What to do next?** Implement the teaching activity or parts of it

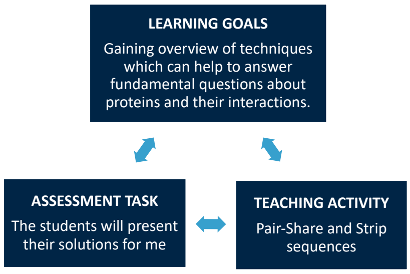


Figure 1: **Constructive alignment**

4. Looking forward

The aim of this teaching activity was to improve the connection between the fundamental concepts of proteins that the student learn during the first weeks of the course to the more advanced concepts and techniques that the students learn later in the course. The teaching activity has not yet been performed in its full form since it is fairly time consuming (it requires at least 20-25 min). However, I have on several occasions used parts of the teaching activity in my normal theoretical exercises. For instance, I have asked the students to discuss in groups how a particular technique can be used to answer some of the fundamental questions about a protein and its interactions, and which strengths and weaknesses the particular technique has compared to other techniques.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Thorbjørn Vincent Sønderby
Otzen Group
Interdisciplinary Nanoscience Center

Soil threats – what about it?

Student activation: from textbooks to the real world

Learning Lab

The time spend one-way teaching had to be reduced in the master course Agroecology and Environment, to limit the risk of the lectures feeling like a waste of time. Based on an example given during the first lecture, students had to prepare, in small teams, a PowerPoint which addressed important elements of an agricultural soil threat. A rubric was used for assessment of both content and style. The results ranged from moderate-good to good. Students were glad to research soil threats themselves, but could not yet reflect on how the activity contributed to the final course assignment. The activity will be part of lectures next year.

COURSE FACTS

- **Course name**: AgroEcology and Environment
- **Level**: Master
- **Language**: English
- **Assessment**: popular paper of topic of own choice
- **ECTS credits** : 5
- **Number of students**: 5-12
- **Your role**: 2 x 3 h lectures

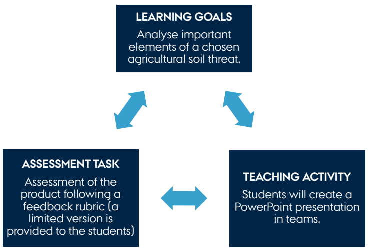


Figure 1: The teaching activity follows the principle of constructive alignment.

MAIN POINTS

1. **Main challenge:** Improve student activation.
2. **Teaching activity**: In teams, make PowerPoint of important elements of an agricultural soil threat.
3. **How did it go?** Start was difficult, results were good.
4. **What to do next?** Continue. Include example in lecture (before break).

1. Identifying a problem

Context

1. Lectures taken over;
2. Little hands-on on the first day;
3. The little student activation is based on course preparation (textbook based).

Lectures: Introduction to soil, Day 1

Introduction; Soil functions; Soil threats (agriculture); Soil formation & classification.

Problem

1. One-way teaching risks boring lecture:
   i. Feels like a waste of time;
   ii. Demotivates course preparation.

Aim of activity

1. Actively research relevant agricultural soil problems in the real world.

2. Planning a teaching activity

The activity reduces the focus of one-way teaching, and follows the principle of constructive alignment (*Fig. 1*) by e.g. practicing the course assignment;

Activity: Soil threats – what about it?

Learning goal

1. Analyse the important elements of a chosen agricultural soil threat;

Skills practiced

1. Critical thinking (popular paper!);
2. Share and discuss information;
3. Practice making a good PowerPoint.

Product

1. Each team delivers a PowerPoint presentation answering:
   i. 5 W: What, where, when, why, who?;
   ii. 1 threat: Erosion, Soil organic matter decline, Salinisation, or Sealing.

3. Trying it out in practice

The planning

11.15 Introduction of teaching activity

1. Overall assignment;
2. Discuss interpretation of the 5W's (*Fig. 2*);
3. Present (limited) example on soil compaction (*Fig. 3*);
4. Team-up in teams of 2-4, divide the topics;
5. Present (limited) rubric for assessment (*Fig. 4*);
6. Deadline assignment 1 week.

11.35 Group work & guidance.

11.50 Summary & follow-up.

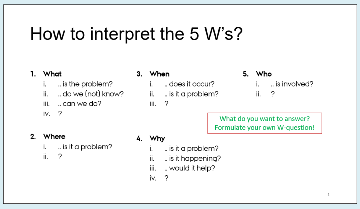


Figure 2: Teaching material, slide to support the introduction of the teaching activity, used to discuss the contents of the PowerPoint presentation.

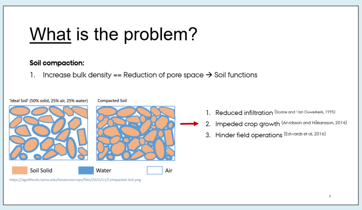


Figure 3: Teaching material, slide of the example shown to the students;

In class

Introduction:

1. Students were uncomfortable with the assignment at first: questions.
2. The discussion of the 5 W's was considered helpful (comfort ^).
3. The example gave the students a better understanding of the assignment (comfort ^).
4. Rubric supplemented the example presentation.

Group work:

1. Different teams had different approaches: some started with formulating and dividing questions, others started with think-pair-share.
2. We had little time in class, but I guided all of the groups.
3. I receive no questions via e-mail.

The assessment & feedbacks

1. The teams delivered moderate-good products, found feedback helpful.
2. The teams evaluated the assignment and feedback positive: it triggered their curiosity and scientific skills (mentioned Day 2).

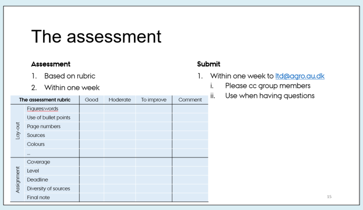


Figure 4: slide to explain the assessment of the teaching activity, used to provide a framework.

4. Looking forward

Students could not yet reflect on how the activity contributed to the final course assignment. The activity will be part of lectures next year. Avoid introducing more 'out-of-class' working hours. There is no time for presentations (estimated correct).

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Loraine ten Damme
Soil Physics and Hydropedology
Department of Agroecology

A visual list to compare two *in vivo* experimental methods

enhancing understanding of practical work

Learning Lab

Abstract: For the course Feedstuff evaluation students perform an *in vivo* digestibility study in pigs. Due to time limitations students have a hard time comprehending the reasoning behind the experimental set up and thus its results. To improve understanding students were asked to fill in an adapted visual list. This enabled them to link theoretical knowledge to their practical experience. Students positively responded to the activity by showing high involvement during the plenary discussion. Evaluation showed that student understanding of the experimental method and the results as well as their confidence for the final exam had improved. In the future the visual lists can be used before starting the practical work.

COURSE FACTS

- Course name: Feedstuff evaluation
- Level: MSc
- ECTS credits : 5
- Language: Danish/English
- Number of students: 8
- Your role: Teaching assistent

TEACHING IN PRACTICE

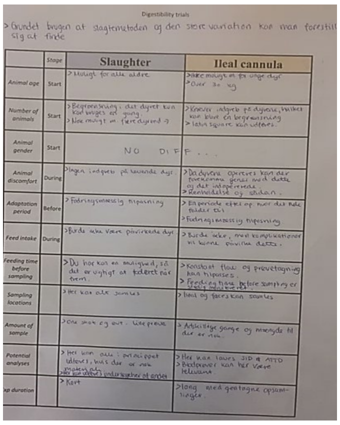
1. Identifying a problem

In this course students design and perform a digestibility study in pigs. Results obtained are closely linked to decisions made during and before the experiment. However, limited time meant that students had little time before and during the practical work to comprehend the implications of the practical activities on the results that were obtained. The teaching activity aims at giving the students the tools to 1. Discuss differences between two methods for assessing digestibility. 2. To critically reflect on the method they've used themselves.

2. Planning a teaching activity

A visual list (fig. 1), comparing two methods for evaluating digestibility *in vivo*, is used. Categories are added to structure the thinking-process, and are designed to help understanding results that were obtained. As students have some practical experience of one method, using another method for comparison will help them identify strengths and weaknesses of their method. The activity should help the students to 1. Identify pros and cons of the experimental method used in this course 2. Explain the results obtained from the *in vivo* experiment.

3. Trying it out in practice


Digestibility trials

>Grundet brugen af slagtemetoden og den store variation kan man forestill[e] sig at finde

	Stage	Slaughter	Ileal cannula
Animal age	Start	>Muligt for alle aldre	>Ikke muligt m. for unge dyr >Over 30 kg
Number of animals	Start	>Begrænsning, da dyret kun kan bruges en gang. >Ikke muligt m. flere dyr end ->	>Kræver indgreb på dyrene, hvilket kan blive en begrænsning >latin square kan udføres.
Animal gender	Start	NO DIFF ...	
Animal discomfort	During	>Ingen indgreb på levende dyr.	>Da dyrene opereres kan der forekomme gener med dette og det indopererede. >Renholdelse og sådan.
Adaptation period	Before	>Fodringsmæssig tilpasning	>En periode efter op. hvor dyret heler til >Fodringsmæssig tilpasning
Feed intake	During	>Burde ikke være påvirkede dyr	>Burde ikke, men komplikationer vil kunne påvirke dette.
Feeding time before sampling		>Du har kun en mulighed, så det er vigtigt at fodret når frem.	>Konstant flow og prøvetagning kan tilpasses. >Feeding time before sampling er [illegible]
Sampling locations		>Her kan alt samles	>Ileal og faeces kan samles
Amount of sample		>One shot og ud. Lille prøve	>Adskillige gange og mængde til der er nok.
Potential analyses		>Her kan alle i princippet udføres, hvis der er nok materiale >Her kan udføres undersøgelser af andet	>Her kan laves SID & ATTD >Blodprøver kan her være relevant.
Exp duration		>Kort	>Long med gentagne opsamlinger.

Figure 1: Visual list filled in by students

In pairs students were asked to take 15 minutes to predict how each category is affected by the two different methods. Afterwards a plenary discussion was held led by the TA. Students were asked to explain their answers. Thereafter, the TA either asked further questions or helped students identify links with their own work. TA found that involvement during the discussion was higher than normal. The teaching activity was evaluated by asking the students how understanding of the experimental design, the obtained results, and their confidence for the final oral exam had changed after the teaching activity compared to before. All students indicated increased understanding of experimental design. A majority of students ticked the box for "increased" on the other two topics.

MAIN POINTS

1. **Main problem/challenge:** Time limitations led to reduced understanding of experimental work
2. **Teaching activity**: Visual list
3. **How did it go?** High student involvement and perceived understanding increased
4. **What to do next?** Implement before start of experiment

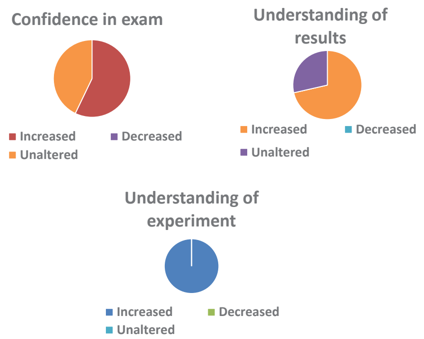


Figure 2. Student evaluation of teaching activity

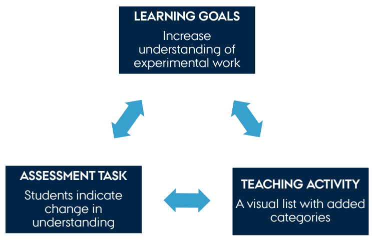


Figure 3: **Constructive alignment**

4. Looking forward

Judging from student evaluations and the TA's evaluation the teaching activity has helped students to understand the experimental work. In the future the activity can be used before starting the experimental work, since it has shown to improve understanding of the experiment itself. A benefit will be that it can be done in relatively little time thus not interfering with the original lesson plan. Moreover, Students can also be asked to mark their perceived change in understanding from 1-10 in order to get more insight into their exact level of understanding.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Marleen van der Heide
Animal nutrition and physiology
Animal Science

Hands-on approach to using and understanding the NLES4 model

- Encouraging active learning in the classroom

Learning Lab

Abstract: The problem with teaching students computer models in class is that they cannot conceptually understand how the input variables impact the results. Most professors will lecture the material, emphasize the needed parameters and then show the results. This is difficult for students to understand what the model is actually doing and how those parameters interact with one another. This is no different for the NLES4 model – which is developed to calculate nitrogen leached from agricultural fields. In this activity students learning the NLES4 model will work hands on with the model under TA supervision as well as have individual and group work problems to do to assess their learning of the model.

COURSE FACTS

- Course name: River Basin Management and Analysis
- Level: Masters course
- ECTS credits : 5
- Language: English
- Number of students: 12
- Your role: T.A.

TEACHING IN PRACTICE

1. Identifying a problem

Computer models can be hard to conceptually understand and even harder to link to the topics you've discussed in class. However, it is more common for students to use computer models in their homework, masters, or Ph.D. projects. This activity is meant to associate the class material, from River Basin Management and Analysis, with the empirical data and parameters used in the NLES4 model – which is required in the course. The outcome of the activity includes, but not limited to – students identifying how the input variables affect each other as well how the results they produce can be used in a practical sense.

2. Planning a teaching activity

By using a hands-on approach it will make it easier for students to understand how NLES4 responds to the input variables (fertilizer use, crop rotation, and climate) through examples given by the T.A. (me), individual work, and group discussions during the activity. We will work through the first part together because there are lots of steps involved and I do not want the students to get lost or simply "just put number in excel". Students should be able to see first-hand how the changes they make in the model will have major impacts on the amount of nitrogen leached from agricultural drainage, and thus, into surface waters.

3. Trying it out in practice

To do this activity I will present the material (NLES4 model) and relate the data needed as input variables to previous lectures (variables such as climate, fertilizer use, soil type, crop rotation). From these data they must find how much nitrogen is leached from their field. The model is built into excel, with its functions already defined, therefore it is simply "plug and play". However, as previously mentioned, it is not the results that matter, it's the logic behind WHY they are using these values and HOW the interact, i.e., how the model is calculating the amount of N leached. After going through the first section together, the students will be left to work individually for 5 min. When we have reconnected, we can go through what they have done in the model with their time. Finally, they can work in groups and ask questions and I will answer questions they have about the process.

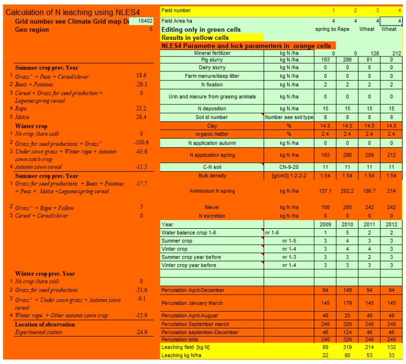


Figure 1: an example of NLES4 where students fill out the spreadsheet based on their interpretation of how crop rotation is done. Each section was done partially together as an example, then individually to assess the understanding of the methods, and finally as a group again to clarify any confusion.

MAIN POINTS

1. **Main problem/challenge:** The biggest issue I had while trying to implement the activity was being interrupted by the professor, which was out of my control. He/she was not used to the activity style of teaching and it was hard let the students have a few minutes to try it out on their own before cont. the lecture.
2. **Teaching activity**: A combined lecture and problem solving session
3. **How did it go?** Overall, it went well, although some minor hiccups, the students seemed to really like pace and asked to cont. They mentioned afterward they liked working together first then in groups
4. **What to do next?** If given a another opportunity, the next step will be to allow more work/discussion time for the students – i.e., increase 5 min to 8 -10min. Especially since they asked for it.

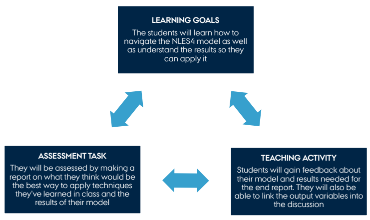


Figure 2: **Constructive alignment**
1) what you intend students to learn 2) how you teach and 3) how you will evaluate whether your students learn what you intend

4. Looking forward

For the future I would like to discuss more with the professor beforehand and make sure they understand more fully what it is I'm trying to do. In relation to the activity, I think posing questions for the students to solve individually and then checking in as a group was what worked the best. The students seemed to really enjoy the activity overall so this will be something I incorporate in the future.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Kari A. Wolf
Water and Climate
Agroecology

Team Review of Homework

- An efficient way to facilitate the learning process

Abstract: Each course might contain some subjects that is not the main part of the course but very essential. In this case, course lecturers may do not spend so much time on them due to time constraints. And, students may be shy to ask questions. Here, we proposed a teaching activity to help the students to learn these kind of subjects in an efficient and fast procedure. In this teaching activity, the students solve the homework both in person and in group, without a prior knowledge about the second one i.e., group solving. The results show that this teaching activity increased the students understanding from 60% to 96%.

COURSE FACTS

Course name: Distributed storage systems

- Level: PhD
- ECTS credits : 5
- Language: English
- Number of students: 15
- Your role: Teacher assistant

TEACHING IN PRACTICE

1. Identifying a problem

Students are supposed to know about the polynomial mathematics because they will use it regularly in the course. It is a different kind of calculations over numbers. The course coordinator teaches it. But, since it is not part of the main structure of the course, he cannot spend too much time on it. And, normally students have problem with it and they are also shy to say if they do not understand some parts of it. As the TA, I like to make sure that they will understand these mathematics completely to help them to understand other parts of the course (polynomial mathematics is a base).

2. Planning a teaching activity

My goal is to make sure that students will not have any problem in polynomial arithmetic. In this teaching activity students are given homework with a specific deadline. So, they spend some time individually to solve it. The deadline is when I start the class. But, I ask them to work on the same homework at the class in a team (They had no prior knowledge about this team task). They have 2 hours to help each other and correct the answer. Finally, I collect the homework with both old and new answers. Since, I) they are less shy to ask questions in the team, II) each of them knows some part of answers, they can help each other to understand the subject very well.

3. Trying it out in practice

I did this teaching activity in some steps as follows:
1- I gave the students some homework to solve. They had 10 days to solve the homework.
2- At the class, which was the deadline for the homework, I explained them about the teaching activity. And, I asked them to make teams of 3 or 4 persons.
3- Then, they compared their answers in the team. If the answers were the same for a question for all the group members, they could skip that question. If it differed, then, they needed to discuss it together or refer to the references to find the correct solution.
4- Meanwhile, I walked through the teams and ask them if they have any questions.
5- At the end of the class, each student gave me her/his homework which he/she has corrected the wrong answers with a different color. Also, I told them at the beginning of the class that it is not important if they have many wrong answers. Just, I expect them the right answer after working with the team. They had about 2 hours in the class to work in a team to correct their homework.

All in all, I think this teaching activity was very helpful for the students. When I was at the class, I could see that some of students who do not usually speak in the class, were asking a lot of questions from their friends to understand the homework. Based on the collected homework, on average, only 60% of the initial answers were correct while 96% of the final answers were correct. Moreover, the course lecturer told me that it was noticeable that students do not have any problem in finite fields anymore.

MAIN POINTS

1. **Main problem/challenge:** Students weakness in polynomial arithmetic and time limitation for teaching it as well as students are shy to ask questions about it.
2. **Teaching activity**: steps: 1) solve homework 2) comparing homework in a team at the class 3) returning the homework containing the old and new answers
3. **How did it go?** Students learn the subject very well.

1. **What to do next?** We decided to apply a similar approach for covering other subjects of the course.

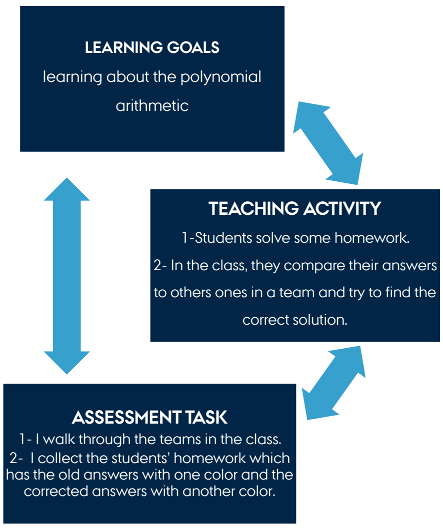


Figure 1: **Constructive alignment**

4. Looking forward

Based on the collected homework and course lecturer's feedback students learned the intended subject. The next step could be applying a similar approach to cover other subjects of the course.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

Niloofar Yazdani
Agile cloud laboratory
Engineering department

Network coding in IoT storage
- Minimizing Bandwidth Use

Learning Lab

Abstract: Since the audience may have different levels of understanding on the topic, a lecture should be designed properly according the levels. A teaching activity is planned to solve this problem, which consists of reading papers and Think-Pair-Share. The activity is aimed to not only provide the students a better understanding of network coding in Internet of Things (IoT) storage, but also encourage them to think critically when reading scientific papers.

COURSE FACTS

- Course name: Network Coding: Theory and Applications
- Level: PhD
- ECTS credits : 5
- Language: English
- Number of students: Max 12 participants
- Your role: TA/Lecturer

TEACHING IN PRACTICE

1. Identifying a problem

Students may have different levels of understanding on network coding and IoT storage. Without knowing the levels of students on this topic, the lecture might be designed to be too simple or too difficult, which leads to an inefficient lecture. Therefore, it is important to have a basic understanding of students' level on the topic before the lecture. Accordingly, I can modify the content, e.g., explaining some parts in detail, or skipping some parts.

2. Planning a teaching activity

In attempt to solve the problem identified above, I will select 5 relevant papers (3 must-read, 2 optional) before the lecture. The students will be asked to read the papers and point out at least 3 advantages and 3 disadvantages of each must-read paper, and write down 3 questions about each paper. The deadline of this assignment is one week ahead of the course date, then I have time to adjust the content of the lecture, e.g., explaining some common questions in detail.
At the beginning of the course day, students will be separated into pairwise groups. They can share the advantages and disadvantages, which will help them to understand the papers from different perspectives. Also, they can discuss and try to help each other answer the questions, which will improve their comprehension in the questions.

3. Trying it out in practice

The teaching activity will be implemented as one class of the course network coding: theory and applications.

1) The lecture will start with an introduction of myself, so that the students are able to contact me after class if they have any questions.

2) Then the second part of the activity in Section 2 will be performed. The students will be given 15 minutes to discuss in pairwise groups. After the discussion, I will summarize unsolved questions. Some of them will be answered during the lecture , and the rest will be answered after the main part of the lecture.

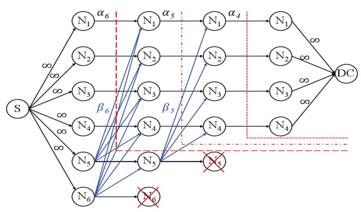


Figure 1: **An illustration of the protection problem based on an information flow graph**

3) During the lecture, I will explain the reason why employing network coding leads to reliable IoT storage, and how to reach its full potential when node failures occur in the system, which is defined as a protection problem. Fig. 1 is used to illustrate that the problem can be mapped to a multicasting problem based on an information flow graph.

Then, a linear programming is established to solve the problem optimally.

4) At last, the remaining and new questions will be answered.

MAIN POINTS

1. **Main problem/challenge:** Students may have different levels of understanding on network coding and IoT storage.
2. **Teaching activity**: Reading papers, Think-Pair-Share
3. **How did it go?** The activity has not been implemented yet. It is expected to help students have a better understanding of network coding in IoT storage.
4. **What to do next?** Implement the activity and adjust it by feedbacks.

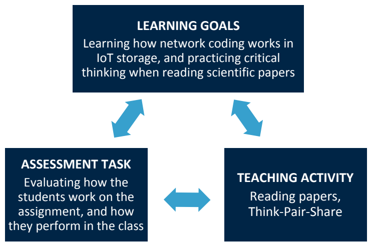


Figure 2:: **Constructive alignment**

4. Looking forward

Unfortunately the teaching activity has not been implemented yet, and it is expected to be implemented later this semester. After finishing the activity, I will talk to the students and get some feedback. With the feedback, the activity can be improved and structured better for future lectures.

AARHUS UNIVERSITET
SCIENCE AND TECHNOLOGY

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