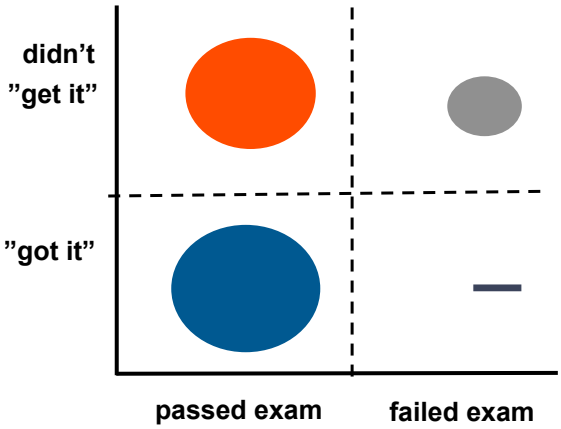
Workshop Day 2

Improving learning in discipline-led courses

Kristina Edström, kristina@kth.se

We can operationalize quality in student learning **outcomes**

Quality of student learning (i)



Conceptual understanding

- Not just reproduction of known solutions to known problems
- Being able to explain what they do and why
- Deeper working disciplinary knowledge

See for instance Mazur, E. (1997) *Peer Instruction*, and Kember & McNaught (2007) *Enhancing University Teaching*.

Quality of student learning (ii)

Feisel-Schmitz Technical Taxonomy

Judge (bedöma)	To be able to critically evaluate multiple solutions and select an optimum solution
Solve (lösa problem)	Characterize, analyze, and synthesize to model a system (provide appropriate assumptions)
Explain (förklara)	Be able to state the process/outcome/concept in their own words
Compute (lösa typtal)	Follow rules and procedures (substitute quantities correctly into equations and arrive at a correct result, "plug & chug")
Define (återge)	State the definition of the concept or is able to describe in a qualitative or quantitative manner

[Feisel, L.D., Teaching Students to Continue Their Education, *Proceedings of the Frontiers in Education Conference*, 1986.]

Now: How to create quality learning **process** to achieve the intended learning outcomes?

The teacher's fundamental task is
to get students to **engage in learning activities**
that are likely to result in their achieveing **the desired outcomes** in a reasonably **effective** manner.

...remember that

what the student does

is actually more important
in determining what is learned
than what the teacher does.

[Shuell, quoted in Biggs 2003]

Difficult questions

Given the conditions in Gibbs' example with peer assessment:

A. Wouldn't it be better if the assignments were marked by teachers? Give a rationale for your answer.

B. Is the quality of the marking really not important? Give a rationale for your answer.

The key to quality learning is that students get started with their own work, regularly. As an added bonus, the marking exercise is a good learning activity in itself.

1. Would it be better if the teacher marked the assignments?

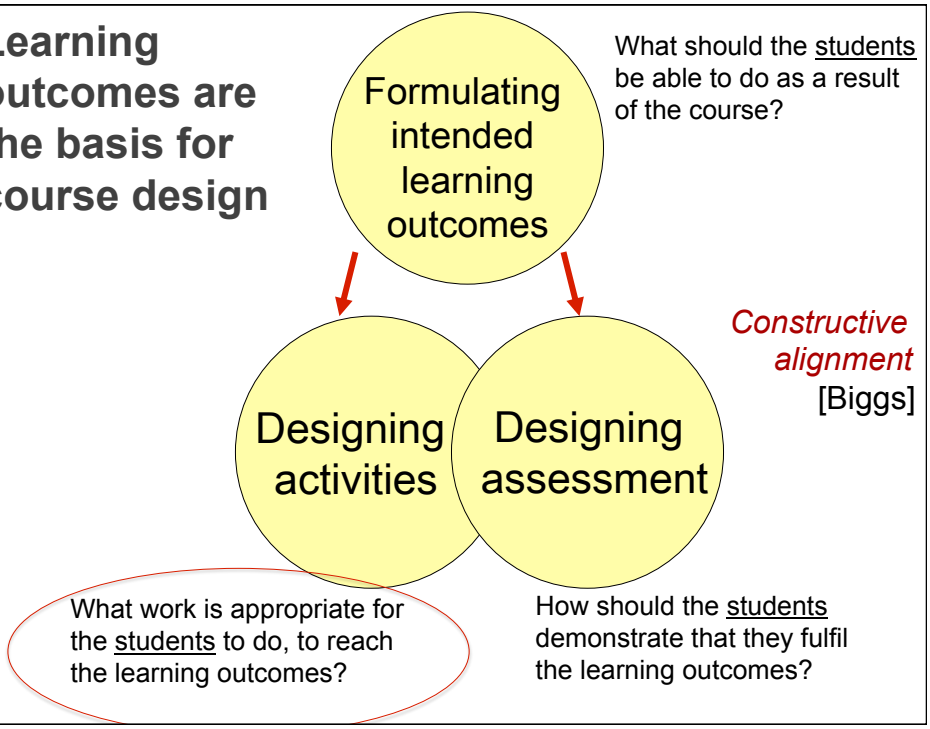
- Teacher feedback would be several times more expensive and much slower.
- The main value for learning here is in **marking the other student's work** using the teacher's template:
  - you get **repetition**,
  - you see **variation**, and
  - you give yourself **feedback**.

2. Is the quality of the marking really not important?

- ***Marking is only a means*** for achieving learning – we must focus on the **quality of learning it brings about**, not the quality of marking in itself.
- "Safe" model: **no student is hurt** from sloppy marking:
  - you can always compare your own solutions with the template, and
  - the result does not affect grade.

!! *Note! The case is completely different if the result affects the grade.*

Learning outcomes are the basis for course design



Examples are illustrations of principles

A specific **example** will **illustrate** **generic principles** to **inspire** **applications** - of many different kinds.

A typical subject based course

…in fact any course *with focus on applying disciplinary theory for problem solving*

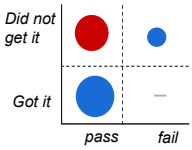
such as Lightweight Structures, Turbomachinery, Microwave Engineering, Signal Theory, Queuing Theory, Antenna Theory…

At KTH it would likely use a traditional course format:

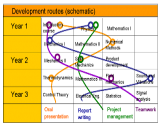
- **Lectures**
  - teacher presents theory
  - students take notes
- Blackboard **tutorials**
  - teacher solves problems on the board
  - students take notes
- **Final exam**
  - students solve problems!

The typical course - with typical problems

- Teachers find students passive.
- Students postpone their studies until just before the exam.
- Many students pass the exam by solving the typical problems, but many do not really "get it".



And the 😈 dean wants the course to train "engineering skills" too…



- *"Come on! Both I and the students already struggle hard as it is"*
- *"We can't take time away from teaching the subject"*
- *"I only have a PhD in [the subject]. How could I teach communication skills?"*

But what if there is **a metod** which

- helps the students understand the content better
- and simultaneously develop their communication skills,
- and it does not mean more work for the teacher!

Student-led recitations in IH1611 Semiconductor Devices 2006-2011

Per-Erik Hellström, Martin Domeij, Gunnar Malm

17

Student-Led Recitations

Teacher preparations

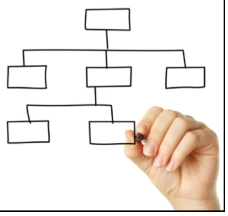
- Rename one recitation session (övning) per week as ”student-led recitation”
- At course start, hand out problem-sets with N problems, one for each week

Student preparations

- Before each session, the students solve this week’s problems and prepare to present their solutions on the board

How the session works

- When students arrive, they ”tick” on a list which problems they are prepared to present
- Teacher ”randomly” picks a students to solve the first problem on the board
- Discussion on alternative solutions, difficulties, ask the group to assist with problems
- Pick a new student for the next problem, etc



“Rules”

§) Ticking at least (say) 60-70 % of the problems is a **course requirement**.

§) The quality of the presentation is not assessed and does **not affect the grade** since the purpose is purely formative.

The presenting students must however show an **honest effort to prepare**, and be able to lead a classroom discussion to a satisfactory solution.

§) If a student who is picked is **obviously unprepared**, all his/her ticks are removed for that recitation.

This has luckily never happened!

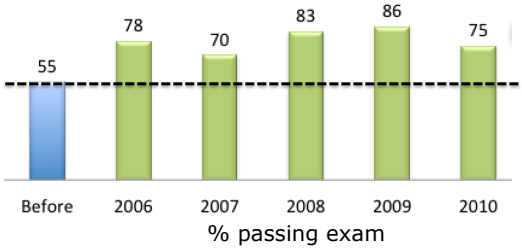
Fears before implementation

- What if students copy solutions from friends (unfair)
  - in preparing to present they will learn anyway
- What if students tick problems without preparing (unfair)
  - no pleasure in failing in front of class
  - \+ we have the rule: all ticks at the exercise would be cancelled
- What if students make poor presentations and slow tempo (boring)
  - students surprise us as good teachers!
  - everyone in the room has prepared the problem
    (they can follow even a poor presentation)
- And what about fairness?
  - students present one or many, difficult or easy problems
  - students may have made errors that are not discovered

Conclusion: do not use for grading, only make it compulsory

Results - Students

- Students do better at the exam



Data from Per-Erik Hellström, Semiconductor Devices, KTH, 7.5 ECTS, undergrad year 2, 25-30 students

- Student motivation increases due to:
  - Sessions are alive and fun
  - Lots of feedback and interactivity
  - Students are allowed to show what they can! (to teacher and class)
- Students like the format (4.2 on a 1-5 scale)

Pick me!

Teacher experiences

It is such a pleasure to discuss the topic with students on a much, *much,* more advanced level than usual!

Per-Erik Hellström
KTH

Less work for teachers

the problems must be prepared before course start, but:

- no preparation before the sessions
- sessions are less tiring than presenting
- much fewer poor exams to correct

More effective as a teacher

- You see early and clearly what is difficult in the course
- You can handle lack of understanding, or move on knowing when they “got it”
- You learn to design problems that illustrate important, critical aspects

From student interview A

- *How long time did you prepare for the student-led recitations?*
  - I tried to prepare as many problems as possible. Not just the minimum, but all of them because it is good for the exam! (laughter)
    Well, for each recitation… I don't know but at least 6 hours maybe.
  - I say the student recitations helped me learn the subject best. I have to calculate things, otherwise I don't get it.

From student interview B

When you prepare, what is it you really do?

- We go to a vacant classroom and do the six problems, helping each other. We use the whiteboard and do one problem each. We stand together discussing it at the board.
- Then the evening before I read through to get a good grip. Well, we sat maybe… how long could it have been, 5 hours in the group and 2 hours on my own.

What about the the four teacher-led exercises?

- I just went there. They are normal exercises where *he* solves problems, right? Then I don't prepare, just copy the solution, try to follow. If you are lucky you understand. Otherwise they don't give much.
- Student exercises are better because you prepare. You should do that in teacher-led sessions too, or at least read the problems. Then you would learn more. But you just copy the solutions.

From student interview C

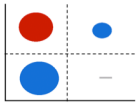
What is it like when another student presents?

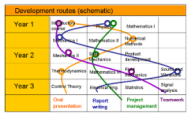
- Well, you know the problem so it is not extremely interesting, but at the same time you can easily follow.
  I guess it is quite good. You see straight away if your solution is wrong.

Anything you want to add?

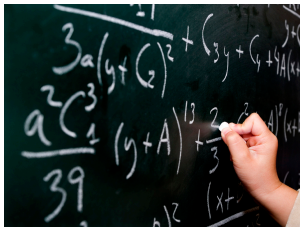
- In the beginning I didn't want the student exercises, it was a scary thought. It was a bit tough that you had to solve problems yourself, but then I realised that I would not have got started working like this without them.

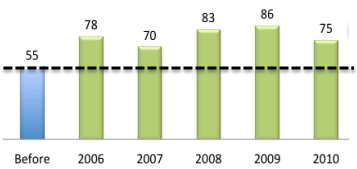
Questions? Comments?





- How big groups?
- Does it have to be compulsory?
- What happens if a student makes errors?
- How easy is it to get the discussion going?
- How do you handle shy or panicking students?
- Do you really pick randomly?
- Must you make new problems every year?





Variations

- **Explain concepts** using an example you come up with (bring an OH transparency)
- Interpret and propose **solution to a case**
- **Reflections on literature**
- **Explain an algorithm** (or method)

Examples are illustrations of principles

A specific **example**

will **illustrate**

generic principles

to **inspire**

applications - of many different kinds.

Analyse the activity:

Why is the learning dramatically increased?

Give the **rationale** for your answer!
Make a poster with your analysis, put it up at 10.00

Analyse the activity:

Why is the learning dramatically increased?

Give the **rationale** for your answer!
Make a poster with your analysis, put it up at 10.45

You may want to use the 5 principles marked in Gibbs (1999) "Using Assessment Strategically…":

1. *Do the students spend time-on-task? Do they also distribute effort over time?*
2. *Does the activity generate appropriate learning activity?*
3. *Does it provide prompt feedback?*
4. *Does it provide feedback that the student pays attention to?*
5. *Does it help students internalise criteria for quality solutions and presentation?*

Analysis – Why is learning dramatically increased?

① Generates time on task!

- *Normally 6-7 hours study per week.*
- *High attendance on recitations!*
- *Punctuality.*

+ Distributes study time during the course!

- *Makes all students study regularly from the first week.*

Time on task - a word of warning

- The aim is not to maximize time on task
- The aim is to maximize learning

- The teacher's role is to help students spend **sufficient time** (anyone can do that) on **appropriate tasks** (this takes some teaching skill).

[Analysis inspired by Gibbs (1999) *Using Assessment Strategically to Change the Way Students Learn*]

Analysis – Why is learning dramatically increased?

② Generates more appropriate learning activity!

- *Preparing the problems constitutes very good studies.*
- *Further, it is not sufficient to arrive at the answer, they must also prepare to explain and present their solution.*
- *Discussions give the whole answer.*

Condition: Assignments worthy of this attention!

- Assignments aligned with intended learning outcomes
- They should illustrate critical and esssential aspects, reflect the desired understanding
- Level of difficulty and complexity should be the same as in exam (good for student motivation)

+ New problems every time (dress them in slightly new clothes)

[Analysis inspired by Gibbs (1999) *Using Assessment Strategically to Change the Way Students Learn*]

Quality of student learning (ii)

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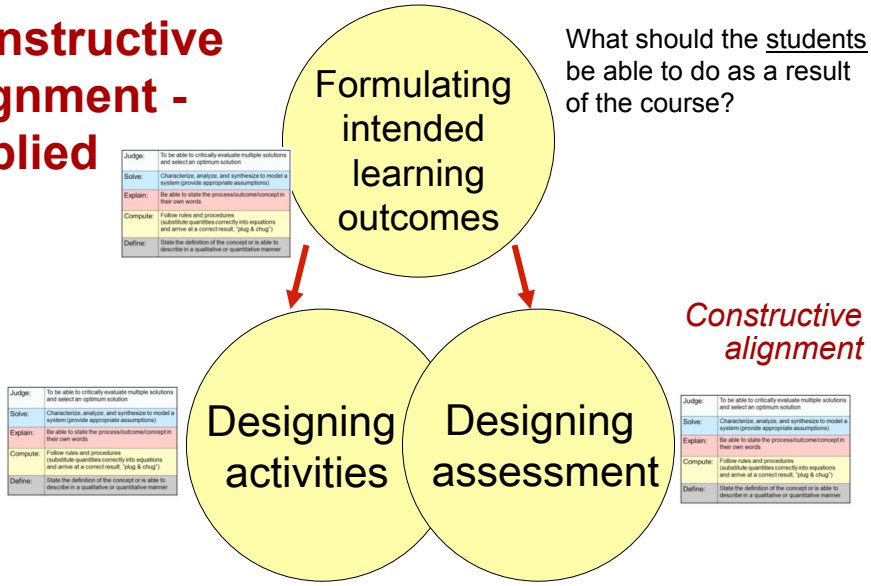
Constructive alignment - applied



Analysis – Why is learning dramatically increased?

③ Generates prompt feedback!

- *Discussion is to give everyone feedback; they should go home with the whole answer.*

⑤ Students develop a judgement for good solutions and good presentations!

- *They all see the variation…*

The discussions should give the whole group feedback!

- Get the students started discussing
- Add any important aspects that needed to be addressed

Good starters:

- *"Did everyone solve it in the same way?"*
- *"I can see that only 8 of you ticked this problem, where did you others get stuck?"*
- *"Why was this problem different from the one last week, why couldn't we use the same method?"*

[Analysis inspired by Gibbs (1999) *Using Assessment Strategically to Change the Way Students Learn*]

Analysis – Why is learning dramatically increased?

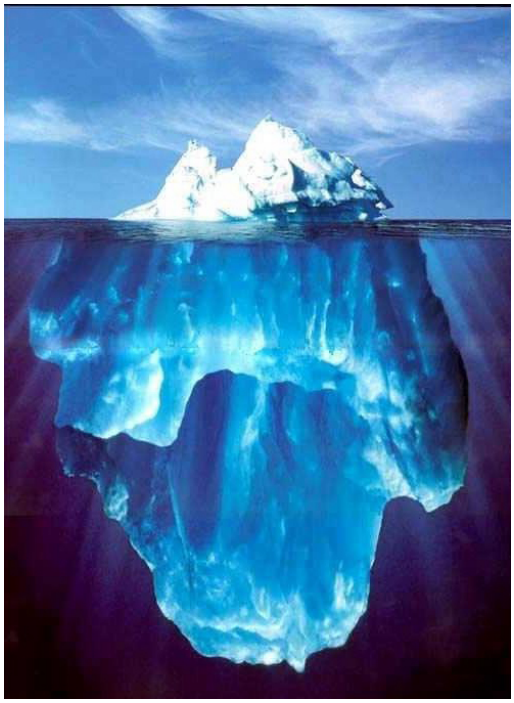
④ Students care!

- *It creates motivation to expose and develop understanding together with the teacher and friends.*
- *We see that students are eager to be picked (a chance not a risk).*

Create a safe and friendly climate!

- Never be rude or sarcastic to a student at the board (don't let the students be either)
- If you engage other teachers to run parallel groups, choose those who can also create a conducive atmosphere!

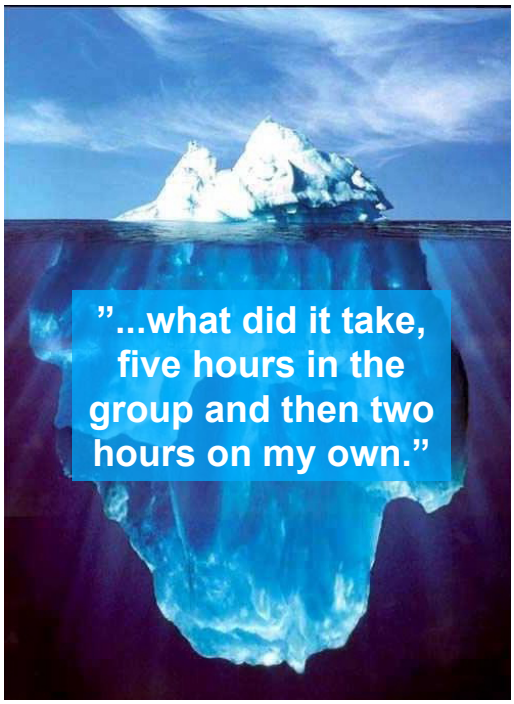
[Analysis inspired by Gibbs (1999) *Using Assessment Strategically to Change the Way Students Learn*]



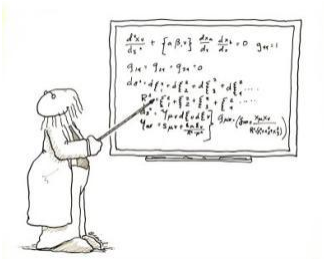
The Iceberg Effect:

For each student-led presentation that we will see...

up to 20 students have done the work to first solve the problem, and then prepare to present it.



"They are quite normal recitations where *he* solves problems, right? I don't prepare for that."



What the professor said:

"It must be better that the teacher presents the problems, after all we are the experts and it is our job."

The teacher's fundamental task is
to get students to **engage in learning activities**
that are likely to result in their achieveing **the desired outcomes** in a reasonably **effective** manner.

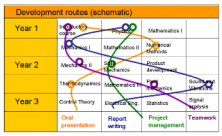
...remember that
what the student does
is actually more important
in determining what is learned
than what the teacher does.

[Shuell, quoted in Biggs 2003]

Did you notice what all
the principles are about?

what the student does

Note that this is an elegant example of integrating communication skills in a subject course!



CONCLUSION:

Every subject course should contribute to students' development of engineering skills, at least to this extent.

Especially since:

- it simultaneously helps the students **learn the subject better**
- and it **doesn't cost more** to teach in this way - all it takes is course design skills!

”Teachers [are recommended to] **embed** useful study skills in their teaching so they are not just teaching what they want their students to learn, but **how to learn it**.”

(Biggs refererar till Chalmers & Fuller 1996)

Said by a student at KTH

There are in principle **two kinds of courses** in our program.

You have the **unstructured** ones where you don’t get any help with how or what to study. Like lectures and a thick book that you don’t know what to do with. There the exam is often very easy or they follow closely to old exams. Otherwise nobody would pass.

Then there are the **structured** ones where you have to work a lot during the course. But you know what to do and can concentrate on that. Even if you fall behind you know what to do to get back on track. There is less anxiety. You learn much deeper in those courses. But there is no chance to pass unless you really work hard.

What we did here and why

- Here we tried out the **student-centered approach to teaching ("what the student does")** and the **principles** for analyzing it - through our analysis of **two methods**

Why choose these two examples?

- they are **cost effective** as innovations (absolute condition)
- they show concrete **implications of** the main principle (focus on what the student does)
- they may appear **counter-intuitive** if we have a teaching/ teacher focus
  (if we have spent so much time and energy to make good quality corrections and presentations that we forgot why)

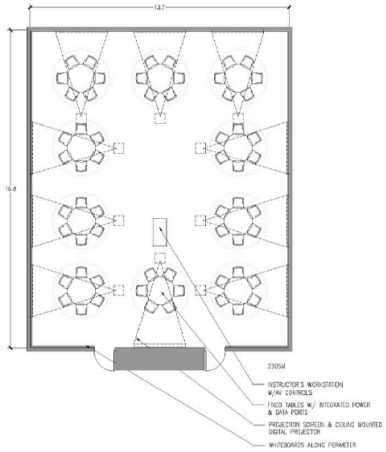
- The aim was to show that
  the **student-centered approach** to teaching
  is a **completely different ball-game**
  where our **old ways of thinking don't work!**

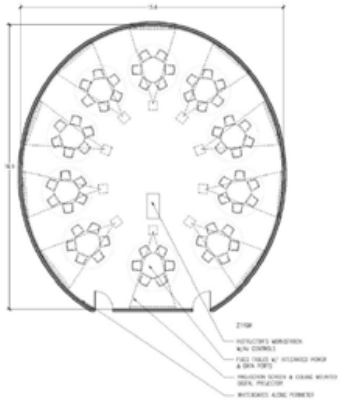
References

- The sheet *Student-led recitations* (handout)

- Crawley et al (2007, 2014) *Rethinking Engineering Education: The CDIO Approach* Springer, New York. ISBN 9780387382876

And when you get to design classrooms…





How can you apply the principles in your course?

1. Do the students spend time-on-task? Do they also distribute effort over time?
2. Does the activity generate appropriate learning activity?
3. Does it provide prompt feedback?
4. Does it provide feedback that the student pays attention to?
5. Does it help students internalise criteria for quality solutions and presentation?

Think on your own – discuss with partner – tell us!