

How to improve student learning without spending more time teaching

"The Teaching Trick"

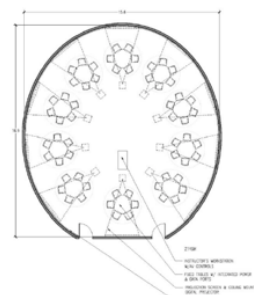


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 - M. Sc. in Engineering, Chalmers
 - Associate Professor in *Engineering Education Development* at KTH Royal Institute of Technology, Stockholm, Sweden
 - 2012-2013 Director of Educational Development at Skolkovo Institute of Science and Technology, Moscow
- **Strategic educational development, national and international**
 - CDIO Initiative for reform of engineering education since 2001
 - Member of the CDIO Council, 2005-2013
 - SEFI Administrative Council, 2010-2013
 - Contributor to Crawley et al (2007) *Rethinking Engineering Education: The CDIO Approach*, Springer.
- **Faculty development**
 - So far 680 participants have taken the 7.5 ECTS course *Teaching and Learning in Higher Education*, customized for KTH faculty

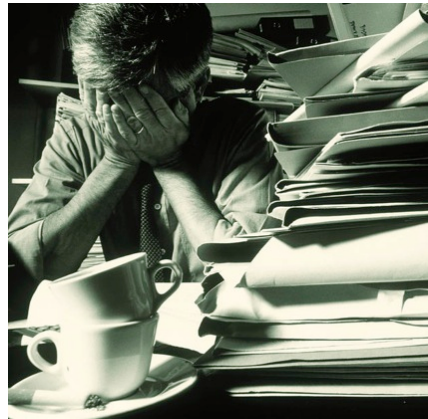


Cost-neutral interventions

To persuade the grumpy professor to listen



To relieve those dedicated to teaching



Anyone can improve a course (some little bit)
by working 100 hours more

Yeah. We don't have those hours.

**But “more of the same” is often
not the best strategy!**



What if we were building a bridge...



Maidenhead Railroad Bridge, England, I. K. Brunel, 1838.

What is it that we have today
that keeps us from replicating
the old bridge?

Technical know-how



Öresund Bridge, George Rotne, 2000.

We want to **improve (maximise) student learning**
with a given (or reduced) level of
teaching resources



$$\eta = \frac{\text{Output}}{\text{Input}}$$

Then we need pedagogical know-how!

"An engineer can do for a dollar what any fool can do for two"

Pedagogical competence



1. setting clear objectives

(intended learning outcomes)

- relevant for the study programs
- defining the threshold level of quality
- deeper working understanding

2. uphold the threshold level of quality

- only pass the students who reach the goals

3. create a course which generates appropriate learning activity

- so students actually reach the goals
- good throughput - with good quality

4. and doing this while using teacher time effectively

- generate appropriate study for the students
- spend your time where it has effect on learning
- create a sustainable workload for yourself
- and sustainability for your institution and country

The teaching trick

**Do more of that which
contributes to learning**

Pretty easy

But since we don't have 100 hours more:

**Do less of that which
does not contribute**

Pretty hard

Which one is easier and which one is harder?

Examples are illustrations of principles

A specific
example

will
illustrate

generic
principles

to
inspire

applications
- of many
different kinds.



Pick one!

/* No comments */

Family dinner

Invest 2 NOK

Pick me!

Seven minutes



/* No comments */

The teaching trick:

Do less of that which does not contribute

**Spend less time on...
finishing student work
for them!**



Professor S told us:



"I got 60 reports. It is a boring task to give feedback and it **takes me two weeks**.

I gave individual comments and asked those who had failed to re-submit.

When the reports came back they were **still bad**. The students had only corrected the things I specifically commented on. They did not even read the rest!

Next year I did not give individual feedback on failed reports. Instead I **made a list with the most common errors**. Now the students had to **find their own errors**. When I got the reports back they were **generally very good!**"

Remember the purpose

- The purpose **is not**
that *this particular* report should be good
- The purpose **is**
that the **student should develop the skills** to write reports
(so that he/she can write 1000 excellent reports later)



For the same reason:

Keep your hands on your back...

when you are assisting students in the computer lab
– do not ever touch their keyboard!



**Every time you tie the shoes for
your child, you hinder her own
development.**

Maria Montessori



Family dinner



The teaching trick:

Do less of that which does not contribute

**Spend less time on...
marking coursework!**

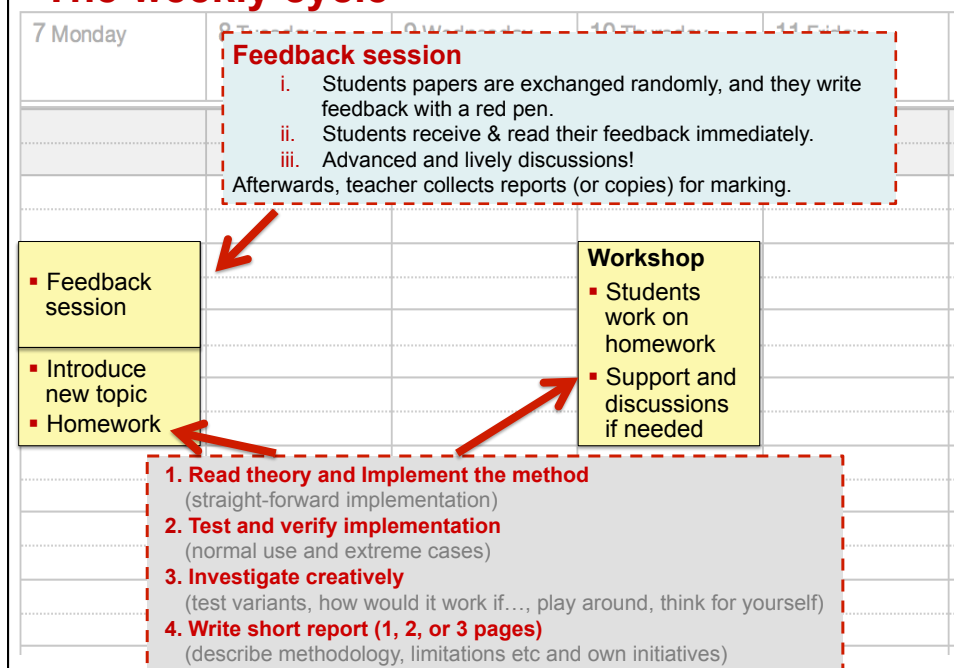


What Professor K does...



The weekly assignment cycle drives the course

The weekly cycle



Here comes the trick: Easy marking 😊

Grading scale

- Fail = 0p (Seldom happens)
- Pass = 1p (Typical grade)
- Brilliant = 2p (Requires lots of own initiatives)
- + With accepted participation in the feed-back loop +1p

Easy to see the difference between 0, 1 or 2 points, in fact it only takes about 1-3 minutes per paper...



At the end of the course, these points are converted to a final grade (no exam)

+ In some courses there is also an oral exam

The principle is to separate the processes

– then both can be made cost-effective

Feedback for learning

- made into a group learning activity
- intense involvement
- learn to discuss the subject
- immediate feedback
- expose variation
- social motivation

Assessment for grading

- by the teacher
- minimalistic
- sufficiently fair

Good for learning!



Continuous studies

- Distributes student effort during the course.

The formative feedback session as a whole (giving feedback, getting feedback and discussions) **generates learning:**

- Repetition – Variation – Fast feedback.
- Deep & interesting discussions (instead of discussions on definitions).
- Social motivation – expose your understanding to others and see theirs.

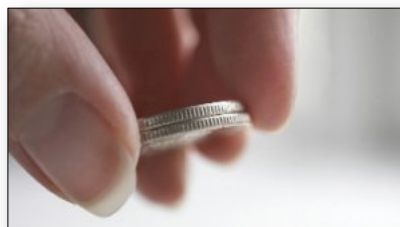
Satisfaction:

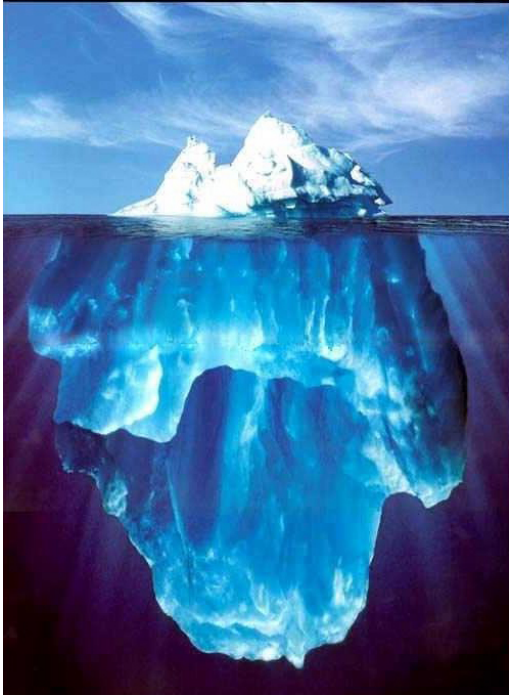
- Students feel that the teacher really cares about their work.
- Clear, fair and transparent grading system.
- Students feel their progression.

Good for the teacher!

- ≈1-3 minutes per paper.
- Final grading is no extra work ☺

Invest 2 NOK





The Iceberg Principle

Group work with
random presenter

Day 1:
All students in the group should be
ready to present the whole project

Last minute:
Choose the presenter randomly

Cost: 2 NOK



Pick me!



The teaching trick:

Do less of that which does not contribute

**Spend less time on...
ineffective tutorials.**



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...

A typical course format:

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



Student-Led Recitations

Teacher preparations

- Rename one tutorial per week as "student-led recitation"
- At course start, hand out problem sets with N problems, one sheet for each week

Student preparations

- Before each session, the students *prepare to present* their solutions on the whiteboard

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
 - "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?"
- Pick a new student for the next problem, etc



Simple "rules"

Ticking a number of problems (e.g. 65%) is a **course requirement**.

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

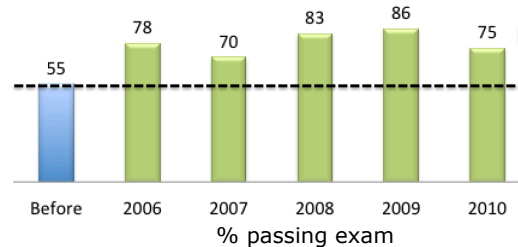
If a student who is picked is **obviously unprepared**, all his/her ticks are removed for that recitation.

The student must however demonstrate an **honest effort to prepare**, and be able to lead a classroom discussion to a satisfactory treatment.

This has luckily never happened!

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 scale 1 to 5)

Student experience - interviews

How long time did you prepare for the sessions?

- I tried to do as many problems as possible, well all of them because it is good for the exam. (laughter) For each session... 6 hours maybe. (A)

How did you prepare?

- We sat in a group and did the six problems, helping each other. Then the evening before I read through to get a good grip. Well, we sat... how long could it have been, 5 hours in the group and 2 hours on my own. (B)

When you study in groups, what is it you really do then?

- We take a vacant classroom and do one problem each and we stand together discussing it at the board. That's how we do the problems, on the board. (B)

If we look at the normal [teacher-led] exercises?

- Oh, nothing at all, I just go there. They are normal recitations where he solves problems, right? I don't prepare for that, just copy the solution and try to follow. Student exercises are better because you have worked on the problems. You should do that in teacher-led sessions too, or at least read the problems. Then you would learn more. But you mostly copy the solutions. (B)

Teacher experience



“It is so much fun to discuss the subject with the students on a much, much, much higher level”

Per-Erik Hellström
KTH

Less work

You have to design the assignments before the course starts, but then:

- no preparation before the session
- much fewer “poor” exams to correct

More effective as a teacher

- See early and clearly what is difficult or not
- You can go faster when you know when they are aboard
- Learn to design problems that show important, critical aspects

Analysis: Why is the 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** (easy to achieve) on **appropriate tasks** (this takes teaching skill).

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

Analysis: **Why is the 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 essential aspects, reflect the desired understanding
- Level of difficulty and complexity should be the same as in exam (tell the students!)
- + New problems every time (dress them in slightly new clothes)



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

Analysis: **Why is the learning dramatically increased? (3)**

Generates prompt feedback!

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

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

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

Analysis: **Why is the learning dramatically increased? (4)**

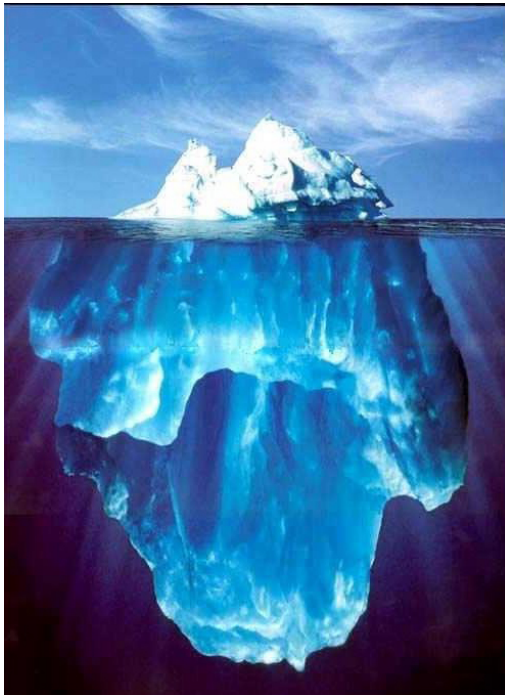
Students care!

- *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!

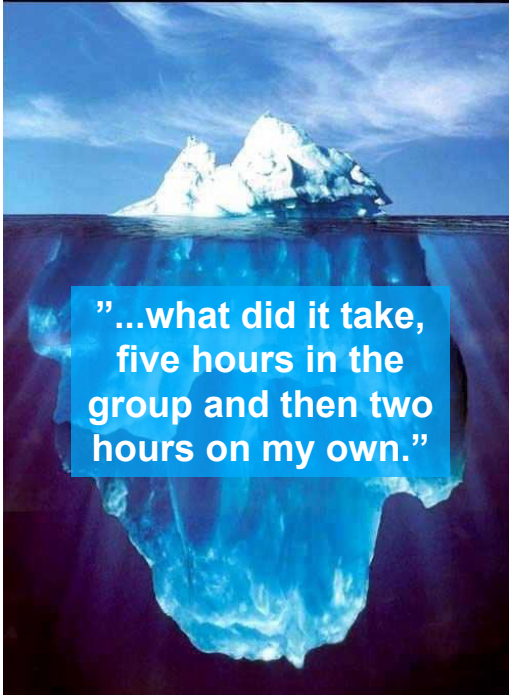
[Analysis inspired by Gibbs (1999) *Using Assessment Strategically to Change the Way Students Learn*]



The Iceberg Principle

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.



"...what did it take,
five hours in the
group and then two
hours on my own."



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



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

Seven minutes



The teaching trick:

Do less of that which does not contribute

**Spend less time on...
designing and correcting exams!**

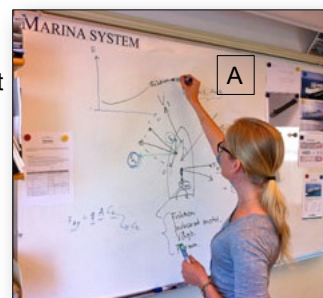


Oral exams are really good for learning

- Can be a better **test of understanding** & be individually tailored
- **Affect student preparation** (create the right expectation) – now they have to show "real" understanding, in real time

Sometimes teachers fear:

- that it is **difficult** for the teacher?
 - Reverse the burden of proof
("the first 7 minutes are yours to show me that you have reached the learning outcomes")
- that it is **embarrassing** to fail a student?
 - Use the written start
 - Ask how they think it went
- that it is **expensive** (takes time)?
 - But for a course of up to N students it is cheaper!
 - What is N for your course?



Katrin taking an oral exam

Written vs oral exam, teacher time

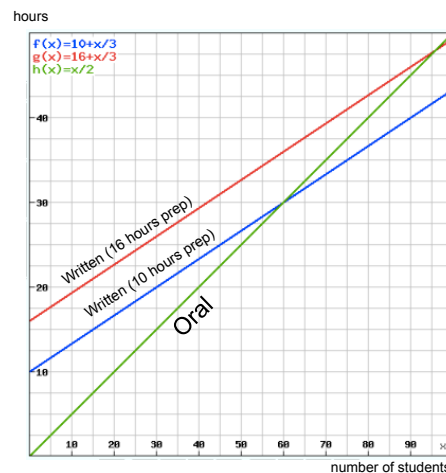
Written:

Design and construction of exam and solution-sheet takes $\approx 10-16$ hours.
Correcting one exam takes ≈ 20 minutes

Oral:

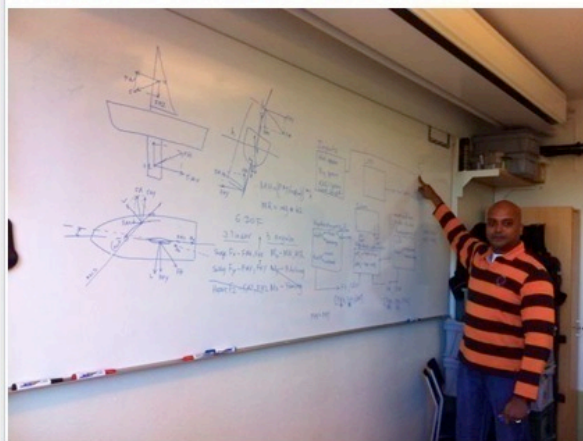
The exam takes ≈ 30 minutes.

**Moreover:
Consider the
gain at re-exam!**



Jakob Kutenkeuler
den 2 november

Jäddrar, så här skall det se ut på muntlig tentamen i seglingsmekanik när toppstudent briljerar vid tavlan. Bara att njuta av åkturen 😊



Sluta gilla · Kommentera · Dela

Du, Magnus Burman, Helene Rune och 17 andra gillar detta.



Skriv en kommentar...

The trick question

Do more of that which contributes to learning *Easy part*
(especially if it is cheap)

Do less of that which does not contribute *Hard part*
(especially if it is expensive)

Doing additional things on top of the old is not sustainable

So why do we often keep doing things that are less effective for learning?

Discuss X minutes with your neighbours

- notes

- notes

What reasons can there be...?

- Student expectations (or what we think they want...)
- Colleagues expectations (or what we think they think...)
- We like to feel clever (lecture, have answers to everything, finish student work so it looks good...)
- Tradition, unreflected routines
- Lack of knowledge and fantasy in course design
- We actually think that everything is the students' fault
- Burden of proof:
"when the old model doesn't work, it is the student's fault,
but if I try something new and it doesn't work, then it is all my fault"

Remember that we are here to
improve education – it is important



Note the general competences in many of the examples.

Tips! Adjust the learning outcomes so this is visible to students and programme leaders. For instance:

After the course you should be able to

- evaluate your own and others' work...
- critically review and give feedback on...
- evaluate technical solutions...
- orally explain and discuss your conclusions and the underpinning knowledge...
- argue and contribute in discussions about...

Student: Why should I [read their report]?

Teacher: It is part of the learning outcomes to be able to [evaluate your own and others work]. This will be a valuable skill in your future working life.

**This was not only about saving time
or a drop of oil in the machinery...**



Above all it is about

- more stimulating roles for teachers
- more stimulating roles for students

The roles that add most value are also the most stimulating ones... and they will be the last to be replaced by MOOC:s!



And it is not only a cliché that we only live once...



Ultimate frisbee



Dear Professor,



I coach the women's **ultimate frisbee teams** and based on your workshop I changed our program for the **practice weekend**.

Normally, since a game only involves 14 players, we would rotate and the others would do some drill on the side.

Now, instead, I had a non-playing team standing on the sidelines and assigned each of them a player. Then I stopped the game periodically and had the sideline players give individual feedback to their assigned player.

It went over remarkably well. A number of the ladies had very positive feedback, and said they had numerous strategy talks that they found incredibly helpful. It was also great for me, since I can't possibly watch every player all the time. It was incredibly time efficient!

So in conclusion, thanks again for the workshop. I thoroughly enjoyed it, and I thought you might like hearing about an application in a completely different "field"!

Best regards,
Professor D

Now that it is allowed to be lazy and smart...

Discuss time-saving ideas!

- Something you already do?
- Something you could do?