Tips, tricks, and experiences with active grading criteria and pointless exams

or

How to trap students into understanding

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Agenda

In a nutshell: assessing student's performance in a way which is *strictly aligned* with the learning objectives of a course is good because it efficiently direct students towards absorbing the material of the course instead of trying to "figuring out the system".

In this talk: *pointless exams* is a controlled, fair, and immediate approach to assess students in an aligned way.
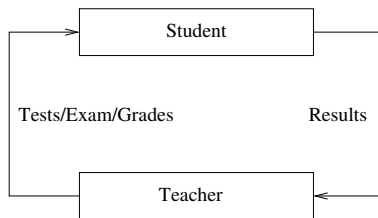
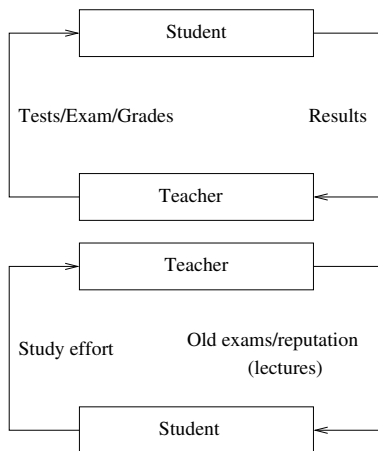**Outline:**

1. Some theory
2. Some practise
3. Some results

Controlling the time-step in computational ODEs...
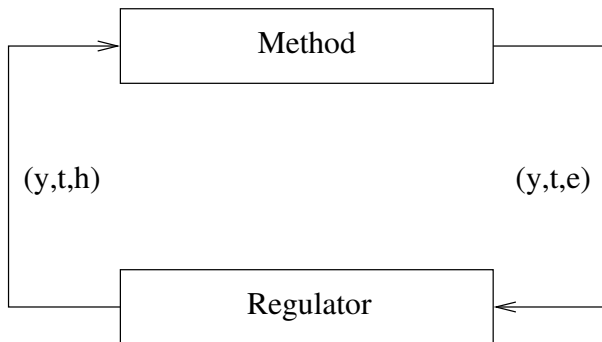
Controlling student's learning...

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Teaching as a control system

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Viewpoint (student): grade $g = f_2(e)$, invested study effort e.

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In other words: *align* the exam with the learning objectives (i.e. *the final grade* with *the amount of actual knowledge*).

Teaching as a control system

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To be fair: "...all students not in a coma want to learn *something*..." *(Biggs & Tang, 2007)*.

In practise...

- A typical exam has 40 points
- If you get 18 points, you get a 3 (pass)
- If you get 24 points, you get a 4 (pass with distinction)
- If you get 32 points, you get a 5 (excellent)

On most exams of this traditional type, the mapping from knowledge k to grade g is nonlinear and discontinuous. Analyzing the degree of fairness (and/or the efficiency) is virtually impossible.
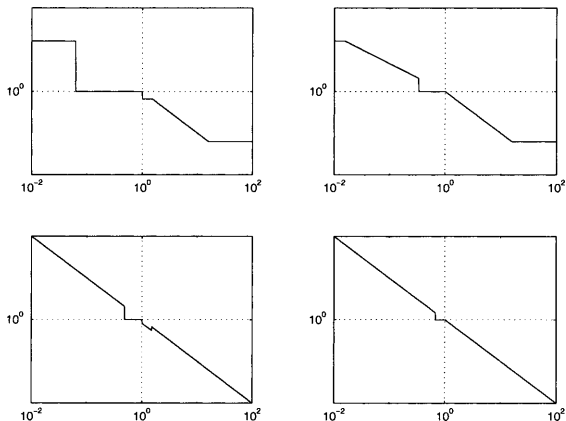
Figure 2. Stepsize strategies. Stepsize change ratios $\log(h_{n+1}/h_n)$ as functions of the error excess $\log(\hat{r}_{n+1}/\varepsilon)$ in four codes: DASSL (top left), RADAU5 (top right), LSODE (bottom right) and DASP3 (bottom left), a lesser known DAE solver developed by the author in 1976–1980. The graphs show the essential features of the strategies. The overall negative "slopes" reflect a negative feedback, which has a stabilizing effect. All strategies are nonlinear, discontinuous and unsymmetric, making it virtually impossible to analyze their dynamics.

Finita element methods: active objectives

To **pass the course** you should be able to

P1 derive the variational formulation for an elliptic PDE in 1 and 2 dimensions

P2 discretize the variational formulation with suitable basis functions and hence formulate a finite element method,

P3 implement the finite element method on a computer,

P4 predict the convergence behavior of finite element methods and -codes,

P5 for *time dependent parabolic and hyperbolic* PDEs, see P1–P3 above,

P6 discuss how finite element software works and use such software to solve more complicated problems.

Finita element methods: active objectives

For **higher grades** you are also required to know how to

- H1 derive *a priori* and *a posteriori* error bounds for elliptic equations in one and two spatial dimensions,
- H2 construct adaptive algorithms for local mesh refinement using these error estimates,
- H3 for time dependent problems, evaluate different time discretization strategies with respect to computational efficiency and stability.

Exam in Finite element methods 2011-04-26

- *Time:* $08^{00} - 13^{00}$. *Tools:* Pocket calculator, Beta Mathematics Handbook.

- This is an exam *without points*; each problem is graded separately with respect to the learning objectives the problem targets. Problems are marked according to the level of the objective: [P] = goal required to pass, [H] = goal for higher grades.

- All your answers must be well argued and calculations shall be demonstrated in detail. *Solutions that are not complete can still be of value if they include some correct thoughts.*

Question 1

Consider the problem: Find $u(x)$ such that

$$-(a(x)u'(x))' + c(x)u(x) = f(x), \quad x \in I = (0,1),$$
$$u(0) = 0, \quad a(1)u'(1) = \alpha,$$

where $a(x) \geq a_0 > 0$, $c(x) \geq c_0 > 0$, and $f(x)$ are given functions.

(a) Derive the variational form. [P]

(b) Let $0 = x_0 < x_1 < \cdots < x_N = 1$ be a discretization of I. Derive the finite element method using continuous piecewise linear basis functions. Present the resulting linear system of equations. [P]

(c) The entries in the load-vector are often assembled by using some quadrature rule. Give an example and write down the resulting formula in the present context. [P]

(d) Suppose that $\alpha = 0$. Prove that there is a constant C such that $\|u\|_{H^1(I)} \leq C\|f\|_{L^2(I)}$ in terms of the $H^1(I)$-norm $\|v\|_{H^1(I)}^2 := \|v\|_{L^2(I)}^2 + \|v'\|_{L^2(I)}^2$. [H]

Grading matrix

Goal	Question	Grade
P1	[Q1] [Q2] [Q3]	
P2	[Q1] [Q2] [Q3]	
P3	[Q5]	
P4	[Q3] [Q4]	
P5	[Q2] [Q3]	
P6	[Q5]	
H1	[Q3] [Q4]	
H2	[Q5]	
H3	[Q2] [Q4] [Q5]	
	Total grade:	

Grading matrix

Goal	Question	Grade
P1	5 [Q1] 5[Q2] 5[Q3]	5
P2	5 [Q1] 5[Q2] 4[Q3]	5
P3	3 [Q5]	4
P4	4 [Q3] 4[Q4]	5
P5	3 [Q2] 3[Q3]	3
P6	4 [Q5]	5
H1	4[Q3] 5[Q4]	5
H2	4[Q5]	4
H3	4[Q2] -[Q4] -[Q5]	-
	Total grade:	???

Diagnostics #1: "Mid course evaluation"

Please criticize in a constructive way the course so far by answering (at the other side of the paper) the questions below. This is your single chance to improve the course!

1. How do you think the lectures and exercise classes are working? How can they be better?

2. How do you think the laborations are working? Comments? Too easy/difficult?

3. Do you feel confident that you will reach the learning objectives of the course? What is the single change that would improve the course the most in this respect? *(The learning objectives of the course are reproduced below.)*

4. Has there so far been anything in the course that you consider particularly difficult and would like to see repeated?

5. Any other comments? *(spoken language, communication, course book, group dynamics...)*

Diagnostics #2: "Grade yourself"

The purpose with this quiz is to help me design the final lecture.

1. **Don't do anything until you have obtained a number**
   $N \in \{1, \ldots, 9\}$!

2. Now, write your number here: $N = \underline{\qquad}$.

3. In the grading matrix below, and for each learning objective, please estimate your own grade should you take the written exam *tomorrow*. *(The learning objectives are reproduced at the other side.)*

4. Based on these grades, estimate also your final grade at 'Total grade'. Explain in one sentence how you arrived at your final grade.

5. Finally, below the grading matrix, write a (very loose) sketch of what you believe is a typical exam problem for one of the learning objectives. If your number is $N \in \{1, \ldots, 6\}$, choose learning objective PN, otherwise if $N \in \{7, \ldots, 9\}$, choose learning objective H($N - 6$).

Course evaluation
eValuering 2.1 - Administration   http://evaluering.ibg.uu.se/cgi-bin/engine_it.pl

EXAMINATION

*Do you feel **confident** with the grading system that will be used at the final exam?*

Svarsalternativ	Graf (%)	%	Σ
1 (= no, not at all)		7	2
2		10	3
3		33	10
4		27	8
5 (= yes, definitely)		23	7

Medelvärde: 3.5
Standardavvikelse: 1.17

*In your opinion, does the grading system make it **more difficult** to pass the course?*

Svarsalternativ	Graf (%)	%	Σ
1 (= no, it makes it easier)		3	1
2		0	0
3 (= about the same)		43	13
4		17	5
5 (= yes, definitely more difficult)		37	11

Medelvärde: 3.83
Standardavvikelse: 1.05

Course evaluation

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*How do you think that the grading system has affected **how hard you have studied** in this course?*

Svarsalternativ	Graf (%)	%	Σ
1 (= I have studied less)		0	0
2		0	0
3 (= about the same)		83	25
4		13	4
5 (= I have studied harder)		3	1

Medelvärde: 3.2
Standardavvikelse: 0.48

- Maybe we can make the average of all the matrix values. I think that will be more fair enough. [1]
- It is more difficult to get Higher grades. [6]
- I do not like the grading system at all! [7]
- I really appreciate that I know what I need to know to pass the course or to get higher grades. If you don't want or can study for the highest grade you can focus on the "pass"-requiriement and learn those really good. This way I can actually understand the basics and if I end up needing FEM later in my life i can easily jump in to a text book and learn the advanced things. Otherwise you learn a little bit about everything and forget it all after 2 weeks. so: 2 thumbs up for pointing up the most important stuff! should be used in all classes! disclaimer: we havn't actually had the exam yet... [9]
- I am really scared to do a "slarvfel" and not pass. [10]
- I like the grading system, it prevents people from just studying for the typical exam problems and forces them to learn all of the course's objectives. [12]
- I think the the grading system is a beautiful idea that doesnt really work in practice. A regular exam/grading system which covers all the goals probably makes the students study and learn as much. Now too much time was spent on explaining the grading system. [13]
- About question 2: I think we will have to wait until Tuesday to answer that one... I should not make it more difficult, but i guess it could since "points" from the Higher goal cant be used [16]
- Jag tycker det är ett bra system. Det verifierar att studenten verkligen har kunskaper som motsvarar kursens innehåll. Sen har systemet inte (hittills) gjort att jag pluggat mer. Men, jag kommer definitivt försäkra mig om att jag kan alla punkterna. [22]
- Some learning objectives are "fuzzy" and have some overlap, which has probably resulted in some confusion over the grading system. But I think that overall it seems reasonable. [24]
- It's more deependent of the teachers impresion and judgement. It's harder to appeal if your not satisfied with the judgement. [25]

Interviews

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"It is clear and good and perhaps fair... but on the other hand I kind of feel that the old system with points... in some way I feel that that is also fair. Because there you don't have to pass all moments but you can sort of prioritize other moments..."

Interviews

Was it more or less fair compaired to traditional exams?

"...it becomes more fair I believe since now the criteria are very clear. Everybody knew that these stuff you must know, and it kind of says on every exercise, "now we will check this". [...] I felt like he checked what you had solved, ..."

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Was it a waste of time to explain the grading criteria?

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Was it too easy to pass?

"No... it's probably the other way around in that case... the point I believe is that you're supposed to understand these [grading criteria], ... in the old system you can sort of take a chance and learn half the course and take enough points so you pass. ... if you miss one of these then you don't pass..."

Conclusions

Pros:

- You have to put some effort in explaining the goals.
- You must think twice when constructing the exam.
- Without explaining yourself you can ask open questions on the exam ("describe", "explain", "write a mini-essay").
- You can quite easily say what a student that passed the exam has actually learnt.
- Students put effort in "knowing what stuff you should know" rather than "knowing what stuff will be on the exam" (simply because they are now the same!).
- You only write comments in the exam. You don't have to prove "where x points were lost".

Conclusions

Cons:

- ► You have to put some effort in explaining the goals.
- ► You must think twice when constructing the exam.
- ► It is more difficult to include extra credits from assignments or diagnostic tests on the exam.