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Innovating a classic course in concrete structures

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Materials, Systems and Structures in Civil Engineering 2016
Segment on

Innovation of Teaching in Materials and Structures



Edited by
Per Goltermann

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Photo 1st cover page: Students participating in experimental course. Credit: Per Goltermann
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INNOVATING A CLASSIC COURSE IN CONCRETE STRUCTURES

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Abstract

A large number of changes, new activities and approaches have been tested at DTU in the teaching of concrete structures: Use of mandatory assignments, handing out solutions before or after exercises, detailed or summary solutions, brush-up teaching materials, strengthened consistency in solutions, videolectures recorded from lectures or produced from Powerpoint, electroic examples, inductive approach, repetition for reexams with or without lectures or supervisor or E-learning material, instruction videos for lab testing and many other things. The author will present his approaches and the resulting impact on the students learning – what worked very well and what had no effect. The author will also identify which of these activities, that can be implemented easily and have the largest effect - eventually with the inclusion of the students.

1. Introduction.

The author started his career as an associated professor in the summer of 2015 after 20 years as a consultant engineer. The classic course in concrete structures was first taught by the author in the autumn of 2015 as a classic course with 4 hour sessions, comprising of lectures and exercises. The student should hand in 3 assignments, (25 % weight) and attend a 4 hours written examination (75 % weight for the grade).

The approach of the teaching was from the beginning of the authors teaching changed from the classic approach to include an inductive aspect [1], so each session would start with pictures, a demonstration or a short video with the phenomena or failure, which the current session would deal with (see Figures 1 to 3).



Figure 1 - Beam tested during a CDIO-project [2].



Figure 2 - Extracted frame from video of the beam testing in Figure 1 [2].

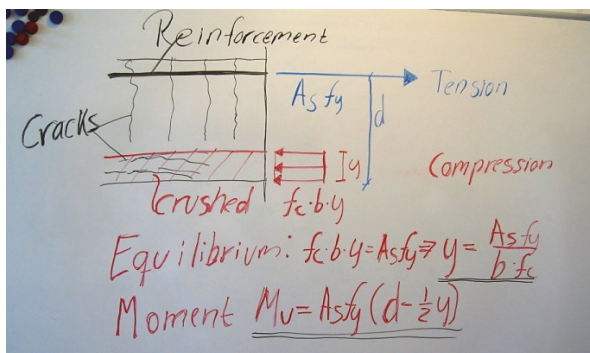


Figure 3 - Analysis of failure in Figure 2 and estimation of the capacity [2].

The use of the inductive approach was very popular, but the results (see Table 1) soon revealed that not all students learned as much as they should do and that many students still fail. This sparked the development of the teaching in this course, which have by now been going on for almost 10 years and been delivered to app. 2000 BEng and BSc students.

Table 1: Performance of all students in spring semesters [3]. Note 1: Values denotes students assignments handed in. Note 2: Values in brackets are for students, actually passing the exam.

Semester	Signed up for course	Attending at exercises	Signed up for exam	Passed	% Passed	% correct among passed
S2006	94	(76) ¹	85	45(62)	73%(53%)	66%(71%) ²
S2007	138	(121) ¹	152	98(77)	64%(51%)	65%(72%) ²
S2008	177	No data	167	114	68%	65%
S2009	193	112	178	120	67%	66%
S2010	222	142	213	173	81%	74%
S2011	231	136	220	151	69%	73%
S2012	230	151	227	159	70%	75%
S2013	236	131	220	161	73%	72%
S2014	256	156	259	201	78%	75%
S2015	151	118	195	138	71%	70%

1.1. The main questions and the test program

A number of options and activities were considered and the following were found (over the years) to be the most important questions:

- Should we change the assignments and the grading approach ?
- Can we do something for the less qualified students and still support and challenge the good students ?
- How should we handle the solutions for the exercises ? Detailed or brief solutions ? Should they be handed out before or after the exercises ?
- Can we facilitate the students possibilities for working independent ? Could this be achieved by using some E-learning aspects ?
- Can we influence the amount of work the students actually do ?
- Can we support the failed students efficiently for their reexams ?

The paper will focus on the teaching in the spring semester, where the largest group of students attend the course. The failed students, who study for a reexam, will be evaluated in their fall semester as this is where the largest number of failed students is observed.

2. The assignments and their use in the learning and the grading

The course was in spring 2006 and 2007 graded on a combination of a written examination (weight 75%) and three assignments for each student (weight 25%). This approach had been introduced in order to increase the number of students passing the course and also to force the students to work more during the lecture period. The work load in developing and correcting these assignments did, however, add up to a large amount of time. It was expected that this time could probably be better used in innovating the course – just as it seemed the this control of the students own planning of their work was in conflict with the university policy and the educations competence profiles of making “the students responsible for their own learning”.

The results (Figure 4) reveal that there is very little correlation between the student performance in the assignments and in the written exam. These observations lead to the opinion that, a number of students had a (too large) amount of help from other students and that the assignments did not truly represent their own contribution. It was therefore decided to cancel the assignments after 2007 as these seemed to have no relevance for the mandatory individual grading.

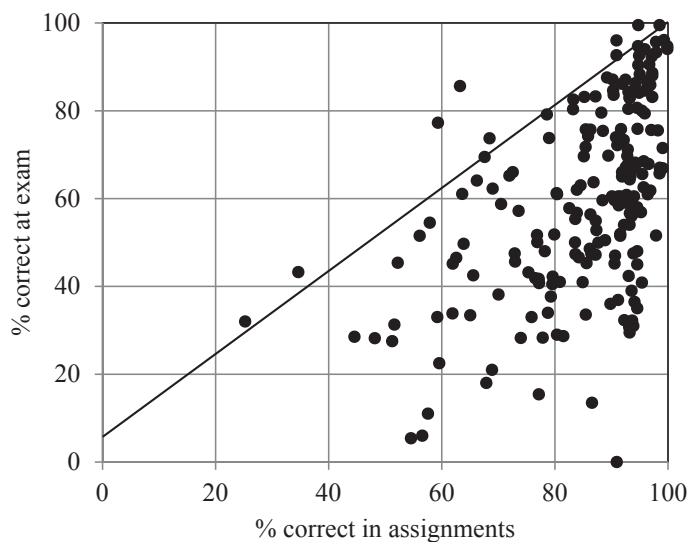


Figure 4. Individual students performance at exam versus performance in their assignments in 2006 and 7 [3].

The surprising effect of this change was that not only did the number of students passing the course remain fairly constant, but the percentage of students passing the exam did actually increase substantially (Table 1). Similar observations have been reported at conferences, but have not been published as far as the author knows.

3. Upgrading the unqualified students

This course has as prerequisite certain building mechanics courses as most university course after the first semester. Not all knowledge from a prerequisite course is normally used in the next course, nor has all that students necessarily understood and remembered everything from their prerequisite courses.

It was decided to start the teaching at the level, which the students within reason should have and not lower the level to accommodate the weaker students, but identify those weak students and offer the an efficient approach to catching up.

Two “self-testing” exercises, in the beginning of the course, dealing with generalized stresses in beams and cross-sectional parameters, as these seem to be where the below average students have their weakest points in the relevant topics. These exercises are based on the required key knowledge from the prerequisite courses and provides the individual student with a clear understanding of his or hers eventual lack of proper qualifications for the concrete structures course – so the student in due time may take action and catch up with the rest of the students.

To facilitate the catching up, a “patch” was constructed and handed out in spring 2010 in the shape of a “cookbook” [4], containing a clear set of procedures and examples for determining cross-sectional parameters, This “patch” was intended for selfstudy and would not be a part of the teaching in the course, although all examples and solutions were rewritten to follow the approach outlined in the cookbook. The students have reported that it has been a great help for the weaker students, and as it can be seen from Table 1, this “patch” and the rewriting of examples and solutions to follow the same approach have improved the performance among the passed students with 5-10% points, corresponding to $\frac{1}{2}$ to 1 grade better in average.

A second experiment in the catching up was to introduce a game based learning system (“Schnittkraftmeister” with English userinterface) for selftraining in 2015 in order to train their ability to determine the cross-sectional forces. This has not lead to any significant improvement of their skills, but nor have their use of the system been registered.

4. Solutions to exercises, how and when

The exercises and their solutions are considered essential for the students learning process. It has therefore often been discussed how such solutions to exercises should be (detailed, summary, only final results or perhaps even not be exist) and also when they should be handed out or not.

Before spring 2011, solutions of varying degree of details had been used in order to force the students to find the explanations in the textbook and by doing so, also be forced to read the text. It was also organised that the student would only get access to the solutions after the end of the exercises, as the main opinion was that students would learn less after they see the solution, than before they see it. This was, however, a tiresome and timeconsuming approach

for the teachers and against the concept of “the students being responsible for their own learning”.

In the spring semester 2011, all solutions had been changed to being detailed and to be available before the exercises – in some cases available from the beginning of the semester. The exam results before and after this change showed no effect in the number of students passing the exam, or in their average performance at the exam (see Table 1). The students were, however, naturally pleased with this change and were much easier to handle during the exercises, as they could work more independently.

5. Establishing E-learning activities

The inductive teaching had from the beginning introduced use of videos from experiments or demonstrations using a webcam, but it was decided to look into the e-learning possibilities, without reducing the contact time between teacher and students. All lectures were therefore recorded by DTU’s LearningLab in spring 2012 including the lectures presentation of slides, demonstrations and examples on the blackboard. As an alternative to these videos, E-presentations were produced from the Powerpoint presentations with the same explanations as in the lectures. All blackboard examples - both those the time permitted and those the lecturer would have liked to present – were produced as E-examples, which could be played and printed.

All videos were placed on Youtube, account ConStruct2800Lyngby and the course materials were placed on a publicly available webpage www.betonkonstruktioner.byg.dtu.dk, where overheads, exercises, solutions, and examples can be downloaded from (they are unfortunately in Danish according to the university rules for basic courses). These materials are not intended to replace the lectures, but to be used as an alternative and to facilitate the students independent studying.

The Youtube records over the last 3 years shows that 60 % of the hits during the lecture period occurs on the day, where the lecture takes place and that a large number of hits are observed in the week just before the exam date.

Questionnaires during the spring semesters showed no clear pattern in which of the different E-learning materials the students preferred. This indicates that the E-presentations and E-examples could replace the videorecordings of the lectures or the other way round and provides some freedom for the teacher’s development of materials.

The experiences are that this concept has not changed the performance at the exam, nor has it changed the student’s frequency at showing up for the exercises (see Table 1). The concept has, however, made the students more independent during the exam period, where fewer students feel the need to show up at the teacher’s office for asking questions.

The materials have later (2013 for iPad and 2015 for Android) become available also through a teaching app “DTU Beton”, in order to facilitate the use of their SmartPhones as an additional screen or to listen to the teaching during transport time.

6. Supporting the failed students

The large number of students in this field has resulted in a number of students, who fail and need to take a reexamin. The students, who fail in the spring semester and sign up for the reexamin in the autumn have over the years been offered different types of help. In the autumn semesters in 2007, 8 and 9 the students could actually follow the lectures and the exercises in the autumn as the course was offered twice a year.

This changed in 2010, where no course was offered in the autumn, only a reexam and a “concrete café”. This cafe is simply a room assigned for the students exercises every Tuesday afternoon, with a teaching assistant available for two hours and offering a general question session a few days before the exam. In 2012 this offer was augmented through the developed E-learning material.

Table 2: Performance of students attending re-examination in the autumn [3].

Semester	Signed up for reexam	Passed	% Passed	% correct among passed
A2007	9	3	33%	68%
A2008	20	11	55%	58%
A2009	25	13	52%	59%
A2010	12	5	42%	59%
A2011	24	12	50%	60%
A2012	25	17	68%	65%
A2013	31	23	74%	71%
A2014	20	14	70%	64%
A2015	28	17	61%	59%

It can be seen from Table 2, that the concept of the “concrete café” in 2010-11 was as good for the students (60 % passing) as the option of following the full course in 2007-9 (50% passing). The experiences were, however, also that when this was combined with the E-learning material in 2010-15, the failure rates at the exam dropped further (68 % passing).

The students who fail in the spring semester are often students, who have not followed the exercises on a regular basis. The number of students, who shows up for the “concrete café” is still low, but the impression (and registrations of individual appearance at the exercises as well as responses from questionnaires) is that they use the teaching material and the E-learning materials at home and shows up for discussions with the teaching assistant, whenever they feel the need.

7. Conclusions

The approach of maximizing the students possibilities for efficient and independent learning have worked by introducing the E-learning, the consistent solutions and examples and the cookbook and have increased the “student production” substantially. The E-learning is at the moment only an alternative to the current teaching in the spring, but has shown it’s value during the autumn semester, where the failed spring students study for their reexam.

It can, however, be concluded that it has been a success to develop teaching material, which optimizes the students chances of studying independently in an efficient manner. The use of this material will be developed and tested further, although it is not the intention to reduce the number of hours contact with the students, but rather the intention to use this time more efficiently.

The future developments in this project will go into further details with the documentation of the effects of different teaching approaches. It is, however, already clear [3] that the student performance at the exam is (in average) correlated to the amount of exercises they attend to, their grades in the prerequisite course, the grade in mathematics and their average grades in their studies – with pretty much the same correlation between all these parameters. This does not mean that the teaching and learning approach do not influence the student performance, but rather that the differences in the students performances to a large extend can be explained by the traditional explanations.

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