Teaching concrete structures

Development and new experiences

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Published in:
Proceedings of the XXII Nordic Concrete Research Symposium

Publication date:
2014

Document Version
Peer reviewed version

Teaching Concrete Structures: Development and new experiences

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ABSTRACT
The teaching of concrete structures has been revised and a number of new approaches have been developed, implemented and evaluated. Inductive teaching, E-learning and "patches" have been found to be improvements and may be an inspiration and help for others development of the teaching and learning

Key words: Knowledge and Teaching, Structural Design, Testing.

1. INTRODUCTION

The Technical University of Denmark offers 61 different engineering educations (17 BEng, 16 BSc and 28 MSc educations). The faculty members responsible for the development and execution of the courses and projects should ideally use 50 % of their time on research and 50 % on teaching and supervision. This shows that teaching is as important for the university as the research, since the engineering candidates must be seen as one of the university's main products. This makes it very important to evaluate, rationalize and improve the teaching and learning activities for the faculty and the students.

The department of Civil Engineering employs app. 60 faculty members, is responsible for 130 courses (some offered bi-annually) and supports significantly 9 educations. The author has for the last 8 years been the main responsible for the courses in basic concrete structures on the educations BEng Architectural Engineering, BEng Arctic Technology, BEng Civil Engineering, BSc Building Technology and BSc Architectural Engineering. The author has in his professor (MSO) assignment experimented with changes in the teaching and grading, use of inductive approaches and E-learning, in order to record, review, develop and test new approaches to rationalize and improve the teaching and learning.

2. DEVELOPING AND TESTING NEW TEACHING

2.1 The intentions – what we really want

We teachers probably all wish our teaching and our students learning to be better and more effective. In order to achieve this, some main actions has been taken:

- Base lectures an inductive approach, which links reality and theory together from the beginning of the session.
- Increase student motivation through illustration of the lectures relevance.
- Improve the possibilities for the students to study independently.
- Record student performance and activities and link these to the exam results.
- Reduce time consumption and the amount of boring work for the teacher.

In order to check the results of these actions the students attending exercises are counted or later even registered individually, the frequency of Youtube hits recorded, course evaluations collected, additional questionnaires issued about students work habits and use of the teaching materials.

2.2 What has been tried so far

During the last years the changes and new activities introduced in the courses have been:

- Introduce the inductive approach, where the lecturer show the phenomena first and develop the theory based on the observations from the observations. This is either based on videos from student final project work or based on a demonstration in the auditorium. Requirement: Students who do testing and videorecord their tests (now standard activity in final projects) plus a Webcam for demonstrations in the auditorium.
- Cancel the mandatory assignments, which formed a part of the grading in the courses.
- Develop a "Patch" for the students who had not understood or perhaps forgotten their basic building mechanics (prerequisite course), dealing with estimations of cross-sectional constants
- Introduce consistent and detailed examples and solutions, following the rules from the patch.
- Introduce detailed solutions to exercises, in the first semester to be handed out after the exercises and in the following semesters to be handed from the beginning of the semester.
- Introduce multiple choice questions as a part (35 %) of the exam.
- Change the course from being offered biannually to being offered only once a year (spring semester) and instead offer a "Concrete Café" in the autumn semester to support failed students in their independent study for the re-exam.
- Develop the course homepage www.concretestructures.byg.dtu.dk, where the course plan and all the teaching materials are publicly available. This contains also 8-10 old exams for download with solutions, following the consistent approach.
- Develop an App "DTU Beton" for IPhone and IPad's to provide easy access to the course materials.
- Videorecord lectures. The videos are placed on Youtube, account ConStruct2800Lyngby. Requirement: DTU's LearningLab recorded and edited the lectures in real time for streaming and storing.
- Produce E-presentations from the Powerpoint show by recording the presentation and the accompanying speech, exporting them as wmv-files and placed these on the Youtube account. Requirement: A Skype Headset and Office 2010.
- Generate E-examples as dynamic pdf-files, placed on the homepage. The text can be seen and printed and the student can listen to the explanations. Requirement: A SmartPen and paper with a special print, where the lecturer writes on the paper and talks exactly as he would do with a student sitting next to him. The students will need Adobe Reader and Adobe Flash Player.

2.3 Overview of the main results

The main results are that

- The student performance at the exam has been improved by a) cancelling the mandatory assignments and b) producing consistent examples and solutions. The performance has not been changed by c) making detailed solutions available prior to the exercises or d) introducing E-learning materials in the spring semesters as shown in Table 1, but it did have a significant improvement at the re-exams as shown in Table 2.
- Productivity has also gone up as the number of students, who pass the courses annually have been increased with app. 50 %, the percentage of re-examined students passing their second attempt has increased app. 50 % and the course is now only offered once a year, reducing the number of lectures with 50 %.

- The students do not have a fixed preference for a specific type of E-learning materials as seen in Table 3, but they do use the materials, especially in the autumn semester.
- There is a clear correlation between how often the students show up for the exercises and how well they do at the exam as seen in Table 4. This can also be correlated to their past performance during the studies and represents essentially their ambition and study habits, (but it did also enable the teacher to identify the 5 % of the students, who worked independently, rarely showed up and still received top grades).

Table 1 - Student performance in spring semester.

Semester Spring	Signed up for courses	Attending exercises (average)	Signed up for exam	Passed Course	Correct answers at exam among passed at exam
S2007	138[1]	Not counted	136	104/85 (76%/62%)[2]	67%%/73%[2]
S2008	177[1]	Not counted	167	114 (68%)	65%
S2009	193[1]	Not counted	178	120 (67%)	66%
S2010	222	142 (64%)	213	173 (81%)[3]	74%
S2011	231	136 (59%)	220	151 (69%)[4]	73%
S2012	230	151 (66%)	227	159 (70%)[5]	75%
S2013	236	131 (56%)[6]	218	156 (72%)[5]	72%
S2014	256	156 (61%)[6,7]	(-)[7]	(-)[7]	(-)[7]

Table 2 - Student performance in autumn semester (among those failed in the spring attend the re-exam in next semester).

Semester Autumn	Signed up for concrete café	Attending exercises (average)	Passed Course	Correct answers at exam among passed at exam
A2007	(9)[1]	(-)[1]	3 (33%)[1]	68%
A2008	(20)[1]	(-)[1]	11 (55%)[1]	58%
A2009	(25)[1]	(-)[1]	13 (52%)[1]	59%
A2010	12	8	5 (42%)[8]	59%
A2011	24	10	12 (50%)[8]	60%
A2012	25	4	17 (68%)[8,9]	65%
A2013	33	6	23 (72%)[8,9]	71%

Notes for Tables 1 and 2

1. Courses are offered biannual until end of 2009, after this only in spring semester.
2. Grade and passing of the course (76% pass) is based on a combination of written exam (62% pass) and assignments (90% pass). The first values in Table 1 are based on those who pass the course and the second are based on those who actually pass the exam. This approach was abandoned after spring 2007, after which the grades are based entirely on the exams. The exams in the spring are 35% based on MultipleChoice and 65 % on traditional questions, whereas autumn examinations are normally entirely based on traditional questions.
3. Detailed solutions are now developed for all problems and made available after excises. A “Patch” has been developed in the shape of a cookbook with examples for the determination of cross-sectional properties. The cookbooks approach is implemented in all examples and solutions.
4. Detailed solutions are made available from beginning of semester and a homepage is developed.
5. Lectures are being recorded in S2012 and S2013 and placed on Youtube (user ConStruct2800Lyngby) along with E-presentations. The remaining course materials

including the E-examples are placed on the course homepage (www.concretestructures.byg.dtu.dk).
6. Individual registration of attendance three times during the semester (student signatures).
7. Exam in spring 2014 will be in May after this paper is handed in, so data for this semester are either missing or incomplete at the moment. Lectures are not recorded this semester.
8. After 2010 the courses are only taught in the spring semester and a "concrete cafe" is offered for those students, who sign up for a re-exam in the autumn semester.
9. E-learning materials from spring semester are available in the autumn.

Table 3 - Questionnaires 2012 and 2013 on use of E-material. Question: "How much did you use the following E-material ?".

	Videos of lectures		E-presentations		E-examples		At least one of the types	
Answer	S2012	A2012	S2012	A2012	S2012	A2012	S2012	A2012
Very much	14%	20%	10%	0%	16%	6%	28%	25%
Much	15%	33%	18%	44%	25%	31%	32%	63%
A little	35%	40%	35%	38%	36%	63%	27%	13%
Not at all	36%	6%	37%	19%	23%	0%	13%	0%

Table 4 – Students performance versus attendance at exercises (individual registration 3 times in spring 2013). Note 1: Grades are A=12,B=10,C=7,D=4,E=2,Fx=0,F=-03.

Parameter	Registered 0/3	Registered 1/3	Registered 2/3	Registered 3/3
Number of students in S2013	33 %	25 %	21 %	21 %
Correct answers at exam	42 %	55 %	64 %	71 %
Percentage passed exam	44%	62%	80%	88%
ECTS/semester	23,2	25,5	27,5	28,5
Average grade during their studies[1]	6,3	6,9	7,0	7,8
Building mechanics, grade[1]	4,2	5,3	6,8	8,1
Mathematics, grade[1]	6,1	6,9	7,1	7,8
Failure percentage in their studies	23,3%	13,2%	9,5%	5,7%

Student motivations has also gone up in these years, registered by the course evaluations and students comments, resulting in the author receiving the students associations price as "Teacher of the Year" at DTU in spring 2013 for the teaching in the courses.

3. CONCLUSIONS

The main conclusions are that

- The new approaches have worked quite well, but study habits (amount of work and work methods) still dominate the student performance. Consistent teaching approaches and substantial possibilities for selfstudy help the students significantly.
- The teachers' workload can be reduced while achieving the same or better performance from the students. The E-learning can often be established with a minimum of investment and training, but should probably always be combined with the traditional interaction between the students and the teacher. The E-learning opens new possibilities.
- Using an inductive approach helps motivating the students, but will not alone improve the student performance.
- Changes in the teaching or learning should preferably always be dealt with as a scientific experiment, where the outcome is measured and compared to a reference (as e.g. how well the students normally perform and how many resources are used).