Constructive alignment in solid mechanics courses by means of project assignments

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***Abstract*— This short text paper describes the procedure of planning and implementing project assignments as a means to constructive align courses in Solid mechanics at the school of Civil enginnering at Chalmers. The courses has now been given twice and we summarize our experiences so far.**

Constructive alignment, Learning outcome, Solid mechanics, Assessment, Project assignment.

I. Introduction

In 2015, the school of Civil engineering at Chalmers University of Technology, launched two new, partly co-organised, programmes: Civil and environmental engineering (180 HEC) and Civil engineering (300 HEC). As a part of this process two new courses in solid mechanics, TME295 [2] and TME300 [3], was developed to replace the one from the old Civil engineering programme.

The old course had for some years been troubled with low examination rates and a high student workload. It was therefore, decided (by the teachers) to redesign the courses from the start instead of simply repackaging the old.

This paper describes the development and the conclusions drawn from this course design process as well as the implementation for the academic year 2016/17.

II. Constructive alignment

Constructive alignment [1] is today an increasingly popular method to design, develop and improve existing courses. One key feature of the method is to assure that the learning activities are aligned with both assessment and learning objectives. This will support the students in their own learning to reach the outcomes. Also note that for this method to work, it is necessary to have clearly defined learning outcomes.

For the reasons described above, constructive alignment was chosen as the main method to redesign the course. In fact, also at the program-level (for the Civil engineering education), constructive alignment is also used. This meant that the activites and goals in the course also needed to align with those set at the program-level.

III. Project

We reasoned, one way to achieve an alignment, between the teaching and learning activities with assessment, would be to introduce a compulsory project. In this project, the students would analyze a local pedestrian and bicycle bridge in Gothenburg as shown in Figure 1. This real-world problem would hopefully be motivating for the students, but more importantly, the included learning activities would cover a large portion of the course learning objectives.

The design of the project and its subtasks were chosen to stepwise introduce the students to the different course topics and let them exercise their skills. Roughly, the tasks connected to the bridge covered about 70% of the course learning outcomes. The remaining 30% was covered by introducing some additional assignments within the project.

IV. Course organization

There are 200-230 students attending the courses in total. In some ways, the courses are traditional in the sense that they include lectures and problem solving sessions (the teacher solves problem in front of the students).

Parallel to these activites, the students work in pairs on the project which itself contains scheduled learning activities such as: weekly consultations with teachers in class; three computer workshops and one physical testing session.

To provide feedback to the students the project is divided into three smaller parts that are to be submitted for correction throughout the course. This allows for (reasonably fast) feedback to the students which help them in their personal learning.

Finally, the course is examined by the project assignment (2.0 HEC) and by a graded final written exam (4.0 HEC) consisting of theory questions and problems to solve.

V. Experimental studio

The course also includes a session consisting of hands-on experimentation. Here the students get to investigate concepts such as *instability*, *reaction forces*, *stress concentration*, *beam bending* and more. During this lab, the students also gets to see and collect experimental data from a live tensile test (the most commonly used experiment in the field). This data can then be

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Fig. 1. Photograph of the pedestrian bridge analyzed in the project.

used in a parallel math course on Mathematical statistics; aligning the activities in one course with the other.

VI. Assessment and course evaluation

At the time of presentation, the new courses will have been given twice. However; at the time of writing, only data from the first year is available.

After the first written exam (year 16/17) 75% of the students passed. This can be compared to an average of 55-65% for the old course. Clearly, it is yet too early to draw general conclusions since this observed increase may be caused by other factors. However, we still find the results promising.

Comments from the course evaluation has mostly been positive: The physical experiments and the analysis of a real bridge structure was highly motivating. Additional comments from students say they experienced a high workload but they felt that the project “forced them” (in a good way) to follow the course tempo as well as preparing them for the final exam.

Also the commitment of the teaching team was appreciated.

One the down-side, a few students sometimes felt that their assignments were not judged and corrected equally by the teachers. This is of-course a risk when there are multiple teachers involved int the correction.

Finally, we end with one of the most rewarding quotes we received from a colleague in the structural engineering course; *“I have never ever experienced a group of students from a solid mechanics course, that are so well prepared for attending my course”*

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