Increasing student lab activities - at a low resource consumption

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ABSTRACT

The increased focus on innovation, development and active learning at DTU has lead to an increase of laboratory facilities and an increased use of experimental activities in courses and projects. This paper presents experiences in six concepts successfully tested at DTU's civil engineering department DTU Byg, describing how the experimental activities in courses and projects can best be organized and used with a low resource consumption for educators, students and the university.

Key words: Teaching, Testing.

1. INTRODUCTION

The Department of Civil Engineering at the Technical University of Denmark (DTU Byg) supports 10+ engineering educations, contributes to teaching in 130+ courses and supports 300-400 thesis students annually, due to the doubling of student intake during the last decade. DTU's strategy 2016-19 states that "*DTU will assure and expand the students' access to experimental facilities and activities designed to train engineers*" and DTU has therefore invested heavily in new facilities and renovation of teaching facilities, including four new laboratory buildings and a new teaching building for DTU Byg [1]. This forms the basis for DTU's future strategy "*DTU has three strategic objectives in the period 2020-2025: Developing Europe's best engineering education, promoting technologies for sustainable change, and realizing the potential of digitalization*".

The new facilities enable an increase of experimental activities in teaching, in the educations and in the project activities, which we see as essential for the latest, ambitious goals to improve the students learning and motivation to innovate and experiment.

An increase in these activities requires increased resources and this is a challenge for any university with its limited financial budgets. This paper presents six new concepts established at DTU Byg to accommodate these changes efficiently.

2. THE COURSES AND THE PROJECTS

The six new concepts used in courses and projects are described in the following.

1. Safety instructions: These are often time consuming, as repetitions in several languages are required several times a year. DTU Byg has therefore developed a concept with Danish and English language based safety instruction videos along with a mandatory digital test. This has been used by over 1000+ students and staff members and is being copied by other DTU departments.

2. Educational labs: Experimental activities with many students are a challenge in a normal research lab due to space limitation and equipment complexity. DTU Byg has therefore developed educational laboratories in two buildings with room for up to 90 students (Figure 1a and 1b).

Figure 1. Educational laboratory (left) and easy to use mechanical testing equipment (right).

These laboratories contain student friendly equipment (easy to use) and often with plug-and-play planning; where equipment and materials are prepared well in advance and can be lifted from the storage shelf when required. This means that the space and equipment can be set up during an afternoon, the next morning be used for the planned activity and the afternoon be used for clearing of the space. Consequently, the next teaching activities benefit from these actions as the space is available again. This approach is essential, as an increasing number of courses will implement experimental activities. The record so far is a course with 260 students doing testing in groups of 4 persons – but organized in three shifts as the max capacity in the largest lab is 90 students plus supervisors and teaching assistants. For mandatory courses with mandatory participation in the experimental activities, the presence can be registered utilizing student ID readers, thus avoiding later conflicts. In addition, peer reviewing are used as a tool to support the reporting of the first experimental activities and their evaluations and reporting, which are combined with a final, traditional assessment and it has been observed by the teachers, that this seems to lead to a better quality of the final reports.

3. Model building: The students may also build their own models for illustration, demonstration or testing in these educational labs, which are cleared periodically of old models, materials etc. In practice, the students will use the smallest of the education labs (messy) for their model building, whereas the courses tend to use the bigger education lab (clearer and in order). Some courses have used the larger workshops (who also support the R&D activities) and this possibility has been much appreciated by both students and their supervisors. However, this requires definitely much more planning and control by the supervisor, than model building activities in the educational laboratory, unless we are willing to accept that these activities will disrupt the R&D-support and activities and use most of the available supporting resources.

4. Activities in the research labs: There is usually no space for instructing more than 1 or 2 groups of 4 persons at the same time, which means that instructions must be repeated. Video instructions for equipment and test setup [2], [3] released significant supervision time for the supervisor and allows students to prepare before lab activities in their own learning pace and reduces the required time where lab must be available to them. The tendency for disruption of the R&D activities is reduced by placing these course activities in 3-week periods (where students work with one course, one project or one activity) and by limiting the number of students to typically 30 to support an efficient workflow for students and educators. These experiences resulted in placing a QR-code on all permanent test setups so the student/faculty may use a smartphone to access the relevant manuals, documents and instruction videos, thus providing valuable help for both students and regular research activities.

5. BEng, BSc and MSc projects with experimental activities: These activities are often a part of our research activities and involved in 2019 a total of 135 thesis students (the remaining 50-60% preferred to stick to theory, design, calculations, BIM and other nonexperimental activities). DTU Byg has developed the “Project Families” concept, where independent teams of students (each team writes their own thesis report) have closely related topics, share a supervision team and often share the practical work and test facilities. This has been a great success where enhanced student engagement leads to better research / results, better grades and less resource consumption with regards to supervision and lab support [4].

The implementation of this concept requires planning prior for the project start which may be the reason why many projects are still running outside of this framework. DTU Byg’s latest student project guidelines do however require the students and supervisors to present a plan of activities, a risk assessment and the equipment required prior to the project start, which is at the moment still quite time consuming. Equipment needs now to be booked through the EIS-system and have lead to increased planning ahead of the project approval and later initiation but it is seen that

experimental activities run more efficiently leading to better student projects and less resource consumption for these types of projects. The use of our EIS-booking system is expected to reduce this planning time in the future, as it will be used for all testing facilities at DTU in the near future.

6. Blue Dot activities at DTU: SolarDecathlon, this is a very ambitious activity, where students from many different educations compete on an international level in e.g. designing a new house. This is indeed a resource and money consuming concept, but is sponsored by external funding from industry and foundations. The concept with an international competition, very mixed student teams and focus on relevant and actual problems makes it a very motivational learning activity with an acceptable resource consumption.

3. CONCLUSIONS

Initiatives with digital safety instructions and the quiz, the educational lab, the plug-and-play concept, the use of an educational lab for the students own production of models and the project families have all worked very well and significantly increased our experimental capacity and activities for the students.

Using a concentrated 3-week period for student activities in the research lab reduced the research activity disruption and allowed an efficient supervision and support. The use of instruction videos allows the students to prepare before the lab activities on their own terms, thus effectively increasing the lab capacity in practise.

The use of our booking system requires further refinement, mainly in the registration and building up of test set-ups. This point has a high priority at DTU, as such booking and registration will support the external financing.

The Blue Dot project SolarDecathlon is constantly being updated and improved, but will never be an off-the-shelf project. It is, however, a very good background for attracting external funding, covering most of the costs.

The situation today is that over 20 % of the courses offered by DTU Byg include experimental activities, model building in the educational labs or similar learning activities that produce over 20 % of the ECTS points obtained at our institute.

We had as a result of this in 2019 a total of 1200+ students doing experimental work, with 1000+ students on courses, 80 on special projects (SolarDecathlon and other, smaller projects) and 135 on their thesis work. The percentages and the number of students doing experimental work is expected to increase further in the future.

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