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Laboratory and project based learning in the compulsory course Biological Chemistry enhancing collaboration and technical communication between groups

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ABSTRACT

The aim of this paper was to describe how changes of laboratory training and project based learning were implemented in order to train the students in making a study design, basic laboratory skills, handling of data, technical communication, collaboration and presentation.

Keywords – laboratory work, technical communication, raw data handling, multi-disciplinary collaboration, data interpretation/presentation.

INTRODUCTION

Biological Chemistry is a compulsory course at 2nd semester for students following the chemistry, food analysis or biotechnology Bachelor Engineering study program at the Technical University of Denmark (DTU). The course consists of a theoretical part, a laboratory part and a project part. Between 24-50 students participate every semester. The CDIO learning concepts were implemented in February 2009 as part of the whole CD(1). The implementation of CDIO concepts at DTU started in September 2008 and the initial process has been described by Vigild et al [2] also a number of course adoptions are described in [3] and [4].

Before implementation of the CDIO learning concepts, the course Biological Chemistry suffered from having a poor integration between the theoretical part, the laboratory part and the project part. The laboratory part was conducted applying the 'cook book' principle, where the students followed a detailed laboratory protocol. The evaluation was done after each exercise by having the students reporting their results in groups by filling in their results in premade tables and answering specific questions. The advantage of this approach was that it was very clear to the students what was requested in order to fulfill the minimum requirements. The disadvantages were that the students came unprepared to the laboratory and gained little understanding of the exercises and the workflow in the laboratory. The project part was a theoretical essay dealing with a biological topic with no link to the laboratory part of the course.

As part of implementing CDIO learning concepts we aimed to create a better understanding between the theoretical and practical aspects of the course moreover, we aimed to improve the engagement of the students in the laboratory part of the course. The student should commit seriously to the preparation, the work related to keeping laboratory journals and reporting of results.

THE PROCESS

The theoretical project and the laboratory part were integrated by making a practical/theoretical project concerning antimicrobial resistant *E. coli* bacteria in retail meats (a topic of public interest). The students now work in groups each responsible for a subtopic (see Figure). All groups collect two meat samples in retail stores based on criteria defined in the class. The samples are subjected to the same set of experiments in all groups. Results are shared between groups based on topic; meaning that the groups do not present their own results, but the results related to their topic on behalf of the entire class.

The students present their subtopic for the entire class prior to the laboratory experiments, and in the end the groups make an oral presentation (20 min) of a prepared poster, followed by an oral examination in front of the class.

Day 1	Main topic: Antimicrobial resistance in Danish and imported meat Introduction to the main topic (teacher)
Day 2	Subtopics (6-10): Sample information, <i>E. coli</i> , tetracycline resistance, multi-resistance, gene detection, horizontal gene transfer Presentation of subtopics (groups of 3-4 students)
	Agreement on common sampling strategy: and sampling in retail stores
Day 3-6	Sampling in retail stores and laboratory work: All groups do the same laboratory experiments on their own samples. Mandatory: Flow sheet on laboratory work (approved by the teacher before starting lab. work), laboratory journal (approved by the teacher before leaving the lab.)
Day 7	Exchange of results between groups: Each group are responsible for obtaining the correct results from the other groups
Day 8	Presentation of a poster for the entire class with examination: All groups present their topic and the related results on behalf of the entire class. Oral feed back from the teachers and censor. Evaluation of the project period

Figure: The elements of the project part divided into days (4 hours one day a week for 8 weeks).

Discussion/Conclusion:

Generally, the students find the main topic interesting, but some students are in the beginning frustrated over their lack of knowledge about their own subtopic. During the project period, the students gain an improved understanding of the topic and understand the laboratory work in greater detail. They work engaged and are forced to take seriously the preparation and laboratory journal work, as well as the technical communication and collaboration. This teaching approach also requires that the students take seriously their obligations to the entire class in sharing results and presenting their topic. They find the oral examination and feedback in front of the class learning full and challenging. In conclusion, this teaching approach is very suitable for introducing CDIO learning concepts on 2nd semester for 15-50 students. The optimal number of students for the project described here is, however, between 20-30 students.

In order to assess the impact of implementing the CDIO learning concept in this course in more absolute terms, we tried to examine the students' evaluation of their perceived outcome of various course elements; overall learning outcome, coherence and synergy between course elements, help and feedback from teachers and the obtained grades at the written examination. No significant measurable impact from the implementation of the CDIO learning concept can be drawn from these course evaluations; however the students did report an improvement in coherence and synergy between course elements and an improved academic understanding. More effort should be devoted to incorporating questions in the standard course evaluation taking CDIO learning concepts into account.

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