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

Yvonne Agersø, Anette Bysted, Lars Bogø Jensen, Mathilde Hartmann Josefsen

National Food Institute, Technical University of Denmark

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. The implementation of CDIO learning concepts was not directly reflected in the standard course evaluation; however, the students reported an increased coherence and synergy between course elements and an improved academic understanding.

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. In February 2009 the course structure was redesigned, and CDIO concepts implemented. Special attention was devoted to designing a coherent series of laboratory exercises to support hands-on and social learning and promote the disciplinary knowledge of the students. Much effort was also put into integrating the learning experiences from the three course elements; theory, laboratory exercises and project work. Active student learning was facilitated by implementing a variety of active experimental learning methods. The CDIO learning concepts were implemented as part of the general implementation of CDIO learning concepts in the B.Eng. study program in Chemical and Biochemical Engineering (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 assay 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). Furthermore, this new project was designed to include the practical execution of techniques and biological experiments taught in the theoretical part of the course, giving the students an opportunity to implement and operate their obtained skills and knowledge. 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. This approach was an attempt to strengthen student teamwork and collaboration.

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.

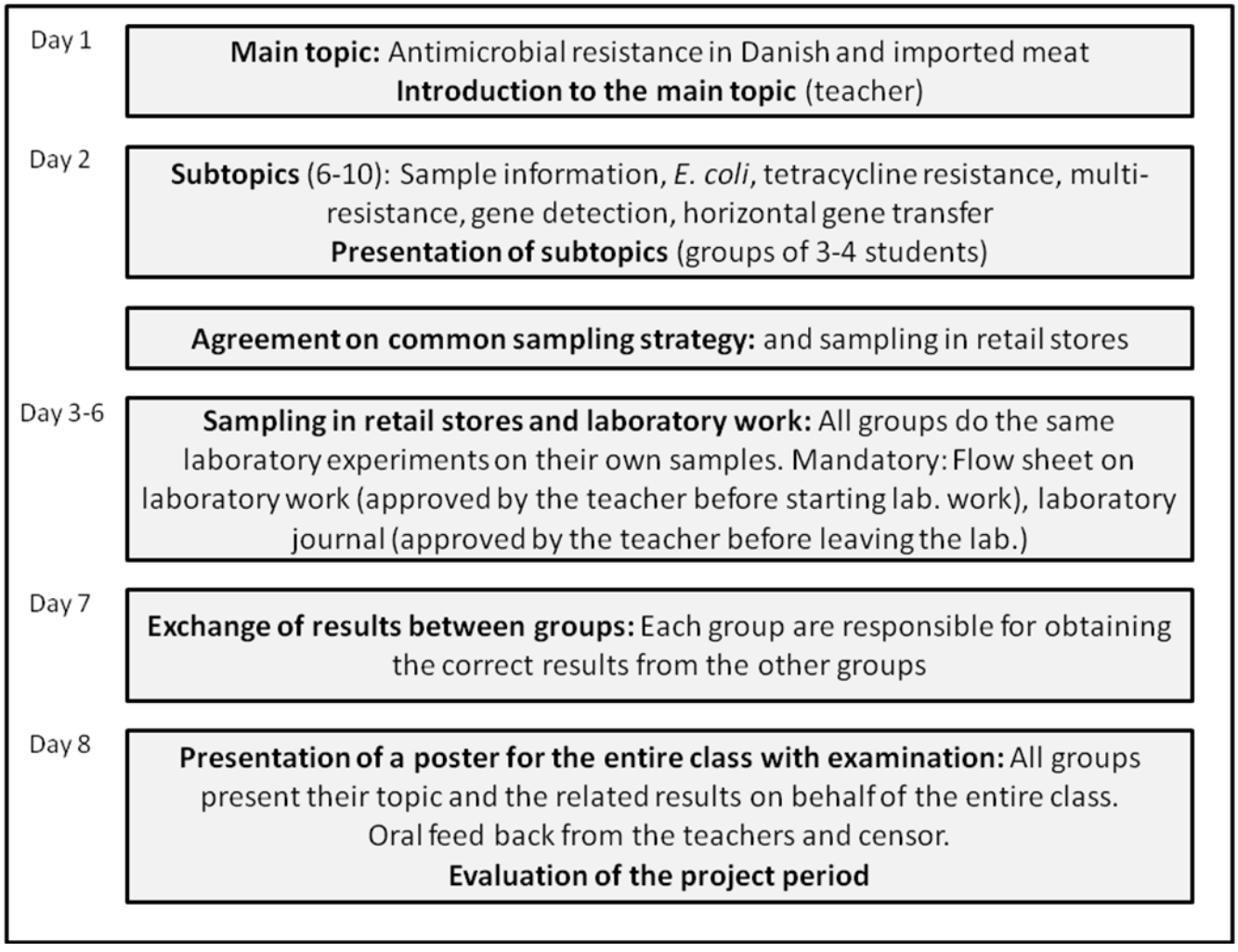

Figure: The elements of the project part divided into days (4 hours one day a week for 8 weeks).

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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Biographical Information

Yvonne Agersø is an associate professor at the department of Microbiology and Risk Assessment, National Food Institute, DTU. She is in charge of the course Biological chemistry,she teaches the Master course General medical microbiology and supervises students and specialists in antimicrobial resistance and food safety.

Anette Bysted is a senior scientist at the department of Food Chemistry, National Food Institute, DTU. She teaches courses in Biological chemistry and supervises students in the field of nutrients and bioactive compounds.

Lars Bogø Jensen is an associate professor at department of Microbiology and risk assessment, National Food institute, DTU. He is the chairman of the study board of the National Food Institute and study leader of the upcoming education “Fødevareanalyse”. Has supervised several students on bachelor, master and PhD and is an expert in antimicrobial resistance and transmission of resistance through the food chain.

Mathilde Hartmann Josefsen is an assistant professor at the department of Microbiology and Risk Assessment, National Food Institute, DTU. She teaches courses in Biological chemistry and supervises students in the field of molecular diagnostics.