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# Project-based Learning for a Biosciences Laboratory in an Engineering Curriculum

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Research in engineering education has established the importance of exploring new avenues of teaching and learning. The emphasis of teaching development is on providing opportunities for deep learning via problem solving and teamwork, which nurture abilities to work in a solution oriented context and transfer theory to practice, to work analytically and systematically and the ability to be creative and innovative in solving professional tasks. Clearly, such outcomes are difficult or perhaps even impossible to achieve by teaching in the classroom or via the traditional laboratory approach. On the other hand, the focus of new avenues for learning in the biosciences has mostly been concerned with changing the way that scientific theory is taught in the classroom, with laboratory experimentation receiving less attention. Moreover, authenticity in laboratory courses is often considered to be self-evident as students work with real samples and real data using disciplinary specialist methodologies.

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A project-based approach was adopted to a M.Sc. level microbiology laboratory course in a Chemical Technology degree program.. The course spanned 7 weeks at 5 ECTS with the requirements of planning (30h) and executing (40h) a microbiology project, a final report and a seminar presentation (12h) and 53h hours allocated for independent work (writing reports, reading and searching for literature). The goals were for students to be able to 1) design and execute a laboratory project and interpret scientific results in accordance to accepted theory and methodologies of the discipline, 2) experience a research science approach and develop critical thinking skills 3) take responsibility for and to contribute to carrying out experimental work in a group.

Three research questions were formulated to evaluate the learning outcomes of the students, the ability of previous laboratory classes to support a constructive learning process, and the constraints and opportunities for implementation of project based laboratory courses in single specialist subjects within an engineering curriculum. **RQ1**. What are the key learning outcomes of a project-based laboratory course in a microbiology within an engineering degree program ? **RQ2**. What are the critical thinking skills and previous disciplinary competencies which support the ability of students to independently plan and carry out real-life microbiology experiments ? **RQ 3:** Can project – based learning be carried out to support desired learning outcomes in an individual specialized subject in a traditional engineering curriculum

Student learning outcomes demonstrated that the development of new skills and competencies and the ability to critically evaluate different options were supported by the project-based approach. In addition, students also faced the frustration and uncertainties that are ingrained into scientific research, but as the projects proceeded students began to appreciate the nature of scientific research. However, some students also tended to find it very difficult to adjust to new learning approaches and feel uncomfortable when no “correct answer” was available. Moreover, critical thinking skills also emerged, as at the end of the course students were able to reflect on their own decisions during the project and pinpoint the problems in their own planning of the experimentation. The feedback indicates that the students did not view the experimental part of the project as very demanding, which may have caused them to overlook the amount of time that they should have spent on the planning and the detail at which the planning should have been done. On the other hand, it is evident that the disciplinary knowledge gained was rather narrow, and in this course focused primarily on identification of microbes. This is in line with other studies which have shown that there are some concerns as to using project based learning in the biological sciences, as students appear to have difficulty in understanding biological complexity and scientific content. One explanation for the development of somewhat narrow disciplinary knowledge in the present study, could be attributed to the fact that students did not have the time to make mistakes and repeat the experiments which could explain perhaps a shallow constructive process. On the other hand, this may also be due to teaching approach, as project-based learning does emphasize the development of skills, whereas development of disciplinary scientific knowledge does not appear to have been analyzed in comparative studies on project-based learning vs. other teaching approaches. ■