

## The Integration of “Project-Based” Teaching into the Curriculum

Dale Shelton

Department of Plant Biology and Biotechnology, LIFE, University of Copenhagen

### Abstract

The aim of this project was to evaluate the project-based course “Theme Projects: Experimental Molecular Biology” from both the students’ and supervisors’ perspectives and determine components which function sub-optimally and can be improved upon in future blocks. Surveys were distributed to both students and supervisors enquiring about different aspects of the projects. The student survey was designed not only to get a general insight into the course but also to get the students to elaborate on comments in the official course evaluation and made in casual conversation during the projects. Whilst some comments made on the official evaluation did not appear to be a general problem for the course both students and supervisors alike see the integration of “Ethics” into the final project as problematic. Overall the course received good evaluations with most students being highly satisfied and willing to consider continuing research in their project area and supervisors willing to participate again next year.

### Background

Numerous different experimental formats exist when designing an experimental molecular biology course, but they generally fall into three different categories (Boyer; 2003).

1. Skill-building or so-called “cookbook” based experiments are the traditional course practical labs. These experiments are usually quite reliable and easy to perform but do not encourage deeper learning
2. Inquiry-based experiments (also known as Problem-based experiments) present students with a problem that can be solved through different paths. These can often be very complicated and have a relatively high risk of failure
3. Project-based experiments are often ‘sub-projects’ that originate from the supervisors own research. These often require specialized equipment or knowledge. Establishing and maintaining a large enough repertoire of projects for each semester/year/block can be problematic but provides students with “real-life” research experience.

The current emphasis on teaching in the science disciplines is to move away from skill-building courses albeit some skill-building components is required. “Inquiry-based” or “Project-based” are often used to engage students and to involve them in active research projects with potentially new and novel findings, instead of using the same practical class every year with highly predictable results (Adams; 2009). Embracing the “Project-based” concept, “Theme Projects: Experimental Molecular Biology (240042)” is a subject offered to third year “Biology and Biotechnology” students at the Faculty of Life Sciences.

Experimental Molecular Biology is run over two blocks with the first block resembling the more traditional biochemistry and molecular biology consisting of scientific theory, the ethics and philosophy of science along with skill-building laboratory exercises. The second block is dedicated entirely to performing a small research project in a group of 3-5 in one of the university departments.

Project supervisors are volunteers and not selected by the course coordinator and usually consist of younger Post-Doctoral Scientists or Assistant Professors. Each potential supervisor gives a 5 minute presentation of the project at the start of the block where the students can ask questions. Afterwards the projects are divided up as democratically as possible. At the end of the intense 6 weeks of lab work, the students write a group report. The project report should not only contain all the details present in a normal scientific report, but should also include a section examining the ethics and scientific philosophy associated with their project. This report forms the basis for an individual oral exam by an external examiner. A poster presentation is also required for each project. It is the project in the second block

that forms the basis of this study albeit with reflections on the activities of the first block.

## Student and Supervisor Evaluation of Projects

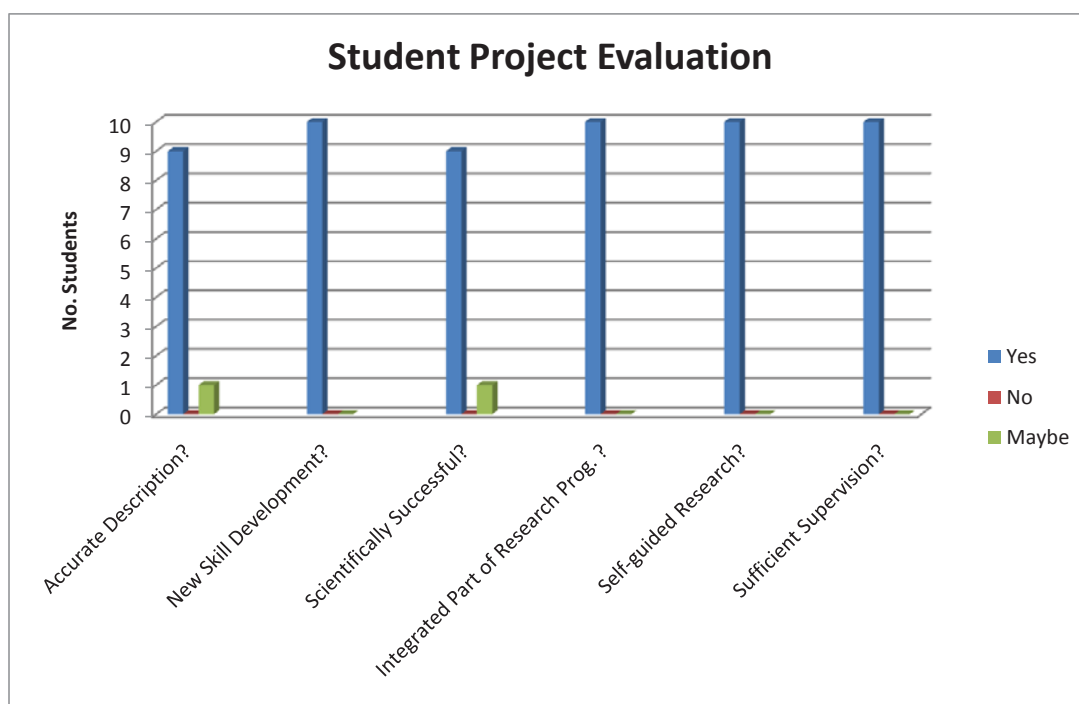
At the completion of each block the students are requested to complete an anonymous online survey evaluating the course. Responses to the second block survey was quite poor (7/37, 19%) compared to the response to the first block (25/37, 68%). I sent a second survey out to the students to get more detailed insight into their impressions of the second block, the project-based component of the course (Appendix A). Unfortunately though the student response rate was still relatively low (10/37, 27%). Furthermore, a survey was also sent to the supervisors to glean their impression of the course (Appendix B) with a good response rate (10/17, 59%). The supervisors' impression of the course was considered important as their participation is on a voluntary basis. Criticisms have been received from the students that projects available are too focused on plant sciences and that they would like to see a greater diversity of projects on offer. Therefore, we would like to know what the motivations are for supervisors to volunteer, what are their experiences with the course and if they are dissatisfied with any aspects of the course. Hopefully, by using this information, we can attract and retain supervisors from more diverse research areas in the future.

## Results of Evaluation

In addition to the standard course evaluation sent out to the students, a second survey was sent to the students by email to get a general overview of their impression of the course but also to determine if the opinions expressed by a few students in the first survey were shared by more students. A few aspects of the course received a below average rating in the initial survey and these were investigated further in the second survey. Probably the most concerning aspects in the initial survey was the relatively poor evaluations of the following statement:

- *“I believe course activities poorly supported development of the competencies stated in the course description”* (paraphrased from Danish)

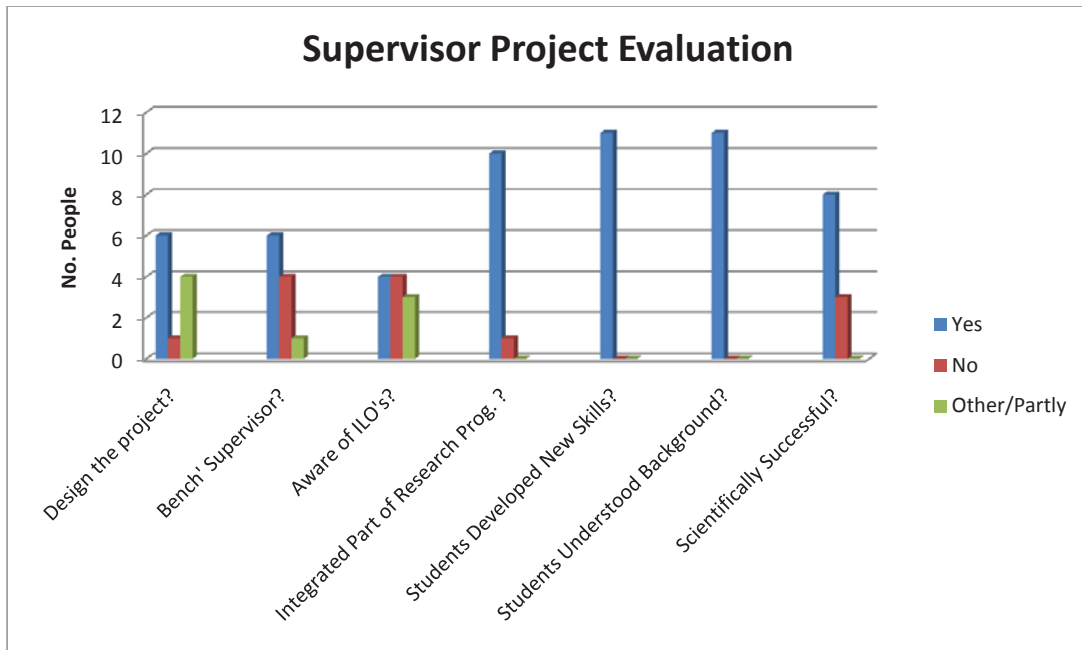
In the follow-up investigation though, it was unanimous amongst both students and supervisors that the students developed new skills in their area of research (Figure 1.1 and 1.2) with many students stating quite strongly that they were very pleased with the new skills they acquired. Comments were made by a supervisor and students of one project that it contained more biochemistry than molecular biology so this comment may relate to this project. Maybe in the future the course description could be broadened to include biochemistry as it is a field that often overlaps with molecular biology. Including some biochemistry in the course may also increase the diversity of project as requested by the students. Furthermore, most students believed the project description presented to the students at the outset of the project were accurate (see Figure 1.1). This suggests that the comments in the first survey may have only reflected the views of a single student or single project but not the course as a whole.



**Fig. 1.1.** Summary of student survey response regarding their research projects

Interestingly though, less than half the supervisors knew what the formal intended learning objectives (ILOs) for the course were (Figure 1.2). A number of supervisors also gave vague answers indicating they had more

“a gut feeling” for what the ILOs were rather than knowing those formally set out in the course description.



**Fig. 1.2.** Summary of supervisor survey response regarding their research projects

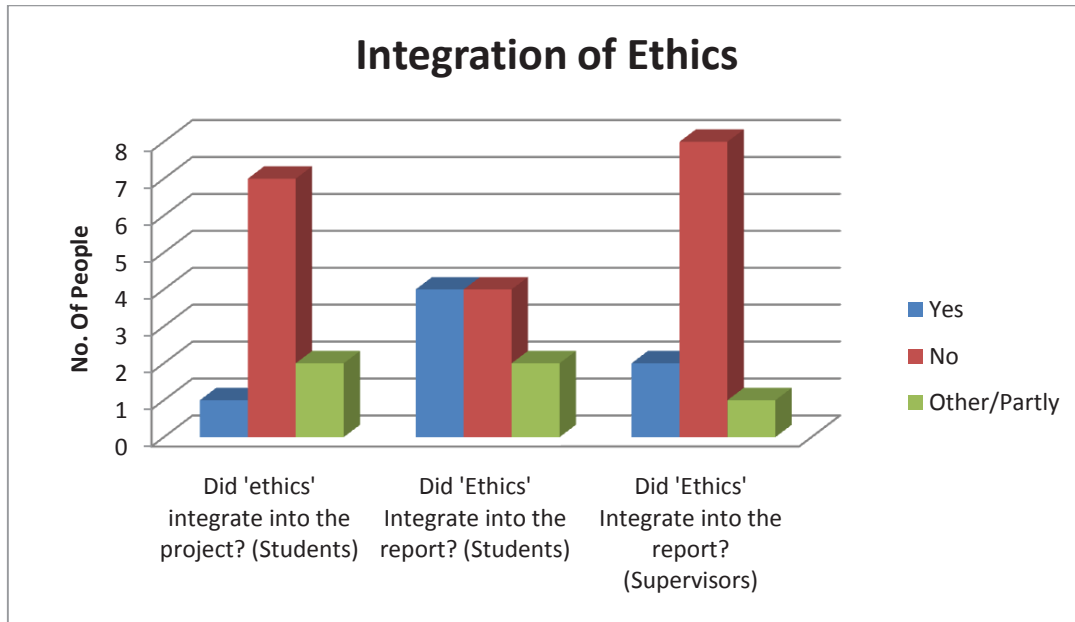
Another aspect of the project work which received relatively poor evaluations in the first in the initial survey was:

- Does the project work allow independent problem solving? (paraphrased from Danish)

Again though, when the students were asked whether they felt there was “adequate opportunity for self-guided research?” they responded unanimously that there was. Similarly the students were also asked if they felt whether “the supervisor had sufficient time for guidance” to which they also agreed (Figure 1.1). This indicates that the projects had a good balance between student and supervisor participation.

At the end of the course it was commented by a number of project supervisors and the external examiner that there was a problem integrating the “Ethics and Philosophy of Science” component into the final report. The second survey indicated that this was a problem not only with supervisors but students alike (Figure 1.3). The student group did however appear to believe they managed to better integrate this component into the report

even though not seeing the relevance of it to their project. The view of the students that it integrated well into the report was not shared by the supervisors.

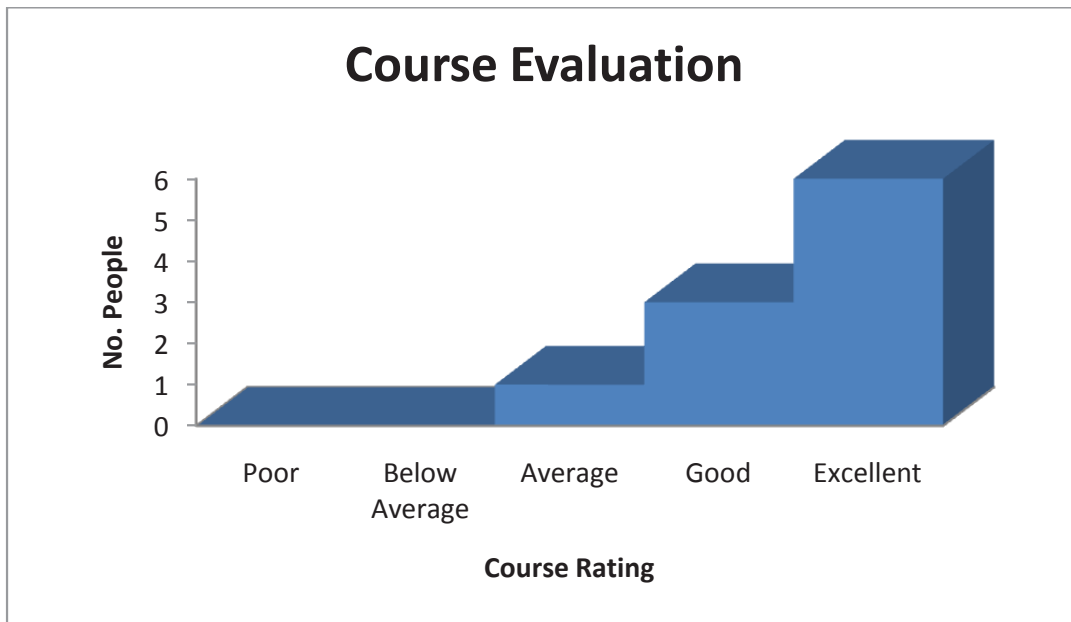


**Fig. 1.3.** Summary of student and supervisor opinion on the integration of the “Ethics and Philosophy of Science” into the research project and report

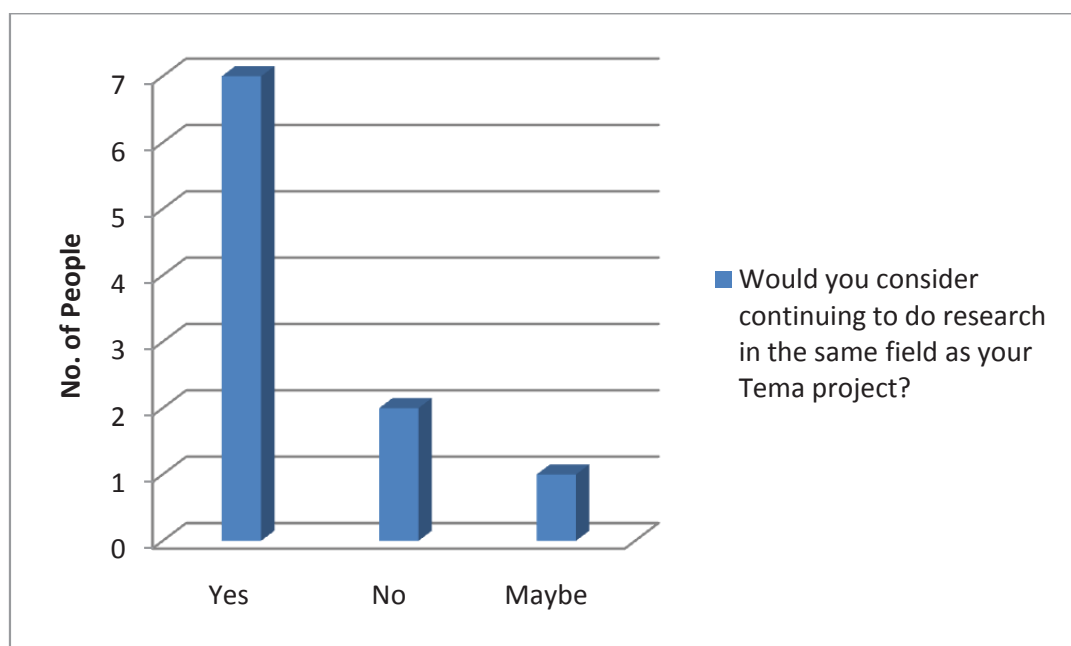
Finally, it was decided not only to evaluate student satisfaction with the classic “*Rate this course 1-5*” question (Figure 1.4) but also ask if the students were inspired enough by their project that they would consider continuing research in that field (Figure 1.5). Both approaches indicated a high degree of satisfaction with the course with majority of students being willing to consider continued research in the field.

## The Supervisors’ Perspectives

The perspectives and the motivations for the supervisors were also of interest to me. Partially because participation is voluntary, labour intensive and funded solely from individual research projects potentially discouraging participation. Hopefully, through knowing why the current supervisors participate we can learn how to “pitch” the course to other research departments and encourage their participation.



**Fig. 1.4.** General course evaluation by students



**Fig. 1.5.** Students willingness to continue research in the same field

The two predominant motivations for supervisors to participate were “*the joy of teaching*” and “*contact with students*” but “*teaching experience*” and “*help with projects*” also contributed. In my opinion it is positive that the main motivations were an equal mix of “selfless” and “selfish” factors. Unfortunately though, selflessness is difficult to encourage so it may be worth emphasizing that “Theme Projects” is a good way of introducing students to your research area, particularly if you wish to attract Master’s students in the future. Interestingly as well, a majority of supervisors also found the projects scientifically successful with one group producing publishable results and could be used a “selling point”. However, caution should be taken when setting realistic expectations for the outcomes of student projects (Bell; 2001). One of the negative factors though, particularly for the PhD students is the disparity between effort imparted and the actual teaching credit accrued. Most supervisors were actively involved full-time for 5-6 weeks but only accrued 37 hours teaching credit. If this situation could be rectified though, maybe more research groups would participate through their PhD students.

## Conclusions

Whilst many aspects of the project-based part of the course appear to function well, the inclusion of “The Ethics and Philosophy of Science” into the final report appears problematic. This is striking given that many students appreciated and enjoyed this component in the first block of this course with some students requesting more focus or time on this section. It may be that while this topic is relevant to keep in mind it does not affect all research projects or influence daily life in the laboratory. This is further exasperated by the fact that many supervisors do not know what is expected for this component in the final report and can offer no guidance or assistance to the students. This was made clear by one supervisor suggesting that the students omit this component from their final report because it was irrelevant. One possible solution for this issue may be to restrict this component of the course to the first block rather than creating the artificial situation where it is included in the scientific report. It would also be beneficial better informing supervisors about what is to be expected from the student reports, not only in regards to ethics and philosophy but in general. One supervisor commented that they found out what was expected of the student report only at the student information meeting.



Overall it appears that the course “Theme Projects: Experimental Molecular Biology” was well-received by the students and had a high degree of student satisfaction (Figure 1.4) receiving comments such as: “*No doubt one of the most intense and gratifying courses I have had at LIFE*” and “*The best course I have ever had*”. The high degree of student satisfaction is also evident in the large proportion of students willing to consider continued research in their project area. This reflects the situation for similar courses at other universities (Caspers and Roberts-Kirchhoff; 2003) and reiterates the usefulness of project-based courses for stimulating student engagement.

## A Appendix

### Student Survey

#### *The Project*

Did the project description at the start of the course truly reflect the project?

Do you feel you had developed new skills after completing the project?

Do you feel the project was successful given the limited time available?

Do you feel the project was part of the department's research program?

Do you feel there was adequate opportunity for 'self-guided' work on the project (as opposed to just taking instructions from your supervisor)?

Do you feel the supervisor had sufficient time to guide you with your project?

How would you describe the quality of your practical supervision? Poor, Satisfactory, Good, Excellent

Do you feel the 'Scientific Theory and Ethics' integrated well into the practical part of the course?

Would you consider continuing to do research in the same field as your Tema project?

#### *The Department*

Did you feel welcome in the department where you did the project?

Do you feel your department had the appropriate facilities (room, lab space, journal access) and equipment?

#### *The Assessment*

Do you feel the 'Scientific Theory and Ethics' integrated well into the final report?

Do you feel the exam format fairly assessed what you had learned during the project?

#### *The Course*

On a scale from 1-5, with 1 being poor and 5 being excellent, how would you rate the course?

Do you have any suggestion for improvements for next years course structure?

## B Appendix

### **'Problems integrating real-life research into the curriculum'**

Did you design the Tema project yourself?

Did you supervise the students '*at the bench*'?

Were you aware of the formal 'Intended Learning Outcomes' or which 'Competencies' the students were to obtain after completing the project?

Was the Tema project you supervised an integral part of your own research programme?

Do you think the students acquired new skills by undertaking the project?

Do you think the students had understood the theory and background of the project?

Do you feel the project was scientifically successful?

The students need to write a short comment on the project in context of 'Scientific Theory and Ethics'. Do you feel this was a coherent part of the final report?

Do you feel your department had the appropriate facilities (room, lab space, journal access) and equipment for the students?

Would you be willing to supervise a project again next year?

What was your motivation for 'volunteering' to supervise a project?

Do you have any suggestions for improvements for next year's Tema projects?

All contributions to this volume can be found at:

[http://www.ind.ku.dk/publikationer/up\\_projekter/2009-2-1/](http://www.ind.ku.dk/publikationer/up_projekter/2009-2-1/)

The bibliography can be found at:

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