Mentoring scientific minds through group research projects: maximising available resources while minimising workloads

Momna V Hejmadi, Department of Biology and Biochemistry, University of Bath, Bath BA2 7AY
E-mail: bssmvh@bath.ac.uk

Background and rationale

Laboratory research projects should be designed to help train scientific minds by enabling students to understand the process of inquiry and scientific rigour. In practice however, they place huge demands on resources. In our department, student numbers have increased substantially without any increase in research lab space. Projects are expensive but the budgets are small, and they place huge demands on staff workloads. Most importantly, students may not necessarily enjoy or appreciate the process of scientific inquiry or develop the key skills needed for research or employment. These problems are common to many universities (Cowie, 2005a).

To tackle these issues, I successfully introduced changes to our final-year laboratory project for biochemists in 2005: Students carry out laboratory research projects in pairs or groups of three, and are assessed on the individual report and key research skills. The changes were designed to help students appreciate the process of scientific inquiry and develop transferable skills such as team-work, problem-solving, etc., with a minimal demand on resources. This 12-credit unit, involving 200 study hours, runs in Semester 2 (11 weeks) and is mandatory for all final year biochemists without placement experience and optional for those with placement experience (year 3/4).

How to do it

Instead of taking place in research labs these projects are carried out in the teaching labs, with students working together to plan and carry out their research. Additional assessment criteria encourage development of key skills, and staff workloads associated with student research projects are minimised. The specific changes are outlined below:

- **Choice of Projects:** Students choose from research projects which are carefully selected to highlight key research skills while minimising demands on space and consumables. E.g. Bioinformatics projects involving identifying novel targets such a gene homologues, splice variants, differentially imprinted genes/ promoters etc in different but relevant tissues, assay development strategies etc. Initial training on bioinformatics, PCR, cloning etc. is given to the entire group. Students are also encouraged to help each other by sharing reagents, resources etc.
- **Location:** Instead of using research labs, these projects take place in the spacious practical-teaching labs, thereby making the best use of the resources available. Bench space is set aside for project students and students are directed to manage their experimental time around scheduled practicals. The labs are fully equipped and technicians are on hand to supervise basic aspects of laboratory work (buffer / media preparation etc.). The research ethos is maintained as a result of these students collaborating with each other, other postgraduate students and regular meetings with the supervisor (similar to a regular research environment).
- **Team work:** Each project is done by a pair of students (3 if needed). This helps develop their team work and communication skills, with the added benefit of students learning from each other. It also reduces the number of projects by at least half. Generally, students self-select their partners and project choices, but I have intervened occasionally where I thought this would benefit the students.
- **Using dedicated postgraduate demonstrators:** Two PhD students help in the supervision of the projects. They are funded by the department for 4 years (instead of 3) with the undertaking they help in this project for 11 weeks every year. The benefit for the postgraduate students is that they gain experience in research supervision work and are involved in all aspects of project teaching, including assessments. These students are trained in aspects of research supervision by regular meetings with the unit convenor and by attending staff development workshops on research supervision.

- **Assessment:** Instead of conventional assessments based on a written report alone, I embedded additional key skills as part of the assessment (below). These were monitored contemporaneously through regular meetings with the supervisor. This was done to enable students to recognise and develop key skills that are invaluable for their future (either PhD or employment). These skills are presumed but not always rewarded in conventional assessments for research projects (usually written report / viva).

Assessment weighting (%)	Assessment criterion/skills assessed	How assessed/ assessment task
50	Scientific report writing?	Final report
5	Experimental design	Experimental draft (before meetings)
5	Critical appraisal skills	Abstract of project and literature review (week 2)
5	Data analysis and interpretation	Reflection in lab records; discussion meetings with supervisor
25	Performance in the laboratory:	
10	effort	Observation and lab records
5	good laboratory practice	Observation and lab records
5	record keeping	Lab notebook
5	team work	Observation, lab records and progress
5	Development of problem solving skills	Discussion meetings with supervisor
5	Originality / flair for experimentation or initiative	Discussion meetings with supervisor; lab notebook

Advice on using this approach

Preparation: Carefully planning and choosing projects that optimise output is vital. For example, a broad project can be shared by a group of teams with each team adding their component e.g. assays, RT-PCR, Western Blots, etc. can be done by individual teams and contribute to the overall results. It also encourages teamwork.

Communication: It expedites things if everyone is informed of the details in advance, e.g. teaching technicians (for practical scheduling etc.), students (choice of projects given at least 2-weeks in advance), and postgraduate demonstrators (detailed briefing sessions).

Regular meetings: I found it very important to schedule regular meetings with student teams to go over problems, discuss results and ways forward. I always try and get them to think out answers to problems and ways forward. I usually meet students every week for ~30 min for each team (sometimes a whole day may be spent doing this).

Troubleshooting

This style of lab projects has run very well for the past 2 years. There have not been any major problems. However some issues that have arisen in the past include:

- Large numbers of students: I started off with 12 students in the first year and had 25 last year. The maximum capacity for doing research in the practical labs is ~40. This has enabled four colleagues to share this space with their project students using a similar model.
- Most of the students were very keen to spend more time in the lab to get good data, although not everyone will be so inclined (see student feedback). Ensuring that students have realistic expectations of how much they can achieve in terms of results within the available time is important.
- Some students, particularly those from overseas, have not always interacted well with the rest of the group. This could be due to the relatively large student cohort (~60 in the biochemistry degree) combined with language or cultural barriers. See below for how we plan to address this issue.

Does it work?

- Mentoring the research mind: Since the new strategy for projects was introduced (including assessment criteria), more than 50% of the students have gone on to do a PhD, either in the UK or the USA. Although lab projects may not be the only reason, the research environment and ethos created may certainly have contributed to their decision (see feedback below).
- Effective use of resources: Maximising use of the bench space and reagents available. Reducing workloads on staff.
- Postgraduate skills training: The responsibilities given to postgraduate demonstrators ranged from lab supervision to marking written reports (moderated by me). This empowerment helped their own research training and enabled them to better appreciate their own research supervision.

Student feedback

The vast majority of students (~ 85%) who completed the module evaluation form indicated the project had been a useful learning experience for them. Example comments on the best things about the project were:

- "The insight into real research gained through actually taking part in a real research project …"
- "Being able to complete a project from beginning to end without simply following a protocol, learning new skills and implementing the science you have learnt over the years. This project involves a lot of hard work but is very rewarding and enjoyable and a great learning experience"
- "My project was interesting and enjoyable. It has given me the chance to develop techniques and skills I will need for my PhD"
- "Really enjoyed it …"

The major criticism about the project from the student point of view was the amount of time spent in the laboratory (they felt this was much higher in practice than indicated in the module handbook).

Peer Response

I gave a talk to colleagues in the department on how I run the project and four colleagues have since used it for the projects they run. The external examiner commented "these carefully designed 'teaching' research projects can be more informative to a student than a poorly-planned or speculative 'real' research project. They also provide a more level playing field for the assessment of the abilities of these students."

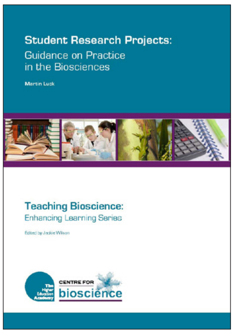
Further developments

- Realistic expectations: Need to better manage student expectations by clarifying time limitations will result in limited data.
- 'Bonding' exercise: I was inspired by Elizabeth Dunne's (University of Exeter) teamwork activities presented at a Higher Education Academy meeting (Assessment: Students supporting students – London, 21 March 2007). I will be adapting some of her methods for this unit next semester in order to get the students (especially overseas students) to integrate better as a group.

Reference

Cowie, R.J. (2005a) A snapshot of final year project practice in UK bioscience departments. Available at www.bioscience.heacademy.ac.uk/ftp/SIG/projectsurvey.pdf

Accompanying materials



This case study was included in the Teaching Bioscience: Enhancing Learning guide entitled *Student Research Projects: Guidance on Practice in the Biosciences*, written by Martin Luck and published by the Centre for Bioscience. The associated website (www.bioscience.heacademy.ac.uk/resources/TeachingGuides/) contains a downloadable version of this case study and the following additional material:

- Project handbook

Case Study published October 2008

Centre for Bioscience
Room 9.15 Worsley Building
University of Leeds, Leeds, LS2 9JT
Tel / Fax: 0113 343 3001 / 5894
Email: heabioscience@leeds.ac.uk
Web: www.bioscience.heacademy.ac.uk