'Analyses in Biology': an analytical alternative to traditional research projects

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Background and rationale

At the University of East Anglia (UEA), we pride ourselves in our strong commitment to research led teaching. In the School of Biological Sciences this is ultimately borne out in the final year (year 3/4) research project, where all our undergraduates have the opportunity to carry out their own piece of novel research. At UEA these projects have traditionally taken the format of the student spending 8 weeks (10-15 hours per week) on the data collection aspect in the laboratory or in the field prior to writing a report and giving a talk. Over the last few years a number of different pressures on traditional project provision have built up from both students' and supervisors' perspectives, as they have at other universities (Hollingsworth et al., 2004; Ryder, 2004). From the students' perspective a small, but significant, proportion of students each year do not want a practical-based project due to particular career aspirations or the knowledge that hands-on research is not for them. From the supervisors' point of view growing numbers of students have imposed increasing strains on the provision and supervision of the projects. These combined pressures led us to seek an alternative to the time and resource-consuming laboratory or field-based research project, but which maintained a strong research led approach to teaching. This resulted in the development of a new Year 3 module titled 'Analyses in Biology'.

'Analyses in Biology' is an alternative to the laboratory or field-based project with very similar learning objectives, which runs in tandem with the traditional project module. Its aims are to provide an introduction to biological analysis, the formulation of hypotheses, and appreciation of the processes involved in undertaking rigorous analysis of existing data and determining outcomes. Upon completion of the module students should have:

- Developed an understanding of the nature of scientific research and analysis;
- Developed key skills including an appreciation of experimental design and hypothesis testing, written and oral communication and the use of specialised analytical methods; and
- Developed the ability to acquire, analyse and assess data and to critically test theories and concepts.

It is compulsory for all our students to take a project of some description. The choice between the two project modules is open to students on all of our degree programmes except Ecology, who take their own variant of the project module (Ecology Research Project). Students on our Biochemistry degree programme can choose either of the bioscience project modules, or a project module based within the School of Chemical Sciences and Pharmacy. Students make this decision in the spring preceding their final year. At registration in September they are provided with a list of supervisors and research areas and have two weeks to meet, chat and discuss possible projects with the supervisors. Students then submit their top four supervisor preferences. The module organiser then has the task of allocating students to projects, ensuring suitability of project for degree programme and an even spread of projects between members of faculty.

How to do it

'Analyses in Biology' is not an easy alternative to the traditional 'hands-on' research project nor is it an opt-out from research. Importantly, it is also not just a literature review. Instead it involves the student undertaking his or her own rigorous analysis of existing biological data. A variety of projects can be imagined; here are a couple of examples from UEA. One student looked at protease profiles in head and neck cancers and their correlation with certain risk factors. The project student was provided with real time PCR data generated by a PhD student from the supervisor's laboratory. The student interrogated the data to determine if there was a gene signature that correlated with gender or smoking status and tumour grade. They produced hierarchical clustering and heat map data alongside an in-depth literature search of gender and smoking in head and neck cancers. A similar sort of project was offered with data generated from microarrays (normal vs. pathological samples). Another example is to use online databases such as FlyBase and FlyAtlas and to ask questions about specific Drosophila genes. The student identified interesting

expression patterns of a family of genes and postulated function from location. Comparisons were made to other species and phylogenetic trees were created. These sorts of projects therefore provide the students with a slightly different skill set, yet one which is of equal value to them.

The students will still 'own' the research and they will be producing novel findings. Examples of such projects from the previous two years include: protease profiles in head and neck cancers and their correlation with certain risk factors (using real time PCR data), simulated computer models of protein folding, analysis of microarray data to identify the patterns of gene expression within a tissue and investigating gene homologues and sequence comparisons for a number of species.

The students choose these projects at the same time as the laboratory or field-based projects (in September), so it is important colleagues have been reminded of the different types of projects to offer so they have had time to think about potential analytical projects. The students doing analysis projects are expected to spend a similar amount of time on the data analysis part of the project as the laboratory-based students spend in the laboratory. They are also assessed along the same lines as the laboratory-based students: on their conduct during the project, the written report and an oral presentation.

Advice on using this approach

It is important both styles of project are regarded as equally robust and scientifically equivalent by both staff and students. The value and importance of 'Analyses' projects must therefore be 'sold' to both groups, since the laboratory and field based projects are often considered the 'gold-standard'. It is important to be transparent about the objectives of both styles of project and their intended learning outcomes. Assessing students undertaking analytical projects by similar criteria to those doing the laboratory or field based projects is a useful quality control and ensures comparable standards.

In our experience both strong and weak students opt to take this module. Strong students can really excel at an analysis project — they can demonstrate independence, initiative and critical thinking. They are not handicapped by experimental errors or technical difficulties that can be common in laboratory undergraduate projects and, consequently, can achieve a lot in comparison to some more traditional projects. Weak students, however, can use this style of project to 'hide'. If, during the course of the project, the student is working 'out of sight' of the supervisor and only meets with the supervisor once a week, for example, then the student could put little effort into their project or struggle with concepts.

Troubleshooting

We now have two years experience of offering the analysis alternative to the traditional research project. Several issues have arisen in this time. The first is convincing colleagues of the value of such a module and this type of project, and that it is not a soft option for students. One colleague was very sceptical as to the appropriateness of the module. However, having supervised a student undertaking this sort of project (bioinformatics/molecular modelling), he is now a strong advocate of the Analyses in Biology module. Not only are these types of projects relatively cheap (no consumables, though there can be software requirements), they are less time consuming as the student needs much less 'hands-on' supervision and often the student can carry out some sort of analysis which the supervisor has been wanting to undertake.

Nevertheless, some colleagues remain reluctant to offer this type of project. Sometimes this is a case of lack of ideas or data for the student to work with, but more often it is that the supervisor has not thought through the possibility of such a project nor realised what this style of project could offer a student.

Some students are reluctant to opt for an analysis project, although the reasons for this are not immediately apparent. Perhaps it is perceived as having less importance than the traditional laboratory project, and we have not yet managed to convince them of the value. We hope that this issue will become less of a problem as more students (and supervisors) have successfully passed through the module.

Does it work?

We have run the Analyses in Biology module for only two years and in that time only a relatively small proportion of our students (7%) have taken the module instead of the traditional research project. With such small numbers of students it is difficult to obtain meaningful statistics; however, in their evaluation of the module this year it scored the same high score as the traditional research project. The students were very positive about their experience: "I really did enjoy my project, it was brilliant. I got to delve in to the subject" and "I enjoyed the project and liked the nature of the analysis". Students have also recognised the advantages of an analysis project "felt as if you were up and running right from the start rather than the slower learning curve of a lab-based project". As more of these projects are carried out both staff and students are becoming more comfortable with their style and learning outcomes. Colleagues are beginning to see the projects' value (scientifically equivalent to the laboratory or field-based research projects and time

and financially less intensive) and that they have a useful place within our final year teaching.

References

Hollingsworth, M., Mahon, M. and Thomas, L. (2004) Web projects for life science students. *Bioscience Education e-Journal*, **4**-5, available at www.bioscience.heacademy.ac.uk/journal/vol4/beej-4-5.aspx (accessed 13 June 2008)

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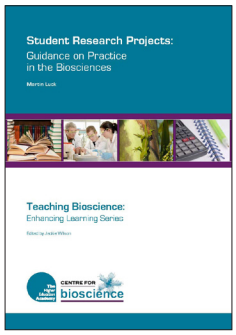
Additional materials



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

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