How to do research with second-year undergraduates: a research-based field course

Tom Reader, School of Biology, University of Nottingham, University Park, Nottingham NG7 2RD
E-mail: tom.reader@nottingham.ac.uk

Background and rationale

Ever thought about getting a whole class of second-year undergraduates to develop their own research projects with the aim of producing novel primary research of publishable quality? Perhaps not, but it is possible. Most second-years have the imagination and intellectual capacity to do much more than soak up facts in a stuffy lecture theatre. In the right atmosphere, with the right level of support, they can engage in cutting-edge research in an enjoyable and productive way. This is the guiding principle around which we built our Behavioural Ecology Field Course field course twenty years ago, and it has been (largely) successful ever since.

The field course constitutes an optional 20 credit second-year module aimed at exposing students to "real" science in the field, and preparing them for their final-year research projects. It is an intensive two-week residential course for 30 – 40 students, largely from our honours degrees in Zoology and Biology, and runs in the Easter vacation.

The ultimate objective of the course is for the students to produce work of a publishable standard. In many cases, they end up collaborating with staff to write their work up for publication in peer-reviewed journals. Such an outcome is obviously not possible in every case, so the course has a set of more prosaic learning outcomes which focus on the scientific and transferable skills we expect a professional biological researcher to have. The aim is for students to learn how to:

- Design their own scientific experiments, collect data in a systematic fashion, and analyse their results statistically.
- Explain their results, both orally and in writing, and set them in the context of published research.
- Think independently while giving due weight to the arguments of others.
- Work productively with others.
- Organise their working time, schedule tasks, and meet deadlines.

How to do it

- **Location, location, location** To make workable and interesting research projects possible in the context of an undergraduate field course, you need a good location. It doesn't need to be exotic, but the students need to be able to live and work in close proximity to interesting organisms. Coastal locations in the UK with rocky shores provide good access to marine wildlife all year round, but for insects and flowering plants, you'll need to go in summer, or choose somewhere warmer than Britain. This latter option might sound expensive, but with the costs of flights being so low, and UK field centres charging top dollar, a trip to Southern or Eastern Europe can be surprisingly economical. We take students to Portugal: the students cover the cost of the flight to Portugal, and we subsidise the rest without bankrupting the department. Finding the perfect spot is going to take hard work. In our case the field station (Quinta de São Pedro near Lisbon) was rebuilt with our requirements in mind, but, with a bit of imagination, there are plenty of places to be found that will fit the bill. The best short-cut is to find out where other institutions take their field courses – there may be unoccupied slots you can fill.
- **Make it residential** A key factor in the success of our course has been access to a field station with excellent accommodation and some basic lab facilities. With everything and everybody on-site all the time, you can foster a healthy work ethic and a sense of togetherness that is crucial for student teamwork. With nowhere to hide, staff are obliged to engage with students intellectually and socially, giving the latter a chance to develop the kind of academic maturity that you seldom see in a lecture theatre or lab practical.

- **Staff it well** This kind of field course works best if there are plenty of academic staff around to generate an atmosphere that promotes staff-student interactions and imaginative research. We take five lecturers to Portugal, which might seem overkill for a course with only 35 students, but the benefits easily outweigh the costs. Students can bounce ideas off each of us and, with every staff member having a different opinion, they begin to see that real science thrives on debate and controversy. After the initial intense period in which the projects are established, the staff actually find plenty of time to concentrate on their own work. In the absence of the usual distractions, papers get written, new research ideas discussed and analytical problems solved.
- **Make it multi-national** For several years, academics and students from an Egyptian university have joined us on the field course (supported by the British Council). The idea developed as a result of a long-standing research collaboration with Egypt, and the benefits have been tremendous. The Egyptian students revel in the opportunity to experience a new scientific and cultural environment (most have never been abroad before), and the novel intellectual and social interactions generated are immensely beneficial for our students. What's more, late-night discussions around the camp fire with foreign academics turn out to be the ideal way to generate plans for new collaborations. To set this kind of thing up is clearly not a simple matter, but it really is worth thinking about. It may be unrealistic for the average UK field course to link up with students from a developing country, but if you are based abroad, you can always interact with local academics and their students. We have met and worked with Portuguese academics and students in the past, and gained an enjoyable insight into the way research and teaching are done in a different country as a result.
- **The structure: focus on group project work** When designing a biological field course, it's tempting to drag out the old favourite taught exercises (sampling strategies, habitat surveys, species identification etc.). But if your objective is to show students what real science is all about, why not cut to the chase? We have an intense one-day sampling exercise at the start of the course which takes the students through the process of collecting data, doing analysis and preparing a talk. In this short window, they discover many of the pitfalls of field work and data manipulation. They thus start their project work forewarned and forearmed, but with the maximum amount of time to get the most out of their study systems. Each student works in a team of 3 – 5 for the sampling exercise and a different team for the project. Groups quickly establish a sense of ownership over their work, and the residential nature of the course tends to ensure that students who might be prone to letting the side down pull their weight. Students are also motivated by the fact that we award an on-course mark for each participant based on their contribution to their group effort. Our students have been involved in many kinds of projects over the years (looking at, for example, the effects of spider predation on honeybee flower choice, the ecological correlates of feather mite burdens in birds, and the causes and consequences of asymmetry in flowers), but the one constant theme is that the work is genuinely novel, with the students playing the role of scientific explorers.
- **Supervision: less is more** Perhaps more than in any other teaching environment, the "student-centred" approach works brilliantly on a field course. Our philosophy is that supervisors are there to encourage and suggest, not to direct. Before the course begins, students allocate themselves to projects, the titles of which are proposed by staff. They are provided with a description of the species they will study, and the germ of a research idea. We hold their hands fairly tightly in the first day or two of project work, and then judge on the basis of their performance how much supervision they will need for the rest of the course. High flyers can obviously be left free to drive the project themselves, but even groups of strugglers stay motivated if they share responsibility for decision making. For much of the course, we try to take a hands-off approach, encouraging students to seek us out to discuss their progress when they feel they need advice. You might think that periods in the field without supervision would lead to bouts of confusion or apathy, but much more often we find that groups return at the end of the day with the sense of exhilaration that "real" scientists feel when they have found a way to solve the problems that a typical research project throws up.
- **Students should present to their peers** Learning to present findings to a critical audience is a key part of the research experience. Students on our course are given guidance (an evening lecture) on how to give a research talk, and then asked to present to the rest of the group twice, once at the end of the initial sampling exercise, and once when they have finished their projects. This helps the students to develop a key skill, and the knowledge that they are up for public scrutiny ensures that they stay motivated throughout the course. The final project talks are especially important; by requiring the

students to give a conference-style presentation of their results, we effectively ensure that they get all their analysis sorted before they leave Portugal. The writing up process in the weeks that follow is made immeasurably easier as a result.

- **Keep it rolling** You can't develop a good field course over-night, and research projects take time to mature. That's why it's been crucial for us to keep a record of what we have done, and to keep on building on past experiences. Every year, we bind the best student projects together in a single volume. Volumes from previous years provide a model for future students and a means of ensuring that valuable data are not lost, and the selection of student work at the end of each course adds a helpful hint of competition to keep the troops motivated during the write-up. We can now call on a library of varied and fascinating projects spanning twenty years.
- **Publish** We view the publication of research done by the students as an integral part of the field course. Nothing beats seeing the look of pride and satisfaction on a student's face when they see their name in print, and nothing convinces your colleagues more effectively that you've not been putting your feet up on holiday for two weeks than a list of field course publications in internationally respected journals. On average, we produce about one paper per year, and each may integrate a number of student projects spanning several years. Writing the publication is usually a group effort by the staff, with input from the students.

Advice on using this approach

- **Convince your colleagues it's worth the effort** If you're setting up a new field course, you can expect to meet with healthy scepticism from the people holding the purse strings. Just remember the benefits of a course like this are enormous, and they're not just pedagogical. As a student recruitment aid and a driver of research collaborations, our field course easily earns its keep.
- **You don't have to teach ecology** Although the course currently focuses on behavioural ecology, we've been surprised at how flexible the format is. Over the years, as staff input has varied, we have had student projects in genetics, parasitology and physiology, and they have all worked pretty well.
- **Get the students to prepare in advance** If students understand the central scientific themes underlying their projects before they arrive on the field course, they will be much better placed to conduct meaningful research. Our students meet as a group and discuss relevant literature and ideas for experiments weeks before they get on a plane.
- **Keep your eyes open** Finding new productive avenues for research can be challenging, so you should never miss a chance to develop a new project. Strange observations and student accidents often end up presenting opportunities for future projects which could easily be missed.

Troubleshooting

The biggest headache with a course of this kind is the logistics. No matter how carefully you prepare (and we start planning the next year's course as soon as we return home), there will always be glitches. Students who fail to show at the airport, inopportune staff illness, equipment that goes missing… all these things will happen, you just have to remember to have a Plan B. And in the modern era, making sure all necessary health and safety issues are dealt with properly should be one of your highest priorities.

Does it work?

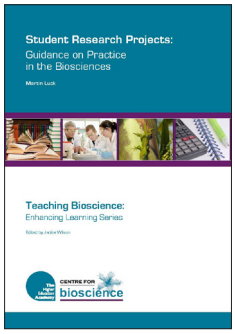
After twenty years of work building the course, we are very pleased with the way it works. The student evaluation of every aspect of the course is extremely good, and participants go on to produce demonstrably better final-year work than their peers who opted to avoid the course.

Further developments

But that doesn't mean there are not weaknesses we are trying to address. The format works best for the most academically gifted students, and the results can be spectacular. The publications we produce (see accompanying website) and the experience the students gain on the course have provided a spring-board for many to go on to become professional scientists. There are PhD students, postdocs and lecturers dotted around the world who cite their time on the field course in Portugal as the moment they discovered that they were capable of doing real science. We're conscious, however, that there can be a tendency for weaker students to become disconnected from the learning experience. In recent times, we've added evening lectures as a way of increasing the formal taught

content of the course and reinforcing the key messages, but there is still work to be done in this area. The course also asks a lot of students in terms of social skills and teamwork. We could do more to address the needs of those individuals who struggle with that kind of challenge. On a more mundane note, for years the students complained about the quality of the food provided by the local café we used to visit every night. This has led to us doing more of the catering ourselves, and so far this has been successful – with the students mucking in, a meal for 50 can be a surprisingly satisfactory affair!

Additional materials



Our field course website can be found at: www.nottingham.ac.uk/~plztr/groupsite/fieldcourse.html

This case study was written to accompany 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:

- Course handout.
- List of publications arising from the field course.

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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