Improving Students' Bioscience Skills: From Education to Employability

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Background

There is increasing concern that Biosciences students lack subject-specific practical skills that employers seek, and require substantial extra training to make them effective employees [1]. Research by SEMTA, the Sector Skills Council for Science, Engineering and Manufacturing Technologies, has found that skills shortages and gaps are higher in Biosciences than in any other sector [2]. Graduates often lack competence in using standard equipment, while more advanced skills, such as ecological surveying protocols and experimental design, are even less well understood. This is mainly due to a reduction in practical work within Biosciences degree programmes [3], which means that key skills are either omitted or experienced only rarely so students don't obtain the experience necessary to perform techniques to a professional standard. These issues are largely down to fiscal and logistical constraints, increasing modularisation reducing opportunities for practical work, and reduced contact time [4]. There is also concern that increasing pressure to teach transferable skills explicitly within curricula erodes time for teaching subject-specific skills [4,5].

Students are becoming increasingly concerned that failure to learn key techniques will hinder career prospects [5]. However, teaching practical skills within the current framework is hard, especially as students are also entering Higher Education with ever-decreasing skills backgrounds [6]. Discrete skills-based modules are often unsuccessful because skills are taught in the abstract [7] or are regarded as hoop-jumping. Even some problem-based learning approaches fail to engage students because the problem is manufactured, such that students view trying to solve it as worthless [8].

This case study details initiatives that I have developed to enhance graduate employability. I describe two specific projects for skills acquisition - one field based and one laboratory based - and then discuss ways that students further develop these skills through innovative "learning on the job" projects. In all cases, I explain the rationale for the project and describe its benefits, as well as providing student feedback. I also demonstrate the transferable skills that can be gained through these approaches, such that there need not be a conflict between teaching practical and transferable skills.

Example 1: Acquisition of practical fieldwork skills

Field courses are intensive and expensive undertakings and it is essential to guarantee that resources and time are used effectively. Underprepared students do not get the most from field courses, especially ones held in unfamiliar locations [9], and staff time is consumed teaching the basics instead of stretching students' academic abilities in exciting and novel situations [10]. Second year students at the University of Gloucestershire have the option to move out of their biological comfort zone by attending a field course, which I have developed in the Savannah grasslands of South Africa. Field skills are essential for biologists [7], and this highly applied trip allows students to learn numerous techniques including mammal surveying, grassland condition assessments, methods to quantify bird-habitat interactions, and use of camera traps for surveying nocturnal species.

To enhance student experience, and ensure maximum benefit is gained from fieldwork, I recently led two successful funding bids, totalling >£3000, to the Higher Education Academy and the Dame Janet Trotter trust to make a series of videos to support learning of field techniques. Rather than making the videos myself, I wanted to involve students. Accordingly, students on the 2012 trip were involved in planning, writing, shooting, and directing 25 videos, focussing on key techniques such as those described above. This helped reinforce their own understanding of key techniques; a prime example of the "see one, do one, teach one" philosophy [11] and provided additional transferable planning, communication, and teamwork skills valued highly by biological employers: [12], as well as technical aspects of filming.

To support this process, I organised a preparatory interactive workshop with a cameraman who has worked with the BBC Natural History Unit. Students received a detailed insight into wildlife film-making and participated in an interactive workshop in which they storyboarded a short film on leaf-cutting ant foraging and then film their story using lab-based ant colonies. Student feedback, collected via an online survey showed this session was extremely well received, with 100% of participants agreeing the session was helpful in skills acquisition and 87% saying it was "excellent" or "very useful" in preparing them to undertake filming in South Africa. Because the whole project, from preparation to final result, involved both staff and students, it engendered a collaborative atmosphere and extended other initiatives that I use on field trips to further students' academic development [13].

The videos (totalling 5.5 hours) have been introduced pre-trip for 2013 students to prepare them to "hit the ground running", and have received 100% positive feedback, with students saying they are "invaluable". They have proven to be particularly useful for students who find it hard to learn from written instructions or diagrams, including dyslexic and dyspraxic students. To ensure the videos are maximally useful, I have designed, in my own time, extensive supporting materials. These additional resources include briefing documents for specific methods and data analysis guidelines with suitable worked examples. All resources are freely available under Creative Commons Licence on a website I designed (http://www.africanbiosciencevideos.esafari.co.uk) and have been used by several other UK universities, including UWE. The effectiveness of the video project is explored in a journal article to ensure wide dissemination of the approach [14].

Perspectives

Student perspective on preparation session: "*The session was invaluable! Being taught by such an inspiring wildlife filmmaker was brilliant, I'm now considering this as a career", and "A fantastic session - our films will have some assistance from a professional!"* **Questionnaire**

Student perspective on making technique-based films: *"The Africa fieldtrip was the best two weeks of my life. Making the videos was really interesting & made me really think about the techniques I had learnt and how to communicate them" and "I learnt so much more than I could ever have imagined"* **2012 module evaluation**

Student perspective on using technique-based films pre-trip: *"The videos are really helping us learn field skills in a way you just don't get from a book – they are amazing! I love the fact that they have been made by students for students"* **2013 student**

Colleague perspective: *"I have been on numerous field-trips with Anne where she has guided students through high level ecological skills, which give students a real employability advantage. The video project, which was Anne's innovation, has been extremely successful"* **Adam Hart, Prof Science Communication, NTF**

External perspective: *"The videos are excellent for teaching students complex fieldwork skills in a memorable way"* **Lucy Clarke, Leader (Animal and Land Sciences), UWE**

Benefits

Film-making students refined skills through making videos and gained key transferable skills such as teamwork and communication

Key resources to help students prepare for fieldwork so they get the most from it

Long-term project – more videos can be made each year to extend resource

Videos hosted on a permanent website so they are a long-term revision resource

Videos can be used to support non-field based classed

Resources can be used by other institutions and to aid skills acquisition

Innovative use of technology to support learning

Example 2: Acquisition of skills in a laboratory setting

Biosciences graduates have highlighted experimental design as an area where they frequently lack the skills demanded by employers [5]. Accordingly, I have developed, with two colleagues, a computer simulation package called the Virtual Rocky Shore to teach experimental design. This was part of an HEA initiative to produce interactive teaching resources, funded by a £31,000 grant from JISC. The project was inspired by the challenges inherent in teaching experimental design in traditional undergraduate classes. Although deep understanding is best achieved through experiential learning [15], manipulative experiments are costly, time-consuming, and logistically-challenging, making principles notoriously hard to teach [16]. The Virtual Rocky Shore facilitates rapid, student-centred, learning of experimental design through students devising and conducting their own experiments on species-ecosystem interactions in an e-learning environment. Published analysis shows using this teaching tool leads to a statistically significant increase in understanding relative to initial knowledge and theory-only sessions [17,18], with grades increasing by 71% and 36%, respectively. Student perceptions of their own understanding also increased. All materials are available as an open educational resource on JorumOpen through a Creative Commons Licence (http://open.jorum.ac.uk/xmlui/handle/123456789/2729).

Example 3: Furthering skills development by learning "on the job"

To build on the above projects, I have developed holistic approaches to allow students to develop skills further "on the job" through real-world projects. I have achieved this partly by pioneering links with the wider University. For example, in my *Ecological Monitoring* module, students monitor pollution in the University lake. Following student advice in 2011, the Estates team removed autumn leaf-fall from the lake, which resulted in a richer aquatic insect community. Another link involves students on my *Conservation Ecology* module formulating Biodiversity Action Plans for the University, again in consultation with the Estates team, while initiatives set up with the Landscape team have resulted in projects on making planting more butterfly-friendly. These projects were significant contributors to the University being ranked 2nd out of 131 UK Institutions in the Green League table for Environmental Performance in 2011 (scoring maximum points on biodiversity management) and winning a Gloucestershire Wildlife Trust Business Award in 2012.

Perspectives

Student perspectives (Ecological Monitoring): "Taking part in a real project was motivating as it felt we were doing something that had real benefits" and "*We were able to do actual research and work with the estates teams - things we would not be able to experience properly in a theoretical assessment scenario".* **2012 Module Evaluation**

Student perspectives (Conservation Ecology): *"The Biodiversity Action Plan assignment was one of my favourites! It was really cool helping the estates team, learning so many skills, and feeling a bit like a 'proper' conservationist rather than a student!" and "I feel in the future it will be really useful career wise as I have a piece of work that I could use and feel confident in showing my ability".* **Comments via email**

Evaluations for both modules: *93% agreed with "Participating in this module has stimulated my interest", while 96% agreed with "Teaching and learning outcomes have enabled me to achieve the stated learning outcomes" (mean scores across Department = 60% and 83%, respectively)*

***Colleague perspective**: "Working with Anne and her students has been very helpful in forming actions that help the University meets its environmental targets and create a greener environment for us all"* **Andy Simpson, Head of Estates**

More widely, I have been a lead developer in a Department-wide internship module. I have identified devise projects where students learn "on the job" and make a difference in diverse placements, for example with the Cheltenham Science Festival, Bee Guardian Foundation, Mammal Society, and local schools. As part of this module, students write CVs and cover letters, on which they receive formative feedback, thereby aided Personal Development Planning. I have also set up collaborations for dissertation students with link organisations, including West Midlands Safari Park (WMSP), Ecotricity, the RSPB, Royal Agricultural College (RAC), and the Wildfowl and Wetland Trust (WWT). All projects have

involved training/advice input from the link organisation and answer real questions raised by that organisation, such as the impact of visitors on penguin behaviour (WMSP) and the effect of field margins on bird diversity (RAC). In many cases, findings have been used by the link organisation to change practice (for example, bat survey methods used by Ecotricity and bird nestbox placement by the RSPB) and have led to co-authored papers between the student(s), myself and the link organisation [e.g. 19]. These projects demonstrate the mutual benefits that can be derived through taking a problem-based learning approach, especially when the "problem" is a real one that needs solving [20].

Student perspective: *"Doing my dissertation on penguins at the Safari Park was a great opportunity. It was brilliant doing something that was actually useful, not spending months working on a project just for the sake of it."* **KH, third year student**.

Link organisation perspective: *"We had genuine questions about tiger behaviour, but no time to undertake a long-term study so a student project was ideal. The students were fantastic and their research is helping us improve animal husbandry."* ***Katie MacDonald, Research Officer, West Midlands Safari Park***

I have extended the internship/dissertation model by working with colleagues, especially Dr Matt Wood, to launch a research bursary scheme, whereby students work jointly with staff on research projects funded by small University stipends and "in kind" contributions from external bodies. Four of these launched in 2012, involving eight students, two of whom worked with Dr Wood and myself on a bird migration project based at Portland Bird Observatory (PBO), who provided accommodation. We analysed over 350,000 bird records from 42 years producing novel results with immediate conservation implications, which we are currently writing up for publication jointly with the students and PBO. The majority of my work on this has been done in my own time, reflecting my dedication to such initiatives.

Benefits to "on the job" learning

In contrast to discrete skills modules and some "manufactured" problem-based learning scenarios, students really engage with the "learning on the job" approach because work has real-world, tangible, implications

Routinely co-publishing projects with students (10 peer-reviewed papers in 3 years, with 2 more in submission), greatly enhancing graduates' CVs

Results of projects used to inform ecology practice, both within the institution and for link organisations

Tangible employment-related results

Although it is gratifying that my initiatives have led to increased attainment and received excellent feedback (see above), it is far more important that recent graduates have secured high profile jobs in a highly-competitive job market. Recent successes have been graduates getting jobs at leading ecological consultancies, international charities, conservation organisations and government organisations, including the Health Protection Agency, as well as securing prestigious PhD studentships. Graduates from both courses I lead, BSc Animal Biology and BSc Biology, are 7% more likely to be in employment 6 months after graduating than graduates from similar courses (HESA data, 2013), often as a direct consequence of my drive to imbed skills in my modules and, in my course leader role, throughout the curriculum.

Student perspective: *"The interview panel for the top ecological consultancy job I got said they couldn't believe the practical ecology skills I had gained through Anne's modules. That got me my dream job - they don't normally take people coming straight out of a BSc!"* ***LA, 2012 graduate***

To help bridge the gap between student experience and graduate expectations, I support Biosciences students to take part in a University-wide Employability Award initiative (e.g. facilitating two students to become assistant lab technicians in 2011/12, both of whom used the experience to secure laboratory employment post-graduation). I have also been involved with Graduate Challenge, a HEFCE-funded, Gloucestershire-based, apprenticeship scheme for recent graduates and supported by postgraduate study (http://tinyurl.com/asxqju2). My involvement has match suitably-skilled Biosciences graduates with local ecological organisations, and devising projects that build on the graduate's skills and simultaneously deliver valuable tangible outputs for the organisation concerned.

Student perspective: *"After graduating, Anne supported me through Graduate Challenge. I obtained 8 months paid experience with Gloucestershire Wildlife Trust, followed by a full-time job! If it hadn't been for Anne's support, I am sure I wouldn't be where I am today!!!"* ***C C-G, 2009***

Reflection

My teaching is based on vision and commitment; continually going above and beyond the call of duty to achieve excellence in student experience and academic attainment. I strive to ensure that my teaching and supervisory practices move beyond the routine to become exceptional. Within a Biosciences degree, it should be expected that students undertake fieldwork, complete lab projects, and have effective dissertation supervision. It might not be expected that students will have opportunities to learn wildlife film-making from the BBC to support their field learning experience, routinely co-publish with staff, or have numerous opportunities to solve real, important, questions with link organisations. Most people undertake a University course to improve job prospects [21], thus, whatever else a degree provides, and however important the life-lessons learnt along the way, providing a head start on the career ladder is arguably the most important thing a degree can do [22]. Through teaching practical skills crucial for employability beyond what is expected at undergraduate level, and by providing exciting opportunities for students to apply these, I achieve just that.

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