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What is PLANET?

PLANET is the bi-annual publication of the LTSN Subject Centre for Geography, Earth and Environmental Sciences.

Its aims are to:

- Identify and disseminate good practice in learning and teaching across the three disciplines of Geography, Earth and Environmental Sciences and present examples and case studies in a "magazine" format.
- Provide a forum for the discussion of ideas about learning and teaching in the three discipline communities.
- Provide information for readers on Subject Centre activities and on related resources, conferences and educational developments



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Editorial

Linking Teaching and Research and undertaking Pedagogic Research in Geography, Earth and Environmental Sciences (GEES)

Steve Gaskin, LTSN-GEES

Teaching and research are Higher Education's two principal activities but are often seen as separate and in competition, or even in conflict. However, evidence suggests that connecting student learning to staff research can be beneficial for all, providing that the relationship is positively managed. Student learning itself can generate opportunities for pedagogic (educational) research which can both lead to staff publications and then feed back into enhanced student performance. Also, academics can in some circumstances benefit from student involvement in research. Either way, linking teaching and research effectively and undertaking good pedagogic research take considerable time and effort.

This special edition of PLANET brings together 25 short papers on pedagogic research and linking teaching and research in Geography, Earth & Environmental Sciences. It will hopefully give you, the practitioner, some basic ideas and approaches to adopt or adapt in your own teaching. Many of these papers were presented at the LTSN-GEES residential conference on teaching and research in June/July 2003 which saw over 80 GEES academics discuss these important topics at a national level.

This special edition is organised into two main sections. Part A focuses on linking teaching and research. Part B focuses on pedagogic research. Here, the outputs of the LTSN-GEES pedagogic research programme on fieldwork are presented, together with some additional pedagogic research articles.

The selection of papers presented in both sections of this edition highlight the diversity of work being undertaken in the GEES disciplines, both in the UK and overseas. As you will see, with respect to linking teaching and research, contributors in this edition demonstrate how these links can be managed through curriculum design, national and international fieldwork training, multi-media and GIS packages, departmental research conferences, utilising case studies from business, adopting problem-based and team-work approaches in the classroom and through working in partnership with the local community to understand better environmental problems. Discipline-based pedagogic research has been undertaken to improve students' experience of fieldwork, to assist in the planning and delivery of courses and to gauge students' understanding of complex issues in an environment and development course.

I hope that you enjoy reading these PLANET articles in this fifth special edition. Please feel free to contact the authors, or LTSN-GEES, for any additional information that you might require.

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Part A Linking Teaching & Research

Designing a curriculum that values a research-based approach to student learning in Geography, Earth and Environmental Sciences (GEES)

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Abstract

For many of us the teaching and research nexus is what distinguishes higher education from other education sectors. Yet, the research evidence cautions us that positive teaching/research links are not automatic. This article sets out a range of strategies that individuals and course teams in GEES can use to examine their current courses and strengthen teaching/research connections to benefit student learning in these disciplines.

Three Propositions and One Question

"Universities need to set as a mission goal the improvement of the nexus between research and teaching...the aim is to increase the circumstances in which teaching and research have occasion to meet."

Hattie and Marsh (1996, p533)

For academic staff in GEES disciplines, as for staff in all disciplines, their identity and their motivations are profoundly shaped by their commitment to research in their discipline. For many of us what is distinctive about *higher* education is that there is a close interconnection between staff research and student learning. However, there has been little formal public discussion or publications from within disciplinary communities on how to achieve teaching/research links. Perhaps they are seen as so self evident as not to require analysis or formal discussion?

Important Issues for Consideration

Three linked issues make it imperative for all disciplinary communities to formally consider these issues:

- There is strong research evidence that questions the often presumed close connection between staff research and teaching quality (Hattie and Marsh, 1996);
- Governments in the UK and elsewhere are selectively using that research evidence to justify policies that in effect create 'teaching only' institutions /departments;
- Furthermore, there is research evidence that the UK Research Assessment Exercise has resulted in a structural separation between teaching and research in some institutions and departments (Jenkins, 2000; McNay, 1999).

In my view, teaching and research need to be re-shaped so that they connect in productive ways. This requires action at a whole range of levels from the individual academic to the national system and indeed international disciplinary communities (Jenkins et al, 2003). Such actions need to start at the level of the individual teacher and course team and build on the insights of Brew and Boud (1995, p272) that, *"teaching and research are correlated when they are co-related."* One way to achieve this is to *"exploit further the link between teaching and research in the design of courses."*

Formulating Design Principles

How might we develop a set of principles that will guide us in designing a curriculum that seeks alignment between the cultures and practices of the teacher-researcher and the learning experiences and processes of students? One approach is to draw on examples of existing good practice:

A University College London (UCL) Geography Department Case Study

Consider this example as a curriculum strategy to connect research and teaching. In the first term of the geography undergraduate course all students interview a member of staff about his/her research.

- Each tutorial group is allocated a member of staff who is not their tutor.
- Each tutor gives his/her tutorial group their CV and three pieces of writing which are representative of their work.
- Before the interview, students are expected to read these materials and develop an interview schedule etc.
- On the basis of their reading and the interview, each student writes a report on (a) the objectives of the interviewee's research; (b) how that research relates to their earlier studies; (c) how the interviewee's research relates to his or her teaching and (d) how it relates to geography as a whole (Dwyer, 2001, p366).

In my view, this is very 'effective practice' for the context of a highly rated research department. Such an approach expects that every member of staff will be 'research active' at an international level. This, however, is not the context of most undergraduate courses elsewhere. Nevertheless, the case study reveals a basic principle that the connection between the teaching and research and the use of this situation as a rich resource for student learning does not occur incidentally. It needs to be explicitly designed into a course.

The case study also highlights that in this context the nexus between the teacher as researcher and the curriculum is introduced at an early stage of the course. In many courses this connection is only central at the time students undertake their final year dissertation or thesis.

UCL students also learn from this experience that teaching staff have commitments and responsibilities to research, and are not just here to teach students. Focus group interviews with undergraduates and postgraduates at Oxford Brookes University (Jenkins et al 1998, Lindsay et al 2002) revealed that students were often not aware of staff research, or thought it was some sort of 'affair' that staff had surreptitiously late at night and at weekends (although perhaps there is some truth here!).

Curriculum Strategies for Developing Students as Stakeholders in Research

The task facing course teams whose view of 'quality teaching' is one that relates closely to staff research, is to make undergraduate students feel that they are stakeholders in the learning through research enterprise. The UCL case study shows the importance of careful explicit design to achieve that curricula aim. It is also a model that can be adapted to other contexts. I have seen similar courses in health care at Rutgers (New Jersey, USA) where undergraduate student teams interview community health care professionals on how their practice explicitly draws on current research on HIV, sexual health practices etc. This is a good way of exploring evidence-based professional practice that is central to a large range of undergraduate courses, and many at postgraduate level.

The UCL exercise is actually based on one devised in about 1980 at the then Oxford Polytechnic, which at that time received little or no money for research. As part of a third year 'reflective' synoptic module integrating their studies in geography, student teams interviewed staff about their research and their views about the development of the discipline, and how this had been included in the courses students had experienced (Cosgrove, 1981).

Designing the Curriculum to Focus on What Students Do

Biggs (1999 and 2002) draws the distinction in any teaching and learning system between what the teacher does to promote students' learning and what the students do to learn.

One limitation of the UCL case study is that it can focus attention on what *staff* do and omit or fail to centre on the important dimension of *what students do*. In this context we focus on the 'scholarship and research' that *students* do in reading the research papers, interviewing the staff and analysing the interviews. For while the research evidence on the value of staff research to student learning is problematic, the benefits to students learning through student involvement in research and enquiry is not in doubt. The central message for course teams is to *focus on the student experience of appreciating, using and doing research*. What follows are brief descriptions of the views of four of the current researchers/scholars in this area, all of which direct us to focus on what *students* do as learners and *how* teachers teach and design courses.

Perspectives from Current Research and Scholarship

Ron Barnett (2000, p163), argues that universities need to be reformulated to help students and society deal with 'supercomplexity'. He sees teaching and research as "activities (that) are separate and distinct and are not to be confused. However... institutions, and also their students, have a right to expect that their lecturers are engaged in research ... *but the issue is whether lecturers adopt teaching approaches that are likely to foster student experiences that mirror the lecturers' experiences as researchers.*"

Angela Brew (1999, p299) sees "*the relationships between teaching and research (as) dynamic and context driven.*" The contexts include whether research is seen as an objective product or as a process of enquiry, and whether teaching is seen as transmission of what is known or an exploration. "*If researchers recognise the ways in which their activities parallel those of students and take steps to involve students in research-like activities, research can inform practice in facilitating learning.*" (Ibid.298)

Lewis Elton (2001, p43) agrees that there "*may well be a positive link (between research and teaching) under particular conditions.*" These he sees less in terms of the outcomes (e.g. published papers by 'research active' staff) than in the extent to which students learn through some form of student-centred or enquiry-based approach.

Marcia Baxter-Magolda (2001) sees involving students in research and research-like activities as supporting them in developing more sophisticated 'ways of knowing' /conceptions of knowledge. In a research study of an intensive undergraduate summer research programme (at the University of Miami, Oxford, Ohio), she concluded that students who took part in the research programme became more confident as learners and more capable of thinking independently. Her research suggested that more complex assumptions of knowledge stemmed from participating in a mentored, independent research experience. Baxter Magolda (1999, p9) sees such research as validating what she describes as "*constructive development pedagogy ... (in which) teachers model the process of constructing knowledge in their disciplines, teach that process to students, and give students opportunities to practise and become proficient at it.*"

Guiding Principles for Curriculum Design

The way that course teams seek to apply these research perspectives in curriculum design will of course vary by staff views and disciplinary concerns. There is no one way of making such effective links and developing courses that support students' understanding of, and ability to 'do', research. Sharing course structures and examples such as the UCL case study, will help course teams and disciplinary communities decide what they consider appropriate. This is a main aim of the project funded through the LTSN Generic Centre on 'Linking Teaching and Research in the Disciplines'. <http://www.brookes.ac.uk/genericlink/> in which LTSN-GEES has been centrally involved.

While for those of us who are educational developers, perhaps we have spent too long bemoaning staffs' commitment to their discipline and research: and too little attention to working with those concerns (Healey and Jenkins, 2003). Our understanding of how to design courses to work with these interests is limited. The suggestions on course design that follow, build on the insights of current pedagogic research on the nexus, but are very much work in progress. They will benefit from critical analysis and discussion, and testing out in the GEES and other disciplinary communities and through discussions in your department. Such also need to be supported by actions at department level that assist staff in developing the links between teaching and research. Here again we need to share and discuss what is seen as effective practice (Jenkins and Zetter, 2003). But the central argument is that there is much that individual staff and course teams can do in the design of a course to promote the 'teaching /research nexus.'

Curriculum strategies for linking teaching and research at the level of the module/course

Here are some ideas on how the teaching/research link within GEES courses can be made more explicit:

- develop students' understanding of the role of research in their discipline;
- bring out current/or previous research developments in the discipline;
- develop student awareness of learning from staff involvement in research;
- develop student understanding of how research is organised and funded in the discipline/institution;
- develop students' abilities to carry out research/consultancy in their discipline;
- support students' learning in ways that mirror/support the research/consultancy processes in the discipline;
- assess students in ways that mirror/support the research/consultancy processes in the discipline. For example, requiring students to have their work assessed by colleagues according to the house style of a (fictitious) journal before submitting it to you; this mirrors how academic journals use referees to decide on whether an article is to be published;
- provide training in relevant research/consultancy skills/ knowledge;
- develop student involvement in staff research/consultancy.

How to Manage the Student Experience

- Limit the negative consequences for students of staff involvement in research/consultancy. Most important here is managing the student experience of the days (and sabbatical terms) when staff are 'away' doing research. At a minimum, students need clear information as to when staff are available/away;
- Evaluate/research the student experience of research/consultancy and feed that back into the curriculum;
- Support students in making clear to them the employability elements of research and consultancy. This is particularly important for those students whose focus is on using a degree to get employment - and who may not otherwise appreciate the value of a research-based approach.

Conclusion

In the UK and elsewhere academics have to confront the intentions of many governments to restrict research funding to a few institutions/departments. That must be resisted because of the danger that many students and the wider society will fail to benefit from a genuine higher education experience. As academics, we have to take some or much of the responsibility for the prevailing government view that teaching and research can be de-coupled. For too often we have failed to ensure in our courses and in practices within departments and institutions effective teaching /research synergies. What this article has focused on is what individual staff and course teams can do to strengthen teaching /research connections. There are also wider questions of what GEES departments, institutions and national systems and international disciplinary communities can and should do to ensure a more positive environment for staff to progress these links (Jenkins et al. 2003 and Jenkins and Zetter, 2003). But, what has been outlined in this short PLANET article can be achieved by GEES staff as individuals and as course teams.

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The Research-Teaching Nexus in Geography, Earth and Environmental Sciences (GEES)

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Abstract

This article is an edited version of a longer essay on the topic available on the LTSN-GEES Web site (www.gees.ac.uk) (Healey et al., 2003). Drawing on an LTSN-GEES project, it argues that students may benefit from developing links between teaching and research in all kinds of higher education institution. However, the nexus between research and teaching in geography, earth and environmental sciences is complex and contested, takes a variety of forms, and varies by subject and type of institution. Moreover, it reflects the changing concepts that staff and students hold about the nature of research and teaching. Most of the previous literature on the linkage comes from geography, which has been extensively reviewed elsewhere (Healey, 1997, 2000; Jenkins 2000; Johnston and Cooke, 2001). To help correct the disciplinary balance for a GEES audience, two appendices are included with this article, which deal specifically with linking teaching and research in environmental sciences and earth sciences respectively. The main article reviews some of the themes in the international debate about the research-teaching nexus.

Introduction

Even before the publication of *The Future of Higher Education* White Paper (DfES, 2003), higher education institutions (HEIs) and departments in the UK were beginning to position themselves where they perceived that they had the greatest competitive advantage. Many research-intensive universities and departments, such as the Department of Geography at the University of Southampton, claim that teaching and learning in their undergraduate programmes is "research-led" (Table 1). However, it is clear from the project reported here from the Learning and Teaching Support Network's Subject Centre for Geography, Earth and Environmental Sciences (LTSN-GEES) that linkages between research and teaching may be found in all types of HEI. The study, which draws on international research and practice, shows that the nature of the research-teaching nexus in geography, earth and environmental sciences is complex and contested. It is argued here that students are likely to gain most benefit in terms of depth of learning and understanding when they are actively involved with research of all kinds. The development of such research-based curricula will provide challenges to staff across the sector, not least because they may lead to finding new ways for staff and students to work together.

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Research-led Learning & Teaching

At Southampton we pride ourselves on the quality of our geographical research and this is reflected in our approach to teaching. Specifically, we believe strongly in our philosophy of research-led teaching and learning. The degree programmes we offer therefore reflect the research interests of staff within the School, which in turn are carefully structured within three main research themes. These research themes are defined in sympathy with international research priorities so we are able to contribute significantly to high profile debates. At undergraduate level the content of the research themes is reflected in a clear route for the intellectual growth of students undertaking our degrees. We believe that it is our emphasis on research-led teaching, together with the content and structure of the research themes themselves, that makes our school distinctive, dynamic and challenging for students and staff alike.

Source: www.geog.soton.ac.uk/ugadmiss/vision.asp (accessed 28th August 2003)

Table 1: Promoting the Department of Geography's approach to teaching at the University of Southampton

The Complexity of the Linkage

One reason why the links between teaching and research are not simple is that they may take a variety of forms (Tables 2 and 3) (Healey and Jenkins, 2002). These include students being taught about research findings and methods and being introduced to the culture of the discipline. This can be a fairly passive experience for students if a transmission model of education is followed. More effective can be the use of a variety of ways of engaging students actively in their learning (Biggs, 2003; Prosser and Trigwell, 1999) through getting them to do research themselves through undertaking some or all of the stages involved in carrying out a research project (Elton, 2001). Students commonly experience active learning in GEES subjects through fieldwork, laboratory and practical work, and when they undertake projects and dissertations, but active learning may be integrated into all forms of teaching (Hands-On!, 1998). Underlying all these ways of developing the research-teaching nexus is the need to develop among our students the skills of critical thinking and asking questions (Johnston, 2003).

Developing the Linkage between Teaching & Research

- 1 Bringing data and findings from staff (faculty) research into the curriculum
- 2 Developing student appreciation of research in the discipline
- 3 Development of student research skills (explicitly, in addition to other disciplinary and generic skills)
- 4 Using assignments which involve elements of research processes (e.g. literature reviews, bidding for grants, drafting bids or project outlines, analysing existing project data, presenting at a 'conference')
- 5 Using teaching and learning processes which simulate research processes (e.g. project-based modules, dissertation modules, problem based learning)
- 6 Giving students the opportunity to work on research projects alongside staff (e.g. as a research assistant)
- 7 Giving students firsthand experience of commercial consultancy (e.g. as an 'intern', as work-based learning, as a consultant assistant or as a supervised consultant)

Table 2: Individuals and course teams may develop the linkage between research and teaching in a wide range of ways

At Glasgow Caledonian University human geography students submit reviews for publication made available to the local community in the fieldwork location

Practising Geography, the second year undergraduate Human Geography module at Glasgow Caledonian University, offers individual students the option of submitting coursework in the form of a briefing paper based on a small-scale, fieldwork-based research project that they themselves have designed and executed. On completion of the module, students can then elect to have their paper refereed by an independent expert (generally a local resident from the field locality or a member of one of the Royal Scottish Geographical Society's Regional Centres) as part of the StuP project (STUdent Publishing of fieldwork geography). The StuP project is based on the module. Publication on the StuP project website is conditional on an acceptable referee's report.

Source: McKendrick *et al.* (2003)

Students across all three years of an environmental studies degree course work together on local sustainability projects

This project outlines and evaluates the aims and practice of a local sustainability project, which brings levels 1, 2 and 3 students on an Environmental Studies degree at the University of Sunderland in small research groups to work in collaboration with Sunderland City Council's Local Agenda 21 personnel, and other local environment and development agencies.

Source: Hughes *et al.* (2001)

Students at University College London interview staff about their research

This example describes a project used in the first-year curriculum that requires students to interview a member of staff about their research as a possible model to link research and teaching in the university. Through a critical evaluation, which draws upon responses canvassed from students and staff, the value of the project is assessed and its scope for application within other institutions suggested.

Source: Dwyer (2001)

The research methods in geography course at University of Canterbury, New Zealand uses a problem-based learning approach

This geography research methods course focuses on research methods and the problem-based learning approach in which the students learn about research by being fully engaged in the research process. The items of assessment all involve research skills and the use of peer assessment mimics the professional research world. The use of research problems devised by an external agency adds extra motivation for the students. Students, who work on the research problem in groups, are enthusiastic and stimulated by the approach.

Source: Spronken-Smith (2003)

Students in Australia work with staff on a geological mapping project

Staff and students at Canberra College of Advanced Education have jointly been working on a regional geological mapping project in southeastern Australia since 1985. Integration of teaching and research has resulted in educational and financial benefits and has also produced a new atmosphere of cooperation and achievement for the department as a whole.

Source: McQueen, *et al.* (1990)

Based in part on Healey (2003)

Table 3: Cases illustrating ways in which teaching and research may be linked in the GEES curriculum

The geography, earth and environmental sciences (GEES) group of subjects provide an intriguing test ground in which to examine the linkages between teaching and research because of the position they hold at the intersection between the natural and physical sciences, the social sciences and the arts. They cover aspects of all four discipline types (soft, hard, pure and applied) recognised by Biglan (1973). Few of the other LTSN Subject Centres provide this degree of inter-disciplinarity. However, this means that the situation is more complex than that faced by most other Subject Centres, in that there is a greater variety of ways of developing the link between teaching and research in the GEES disciplines. The intra-GEES variability, ranging from cultural geography to geochemistry, and environmental management to philosophy of geography, suggests that there is no single agreed approach to linking teaching and research in these disciplines.

The Nature of the Teaching-Research Nexus in GEES

In the original essay (Healey *et al.*, 2003) a variety of different types of research and teaching and approaches to carrying them out are explored. In particular, attention is drawn to Boyer's (1990) distinction between four types of scholarship - discovery, application, integration and teaching. He argued that recognition of these four types of overlapping scholarship would help overcome the futility of the research versus teaching debate and give equal recognition and reward to all the forms of scholarship undertaken by academic staff.

Griffiths (in press) takes the argument a stage further by providing a useful distinction between research-led, research-oriented, research-based, and research-informed teaching (Table 4). However, a perusal of institutional teaching and learning strategies suggests that the terms are used loosely and interchangeably. Moreover individual academics often follow a combination of these approaches in different contexts.

Models of the Teaching-Research Nexus

- Teaching can be **research-led** in the sense that the curriculum is structured around subject content, and the content selected is directly based on the specialist research interests of teaching staff; teaching is based on a traditional "information transmission" model; the emphasis is on understanding research findings rather than research processes; little attempt is made to capture the two-way benefits of the research teaching relationship.
- Teaching can be **research-oriented** in the sense that the curriculum places emphasis as much on understanding the processes by which knowledge is produced in the field as on learning the codified knowledge that has been achieved; careful attention is given to the teaching of inquiry skills and on acquiring a "research ethos"; the research experiences of teaching staff are brought to bear in a more diffuse way.
- Teaching can be **research-based** in the sense that the curriculum is largely designed around inquiry-based activities, rather than on the acquisition of subject content; the experiences of staff in processes of inquiry are highly integrated into the student learning activities; the division of roles between teacher and student is minimised; the scope for two-way interactions between research and teaching is deliberately exploited.
- Teaching can be **research-informed** in the sense that it draws consciously on systematic inquiry into the teaching and learning process itself.

Source: Griffiths (in press, 11-12)

Furthermore, there is evidence that the conceptions that staff hold of research influences their approach to the research-teaching nexus.

So, for example, an academic who has a conception of research focused on the external environment (Brew, 2001) may view research-led teaching as involving students in a range of social activities mirroring research conferences, journal publications, presenting posters, engaging in teamwork and networking. Someone who has a conception of research focused internally on the analysis of data to develop an understanding, may see research-led teaching more as a process of engaging students in courses on methodology, interpretation of data etc. (University of Sydney, 2003).

Although there is little evidence of a direct correlation between research productivity and teaching excellence (Hattie and Marsh, 1996; Marsh and Hattie, 2002), the view that there is a relationship persists.

Politically, the stakes are loaded against evidence showing there is not a link between teaching and research. Neither staff, who wish to be allowed to continue to engage in both teaching and research, nor institutional managers, who want to maintain university funding based upon research and teaching, have any desire to see the link severed or weakened (Brew and Boud, 1995a, p37).

Some of this debate has been specifically about geography (Healey, 1997, 2000; Jenkins, 2000; Johnston and Cooke, 2001). On the one hand, it is contended that the best teaching and learning in geography is led by the best researchers (Cooke, 1998) and that there is a strong correlation between where the best geography research is done and where the best teaching is available (Johnston, 1996). On the other hand, it has been suggested that in the UK the competition induced by the research assessment exercise (RAE) has had deleterious effects on the quality of undergraduate teaching in geography (Jenkins, 1995).

Several writers argue that a correlation between research and teaching will only occur where the relationship is mediated through another variable or variables. Elton (1986, 1992, 2001) suggests that an input of scholarship, in the sense of a deep understanding of what is already known in the subject taught or researched, is the key intervening variable. A slightly different interpretation is given by Brew and Boud (1995a), who argue that any linkage between teaching and research operates through the element they have in common, the act of learning. For them research is a process of learning or discovery, while teaching is concerned with facilitating learning. This may help to explain Cooke's (1998) contention that the best researchers make the best teachers, because "as researchers, teachers are often engaged in the same activity as their students, namely learning" (Brew and Boud, 1995b, 270) and "Both learning and research are about making meaning" (Brew, 2003, 15).

This argument is taken a stage further by Scott (2002), who argues that with the shift to a Mode 2 knowledge intensive society, all students need to be researchers and all researchers need to be teachers. Hence, for him, much of the current debate about possibly breaking the link between teaching and research is about "separating the inseparable" (p.27).

This raises the issue of the student experience of research. Most of the studies of the teaching-research nexus have focused on the experience of academic staff and whether they need to be excellent researchers to be excellent teachers. Relatively few studies have examined the perception of students of the relevance of research to their learning (Healey, Jordan *et al.*, 2003; Jenkins *et al.*, 1998; Neumann, 1994; Zamorski, 2002). Key findings from this research include that:

- Students perceived clear benefits from staff research, including staff enthusiasm, the credibility of staff, and the reflected glory of being taught by nationally and internationally known researchers.

Table 4: Models of the teaching-research nexus

P L A N E T

- They also perceived disadvantages from staff involvement in research, particularly staff availability to students. Moreover, students had little sense of ownership / involvement in these activities, why it was taking place, and which members of staff were doing what. They did not feel staff research should take priority over their needs.
- Despite students believing themselves to be primarily recipients of research, rather than actors in its production, they recognised that their awareness of the nature of research and the development of research skills increased most when they were actively involved in undertaking research projects. The students also perceived benefits for future employment from their participation in research activities.
- Many students expressed a desire to learn more about the research and consultancy undertaken by their teachers and to find ways in which they could become more involved.

Some of these points are illustrated by the following quotes from GEES students at the University of Gloucestershire (Pell, 2003):

"I think it (staff research) does act as a catalyst for a student as well. If you know your lecturer is going to be doing research or your advisor is doing research, then obviously you want to know as much information about this particular research subject just so as you don't look stupid in exams or in a test!"

"The [name of research unit] was quite important for me ... if it's got so much prestige then obviously if you want to work in that field, and they can link you with this department, then it's going to be very beneficial to us."

"Maybe they (academic staff) just need to talk about it (their research and consultancy) more, and bring the students actually into their work."

The ease of involving students in research varies by discipline (Colbeck, 1998). This is because in terms of ease of understanding the latest research, the linear nature of knowledge in the sciences can make it more difficult to integrate the latest research findings into undergraduate classes than it is in the humanities and social sciences. In contrast the practice of using research teams in the sciences means that it is easier for an undergraduate to be given experience as a research assistant than it is in the humanities and social sciences, where the model of the lone researcher is more common. This suggests that students in human geography may find it easier to understand the latest research, but may have fewer opportunities to work alongside staff than is the case for physical geographers and earth and environmental scientists.

As with any form of teaching and learning, adopting research-based learning does not of itself lead to improved student learning. The way in which the curriculum is designed and assessed, and how it relates to the rest of the programme are critical. There are many examples of effective research-based learning in GEES (Table 2 and 3), but poorly designed exercises, which are inappropriately assessed and not linked with the rest of the course, provide little benefit to students. Consideration also should be made for students with different learning styles (Healey *et al.*, in submission). Furthermore, allowance needs to be taken of the danger of exploiting students where they work on staff research projects and do repetitive research which goes beyond what they need to understand the subject or research techniques (University of Sydney, 2003). Strategies for benefiting student learning at individual, department and institutional levels are discussed in Jenkins *et al.* (2003).

Conclusion

The nature of the linkage between teaching and research in GEES is complex and contested. This is in part a function of the range of ways in which these linkages may operate, but more fundamentally reflects the fact that the nature of research, teaching and learning is changing and conceptions of them differ, both among staff and among students. The widerange of discipline types included within the GEES subjects further complicates the matter.

Following the work of Boyer (1990) and his colleagues, adopting a broader definition of research than is currently common is a way forward, which should benefit the learning of GEES students in institutions with a range of different missions. Indeed, there are signs that his call that the different forms of scholarship found in the academic enterprise (discovery, application, integration and teaching) are given fuller recognition, is beginning to receive attention in higher education policy circles in the UK (e.g. Gordon *et al.*, 2003); and in part underlies initiatives, such as knowledge transfer funding, Centres for Excellence in Teaching and Learning, and the Higher Education Academy. Gibbs (2002) has gone further and called for the type of research undertaken to be re-oriented towards those which are likely to benefit undergraduates the most (i.e. application, integration and teaching).

Assuming the recommendations in the recent UK Higher Education White Paper (DfES, 2003) are implemented and discovery research funding becomes more concentrated in a few universities in the UK, then it is likely that other forms of scholarship will receive greater attention, particularly among the less discovery research-intensive institutions. Meanwhile, the importance of developing synergies between teaching and discovery research is likely to receive greater emphasis in research-intensive universities, particularly in the light of evidence cited by Colbeck (1998) that as much as 45 per cent of academic staff's work-time in the United States was taken up achieving multiple goals, associated with both teaching and research.

There is an increasing amount of evidence that students may benefit from research activity, as indicated in the GEES case studies in Tables 2 and 3. It is important now that, as Brew (2003, 15) argues, *"Attention should be given in curriculum design to how staff research can benefit student learning."* Involving students in research need not be restricted to the final year dissertation in the UK or the capstone course in North America, but could be integrated throughout degree programmes.

If such an active learning strategy is to become commonplace in GEES and higher education generally then the nature of higher education itself will need to be reconceptualised so that staff and students work together in what Brew (2003, 12) calls *"academic communities of practice"*. This she argues:

"... means sharing power and it means being open to challenge. So the final question is this: are we ready to really take up the challenges of bringing research and teaching together?" (Brew, 2003, 16)

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Appendix 1 - Linking Teaching and Research in the Environmental Sciences

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Introduction

Investigating a link between teaching and research in the environmental sciences highlights the problem so admirably described by John Passmore (1974) in the early 1970s as being "forced to slosh around in the ooze that is interdisciplinary studies". Not only are you presented with the problem of defining what is research and considering the many typologies (see details above), and with the arguments that surround definitions of 'teaching' (Biggs 2003), but you are also faced with the complex nature of environmental science itself.

This complexity was well rehearsed in the work of the Subject Benchmark Panel for Earth Sciences, Environmental Sciences and Environmental Studies (QAA 2000) (ES³) and culminated in the production of a Venn diagram to try and illustrate what the Panel thought the contributing disciplines and sub-disciplines were and how they related to each other. In the end, the diagram was not included in the Statement, but the vigorous debates it induced highlighted the slippery task of trying to define the nature and boundaries of the discipline(s) (Eastwood and Blumhof, 2002). The Panel had to accept that it had a "wide remit, ranging from the scientific study of the physical characteristics and environmental systems of the Earth, to the social and political issues of human relationships with the environment" (QAA 2000 page 2). This wide remit spanning the 'hard' and 'soft' sciences asks questions of environmental science's position in relation to the argument posed by Feldman (1987, cited by Griffiths 2003).

"that there is some evidence that stronger relationships between research and teaching exist in so called "soft" disciplines, such as humanities and social sciences, than in "hard" ones, such as natural sciences."

Whether Feldman's assumption is correct is debateable. What is clear is that it is at Departmental or even Programme level that the dominance of one paradigm or other is evident, giving a very mixed picture of the research-teaching nexus in the discipline as a whole.

Despite the "hard" science, "soft" science dichotomy and the practical applied or discovery research continuum that is so much a feature of environmental sciences, the Benchmark Panel believed that ES³ Programmes share the following important features:

- most tuition has an holistic, multi-disciplinary and inter-disciplinary approach;

- the integration of fieldwork, experimental and theoretical investigations underpins much of the learning experience in earth and environmental sciences, but may be less significant in, but not absent from, courses in environmental studies;
- quantitative and qualitative approaches to acquiring and interpreting data are both in evidence;
- most programmes involve an examination of the exploration for and exploitation of physical and biological resources in the context of sustainability (QAA 2000).

The importance of research and for students to experience a 'research rich' environment is evident and this was further highlighted in the Graduate Key Skills that the Panel argued should be developed in ES³ degree programmes. In particular the 'intellectual' and 'practical' skills could have been renamed 'research skills'. As was stated, "Research and scholarship inform curriculum design of all ES³ programmes. Research-led programmes may develop specific subject-based knowledge and skills." (QAA 2000, p6)

Research-Teaching Nexus

Using the four main typologies of research listed above, the research-teaching nexus in environmental sciences can be:

- *Research-led* in the sense that the curriculum is structured around subject content (as is the case in many final year modules designed to reflect the research interests of members of staff and final year project titles focused on research interests). At the University of the West of England, Bristol, final year applied sciences modules such as Ecological Survey, Estuarine and Marine Ecosystems, Pollution Management and Environmental Monitoring and Assessment, amongst many others, are structured around the active research interests of the teaching team.
- *Research-orientated* in the sense that the curriculum places emphasis as much on understanding the processes by which knowledge is produced (as evidenced by the emphasis given to the development of skills in ES³ - see Eastwood and Blumhof, 2002). For example, Veronica Edmonds-Brown's case study of the use of Pymmes Brook, North London, as a resource and tool in pollution and monitoring modules is an example of how research skills are developed in the field by final year environmental science students. (<http://www.gees.ac.uk/linktr/EdmondsBrown.htm>)
- *Research-based* in the sense that the curriculum is largely designed around inquiry based activities (as evidenced in the development of problem-based learning and a case study approach by Blumhof, Hall and Honeybone, 2001 and Honeybone, Blumhof and Hall, 2002). For example, at the University of Hertfordshire, first year Environmental Science students have engaged in a problem-based case study (The Broadland Case Study) focussed on a real-life, real-time problem. The importance of investigative skills and the research process is emphasised. In a similar way, final year students at the University of the West of England, Bristol, studying the module Environmental Monitoring and Assessment undertake a problem based case study in which they must design an air pollution monitoring programme for a busy street within certain specified but complex constraints.
- *Research-informed* in the sense that it draws on systematic inquiry into the teaching and learning process itself. The LTSN-GEES New Lecturers Workshops that have run for the last three years with participants from all three GEES disciplines are testament to the interest in learning and teaching theory and practice.

Summary

At present there are areas for development but also some unknowns. Though the nexus is multifaceted and arguably embedded in environmental sciences, it is not necessarily made explicit and this is clearly an area for development. Additionally, the growing strength of the professional bodies and particularly the independent umbrella body for environmental professionals, the Society for the Environment (at present working to provide an internationally recognised professional qualification for environmental practitioners-Chartered Environmentalist) is going to affect the 'shape' of the nexus though how is not yet clear. It is also not clear what will be the long-term implications of the fall-out from the last RAE and the negative affect this has had on many environmental science programmes, though some go from strength to strength. Finally, the potential research-teaching divide proposed by the White Paper (DfES 2003) raises more uncertainties for environmental science but has also been a catalyst for deep thinking about the research-teaching nexus and the chance to strengthen both. LTSN-GEES offers opportunities, through a whole range of staff development activities, and it is this support that a discipline under pressure needs.

The above analysis is the author's and does not necessarily reflect the views of the whole of the Environmental Sciences community.

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Appendix 2 - Linking Teaching and Research in the Earth Sciences

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Introduction

Research, and the Research-Teaching (R-T) link, in Earth Sciences is influenced by the nature of the subject arguably to a greater extent than in any other natural science. To understand the R-T nexus, it is important to understand the discipline and how it has evolved. The study of Earth Sciences is concerned with spatial and temporal scales but, unlike geography and environmental sciences, the 4th (i.e. time) dimension has greater emphasis because geological processes and products date back to at least 4.6 billion years. It can therefore be argued that the discipline itself is very different from cognate disciplines and from the other natural sciences and therefore research and the way in which it influences, and is influenced by, teaching takes a very different form. Earth Sciences has evolved fundamentally in the last 35 years, a crucial fact in understanding the research-teaching link. The discipline has moved from being principally an observational science (traditional 'Geology') to a multi-disciplinary science reliant on methodologies and skills in modelling, observation, recording and experimentation and is heavily dependent on synthesising data from multiple sources to test theories and hypotheses. Despite the continued importance of direct observation, Earth Scientists are now heavily dependent on remotely sensed data from the atmosphere down to the Earth's core to help explain surface measurements and observations in the context of the Earth System. No other subject has the same profile.

Research-led Teaching

A major turning point for the Earth Sciences came during the 1960s with the development of the plate tectonics hypothesis. For the first time, numerical scientists became crucial to research in the discipline, making the multi-disciplinary nature of the subject explicit. At this point in history, and subsequently, the teaching of Earth Sciences has, to a great extent, revolved around the plate tectonics paradigm. This is a fundamental example of a link between research and teaching, indeed a case of how advancement of research was responsible for completely changing the way a subject (and in fact, a whole planet!) is viewed. Oreskes (2003) documents extensive confirmation of this statement from the viewpoint of key scientists who were teaching students about the groundbreaking plate tectonics research at the same time as conducting it! This is an example of teaching being *research-led* where the curriculum is underpinned and built around the specialisms of the core teaching team. In this model, there is often an over-reliance on information transmission, rather than active participation in the research process. Traditionally, and currently, this model is heavily practised in Earth Sciences degree programmes. It has many benefits, such as motivating students to learn about the cutting edge of the subject, often resulting in their deciding to follow a career in research. However, there are drawbacks, particularly in that little attention is given to the development of students' research skills and limited emphasis on how research can benefit teaching. There are, nonetheless, other ways in which research can and does enhance student learning in the Earth Sciences and many of them are linked to learning that is achieved in the field environment.

Research-Orientated Teaching

Like the Earth Sciences, Geography, Environmental Sciences and Life Sciences include fieldwork as a core learning environment. For example, all geology undergraduates will produce, as part of their final year independent work, a geological map of a selected area. Map production is common to several disciplines but the end product in our case – the geological map – is generated by a rigorous research methodology. This combines observation, measurement at a number of different scales, recording of data in a way not seen in any other discipline, processing of those data by computational and non-computational techniques and subsequent interpretation of observed features to develop a final product. Therefore, when students are trained in mapping techniques they engage in an exercise in *research-oriented* teaching. Modern technology is now being used to further enhance student understanding of the research processes involved in geological mapping (e.g. McCaffrey *et al.*, 2003)

Research-Informed Teaching

Important learning in Earth Sciences also takes place in the laboratory or classroom environment. Until recently, departures from the traditional, didactic lecture-practical teaching model have been restricted to some exemplars, developed by open-minded academics. The first coherent collection of curriculum materials designed to develop students' key skills resulted from a DfEE-funded project (Thomas, 1998). Many of these exercises concentrated on developing a researched-based approach to teaching, with the exercises designed around the research process and staff acting as facilitators of inquiry-based learning. These examples covered scales ranging from single tutorials (e.g. Bowler & Francis, 1998) to semester-long tutorial schemes (e.g. Barker, 1998) and single practical classes (e.g. Lee, 1998) to whole modules (e.g. Colley, 1998). Subsequently, Earth Science educators have realised the potential benefits of problem-based and action learning and utilised this mode more frequently in programmes at all Levels. Much of this work remains unpublished but examples can be found in McQueen (2003), Lee (2001), Thomas (1999, 2000) and Gravestock (1998). There is no doubt that Earth Science degree programmes are enriched by research-informed teaching but the developers of such programmes are often reluctant to publish their work for reasons of time pressure and academic credibility. Earth Sciences, unlike Geography, has not fully embraced research into L&T as a credible activity. Therefore, the *research-informed* method, where teaching is designed around the conscious inquiry into the L&T process itself, is not generally used at undergraduate level in the Earth Sciences. This exclusion may have been a barrier to a fully effective R-T link in the discipline. This may well be a general problem in the natural sciences but has not gone unrecognised. In the USA, the National Science Foundation (NSF) has programmes to promote more effective research-teaching links (in all sciences, including Geosciences) such as the Research Experience for Undergraduates (REU) (NSF, 2000) and inclusion of a broader impacts criterion in subject-based research bids, a component of which seeks to "...*advance discovery and understanding while promoting teaching, training and learning...*" (NSF, 2003).

Programme Considerations

So, how can Earth Sciences best integrate the different link models to suit the characteristics and culture of the discipline? In Earth Sciences, all effective teaching programmes should be research-led to some extent. If teaching does not communicate the fruits of cutting edge research then that programme neither complies with the requirements of the ES3 benchmark statement (QAA, 2000) nor satisfies the requirements of Geological Society accreditation (if already held). Aside from these rather technical reasons, the student learning experience would not be sufficiently comprehensive without this kind of link between research and teaching. However, it is inappropriate for the research-led model to operate in isolation and the danger for Earth

Sciences is that, in some programmes, it may be over-utilised. The importance of research-oriented and research-based approaches is clear from the discussion above and underpins some fundamental aspects of undergraduate Earth Sciences programmes. The challenge to Earth Sciences is to find the most effective usage-balance for the different models. Some would argue (e.g. Jenkins, 2003) that careful planning is needed to ensure effective usage balance of the various models. This has merits, though a radical culture change would be required in Earth Sciences to move towards the ideal scenario preferred by Jenkins. Working on the principle that change is best effected in stages, an intermediate step in the development of a more dynamic R-T nexus in Earth Sciences may be to make students aware of when the various models are being used in their programmes and encourage them to evaluate their learning in the different contexts. For this to work, it is necessary for students to be exposed to sufficient examples of each model in operation which, in many Earth Sciences programmes, they are. Traditionally, the research-led approach is favoured at Level 3 (honours), though there are indications that some departments also underpin their Level 2 curriculum with this philosophy. Such an approach is sensible only if students can relate to the research results themselves, the ways in which they are generated and the way in which the results are being communicated to them by the lecturers. This is where the role played by the other models is important. Evidence suggests that Earth Science students will understand the results and implications of high level research more thoroughly if they can engage in the process themselves (Jarret & Brunley, 2003; Lee 2001; Thomas, 2000). This suggests that a balance of research-led and research-oriented models needs to be achieved, a fact that many overseas Earth Science educators have included in their programmes (e.g. James, 2003; McQueen, 2003; McQueen *et al.*, 1990). In some UK departments, the inclusion of undergraduate masters (4 year) programmes has exposed students to more research-based approaches, particularly at Level 4. Anecdotal evidence from the community suggests that graduates of such programmes are more likely to possess the skills required to be successful researchers than graduates from 3-year programmes.

In order for the R-T link to be fully effective, however, it must be introduced at Level 1, as it is in the Department of Geography at UCL, for example. However, curriculum designers must exercise great care in attempting to achieve this. Recruits on to many Earth Sciences programmes have little or no prior experience of Geology or Geophysics, so great care must be taken not to over-expose new students to the research culture within the discipline. On the positive side, the learning process in Earth Sciences, whilst being essentially progressive, is less linear than in other natural sciences. Modern Earth Sciences is taught in a more holistic, systems-based approach governed by processes. Therefore, coverage of a topic at Level 1 must engage higher level concepts and, with the style of writing used in many groundbreaking papers in Earth Sciences, students are often able to follow cutting-edge research findings at early stages in their programmes. Again, the approach of the educator is crucial but, if carefully planned, can yield dynamic and exciting Level 1 curriculum material. At Level 1, the research-based and research-oriented models, with discipline-specific, personal exemplification from staff would introduce students to the research process and its importance in the discipline. Such an approach would also prepare students more thoroughly for the research-led curriculum material they encounter later in their programmes.

In the UK, the research assessment exercise (RAE), completed in 2001, has generated a culture of fear in the Earth Sciences, with the prospect of future government funding for research being concentrated in fewer departments. This has two potential implications for the R-T link. In departments where research activity is low, there is a real danger of curriculum linkages being restricted to the kind of model portrayed in the Government White Paper (DfES, 2003), where staff are solely scholars of research literature, rather than practitioners of research and

therefore contributors to the literature. When such a model operates, staff transfer knowledge to students without a deeper understanding of, and feel for, the whole research culture, often leading to less convincing delivery. In research-intensive departments, there is a prospect of key researchers being distanced from teaching in favour of generating research grants and publications for the next RAE in 2006. In many cases, this would result in serious loss to the curriculum and the student learning experience.

Conclusion

In conclusion, there is considerable evidence for an active link between research and teaching in Earth Sciences. As yet, it is not clear if the way the link works in practice is appropriate to the culture and current state of the discipline. Three key issues need to be addressed:

- Do course teams effectively explain and exemplify the importance of the 'research ethos' to the health and development of the discipline?
- Do staff teams disseminate cutting edge research processes and outcomes effectively and at the most appropriate times during a programme?
- Are students involved actively with research (e.g. through enquiry-based learning or working as research assistants)?

It is likely that these three issues are being addressed individually across the sector. However, to provide maximum impact on, and benefit to, the student learning experience in each individual programme, they need to be addressed together and a careful strategy designed for engaging research in the teaching programme. Perhaps the way forward is to adopt a 'research-centric' strategy where an appropriate usage-balance of all models is achieved at the correct programme levels and the students are given sufficient opportunity to engage in, and reflect on, this process and their learning. This approach would have considerable implications for curriculum design and delivery and, importantly, would have significant staff development needs.

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Linking teaching and research using Do-It-Yourself (DIY) Interactive Multimedia Assignments (IMM)

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Abstract

This article describes a case study in which students of structural geology are empowered to learn by actively engaging not only with cutting-edge research, but also with the researchers who published it. Working in groups, the students re-engineer the knowledge and information in a journal publication and use it to develop an authored interactive multimedia research assignment. Part of the study involves engaging in a dialogue (by email) with the research author(s). The exercise has been used over many years and has helped to build up a significant database of digital assignments. It is hoped that other GEES practitioners might like to consider using a similar multi-media exercise in enhancing the teaching-research link.

Introduction

The following case study describes a practice where students are inculcated in the principles of geoscientific research through the "knowledge" re-engineering of a topical research journal article. The underlying philosophy upon which the study is based follows from that of Laurillard (1993) who described learning based upon scientific research (and publication) as a meaningful dialogue with the world conducted by the learner using acquisition, discussion and discovery and through the use of experience, interrogation and experimentation. The study was initiated in 1996 as a means of improving student learning using multimedia assignments and was based upon similar concepts described by Sawyer (1995) and Farrow (1993). The learning method has been running continually on an annual basis since that time.

Aims of the Do It Yourself (DIY) Interactive Multimedia (IMM) Assignment

The case study outlined here fits into the category of linking research and teaching by the use of assignments, which involve elements of research processes, (i.e.) analysis and re-engineering of research articles. Overall, the aims of the study are to empower the learners, to allow them to be more creatively and actively engaged with the scientific research and information and ultimately to provide a more equitable balance between teacher-driven and learner-driven education. At the University of Adelaide, third year undergraduate students are encouraged to communicate with journal publication authors whilst developing IMM modules based on their cutting edge research articles. The DIYIMM project has been used in a final year undergraduate structural geology course continually since 1996. In that year a simple student research assignment essay, comprising 25% of the marks for the course, was replaced by the DIYIMM exercise. The exercise was also changed to a group learning exercise, with groups of 2 or 3 students working jointly and collaboratively on development of the multimedia assignment and on an accompanying seminar.

As the research assignment was a major component of the course, the students were provided with details of its aims, intended learning outcomes and components in the introductory period of the course (i.e.) first or second week. The IMM assignment exercise was introduced in conjunction with a change to a more problem-based and flexible delivery of the course overall, with all course materials delivered on the www (which at that stage had only been available for about 2 years). Lectures were replaced with mini "lectorials" and topic

reviews, practical classes were replaced with short problem-based exercises, and fieldwork was supplemented with digital and video media. This was part of a larger development of innovative flexible course delivery as is described in James et al (1995), Clark and James (1993), James (1994), James and Clark (1991, 1993, 1996) and James et al (1997), and is summarised along with a detailed account of the early DIYIMM project in James et al (1996). Students were advised that the aims of the learning exercise were not only to instill in them an understanding of the features and concepts of structural geology, but that they were also being asked to undertake this as active and experiential learners in a self-paced, flexible, and collaborative learning environment. A comprehensive evaluation of the overall study was carried out and published by James et al (op cit).

Process and Procedures

Detailed instructions are provided to the student class at the beginning of the semester. There then follows an intervening 6-7 week period when the exercise is carried out and it is usually presented as a joint seminar during the last contact period of the course. Students are given an introductory and explanatory contact lesson describing the aims, objectives, tools and methods, together with a short hands-on practical class on how to use the available multimedia authoring system (e.g. Hyperstudio, Powerpoint, Hypercard etc) and how to access the array of digital resources which might be needed to carry out the assignment.

Working in pairs (or groups of 3 maximum) the students are asked to prepare a major interactive multimedia assignment from a specialist reading topic provided. Each pair or group is allowed to choose a topic to read about from one journal article from a recent issue of the *Journal of Structural Geology*. They are then asked to research using other recent papers on this topic. They are expected to use the references from their selected article as well as textbooks, the library, the Georef database and the Worldwide Web to find at least another five references to read on the topic.

The students are asked to carry out this research and then prepare and present the assignment in electronic format using one of a number of possible multimedia software authoring tools. Hardware requirements to be able to carry out the exercise include a well-equipped computer laboratory/suite plus access to various tools for scanning images, digitising video, storing and retrieving electronic image/software databases, network access and site licences for the various authoring and digital text and imaging manipulation. The preferred software recommended was initially the Hyperstudio software package by Roger Wagner or Hypercard on an Apple Mac platform. These were utilised initially because of their low (site licence) cost, their ease of use and their interactivity. Subsequently, many of the tools available in these authoring packages have been included in Powerpoint or other web-page authoring software, which have become the preferred options for many students. There is no limit placed on the number of cards or linked stacks (Hyperstudio terminology) or slides or files (Powerpoint terminology) or Hyperlinked web pages (WWW terminology), which may be contained in their multimedia assignments. However, they are made aware of the memory limitations of the computers, file transfer limits, and the limited assessment value of the project (see below).

Students are asked to be careful in the construction of the IMM module and to include as a minimum a title screen, introduction to the aims of the research, a range of text (subheadings/subdivisions are recommended), annotated graphics/digital photographs, perhaps some sound, a summary and a correctly referenced bibliographic screen. They are asked not to feel restricted by these conditions, and they are encouraged to consider incorporating visual and graphic design ideas, flair and innovation. They are told to search for information on the worldwide web about the research topic, but are reminded of the inherent dangers in accessing improperly authorised or published scientific material. Finally, the students are asked to email one or more

authors of one of the papers that they read and to ask a question about the topic, and then to report this together with any correspondence from the author(s) in their assignment. This dialogue is an important key to the research/teaching link as the students have to devise an appropriately and intellectually stimulating and enquiring question to the author(s). Receiving a reply (which does not always happen), is most exciting to the students and is a critical point in the realisation that the author is a real person and is carrying out their research usually in a similar institution (University). Authors generally reply positively to the questions (it at least shows that someone is reading and interested in their own research), and occasionally a general dialogue occurs.

The students ultimately present a summary of their specialist IMM research assignments as a seminar during one of the last practical sessions of the structure classes, as they hand in the assignment. This now happens digitally via an electronic drop box in the Blackboard VLE (virtual learning environment) software. The group has ten minutes to present the seminar, which is not sufficient time to completely cover the topic or to go into great detail. Rather they choose one aspect of interest or one view or theory to present. They give the seminar to the whole class and are expected to present it in as professional a manner as possible using computer projection facilities. Along with the publication of the assignments on the website, this allows access of all of the students' work to each other and externally, which is certainly an improvement on the former essay style of assignment where feedback was only possible between staff and individual students.

Outcomes and Assessment

The exercise clearly provides a close link between the teaching of structural geology and the most current research being carried out in the discipline. Students not only have to read and understand one international journal article (which is now available on line before even the hard copy journal arrives in the library), but they must also search through the bibliography of that article for a number of relevant papers. They must interrogate and summarise not only the text, but also become familiar with the figures, diagrams, plates, tables and these days often simulations and animations which may be available on the author's website. Assessment criteria match these aims of the course, and the students are given feedback and summative scores based on their ability to synthesise data and interpretations, relevance of content, visual impact, simplicity of navigation etc.

The exercise has now been running continuously for eight years. Each year, the class of between 20-30 students produce 10-15 assignments (modules). This has left a legacy of numerous IMM modules providing interesting summaries of much of the last eight years of cutting edge research in structural geology. Immediately following the course in the first two years, individual interviews and student evaluation surveys were carried out to assess the value of this exercise. Most students indicated their support for the IMM assignment exercise and many commented that they "enjoyed" using, what was then, novel software. Some students were concerned with the amount of time the exercise took relative to the assessment value, while others criticised the balance between learning the technology and software versus the learning of "structural" concepts. However, overall the value of improving computer literacy was seen as an advantage, for example in terms of its importance to their future professional careers. Other negative aspects of the exercise included hardware and software difficulties (access, crashes, digital presentation etc), although in later years, these concerns have been largely overcome by improvements in the computer technology. These outcomes are all discussed fully in James et al (1996).

Conclusion

In conclusion, it appears that the exercise has been a successful trial and modification of a typical undergraduate research project. In this case, however, the students are no longer considered simply as

"consumers" of learning and information, but are now also recognised and rewarded as producers. This exercise in the creative use of learning technology is allowing them to be much more active and therefore effective in their learning. It has proved a useful and powerful way to link cutting edge research in structural geology with student learning and teaching.

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Linking teaching and research in the undergraduate fieldwork training programme at the University of Adelaide

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Abstract

Fieldwork is recognised as a significant medium through which to link research and teaching in the geosciences. In this short paper, we provide three case studies demonstrating how these links are applied in our undergraduate curriculum. Level 1 geoscience students are introduced to geology research, fieldwork and mapping in complex terrains in an exercise involving grid sketching of small areas of polydeformation and metamorphism. A second study examines the integration of postgraduate research topics and areas with exploration geophysics techniques training in the Adelaide Hills. Finally, the links between consultancy, research and teaching are shown in a programme of exploration drilling for gold in an emerging mineral field in remote South Australia.

The Value of Fieldwork in Linking Teaching and Research

Fieldwork in the earth and environmental sciences is highly valued both as a critical educational element (Kern and Carpenter, 1984, 1986; Locke, 1989; James and Clark, 1993) and as a link between teaching and research (Edwards, 2003; McCaffrey et al 2003; Shah and Treby, 2003). Field exercises, tours, excursions and camps allow close encounters between active researchers and their students, often in areas where the current research activity is being carried out. Field teaching is inherently motivating, effective, interesting, enjoyable and rewarding and is valued both by the students (Fuller et al 2003) and by academic staff (Andrews et al 2003). The linking of teaching and research in the field makes both activities more relevant, in that research informs and affects the teaching, and the teaching provides a reality check and critical appraisal of the research.

The University of Adelaide has consistently used local and regional fieldwork and the research activity of its academics as the underpinning rationale for its undergraduate geoscience education programme. From the earliest arrival of Ralph Tate (1840-1901), Professor of Natural Science from 1875, the University teaching programs used local field areas such as the remarkable Permian glaciation and unconformity at Hallett Cove (discovered in 1877), to the spectacular Tertiary cliffs of the coast south of Adelaide and of the Murray River basin, as natural teaching laboratories. The die was cast with Professor Sir Douglas Mawson who inducted Adelaide students and future famous and pioneering academics such as Dr Reg Sprigg, and Professors Alan White and Brian Skinner in the fascination of the Flinders Ranges, the Barrier Ranges and the vast "empty" South Australian desert regions. This took place through much of the first half of the 20th century, while he was actively researching the structure, stratigraphy, petrology and mineralisation of these areas (Cooper, 2000). Reg Sprigg, the well known South Australian explorer, entrepreneur, environmentalist and philanthropist, later highlighted the value of this undergraduate experience by championing the use of field teaching in his noteworthy popular book "Geology is fun" (Sprigg, 1989).

Fieldwork has thus long been a fundamental component of the undergraduate experience at Adelaide at all levels. At stage one, field tours and excursions to local sites of spectacular geology provide the large class sizes an insight into not only the description and classification of geological features and processes, but also the research and scientific

methods that must be applied to understand their development. At stages two and three longer excursions introduce students to training in field-based skills and include week-long field geological, geomorphological and regolith mapping camps, where integration of geoscience processes is learnt. Almost all of these field activities occur in areas where the academic staff who lead and teach on the excursions are engaged in active research either through final-year dissertations or postgraduate projects. The three following fieldwork examples show where the links between research and teaching are most closely developed in the undergraduate training programme.

Stage 1 Introduction to Geological Mapping

In the early part (Semester 1) of the stage 1 geoscience training, students are taken on a weekend introductory camp to the southern Yorke Peninsula, about 250km southwest of Adelaide. This is the closest site to Adelaide where complex Palaeoproterozoic basement gneisses are exposed along a narrow shore platform at a safe, local fishing and tourist site called Corny Point. This area lies at the eastern margin of the Proterozoic Gawler Craton of South Australia and is the subject of considerable research interest into the isotopic age and origin of the approximately 1900-2000 Ma Corny Point paragneisses and their complex tectono-metamorphic evolution during the early stages of the Kimban Orogeny at 1845 Ma (Zhang and Fanning, 2001). The rock exposures are subhorizontal, flat, bare and water-washed with 100% outcropping sheets of tens of meters square. These outcrops reveal an array of layered metasedimentary (para-) and massive metaigneous (ortho-) gneisses with intrusive, amphibolite, aplite and pegmatite veins, migmatite lenses and folded intense foliations. The geology is polymetamorphic and multiply deformed, but although the area as a whole is very complex, on a small scale simple concepts and relationships are revealed.

Through a carefully staged training exercise in very detailed grid mapping, the students gain their first experience of a variety of geological concepts (e.g. field relationships, lithological description, intrusive contacts, folding), whilst learning the skills of both observation and field sketching (for a detailed description of the exercise see James and Clark, 1993). The students work alone, though as part of a loose group of 6-8 peers, together with a tutor. As the geology is complex, mapping is carried out on a very small area, which is redefined (and enlarged) during the exercise. Initially, a 1m by 1m square outline box is drawn with chalk on the surface outcrop (Plate 1). At this stage, students begin sketching on a piece of otherwise blank graph paper. Drawing the box as a 5cm by 5cm square in the middle of the graph paper introduces the concepts of scale (1:20) and orientation. While the students are sketching the principal geologic features (boundaries, folds, discordant sheets etc), and transferring the details into the box, the tutor enlarges the area by chalking in the surrounding eight 1m squares, which the students then progressively sketch.

Within about one hour, a simple (but inherently complex) geological map, is produced by each student. Comparisons between the sketches and the outcrop can be made and discussed immediately, and if necessary, a photograph can be taken of the whole area (3m by 3m). Students produce copies of the maps in later laboratory sessions, and write a short report including some rock descriptions made from samples collected during the excursion, and are also encouraged to read the current literature concerning research on the area. Students have been surveyed as to their attitude and generally agree that such field exercises improve their understanding of geological relationships, their confidence at producing results in the field, and their interest in Earth Science research in general. The short time needed to produce a map at an early part of their course is a significant benefit, as is the relative accuracy of the result caused by the use of such a small base map and the graph paper. This exercise has now been used successfully for more than ten years in the degree program.



Plate 1. *Folded and foliated migmatised Corny Point paragneisses with a 1m square mapping grid outlined in chalk*



Plate 2. *The Herrmann's Catchment area with, from left to right in the foreground, an MSc and a PhD student with Lecturer Graham Heinson (bending) showing calibration of an EM 38 conductivity meter to interested undergraduate students. Note the recent Eucalyptus plantation in the revegetated creek area planted to overcome transient salinity.*

Stage 3 Mineral and Environmental Geophysics field training in Pedo-Geophysics in the Adelaide Hills

A more recent innovation in using fieldwork to link teaching and research has been trialled for the first time in 2003 in the Mineral and Environmental Geophysics stage 3 course. The Herrmann's Catchment, an important field locality in the Adelaide Hills, is currently the research area of two University of Adelaide CRC LEME (Cooperative Research Centre for Landscape Environments and Mineral Exploration) -funded PhD students, and is being used to train undergraduate students in field geophysical techniques and exploration.

Herrmann's catchment is about 40 km northeast of Adelaide. The field-site geology hosts Cambrian massive sulphide mineralisation and a variety of related environmental problems, principally salinity, acid drainage and acid sulphate soils (Fitzpatrick et al 2003). The two PhD students who work in the area are Andrew Baker, an isotope geochemist mapping mineral pathways through cover sequences, and Mark Thomas, who is working on transient salinity effects using geophysics to map areas susceptible to salinity.

In May 2003, eighteen undergraduate students designed and carried out a geophysical investigation (Plate 2) to address some of the fundamental regolith issues in Herrmann's catchment, which had previously been defined within the research aims of the postgraduate student projects. In terms of environmental objectives these included the definition of near-surface hydraulic structure, mapping of clay concentrations, the identification of salinity pathways and areas of transient salinity and the relationship of geophysical signatures to pedological information. Mineralisation identification included definition of depth to basement, location of sulphides, fracture orientation as potential pathways for fluid flow and aquifer structure (Skwarnecki et al 2002).

Nine different geophysical techniques were carried out along profiles across the catchment including DC resistivity and induced polarisation (IP), seismic refractions, gravity, magnetics, magnetic susceptibility, electromagnetics (EM), self potential (SP) and elevation. Initial results of the surveys were very exciting for the postgraduate researchers as well as the undergraduate students. The most interesting features discovered were short-wavelength (< 20 m), but very highly magnetic responses within the valley. Such magnetic signatures are due to maghaemite concentrations, probably concentrated in palaeochannels within the valley. The source of maghaemite is likely to be colluvial accumulations after bushfires on the slopes of the valley. Similar morphologies in the magnetic signatures may indicate a meandering of the palaeochannels. There was also a clear correlation between the magnetic susceptibility from maghemite and electrical conductivity from salts and/or clays in the valley palaeochannels and the results show that high-resolution ground geophysical methods can be used to map regolith environmental systems and act as a proxy for soil toposequence processes.

Mapping mineralisation beneath cover was the second series of objectives. Locating sulphide mineralisation at the head the catchment is important in determining the controls on formation of acid sulphate soils, and sources of acid drainage. The resistivity and IP surveys found clear evidence for sulphides in basement beneath cover and although the formations have been drilled previously, profiles collected in one afternoon at very low cost, provided considerable extra detail on the depth and extent of the sulphides.

The Herrmann's catchment field geophysics has been valuable as a combined teaching and research exercise. Students were presented with real CRC LEME exploration and environmental problems, and developed field data collections to address some of the issues. The students developed teamwork skills and gained a better understanding of the importance of integrating geophysical, geological and geochemical constraints. For the LEME postgraduate researchers, the teamwork effort of the students provided new data and models that would have been time-consuming to achieve otherwise.

Stage 3 Economic Geology Gold Exploration Drilling Programme

The final example where research and teaching are being linked in the undergraduate geoscience education programme at the University of Adelaide is at the time of writing yet to take place, but is in the last stages of planning. In September 2003 twenty five students in the stage 3 Mineral Deposits course will be undertaking a week-long exploration drilling programme around the Barnes prospect in the newly named Central Gawler Gold (CGG) Province of South Australia (Ferris and Schwarz, 2003), some 600km west of Adelaide. The Proterozoic Gawler Craton of South Australia contains the world class Cu-Au-U Olympic Dam mineral deposit, the newly opened Challenger gold deposit and many new and emerging gold prospects and targets. It is thus the site of intense research and exploration activity, much of which is being carried out by State and Federal geoscience organizations (Primary Industries and Resources South Australia and Geoscience Australia), mining and consultancy companies, research organizations (CRC LEME and CSIRO Exploration and Mining) and academic researchers.

Much of the research activity has been fuelled by the high-resolution geophysical (airborne magnetics, gravity, radiometric and spectral) surveys, and the success of geochemical sampling focused around using the widespread surficial calcretes as surrogates for buried basement mineralisation. The Barnes Gold Project (Drown, 2003) is a recently discovered gold prospect, where Adelaide Resources Limited have drilled a blind bedrock-hosted gold mineralisation target beneath a gold-in-calcrete geochemical anomaly (Plate 3). Company drilling so far has revealed mineralisation associated with phyllic and propylitic alteration, and quartz vein systems with significant gold intersections, including an 8m interval at 2.97 g/t and a maximum published intercept of 2m at 67.6 g/t gold.



Plate 3. Company drilling operations at the Barnes Gold Project. Photograph and copyright provided courtesy of Adelaide Resources Limited

The CGG Province is thus in the midst of an emerging resources boom and gold rush. Students on the excursion will work with the most modern and up-to-date research and exploration data. They will plan and carry out a variety of drilling and sampling procedures using a rotary diamond drill rig and percussion drill. Further definition and resolution of the gold-in-calcrete anomaly and its extension beneath transported and surficial colluvium and dune deposits will be investigated. As well as conducting the drilling and sampling, they will return the samples to the laboratory for assay and analysis, and it is hoped that many of them will continue to further study (Honours), research (Postgraduate) or exploration (company) within industry on related projects.

Conclusions

The University of Adelaide is developing and implementing innovative field-based strategies to further embed the research ethos into its undergraduate geoscience training programmes. Negative factors including time, cost and safety must be balanced against the significant advantages of supporting such a vigorous field programme. However, we feel that this is a powerful way of linking teaching with research in the department.

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Examples of Integrating Field-based Research and Teaching in Geography, Earth and Environmental Sciences

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Abstract

Fieldwork is an essential component of any degree in geography and the earth and environmental sciences (GEES). Graduates with these degrees need to have received adequate appropriate field training. Academic staff involved in running fieldwork invest a large amount of time and effort in this activity and really only benefit if they can demonstrate some tangible output for their efforts. At the University of Greenwich, field-based research and teaching are highly integrated in some subjects in order to enhance teaching and learning activities for students and to maximise benefits to staff in terms of scholarly output and improved teaching materials. A highly successful, on-going process presently in operation at Greenwich is as follows: staff use their field-based research to inform their teaching and to stimulate interest in their research; interested students undertake their final-year research project allied to staff research; student research then informs staff research and aids enhancement of teaching; the cycle continues and increases the link between research and teaching to the mutual benefit of both staff and students. Taken a step further, this linkage may be successfully used to develop field guides and virtual field trips¹. The latter can be particularly important for widening access for disabled students who are unable to fully participate in traditional field activities.

Introduction and Rationale

At the Learning and Teaching Support Network (LTSN) Residential Conference on Teaching and Research in GEES, it was unanimously agreed that the field experience is absolutely essential to high quality teaching and learning in GEES, in terms of both the academic and the social development of students. The importance of fieldwork is further underlined by the Geological Society of London in its requirements for the accreditation of geoscience degrees. Despite these necessities, fieldwork currently is highly vulnerable owing to its cost to both students and their departments, the time it consumes and the requirements of health and safety. For the future health of GEES, it is essential that sufficient fieldwork is undertaken by all students and that the overall field experience is enhanced. In addition, there is an increasing need to provide a field experience for those students who are not able to undertake traditional fieldwork.

Many GEES academics have experience of undertaking field-based research, which they may utilise in the teaching and learning activities that they perform. This research may be adapted more formally to enhance the student field experience by developing and publishing course-support materials, such as books (e.g. the geological guides published by Terra Publishing and the Geologists' Association), pamphlets and virtual field trips (e.g. University of Leeds, 2003). Such an approach has the additional benefit of tangible output for the staff involved. It should not be forgotten that student fieldwork, especially that associated with research projects, may be harnessed by academic staff to provide useful information and data to support their own research and teaching.

The aim of the present paper is to demonstrate that field-based research and teaching may be linked not only to the mutual benefit of both academics and students, but also to provide a two-way development of teaching and research for academic staff. The paper describes an on-going process of linking research and teaching at the University of Greenwich and focuses on the eastern Mediterranean island of Cyprus² that is, and has been, a popular field location for GEES field research and student field trips for over two decades.

Why Cyprus?

The Department of Earth and Environmental Sciences (DEES) at the University of Greenwich has an established tradition of integrated teaching of GEES. Within the United Kingdom more and more universities are offering degree programmes that integrate GEES in a manner similar to that adopted at Greenwich, rather than continuing to teach GEES as three completely separate entities. This integration demands that field locations must be able to provide field sites suitable for all GEES disciplines. In this context, Cyprus is an excellent field location.

Cyprus is perhaps best known for its geology, but its geography and environment lend themselves to field investigation. In addition, there is growing interest in the impact that human activity has had, and is having, on the natural environment and resources of the island (e.g., Malpas, 2000). The rocks, sediments and structures of the island are extremely well exposed and provide a history of seafloor spreading, convergent tectonism and uplift. The island hosts a wide range of metallic and industrial minerals and has a long history of mineral extraction that dates back until at least the third millennium BC. The geology, soils, topography and climate support a rich diversity of flora and fauna, and the soils and climate permit productive cultivation of land and farming. The climate, scenery and beaches support a tourist industry that attracts around two-and-three-quarter-million visitors a year. Agriculture and tourism are placing water resources under severe stress and this problem has been exacerbated in recent years by short-term climatic changes that have resulted in periods of severe drought. Tourism is also largely responsible for the overdevelopment of the coastal zone. These aspects of GEES, and many others, may be studied separately or holistically depending upon specific course and degree requirements. Such studies are aided by very good access to field sites and by support provided by many of the departments of the Government of Cyprus.

Since 1996 in DEES at Greenwich, Cyprus has been used extensively in an initiative to integrate field-based research and undergraduate teaching. At level 2, field-based case studies are used in lecture-based teaching of aspects of environmental earth science (resource exploitation and natural hazards) and igneous petrology (ophiolites and oceanic lithosphere). At level 3 Cyprus is used each year by a number of students for their independent research projects, which form half of their final-year assessment. Students at level 2 always comment positively on the Cyprus-based case studies and those who choose to undertake their projects in Cyprus state that these were the stimuli for their choice.

Examples of Linking Research and Teaching

A Specific Example

In order to demonstrate the linkage between field-based research and teaching, an example is presented here with fuller details on specific aspects presented in the following sections. In the 1990's a considerable amount of research was undertaken on the environmental impact of mining in Cyprus (e.g., Charalambides *et al.*, 1998). University of Greenwich staff were involved in this research and used their findings to inform their teaching on the processes and impacts of resource exploitation. Over a period of several years a number of students were stimulated by this teaching into choosing a final-year research project on this theme. Projects focused on topics such as the mineralogy and geochemistry of mine waste, the fluvial transport of mine waste, and water and soil quality adjacent to mined areas. These projects not only provided an important teaching resource, some were worked up by staff to yield research output with students as co-authors (Edwards *et al.* 1996, 1998). The previous research is aiding further research (Hudson-Edwards *et al.* in prep.) and the development of teaching resources (a field guide and a virtual field trip, as outlined below). It is, thus, demonstrable that staff research informs teaching that stimulates student research, which enhances staff teaching and research that leads to more student research, and so on.

Student Research

At Greenwich a member of academic staff oversees and supervises the final-year student projects in Cyprus. Throughout the year this person is in contact with relevant government departments in Cyprus to determine appropriate and topical subjects for student research and to ensure access to all the necessary field sites. Details of the research topics and approximate costs are made available toward the end of level 2 and interested students sign up for a project. The students then follow the standard procedure for undertaking an independent project in DEES. They begin to investigate their chosen topic by writing a draft research proposal that is followed by the submission of a final proposal before the end of the Level 2 academic year. Fieldwork is planned and undertaken over the summer months and is completed by the early part of semester one of the final year. In Cyprus, students receive a week of supervision from their supervisor and liaise with experts in appropriate government departments. On return from the field, students complete an interim report that summarises their project to date; it presents the data collected and outlines a plan for completion of the project. At the end of semester one, students submit their projects and about a week later give a related oral presentation. By this process, students work through the research process and the supervisor and the appropriate government department in Cyprus both benefit from the research output. For example, the student sends a copy of their project to the government department that assisted them. The field research in Cyprus is always a high point of the student experience in DEES, and external examiners regularly comment on the enthusiasm and quality of work of those students who have worked on the island.

Development of a Virtual Fieldtrip

Through staff research and teaching and student research, there now resides in DEES a considerable knowledge and data base specific to the teaching, learning and research aims and activities within the department. However, this information is contained within field notes, maps, photographs, course notes, scientific papers and student dissertations. As such, it is not readily available to students in one easy-to-access location. In order to rectify this situation and to permit disabled students 'access to the field', a decision was taken to integrate some of the information into a virtual field trip to Cyprus that will focus on a few specific areas and topics that are essential to support teaching and learning activities within DEES. In order to continue their

research experience, students who undertake their Level 3 projects in Cyprus are being encouraged to participate in the development of the virtual trip by publishing summaries of their projects as a series of web pages. Initial responses to the invitation to publish have been very enthusiastic. The virtual trip is in the initial stages of construction, so it is too early to assess its effectiveness as a teaching and learning aid.

The virtual field trip is intended to do more than just support specific teaching and learning activities. It is also being used as a vehicle for encouraging a stronger e-learning culture amongst both staff and students within DEES, and it is being used to investigate how students e-learn. With respect to the latter, initial pedagogic research has been undertaken and the method and results are worthy of brief presentation here. Students were exposed to a variety of electronic information: course notes, illustrated course notes, published web pages and professional electronic courses, such as those produced by the UK Earth Science Courseware Consortium. In some cases students were asked to complete paper-based exercises linked to the electronic information. Finally, students were asked to discuss their views on their experience with respect to the delivery of information electronically. Their main views are being engineered into the development of the virtual trip and they were that:

- e-learning resources are very useful when large amounts of illustrative material and data need to be examined;
- these resources should contain concise text and, ideally, must make maximum use of illustrative materials such as maps, diagrams and photographs;
- the most effective way to e-learn involves responses to questions and completion of exercises;
- electronic delivery of teaching material should not be the only mechanism of teaching and blended learning: (involving a component of face-to-face teaching) is the most desirable.

Production of a Geological Field Guide

Cyprus is one of the most visited foreign field areas by UK universities running GEES, especially geology degrees. Over the past three decades, the island has also seen a large amount of research focussing on its geological evolution and resources. As a consequence, there is a vast amount of information on the geology of the island that should be readily available in a user-friendly format to enhance teaching and learning activities based on the island and to assist future field research. To this end, a field guide on the geology and environmental geology of Cyprus is in production (Edwards *et al.*, in prep.). It is intended that the guide will also appeal to the interested public in order to raise awareness of the island's natural environment and resources.

Conclusion

Research and teaching may be successfully linked to the mutual benefit of both academic staff and students. In GEES disciplines this is particularly relevant where fieldwork is involved. Staff research that is fed into teaching may stimulate student research, which, in turn, feeds back into staff research and teaching, and so on. Taken further, production of virtual field trips, that involve student input, and publication of field guides are tangible outputs that benefit staff and student development. Students who assist with staff research feel that their work is highly worthwhile and are stimulated by the recognition that they receive.

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Endnotes

- 1 Virtual field trips are no replacement for real field trips and must not be seen as a substitute for the real experience. The term is also rather inappropriate, but generally accepted and used here, because virtual field trips are really electronic field guides or case studies.
- 2 This article refers only to the non-occupied southern half of the island of Cyprus.

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Linking Teaching and Research through Departmental Research Conferences for Student Project Work

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Abstract

Organising a departmental conference involving student research papers can be a useful vehicle for bringing together pedagogic issues and research activities. It can also help refine academic and personal transferable skills. The conference provides opportunities for students to disseminate research findings and demonstrate higher-level skills to a wider audience of students, staff, external agencies and/or the public. It provides a forum for the sharing of ideas and experiences of research projects. Although challenging for students, such conferences increase their range of learning experiences and improve their employability.

Introduction

Most undergraduate degree courses introduce oral and graphical (e.g. poster or PowerPoint) presentation skills early on in the programmes, often in small group, informal environments. However, there are few occasions when students are involved in more formal presentations, either to academic staff, students or employers. Geography societies may arrange lectures, and Departmental, School or Faculty research series lectures are widely advertised to students, but student attendance is commonly disappointing. Undergraduate students have little knowledge or contact with external academic activities. Often, only when a conference is held at a student's institution and students are offered free places or are assisting in the logistical running of the conference, do they become aware that their tutors present papers on their on-going research at national and international conferences. Although some departments may require their dissertation students to present short talks at the planning stage and/or upon completion, typically there is little opportunity for students to share their research and learning with their peers.

Actively involving final year students in a department-wide research conference alongside academic staff and postgraduates presents an opportunity for undergraduates to demonstrate higher-level academic and transferable skills acquired during their whole degree programme. This article outlines an annual, day-long Research Symposium, recently inaugurated in the Department of Geography at Bath Spa University College (BSUC), where students present research papers based on undergraduate assignments, alongside postgraduate progress reports and research papers presented by the lecturing staff.

The Case for a Conference

The Geography Research Symposium arose from the need to provide a forum for students enrolled on an advanced research-oriented module to disseminate their reports to a wider audience. The Advanced Geographical Investigation (AGI) third year module (see Simm and McGuinness, in prep.) develops higher-level transferable skills, such as effective teamwork, writing of multi-authored reports and oral presentation. In contrast, the dissertation is often seen as the pinnacle of a student's achievement in their degree, an opportunity to demonstrate the range of academic and transferable skills attained throughout their degree, and an opportunity to apply the knowledge and understanding of Geography to a topic that interests them. However, as Simm and McGuinness (in prep.) identify, the dissertation, as an individual enterprise with contact only with a supervisory tutor, does not necessarily provide a representation of the skills required in the 'real' world. There are other higher-level transferable skills, such as

teamwork and oral presentations, that, although highly valued by employers, are not commonly found explicitly embedded in dissertation modules. As well as providing additional skills training, the format of the AGI module also provides students with a foretaste of postgraduate study, should they wish to pursue this route. The module runs in the second semester of the students' final year as an undergraduate, and can therefore be seen as the culmination of their academic and transferable skills.

Prepared by a compulsory research methods module in their second year, third year student groups on the AGI module are responsible for identifying, planning, researching and undertaking fieldwork (at present overseas, in Boston, Massachusetts, USA). The Geography and Earth Sciences, Environmental Sciences and Environmental Studies (ES3) subject benchmarking statements explicitly call for research 'design' and 'execution' skills in 'field-based research' activities. Including our students in the Research Symposium, however, pushes them to a further stage, explicitly identifying and rewarding 'dissemination' skills, assessed through a multi-authored, journal-style report, the preparation of a high-quality research poster and the conference presentation itself. Students enrolled on the AGI module are also required to undertake peer assessment of other students' Boston presentations.

The staging of a departmental conference/symposium can serve many functions. The annual Geography department Research Symposium at BSUC provides a mix of staff, postgraduate, undergraduate dissertation students along with a separate themed session on Boston student research based on the AGI module. Specifically, the research symposium:

- acts as a formal forum for the dissemination of the student group research projects from the AGI module;
- provides a forum for the presentation (and discussion) of recent staff research. Staff are able to trial ideas as working papers to a wider audience, as well as making colleagues further aware of the range of research being carried out in the department;
- provides an opportunity for postgraduate research students to present their on-going research. Final year dissertation students are also invited to contribute;
- can be used as a tool for raising the profile of the department in the local community. It may be used as a vehicle for Widening Participation purposes and also to maintain links with alumni;
- provides reference resources for future students on the AGI module (e.g. reports, posters, copies of the Powerpoint presentations);
- acts as an advertisement for future students to enrol on the AGI module;
- may interest and inspire students to undertake postgraduate study;
- may produce papers which contribute to the department's *Occasional Papers in Geography Series*;
- provides a precious opportunity for students at all levels to see the Department of Geography's activities as a whole; otherwise difficult within the 'pick-and-mix' structure of modular schemes.

Organising the Geography Department's Research Symposium

The Geography Research Symposium is set up to imitate a professional conference. Students could get involved in the logistical planning of the conference, but this was not one of the aims of the AGI module. A 'Call for Papers' is circulated around staff and students by e-mail, intranet and departmental noticeboard. All participants are requested to submit a title and abstract by a specified deadline. A Symposium Programme booklet is published, listing all presenters, abstracts and information about departmental research groups. The Symposium is advertised across the campus and a press release is sent to the local daily newspaper. Attendance at the Symposium is open to all and participants

are diverse: geography students from all years, their housemates, friends, family members and partners, academic staff, postgraduates, geography alumni and members of the general public. In future, the Symposium will be used as an annual focus for us to maintain contact with our alumni, many of whom remain resident locally and may enhance opportunities for developing potential research, training and teaching links with local employers through the alumni network. We are keen to get employers involved as well in the future.

It is good practice to extend the invitation to secretaries and, in particular, technicians, some of whom may have been involved in the preparation of samples for analysis and maintenance of field and laboratory equipment used by staff and students. It could also be an opportunity for a photo-shoot by a local news reporter in order to raise the institution's profile in the local community.

Participants are briefed beforehand as to the format and structure of the day. AGI students are given general advice on what to expect, what is expected of them, and how to approach the day. They are asked to mount posters, either in the lecture theatre or in a coffee room so that they can be viewed in advance of the first session. The lecture theatre should also be made available prior to the conference to allow students time to familiarise themselves with the equipment and to allow 'dry runs' in advance (Nicholson, undated).

The resources that need to be provided include an overhead projector for acetates, a whiteboard (or large flip-chart) including pens and paper, audio-visual facilities such as a PC with internet and PowerPoint linked to a screen projector, a slide projector, slide carousels, poster boards, and extension leads (Nicholson, undated). Asking a technician to be on stand-by is also useful. Coffee and a buffet lunch could be provided, allowing participants the opportunity to discuss papers informally and to peruse the research project posters on display.

The morning is allocated to a range of papers (usually not themed sessions) presented by staff and postgraduates. This sets the tone of the Research Symposium and also sets an example to the undergraduate students scheduled for the afternoon sessions on the AGI module. The themed Boston sessions give the module identity and structure, requiring all AGI students to attend all the afternoon sessions because peer assessment also forms a minor part of the assessment. It is important that one of the tutors involved in the fieldtrip chairs the Boston-themed session in order to reassure the students in case of difficulty, and to provide moral support. Student papers reflect the diversity of the geography discipline, including an examination of the development of an Irish Heritage Trail, the changing management strategies for Boston Common and environmental quality audits of a series of riverside parks in the city.

The Student Experience

Presentation to a mixed, wider audience under the formality of a conference-style setting demands much from the students. They need to draw on their study skills, teamwork, time-management, collaborative learning, student autonomy, inter-personal, critical awareness and evaluative skills (Nicholson, undated). They are also required to demonstrate a minimum standard of professionalism, building on the transferable skills acquired in earlier years.

Nicholson (undated) identifies that, in order to be successful, there needs to be adequate direction and support during the preparation stage. Firstly, the themes, titles, topics and issues to be covered, literature searches and reviews, and aims and objectives, need to be identified. Secondly, a supportive and accessible structure is needed. Thirdly, students need to have a clear understanding of what is required of them. For the AGI students, these have already been identified as part of the semi-structured research design stage of the module. Throughout the module, students are supported by regular seminars and workshops, and group and class discussions allowing topic-specific and generic issues, respectively, to be discussed (Simm and McGuinness, in prep.).

P L A N E T

The module, and in particular the symposium, enables students with different skills to mix, thereby promoting teamwork. However, all students are required to make an oral contribution. Although some students may shy away from public speaking, many find group presentations to be less daunting. As part of the AGI module, students have a common, shared experience, 'bonded' through the group research, planning, preparation and intense fieldwork overseas. Regular class discussions in an informal classroom setting engage all students and provide them with the confidence and expectation to speak in front of others. These trials have generally forced the students to demonstrate the maturity, academic rigour and application of previously acquired knowledge and skills, which prepares them well for the challenges of the conference. The students develop autonomy and effective time-management skills. Any groups or individual students who appear to be struggling at any stage during the module are given careful guidance by tutors, so that no group approaches the dissemination stage with undue uncertainty or seriously flawed research.

Students are responsible for presentation style. With increasing IT-literacy and training in degree programmes, students are able to research the internet and to manipulate programmes such as PowerPoint. Many students, and departments, now own a digital camera so it is a simple procedure to download images onto a PC and then to import them into PowerPoint. Nicholson (undated) suggests a wide-range of ways in which material can be presented, from traditional talks to role-play and chat-show formats involving audience participation and discussion. However, this Symposium was designed to adopt a traditional format, imitating, albeit on a smaller scale, those of professional societies and organisations.

In terms of quality control, students are encouraged to submit drafts of their research reports prior to the conference. The tutor can then provide advice tailored to the needs of the report and the Symposium. A looming deadline of a conference tends also to focus minds, prompting the setting-up of regular team meetings and encouraging effective time-management. The work done throughout the semester culminates in the production of the group project report, which typically will form the basis of the oral and poster presentations. The Symposium is scheduled a few days prior to the submission deadline for the report (the main assessment element) so that any constructive comments or useful ideas which arise in the 10-minute discussion period after each talk (or during the breaks) can be incorporated in their final report. Group work means that, as long as they work effectively, the workload is shared.

However, the often quite different demands of the AGI module were reflected in student evaluations of the unit. The novel forms of assessment led some students to complain that AGI was "over-assessed", "had a lot more work than expected" and had "too much coursework". There were a number of students who felt that there was "too much emphasis on group work" as opposed to individual study. However, the experience of the fieldtrip and in particular the conference/symposium was almost universally praised, most students feeling positive about the new skills that they had gained: "I have become an expert in problem-solving", have "learned to cope when the odds are stacked against you", explicitly identifying that their "planning skills have definitely improved" as well as that the module "developed my communication skills". This general sense of worthwhile achievement and beneficial experience of this advanced module was neatly summarised by one student: "in some kind of sadistic way I have enjoyed this. It has let me realise exactly what I can do after three years of university education".

Conclusions and Recommendations

This article discusses a departmental research conference that incorporates final year student projects produced within taught modules into more general 'research' orientated activity. This promotes

higher standards of professionalism in our students' work as well as building higher-level and explicitly demonstrable transferable skills in team-working and presentation practice. The principles can be applied to any degree level, for instance within a geographical skills module where students could devise and plan topics to be presented in a class setting. However, it is particularly suitable for final year undergraduates and postgraduates. For the AGI students, the Symposium is seen as the culmination of the module and, to a certain extent, also of their degree programme because, anticipating their imminent entry into the job market, it demonstrates their skills and abilities to a more public audience. It also acts as an incentive to students in lower years, setting examples of the standards that can be achieved and, hopefully, interests and inspires students to progress onto postgraduate study.

The high degree of autonomy granted to students in terms of project design was greatly appreciated by our students. The responsibility required students to ensure that their work was completed on time and this led to some outstanding examples of group work actually benefiting all members of the group. In particular, the requirement to present a public paper, rather than just to fellow students they have already bonded with through fieldwork, worked to focus minds and improve quality.

From our experience, we would recommend the following to other practitioners:

- Try to differentiate this type of task from other similar presentations students may have already done through the involvement in the conference of a wider public audience, a Call for Papers, submission of abstracts, formal chairing, and possibly the use of an unfamiliar seminar/teaching room;
- Try to produce a good quality conference programme, listing all speakers and abstracts;
- Invite departmental alumni - this may provide a valuable opportunity for maintaining contact with local graduates and may promote potential employer linkage opportunities and generate postgraduate research applications;
- Ensure that the student research session is chaired by a relevant tutor who knows the issues/group;
- Enable the electronic submission of papers and projects to build an online student research base useful for future years.

The students who have taken this module tell us that this experience has proved valuable in their job search, allowing them to emphasise distinctive transferable skills and qualities to employers through practical experience. Of course, the conference idea is of value to more than just our students, meeting departmental aims as well as individual staff and student needs. Whilst demonstrably enhancing student experience and employability, it has raised the standards we expect of our students (and if module evaluations are anything to go by, that they expect of themselves). Organising a departmental research symposium to showcase student work offers an opportunity to bring geographers of all levels and kinds together, enhancing departmental identity within the wider institution, alumni network and even the local community. Finally, it provides a powerful mechanism for linking teaching and research.

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Santa Cruz Field Course: developing Team Research Expertise

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Abstract

The Santa Cruz Field Course is considered here as a case study for linking teaching with research in the Geography curriculum at level three at the University of Liverpool. The field course develops the transferable and discipline-specific skills of small student groups in undertaking research of relevance to the Santa Cruz community. The different elements of the field course module are described, illustrating how they function in the development and assessment of the student skills and knowledge base, and how they engender the sense of achievement as a culmination of the undergraduate programme.

Introduction

One of the most innovative and successful elements of the Geography undergraduate provision at the University of Liverpool is the Santa Cruz Field Course (GEOG341). In annual feedback from our external examiners and our alumni questionnaire surveys, students refer to the field course as one the high-points of their undergraduate career – it being a culmination of their subject-based and skills training applied to a research question of their choosing. Indeed, the most successful element of the field course from an undergraduate perspective is that they feel fully engaged in the research process in addressing a question of relevance to the decision-making community in Santa Cruz, California. From a staff point of view, the field course is one of the most fulfilling elements of the degree programme in that students are genuinely excited by their endeavour and achievements – often leading to a realisation of the progress they have made during the course of their three years of study, and the skills that they have to offer employers or take into further research.

The issue of linking teaching with research in the curriculum is particularly interesting in the current climate of higher education assessment. With funding being linked to accredited research calibre, it is not surprising that teaching and research are almost considered as opposite ends of a continuum between 'research-led' and 'teaching-only' institutions. However, teaching and research can be complementary as well as competitive (Hudson, 1999). Indeed, Jenkins (2000) advocates the linking of staff research and teaching in Geography for the benefit of student learning. In the case of the Santa Cruz Field Course, this linkage is achieved through something of a problem-based learning (PBL) approach (Savin-Baden, 2001), which, according to Blumhof et al. (2001) "enables natural acquisition of transferable and discipline-specific

skills". In reality, the approach is more like the concept-based approach described by Chappel (2001), and can be regarded as a more wide-ranging and advanced version of the type of research-based project work outlined by Simm and David (2002).

The Santa Cruz Field Course Aims

With regard to linking teaching with research in the undergraduate programme, the Santa Cruz Field Course considers a number of elements. In particular, the field course focuses on:

- developing student appreciation of research in the Geography discipline;
- developing student research skills;
- using teaching and learning processes which simulate research processes, and;
- using assignments which involve elements of research processes.

These aspects of the field course have been guiding principles throughout its history and evolution - our first trip to Santa Cruz taking place in 1994. Given that the trip runs after level three students have completed and submitted their honours dissertation, students are more familiar with the research process and have developed a certain level of confidence in being able to set up, undertake and complete independent research. In this case, however, students are able to call on the combined skills and knowledge base of their small group which will undertake the programme of work. The students groups are, therefore, both self-supporting and self-motivating to a considerable degree, although guidance from staff throughout the progress of the project remains an essential element.

Field Course Structure

The Santa Cruz Field Course is a level three optional module offered to students enrolled on the BA Geography (L700), BSc Geography (Science) (F800), BSc Geography and Biology (CF18), BSc Geography and Archaeology (LV74), and BSc Geography for Management (L720) degree programmes. It takes place during the Easter vacation and lasts approximately 14 days. Student numbers opting for the trip are generally in the order of 50, although this has been as low as 30 and as high as 75. A uniform Departmental subsidy is offered to all students opting for one of the level three field courses offered (to Santa Cruz, Portugal at Spain), leaving individuals to finance the remainder of their costs. Currently, students are required to pay £450-500 to cover all travel, accommodation and logistical expenses for the Santa Cruz trip.

The elements that link teaching with research focus on the research project which will be undertaken in the field. Students are first introduced to California from something of a classical Regional Geography approach in which the module staff give a series of lectures on themes including: the USA in 45 minutes; an introduction to California; landscape and climate; the history of Santa Cruz; current social and political issues in Santa Cruz; and hazards and resources. From these lectures, and from a number of 'suggested' topics given on the field course web site (see below), small groups of students (generally three members) are required to identify a research question of relevance to the Santa Cruz area. Further support for this is also given in a workshop in which course staff illustrate the characteristics of various successful projects – considering the progress from the initial good idea, investigation of the available research literature base, testing the feasibility of the project, evaluating the outcome of the feasibility study, and implementing necessary remedial measures. Despite early project designs being too ambitious or vague, student groups are able to liaise with course staff who have relevant expertise and several years of field experience. The research questions are wide ranging – hence the appeal of the field course to students across the Geography discipline. Projects may be based, one the one hand, on an intensive programme of field surveying or 'home-style' laboratory analysis of

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materials (including vegetation surveys, river bed sampling, coring, lake chemistry, particle size analysis, and the measurement of magnetic properties) or, on the other, questionnaire surveys, interviews with administrative authorities, stakeholders and focus groups, or direct experiences (days in schools, courts, day care and drop-in centres, or spending time with the homeless, 'seniors', 'teens', or the police). Indeed, the range of research topics undertaken during the history of the Santa Cruz Field Course is vast – extending from the general thematic to the specific issue; from current themes in the discipline to idiosyncratic personal interest; and from the research frontier to the confirmation of well-known relationships and principles. Perhaps the best illustration of this spectrum of projects is given by the field course Research Report Series web site, where the final project reports are presented in an edited volume (see below).

Following the selection of a research question, the project to be undertaken in the field is formulated through something of an evolutionary process marked by 'waypoints' from which staff can assess (both formatively and summatively) progress and likelihood of success. The first waypoint is submission of a Project Proposal in the third week on the semester. The proposal is simply a statement project title and group members. Once approved, student groups then engage in a series of weekly meetings with their project supervisor in which they hone their particular research question and project aims with regard to the needs of the relevant user community in Santa Cruz; determine the context for their research through a review of the literature; agree their research methodology and identify their data sources (e.g. set up key interviewees or obtain access to field site *via* e-mail); and identify the particular skills that each member brings to the team. Project feasibility is tested directly through completion of a pilot project in the Merseyside region. In this case the research question may have to be amended slightly so that the pilot study provides an effective test for the methodology. For example, rather than considering earthquake preparedness in Santa Cruz, the group may have to consider preparedness for flooding in New Brighton. The results of the pilot work then help the group identify the likely outcomes of the methodology when it is undertaken in Santa Cruz. Similarly, methodological flaws or shortcomings can be addressed pre-emptively rather than having to make major adjustments during the field course. The different elements of the project, in particular the aims, theory (including conceptual framework), methodology (with lessons learned from the pilot project) and the timetable of work for the first three days of the field trip, are then assessed during a 15 minute group presentation to the entire class in the eighth and ninth weeks of the semester. Assessment is made on specified criteria by two staff members using a pro-forma that has been circulated previously to the students. Comments are fed back to groups at the start of the following week for inclusion in their Research Proposal. This document represents the main framework for their field research and, in fact, provides a template for their Final Report submitted on completion of the module. The Research Proposal, therefore, includes the following sections: introduction and objectives; theoretical framework; research methods – including the theoretical basis for the research methods, detail on the analytical methods to be employed, and a brief outline of the lessons learned from the pilot project; expected findings; field plan; and references. The format for this document is rigorous, to the extent of specifying font and paragraph format, page set-up, columns, headings, table format and the number of figures which may be used. In addition to submission of the Research Proposal in the twelfth week of the semester, individuals are also required to submit a Research Preparation Report in which they describe the particular skills and knowledge base they bring to the group. In addition to the 'personal' element, this document also includes thematic material acquired from the literature that supports, but does not directly contribute to, the Research Proposal. Written feedback from both the Research Proposal (group) and the Research Preparation Report (individual) is given to the students on the first day of the field course.

In the field, students are acquainted with Santa Cruz *via* a walking tour, a quiz on local knowledge, information and landmarks, and a bus tour of the Monterrey Bay region. Whilst individual effort and achievement is assessed through a field notebook, which is reviewed each day and on completion of the field course, group progress and achievement is formatively assessed through a meeting with the supervisor after three research days (with informal feedback continuing for the duration of the field course). Due to the residential nature of the trip, groups maintain regular contact with their supervisor, with the frequency of this contact determined primarily by the group.

A first draft of the final report is submitted on completion of the field course, along with a proposed timetable for the completion of the final submission. The draft is reviewed by the project supervisor on return to Liverpool, with comments being relayed to groups (formative assessment) for inclusion in the Final Report. This is then submitted within two weeks – again following the format specified for the Research Proposal, but with the addition of sections including: Abstract; Results; Discussion; Conclusion; and Acknowledgements.

The final assessment for the field course module is based on the following:

<i>Group assessment:</i>	Pre-trip Presentation (8.3% of total module mark)
	Research Proposal (11.7% of total)
	Final Report (33.3% of total)
<i>Individual assessment:</i>	Research Preparation Report (13.4% of total)
	Field Notebook (33.3% of total)

The above break down into (a) Field Preparation Component (Pre-trip Presentation, Research Proposal and Research Preparation Report, together worth 33.3% of total course mark), (b) Fieldwork Component (Field Notebook worth 33.3% of total), and (c) Final Report (33.3% of total).

Discussion and Conclusions

The entire process is geared towards the further development and application of key learning, research and subject-based skills. The level of expertise and research maturity demonstrated in the completion of all project elements crosses the interface between teaching and research – so much so that on completion of the field course, the student teams have completed the type of project work a graduate will be faced with in employment in a wide range of spheres. The sense of student achievement is tangible on final submission of the field report, and their efforts are rewarded through publication of a Santa Cruz Field Course Research Report Series. The Report Series is an edited volume in which the final reports are compiled and presented as a body of research undertaken on the field course. Copies are given to each member of the field course on graduation and sent to nominated stakeholders, libraries and resource centres in Santa Cruz. This Report Series is perhaps the best reflection of each student's research expertise on graduation, and is regarded amongst the student body as essential material for interviews when potential employers are to be acquainted with their skills and abilities.

The project-based approach is generally very successful, but there are a few key elements in ensuring this success. First, it is essential that projects are problem- or research-led, and that they are able to engage students in staff research interests. This is important in maintaining impetus during the evolution of the project, and also enables students to access a current body of literature. It is also essential that projects address problems and issues of relevance to stakeholders in the Santa Cruz region. Without this, student groups find it difficult to obtain up-to-date information or literature of relevance to their proposed research, or to set up meetings and interviews in the field. In addition, the value of the pilot project cannot be over-stated. This is a crucial

step in the evaluation of the research methodology and the identification of expected outcomes.

Obviously, the course has not been without its problems. In particular, the final edited report submission for the Research Report Series from certain student teams does not always take place – usually when significant modifications are required (i.e. reports of poor initial quality). In such cases, either staff supervisors take on an editorial role, or the submission is dropped from the publication. From a student perspective, the main 'down-side' concerns the timing of final examinations relative to final report submission. However, the requirement for a first draft at the end of the field trip has addressed the issue of significant overlap with revision time. Unfortunately, rescheduling of the field programme is not appropriate in the Liverpool curriculum and funding model, but may be so at other institutions.

Students are clearly proud of their achievement and readily show the Report Series to peers, family and potential employers. Recent graduates have confirmed that the Report Series is well received by employers at interview as an example of ability and performance across a range of key skills (e.g. Penn, 2001). As a consequence, the Santa Cruz field course format has been nominated for awards of teaching and learning best practice and innovation. The possibility of inclusion of such a research-led field programme in the undergraduate provision at other institutions is primarily influenced by funding. However, as the Departmental subsidy has decreased through the years, we have found that students are willing to take on the additional expense – which seems to be out-weighed by the benefits of the field course. From a teaching and learning perspective, elements such as the Santa Cruz Field Course are regarded by the team at Liverpool as an invaluable part of the degree programme as they truly enable undergraduates to engage in the research process and, hence, do what Geographers do.

On-line Resources

Santa Cruz Field Course Web Site:

http://www.liv.ac.uk/geography/Html_use/fieldcourse/California/Santa_Cruz_Home.htm

Santa Cruz Field Course – Research Report Series URL:

http://www.liv.ac.uk/geography/Html_use/fieldcourse/California/Projects/Research_Report2.pdf

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Field Research and Teaching – an Enhancement of Student Learning

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Abstract

For the past five years, fieldwork teaching linked to staff research and undergraduate dissertation work has yielded information and materials used to enhance student learning. This paper discusses the use of such information and materials in relation to a final year undergraduate module concerned with glacial environments. It concludes that the use of current information and materials can provide a more student-centred and enhanced learning environment.

Introduction

In the Natural, Geographical and Applied Sciences Department at Edge Hill we have long believed in students having as much field and laboratory experience as the budget and timetable will permit. Within the physical geography and geology areas of the department, students can undertake residential fieldwork modules within each year of study, both U.K. based and abroad. Almost without exception all modules within these areas contain a laboratory-work element. This ensures that students are well versed in a range of appropriate field and laboratory techniques by the end of their second year and so third year modules can use this knowledge and skills base to adopt problem-based learning, work-based learning and research-based learning approaches. The latter of these is the approach used in the third year glacial environments module, the focus of this current paper.

The author has been taking undergraduate students on annual fieldwork visits to the Jostedal area of Norway for the last sixteen years and a series of "regular" sites have evolved in recent years from which information and materials are collected on an annual basis. This provides some of the raw materials for "hands-on", practical undergraduate research into glacial environments, an integral part of the module for the last five years. Prior to this time, the module included a number of practical exercises along with lectures and directed reading and achieved its learning outcomes with a reasonable degree of success. Due to a natural evolutionary process, the lack of suitable fieldwork sites on active glacial environments within the UK and also to timetable and budgetary constraints, the module has now become highly focussed on the Jostedal and Jostedalbreen area of Norway. Reading the (often) conflicting information about the behaviour of glaciers in a variety of locations and looking at (often) unrelated examples of glacial materials and landforms has given way to a much more tightly focussed set of practical and reading experiences which form the main assessment package for the module. This

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assessment package is set within an extended reading and research ethos for the module and has the benefit of allowing students to appreciate the intricacies and the problems of interpretation that can only be yielded by an in-depth, partly problem-based study of a coherent real-world situation. Students are able to develop their understanding piece by piece as the module progresses. They are able to link this growing understanding of various facets of the glacial environment within the framework of a coherent study area rather than simply by achieving the same expertise and knowledge but within an unrelated and rather disjointed framework. The use of more tightly focussed coursework experiences balances the wider reading and research aspects that underpin the general student experience within the module.

The Information Base

Traditionally, geomorphological studies, for whatever purpose, involve the gathering of information on materials, landforms and processes. Each of these areas needs to be addressed if students are to have a suitable database from which to progress their learning:

In this study:

- Information on glacial materials is obtained by students themselves analysing sediment samples linked to site photographs to investigate the relationship between textural information and the landforms these samples have been collected from. The sites chosen indicate a range of spatial and temporal variations within the glacial environment of the study area. Ice and meltwater samples are also included in the latter sampling strategy, to link to hydrochemistry, weathering and transport parameters. Materials are stored in appropriate sediment and cold stores.
- Landform information is acquired by survey, photographic and mapping procedures. These materials are used by students for the acquisition of raw data for subsequent analyses and interpretations. Repeat survey, photography and sample collection has enabled temporal changes at an annual scale to be presented for students to investigate.
- Processes can be identified by students from their analyses of the repeat photographs and samples, plus the data recorded over short time periods in the field.

To support these materials a limited catalogue of site specific and generalist texts, articles and websites is provided as an initial prompt to the students' wider research.

Coursework Examples

To demonstrate the link between field research, and teaching and learning, two examples of the types of coursework students have undertaken in the module will be outlined. The first example would be undertaken in the early part of the module and the second would later build upon this and be used to widen their experiences of the glacial environments and materials of this area. These exercises would be supported by the use of complementary lecture and reading materials, putting site-specific information within the wider context of glacial environments.

Glacier Mass Balance Example

The aim of this item of coursework is to study aspects of the short-term mass balance variations as shown by glacier snout positions of a series of outlet valley glaciers from the Jostedalbreen ice cap during the twentieth century and to link these to the relationship between glaciers and climate. This assignment is based upon the study of secondary data and information sources. The students are required to read a paper by Nesje et al. (1995) on the terminal response of the Briksdalsbreen glacier between A.D. 1901 and 1994, are presented with a location map of Jostedalbreen and its outlet glaciers, a data table of selected glacier snout positions (from Winkler, 1996; Kjølmoen, 2000

and information from the Breheimsenteret museum, Jostedal) and annual photographs of the snouts of some of the outlet glaciers, for example Bergsetbreen from 1987, Austerdalsbreen from 1989 (all taken by the author, plus website references to other examples).

The students are then set a series of tasks requiring them to interact with this data. For example:

- Write an executive summary of the article by Nesje et al. (1996).
- From the data provided on cumulative glacier front positions, extract data for Nigardsbreen and Austerdalsbreen. Graph the information appropriately and comment on what the graphs show in terms of snout advance and retreat and mass balance behaviour.
- In relation to the information in the article by Nesje et al. (1996) assess, with justifications, the response times of the two glaciers above.
- Using the photographic evidence of Bergsetbreen, comment on the apparent behaviour of the snout since 1974, paying particular attention to the landform evidence shown.

As a result of this exercise, students will have studied background information on the area, have discovered the variability of glacier responses to climatic fluctuations in the area and in general and have been able to show their ability to research and synthesise a range of primary and secondary data sources to answer a specific problem. By using a variety of information sources from the same area, a greater sense of ownership of the material and of the work is achieved.

Glacial Materials and Landforms Example

The aim here is to give students the opportunity to acquire and study a range of information so that they can describe and interpret a series of glacial sediments and landforms from a specific valley glacier environment. This assignment requires the students to collect primary data for themselves from a variety of materials provided. A recent example of this style of learning and assessment used information on the Stordalen valley, Jostedalbreen. Students were presented with a 1:50,000 scale base map of the valley that includes the Lodalsbreen glacier and its catchment, the immediate valley below and the Fabergstolgrandane sandur. A series of photographs (also provided as jpeg files) with short annotations and a number of sediment samples linked to a specific selection of these photographs were available for the students to acquire data from. They were also provided with topic/region specific papers and reports and a more general indicative reading list along with general video footage from the Jostedal area.

Again the students are set a series of tasks, for example:

- Analyse the three sediment samples labelled A to C. For each sample present a full textural and mineralogical analysis with appropriate graphs. From this data attempt a fully justified interpretation of the probable landforms these materials originated from. Appropriate referencing to literature and the exemplar photographic materials provided should be included.
- Study the photographs labelled 1 to 3. For each photograph identify the main landform shown. With reference to the photographs and your reading, discuss the genesis of each landform. Using the map and annotated photograph collection provided, identify and justify an appropriate location in the Stordalen valley where you may expect to find an example of such a landform. Give the grid reference for this location.
- With specific reference to the data and information you have collected above, all the raw materials provided and to your personal reading, submit a written report (approximately 2000 words) on the probable history of the Stordalen valley over the last 500 years. You should conclude your report with a consideration of the current geomorphological processes operating in this valley glacier environment.

This particular exercise, which forms the main assessment element of the module, has allowed students to explore a range of "current" examples of materials and landforms from a valley glacier environment. They have collected information from the materials provided by their own primary research. This set of linked exercises blends the information gathered by the students into a coherent whole building upon their previous knowledge of the Jostedal region. It enables them to interact with and appreciate a variety of scales of materials, landforms and processes set into an appropriate spatial and temporal framework for modern valley glacier environments.

Conclusion

The ability to provide what is essentially a surrogate for field teaching within this module allows a clear enhancement of the student learning experience. When dealing with an active environment no longer found in the British Isles, this attempt at a virtual fieldwork experience, blending sediments and other samples with maps, photographic and video evidence, allows students to gain a research experience from their investigations and analyses of these materials. This research experience enriches the other modes of delivery within the module and therefore forges a stronger link between research and teaching. It allows the students a "hands-on" experience through which they learn more about the nature of glacial landforms and materials. Feedback questionnaires from a number of student cohorts have evidenced this approach as a major factor in their enjoyment and learning throughout the module. Students clearly benefit from this "doing" approach, interacting with materials and information updated annually from a coherent study area. They are more engaged with the content, aims and learning outcomes of the module and achieve a greater feeling of ownership of their knowledge.

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'Research Frontiers': Bringing Research into Teaching via Project-based and Teamwork Approaches

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Abstract

This paper describes some ways in which we have tried to bring clarity to students on how problem-solving ('research') can be of value both inside and outside the university. These ideas were implemented within a refurbished Stage 3 module, Applied Geomorphology. A Problem-Based Learning (PBL) approach was used, not only in lectures, but also in various forms of assessment, including the unseen examination. Additionally, we used a team approach to learning and student support. We also provide some numerical data about student results in teamwork projects and in the examination. We advocate the PBL approach as a means of effectively linking teaching and research in Geography.

Background

Queen's University Belfast (QUB) originally stated that teaching should be 'research-led'. This concept was officially incorporated into the School of Geography's Subject Review in 2000 where it was identified as being too staff, rather than student, directed. However, this formal statement says nothing about how we actually bring research into the learning environment.

We have used a Stage 3 module with 25 students in Applied Geomorphology to try to bring various practical as well as methodological aspects of research methods to our students. Perhaps only the 'brightest' of undergraduates reach a research frontier in terms of factual/theoretical knowledge and, as research frontiers extend, this gap from undergraduate to research frontier widens. Indeed, it may be that students, for the most part, are not really aware of what 'research' really is, how it is undertaken or how it is relevant to life outside the university. Thus, the repositioned Stage 3 module attempts to address some of the issues raised by Jenkins and Zetter (2003).

Accepting this, our view is that we should not try to produce a 'professional geomorphologist' in the three years of a Geography programme. This would be self-indulgent and, overall, probably not too beneficial to the student! Accordingly, we have re-developed a module (Applied Geomorphology) to show more distinctly to students how they can use general and specific research methodologies and techniques to help solve real problems (Brew and Boud, 1995). Both problems and methods used are based on our own research in Applied Geomorphology and from the literature. As a consequence of this approach, 'research frontiers' may be revealed as students grasp theory and practice together with problem-solving techniques which are part of the research processes. By working through the tasks, students are able to grasp the main research techniques and methodologies/processes, many of which will be useful beyond their final year, both in the workplace and/or in postgraduate study. We feel that it is important for students to have the opportunity to practise identifying and solving diverse research problems for these reasons. Thus, the Applied Geomorphology module was redesigned to show students a variety of real, research-related problems and ways to solve them.

Outline of the Redeveloped Module

The module was first taught in 2002 in a generally conventional manner, with most lectures being delivered in PowerPoint, with web-support and handouts as necessary. For 2003 we decided to move towards a problem-based approach. Three sessions, of varying length, of face-to-face teaching were provided each week. Parts of these slots were used for group discussions or for students to look at problems placed on the module's website. PowerPoint notes were provided and for the most part these were in place on the website a couple of days before lectures. Support material was also on the website as the aim was to get students to take charge of their own learning. This material included examples of problems, worked-through solutions and short task problems for further work and discussion. We tried to incorporate problem-based learning (PBL) all the way through the module linked to the use of teams to aid learning (e.g. Allen *et al.*, 2001). We incorporated several ideas within this framework in order to do so. In particular, there was the specific use of how a knowledge of geomorphological principles could be applied to real problems.

Teamwork and Student Perception of Teamwork

We made specific use of learning opportunities around teams - on the basis that research is frequently collaborative and that employers usually stress an ability to work in teams. We took the opportunity to reinforce this in the module. Emphasis was placed on teamwork during three out of four problem-based topics (including two presentations) that were part of the overall assessment. Details of the assessed coursework tasks are given in Table 1.

Practical 1	Estimating Stream Flow	Field trip working in teams, then individuals submitted spreadsheet and report
Practical 2	Soil Behaviour	Field trip working in teams, then teams submitted report and website
Practical 3	Predicting Soil Loss	Teams submitted spreadsheet, report and website and gave short presentation using PowerPoint
Practical 4	Geomorphology in the News	Teams submitted report and website and gave a short presentation using PowerPoint

Table 1. The student tasks in the Geomorphology module

We found that the number of students initially registered dropped across the first two weeks of the course. This may have been due to students commonly 'shopping around' for modules. But one reason may be that, for some, teamwork was seen as too unfamiliar territory. (Note that we stressed teams rather than just doing work in groups and feel that this is a useful distinction.) Early responses from students suggested that they were apprehensive about teamwork and the required independence of the learning tasks set. It seemed, perhaps unsurprisingly, that students wanted 'facts' in order to pass exams.

Thus we think (as did the students) that guidance in the use of teamwork needs to be given at an early stage in the university programme so that they can use such skills more effectively through their university careers. We talked to students, from the outset, about the advantages of both working in teams and collaborative learning. However, telling students that employers like people who work well in teams (Race, 2001, p. 141) is not enough!

The Module Website

We have long believed that module websites are an important resource for students, not just as a repository for notes and reading lists/weblinks but for detailing worked examples of research problems.

After experience elsewhere, we decided to place lecture notes as PowerPoint slides *before* any lecture. There is a view that, in so doing, students will not come to lectures (and perhaps treat the module as a form of distance learning). We did find a variability in attendance, but not one that appeared to differ from modules where notes were not on the website or were placed there afterwards. (Coincidentally, weather conditions on the day of the lecture and approaching dissertation hand-in were a significant factors in attendance.) PowerPoint presentations (especially given the visual importance of the subject matter) contained annotated images as well as animated diagrams that students could download for revision so as to gain a better understanding of laboratory work. Perhaps most importantly, the notes are there not just for revision purposes but to show that research is about using and thinking about a wide variety of existing ideas, data etc. Thus, the website also contained images from fieldwork sessions that could be incorporated into reports. Additional material was made available if students required support (e.g. some treatment of soil mechanical concepts). A further inclusion were webpages with sets of problems - using images - that students were asked to study and report back on in their teams.

The Fieldwork Element

Two sessions of fieldwork were organised as part of Practicals 1 and 2. As predicted, fieldwork was widely enjoyed by the students (and staff!). In the first field trip, students worked in groups but reported individually. The second field trip required students to report work in teams, once the class numbers had stabilised. Fieldwork with a specific objective (the second being a mapping task) allowed reinforcement within the team back at base and an opportunity to use their collected material and integrate it with research materials available in the university (e.g. PhD theses on the Antrim mudflow sites). Our intent was to allow students to become involved, even if vicariously, in previous research documented at the field site.

Assessment

The module assessment was split between coursework (50%) and examination (50%). Coursework details are shown in Table 1. The examination was split into three sections: A, B and C. Section A consisted of a compulsory either/or 'scene interpretation' which was an application of what they had learned but with a research component (e.g.) "you have been asked by the local council to suggest remedial work..." or "an estate agent wishes you to report on..." etc. Sections B and C consisted of elective essay-type questions (students electing one question from a choice of 4 and 3 questions respectively).

The examination 'scenes' (images) in Section A were released to students four days in advance of the examination (by calling in at the School Office or downloading from the website). Although they could research the scenes, they did not know the actual questions to be asked. However, the students had practised responding to these types of question during the module. This form of examination question is one that requires students to demonstrate their research skills. They needed to provide a 'real life' analysis using their research capabilities derived from the module. Thus, by the time of the examination, students had become more familiar with a research-based analysis and interpretation rather than using rote learning.

Student Feedback

Critical Incident Questionnaires (Brookfield, 1995) were used three times in the delivery of the module to ascertain student preferences and views. It was here that we had the first 'formal' statements from

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students. An explicit problem-solving approach, as opposed to learning notes, was clearly somewhat unfamiliar. In the final semester, many students evidently preferred old methods to something new and unfamiliar. However, the post-module review presented a rather different picture. In response to the question, 'what did you like most about the module?', 9 out of 26 explicitly said, unprompted, 'groupwork/teamwork'. To the question, 'Did you like working in teams?' 23 out of 26 said 'yes'.

Group presentations were liked by some, as was the variety of assessment methods used (group and individual coursework and examination). Some students clearly (still) dislike presentations! We emphasised that presentations are an important part of the research process (e.g. Faraday's, 'Work, Finish, Publish').

Overall, student responses were mixed and, although many appreciated the values of the approach taken, their perceived need to learn facts and answer 'conventional' exam answers still seemed to be a predominant student attitude.

Results Analysis

Given that teamwork was stressed as an important part of the research process, we have carried out some analysis of the students' examination and coursework results. Table 2 shows results from two 'representative' students, chosen from the upper and lower tails of the distribution of overall module marks. The weaker student (no. 2) gains notably from the teamwork components of the coursework, while the stronger student (no. 1) loses marginally.

Student	Mark for individual work (Practical 1) (%)	Average mark for teamwork (Practicals 2-4) (%)	Increase in mark from teamwork (% points)
1	68	65	-3
2	48	63	+15

Table 2. Comparison of marks achieved by two students for the individual work and team work elements within the coursework practicals.

Figure 1 shows the change in grade achieved by the whole group as a result of teamwork (as in Table 2, calculated by comparing marks for the individual project (Practical 1) with average marks gained for the three teamwork projects (Practicals 2-4)). As seen, around 60% of the students have gained in terms of marks from the teamwork.

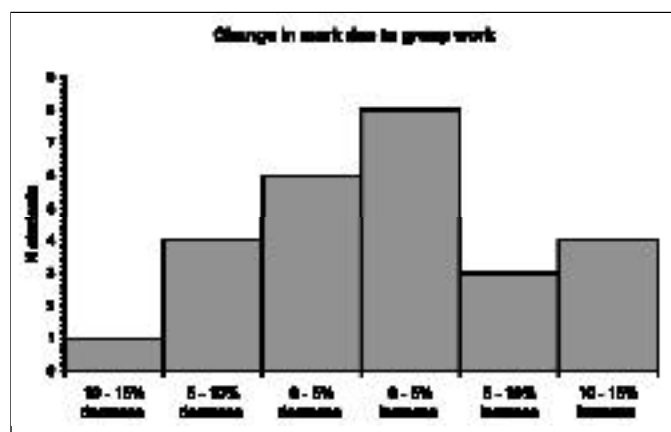


Figure 1. For all students, a comparison of marks gained by means of individual work (practical 1) and teamwork (average mark for practicals 2-4).

Similar data from other modules would be useful in evaluating the results from this study; however, we are unaware of other studies which would provide comparisons. Nonetheless, we feel that can now demonstrate to subsequent student-years that they need not worry about the effects of teamwork on individual performance - most students will benefit.

Turning to examination results, Figure 2a shows the results of students' performance between Section A (compulsory, the scene analysis) and the other two (elective) questions from sections B and C of the examination paper. Figures 2a, 2b and 2c show the narrower range of students marks for the Section A question compared with the marks for Sections B and C. The distributions of results from the elective questions (Sections B and C) have slightly longer 'tails'. Again, we would like confirmation from subsequent years and other similar courses; but we suspect that students performed better on the scene interpretation, using their own understanding and applications of knowledge, than on their responses to rote learning. After the examination, informal discussions suggested that students had liked the scene interpretation questions set.

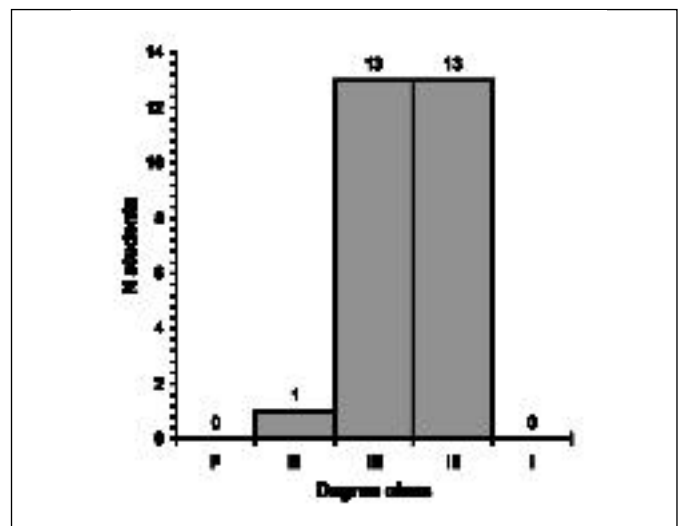


Figure 2a. Examination results from Section A question (either-or choice) of scene analysis. Image (but not questions) released in advance.

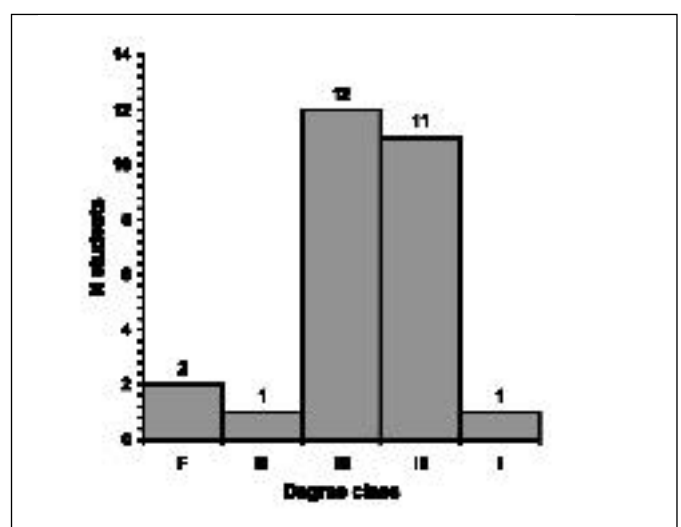


Figure 2b. Examination results from Section B: choice of 4 essay-type questions.

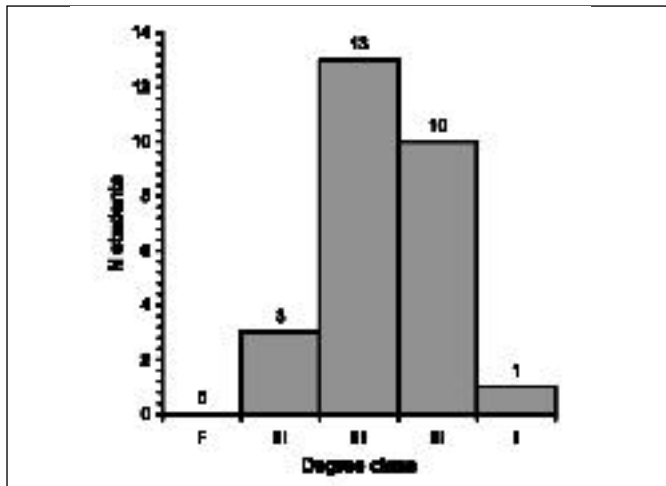


Figure 2c. Examination results from Section C: choice of 3 essay-type questions

Conclusions and Ideas for the Future

We believe that the module is a useful vehicle for showing how research works in practice. Students, on the whole, seemed to enjoy it although initially they were uncertain about the way in which material would be examined. In general, however, there was a feeling that the delivery was perhaps too novel for their final year, final semester. Thus, we strongly suggest that students are exposed to both team-working (as opposed to working in groups) at Stage 2 so that they can understand and experience the advantages without final year pressure. Further, there was a reluctance to 'let go' from the traditional lecture format despite the support we provided. We suggest that independent learning methods be introduced at Stage 1 and continued thereafter. Perhaps not all modules need an out-and-out allegiance to independent learning but at least providing some experience for students of non-lecture teaching methods would be beneficial. In this, the overall pedagogic aim of the module, showing ways of tackling research problems, was successful.

We think too that students will see that results of the module (now that we have them) are quite reasonable and that most will not suffer from any novelty of approach.

We, and the students, liked the idea of a photographic interpretation examination question, although this does ask more of the students. Importantly, it places exam questions in an independent framework and also shows the sort of things a field examination by a research worker might have to deal with. In short, we have found this exercise useful in linking teaching and research.

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Linking Teaching and Research within a Community-Based Project

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Abstract

The Bourne Stream Partnership is a consortium of stakeholders, which includes local authorities, the Environment Agency, water companies, English Nature, NGOs and private businesses. Its aim is to enhance the environmental quality and amenity value of Bourne stream through sustainable development. Bourne Stream provides a local fieldwork site for undergraduate and postgraduate Environmental & Geographical Science students within the school of Conservation Sciences at Bournemouth University. Consortium members have provided opportunities for student placements and research projects (up to and including PhD level) based on various aspect of Bourne Stream (i.e. water quality, ecological assessment, community partnership). This in turn has provided useful information for the partnership, demonstrating the benefits of linking teaching with research and with organisations consultancy external to HE.

Introduction

The link between teaching and research should be evident in our curriculum design (Jenkins, 2002; Jenkins & Zetter, 2003). At Bournemouth University, like many other HEIs, this is most easily achieved in core units/modules such as Research Methods and the final year project/dissertation. These units have specific learning outcomes and help students to develop a range of transferable skills in project and time management. The final year project/dissertation also offers students the opportunity to carry out an in-depth study into a topic of their choice.

In addition, many staff try to make the delivery of their subject more 'interesting' by introducing students to 'live', on-going external projects and using these as a focus for assessment. Such work often involves a problem-based approach which has been found to increase independent student learning (Boud, 1988) and helps to develop a range of graduate skills (Blumhoff *et al.*, 2001) including teamwork skills. It is also hoped these activities engage, excite, and motivate students and by 'doing' they learn through experimental learning (Kolb, 1984) which helps to further improve their understanding and knowledge.

Background - Where is Bourne Stream?

Bourne Stream is a typical urban stream in the south of England, which runs from Canford Heath/Ringwood Road in the Borough of Poole to the sea at Bournemouth Pier. It is approximately 8km long, with a drainage catchment of 12km².

The upper/middle catchment has various designations including a Site of Special Scientific Interest (SSSI), Dorset Heathlands Special Protection Area (SPA), Special Area of Conservation (SAC), Ramsar site and Site of Nature Conservation Interest (SNCI). The lower catchment has a high amenity value with public access to gardens (English Heritage Grade II listed) and Bournemouth Pier.

Bourne Stream is only a short walk from the main Bournemouth University campus and hence has been used as a fieldwork site to demonstrate water sampling strategies and methodologies for many years. Bournemouth University was involved with the Bourne Stream Partnership from the outset and hence opportunities for student involvement in this 'live' project were quickly recognised.

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What is the Bourne Stream Partnership?

"The Bourne Stream Partnership has been formed to improve, protect and enhance the green corridor." (Bourne Stream Partnership, 2002)

The Partnership was formed in 2000, with the official launch by Barbara Young (Chief Executive of the Environment Agency) in March 2002. Members of the Partnership include various stakeholders, including the:

Borough of Poole	Bournemouth Borough Council
Environment Agency	English Nature
Wessex Water	Bournemouth & West Hampshire Water Plc.
Greenlink	Dorset Wildlife Trust
Bournemouth University	Bournemouth Oceanarium
Dorset Coastal Forum	

Funding is from the organisations within the Partnership and through SITA Environmental Trust.

The aim of the Partnership is to enhance environmental quality and amenity value of the stream through sustainable development. Advantages of the Partnership include sharing of resources between stakeholders and access to complementary skills, allowing for an integrated, holistic approach.

The Bourne Stream's Main Problem

Despite reductions in point source pollution, Bourne Stream continues to suffer from poor water quality. Diffuse pollution is a major problem and Bourne Stream is prone to periods of poor water quality especially following periods of rainfall. Surface drainage water and sewer mis-connections (wastewater entering the stream rather than the sewers) are thought to have significant adverse effects. The resulting high faecal coliform counts from animal waste etc. have resulted in failure of Bathing Water Directive guideline standards at Bournemouth Pier and hence loss of EU Blue Flag status for 10 out of the last 12 years (Bourne Stream Partnership, 2003).

The partnership has incorporated the use of sustainable urban drainage systems (SUDS) within the catchment with the aim of improving overall water quality. This has included creation of wetland systems to treat surface waters, which has also resulted in an increase in wildlife that local residents have perceived as being an important improvement.

Linking the Partnership to Student Research Work

Since the creation of the Bourne Stream Partnership, the site and its catchment have continued to be used as a local fieldwork site for undergraduate and postgraduate Environmental & Geographical Science students. For example, it has been used as a site for assignment work for final year options in Ecological Evaluation (e.g. habitat surveys including river corridor survey) and also Water Resources (e.g. monitoring biological and chemical parameters of water quality).

Consortium members have provided opportunities for student placements and research projects (up to and including PhD level) based on various aspects of Bourne Stream and its catchment (i.e. water quality - particularly with regard to urban diffused pollution, ecological assessment, environmental perceptions, community partnership). This in turn has provided useful information for the Partnership.

Current on-going projects include:

- 'Action research inquiry to assess the multi-stakeholder (partnership) approach to environmental management' - PhD student. This student is also the Project Officer for the Partnership and hence is 'actively researching as she is doing'.
- 'Effects of artificial modifications to the Bourne Stream as part of a SUDS initiative, upon habitat quality' - MSc Environmental Quality student.

- 'Evaluation of the capacity of the lagoons and wetlands to reduce pollutants, including oil and petrol from road runoff' - BSc Environmental Protection student.
- 'Education and awareness raising in the Bourne Stream Catchment through a schools drain stenciling project' - BSc Environmental Protection student
- 'Community participation in the Use Water Wisely Campaign' - BSc Applied Geography students. As part of this study, second year placement students supervised first year Applied Geography students to construct and undertake questionnaires for them. This data will form part of their study, which will contribute to a report to be presented to Bournemouth & West Hampshire Water Plc.

From this last project, the value of peer-assisted learning (PAL) was also demonstrated. The first years felt that they *"got a great deal from being involved in a real live project"* and they also *"found it enjoyable to be supported by other students of the same degree course"*. In turn, the second year students got an insight into the difficulties of managing large numbers of people to undertake research, to keep them motivated and focused on the task in hand.

Research, Learning & Teaching Benefits

Through work experience, project and assignment work carried out in conjunction with the Bourne Stream Partnership students have developed a range of research and transferable skills and at the same time produced results, reports etc. of wider interest and benefit to the community. An unforeseen benefit of this has been the raising of the University's profile within the local community, including articles in the local newspaper.

Positive aspects of linking research and teaching through external projects include:

- provision for students to develop research skills within 'live' projects;
- opportunity for students to demonstrate their ability to apply theory to practice;
- integration of fieldwork, experimental and theoretical investigations;
- opportunity for students to gain contacts in their chosen field of interest;
- opportunity for students to meet the aims of the work experience placement.
- opportunity for students to meet the intended learning outcomes of the independent research project, which include:
 - (i) *an ability to formulate a research problem, translate this into a research design and a realistic programme of work and to carry out this programme of work;*
 - (ii) *an ability to select and plan the execution of appropriate research methods;*
 - (iii) *the effective integration of the discrete skills and techniques of various programmes in a research programme of their choice;*
 - (iv) *develop and demonstrate their ability to work independently and with initiative within a research context;*
 - (v) *an ability to evaluate data;*
 - (vi) *develop and demonstrate their ability to produce an extensive written report of their research with some originality of perspective to standards expected in a professional context relevant to their degree (Bournemouth University, 2002).*

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- positive student perceptions of the practical application of skills acquired on their course is improving their confidence and helping to prepare them for the workplace.

In addition the placement complements the academic experience of the programme and aims to provide:

- (i) *wider experience in the appropriate academic and professional discipline;*
- (ii) *an experience of working relationships, employment, hours and practical constraints of the working environment;*
- (iii) *knowledge of an area of employment within which they seek employment;*
- (iv) *experience of contributing to the design and/or implementation of a specific project within an organisation (Bournemouth University, 2002).*

Lessons Learnt

Over the past few years a number of aspects have at times caused some difficulties with student projects or placements within the Bourne Stream Partnership. These are outlined below, with suggestions of how they could be better managed.

- (1) If not carefully managed, students can be provided with different aims or objectives for the same project from the various organisations that make up Bourne Stream Partnership. Hence, it is useful for the partnership as a group first to decide what they want from the project and then nominate one member of their team who from the outset will be the student's main point of contact. This should ensure the project is clearly focused and avoid unnecessary confusion for the student. It also ensures all members of the Partnership are themselves clearly aware of the focus of each project.
- (2) The project outlined by the host organisation must provide the student with the appropriate assessment criteria required at Honours or Masters level.
- (3) The time scale and actual timing of individual projects needs to be realistic. This is not always easy to achieve, since the project work needs to fit around the rest of the academic calendar including examinations. Another more recent and problematic issue is the increased financial pressure on students to work during the summer vacation, which often coincides with the main sampling season. Hence, a compromise may need to be made between sampling times and other important commitments.
- (4) It can be difficult to ensure quality control of the work carried out by the student. Hence, this may need to be monitored closely, especially at the beginning of sampling. In addition, the research strategy must be approved by the University supervisor prior to the start of any fieldwork activity.
- (5) Analysis of a large number of samples required for some of these projects can be expensive for the University. Some forms of analysis requested by the Partnership have been prohibited by cost e.g. certain oils and hydrocarbons, where full analysis would have cost thousands of pounds.
- (6) There is a need to ensure that appropriate support and supervision is given to the student during their placement by the host organisation. The host organisation needs to know, from the outset, the requirements placed on them by hosting a placement student. This usually involves time, space, equipment and transport. Even where students are not paid, there are usually economic implications of hosting a student.
- (7) There is a limit on the number of students who can be involved with projects or placements (or both) with the Bourne Stream Partnership each year. However, to date this has not caused any

problems with other students choosing to focus on different placements and projects.

To end on a positive note, one of the most encouraging lessons has been the interest of local organisations within the Bourne Stream Partnership to be involved with student activities, whether through placement opportunities, fieldwork assistance or the delivery of taught units. Their enthusiasm has far exceeded our expectations of such a community-based collaboration.

Conclusions and Recommendations

The future is likely to see a broadening involvement with the Partnership, beyond placements and into more taught units. Such collaboration is certainly mutually beneficial - not only are projects with the Partnership aiding the involved stakeholders' understandings of the catchment, but also the students are realising the full scope and application of their skills and, in turn, are seeing opportunities for employment and further research.

We would highly recommend this type of involvement with local community projects. A number of environment partnership groups of this kind have been set up around the UK, who are keen to involve their local education establishments. Although most Universities are financially limited in the contribution they can make, a contribution 'in kind' is usually considered favourably. We hope this article illustrates many of the benefits which can be gained from linking teaching with research and consultancy using a collaborative partnership approach.

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Using Digital Mapping Tools and 3-D Visualisation to Improve Undergraduate Fieldwork

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Abstract

Digital mapping methods for capturing and visualising field data are increasingly used in industry and provide alternatives to the traditional mapping techniques that students learn in their academic courses. Over the past two years, a range of digital mapping and 3-D visualisation methods have been introduced into the teaching programme in the Department of Earth Sciences at the University of Durham and are used in preparation for field classes, during fieldwork and in post-field class activities. The introduction of digital mapping into fieldwork classes provides the opportunity to use research results to enhance student learning and understanding of the natural environment, encourage more rigorous and quantitative data collection and increase student awareness of industry practice. We recommend this approach as one way to achieve stronger links between teaching and research in Earth Science departments.

Introduction

Generations of geoscience students have been taught to map the natural world using compasses, measuring tapes, paper maps, field notebooks, mapping pens and coloured pencils. Increasingly, in the Earth and Environmental industries, however, field data are acquired on hand-held computers at Global Positioning System (GPS) determined locations and then visualised and analysed in three-dimensions (3-D) on desktop computers. Whilst the costs of digital mapping equipment and software are falling quickly, they are likely to remain outside the reach of a typical undergraduate for the foreseeable future. Nevertheless, in the Department of Earth Sciences at the University of Durham, students are now introduced to the new digital mapping and visualisation methodologies progressively throughout their undergraduate programmes (Table 1). By incorporating staff demonstrations of digital field data acquisition into field-classes and allowing students to view and work with digital map data before, during and after each field class, the advantages and disadvantages of digital mapping and visualisation versus traditional methods can be experienced and discussed. By exposing undergraduates to digital mapping and visualisation, staff can introduce research data and findings; demonstrate industry methods, develop deeper understanding of fundamental concepts and encourage more rigorous field data collection practices. Thus, the links between teaching and real-life research and industry software tools can be promoted.

Digital Mapping

The digital mapping system involves the integration of three key technological components: (1) a GPS receiver usually capable of obtaining differential correction data that enable sub-metre positional accuracy, (2) a Personal Digital Assistant (PDA) or other digital data-logger and (3) mobile Geographical Information Systems (GIS) (Figure 1).

Year	Before Field class	During Field Class	After Field class
Year 1 'Field Studies' module including Lake District field class	Students have 2 week introduction to ArcGIS™ followed by 4 week project in which they create their own digital geological model of the Lake district*	Evening demonstration of digital geological models using laptop and data projector	None
Year 2 'Fieldwork 1' (including Assynt Mapping training class and 'Earth Visualisation' modules)	Students shown digital mapping equipment and use a GPS during the pre-field class preparation day.	Evening demonstrations and 'hands-on' sessions of detailed digital maps, 3D structural models and regional geology of N. Scotland	In Earth Visualisation, students build their own 3D models by loading datafiles used on the field course. A 3 week project collecting their own digital field data and constructing models.

Table 1. Digital mapping and 3D visualisation in the University of Durham Earth Sciences undergraduate degree 2003/4.

*See EmapScholar project <http://edina.ac.uk/projects/mapscholar/casestudies/#geol>



Figure 1. Digital Mapping Workflow. Digital field acquisition methods (on left) are input in the field into a personal digital assistant (PDA) and then ported to a desktop GIS for visualisation and analysis (examples on right).

Mobile-GIS is a version developed for the PDA that can exchange information with more general purpose desktop versions. GIS have evolved from their early use as a mainframe mapping software to 'an information management system for organising, visualising and analysing spatially-orientated data' (Coburn and Yarus, 2000 p1). Since GIS became commercially available in the 1980s, GIS products are now used in a large number of applications that deal with spatial data, including social and economic planning, marketing, facilities management, environmental and resource assessment (Rhind 1992; Longley *et al.* 2001). In its original guise, GIS largely dealt with 2-D data that was mapped onto the Earth's surface (Rhind, 1992); however, it was recognised that in order to deal with volumetric spatial information or 3-D geometries from sub-surface data, a 3-D GIS or a GIS (GeoScientific Information System) was required, and such systems (e.g. gOcad™, Petrel™, ArcScene™) have now been developed for commercial purposes.

During field-data collection, GIS vector data in the form of points, lines and polygons are acquired at each GPS-determined coordinate in 3-D space. Point data are the locations where observations of an outcrop such as bedding, colour, texture, foliation, lineations, etc. are stored as attributes by means of an input form on the PDA. Contacts between rock units, faults, fold traces are stored as line vectors by following the structure in the field and acquiring 3-D co-ordinates that represent nodes of the line. Areas occupied by different rock-types are stored as polygon vectors in a similar way. In addition to producing an accurate and efficient means of collecting field data, digital mapping techniques open up new possibilities for quantifying many types of uncertainty associated with the mapping process, and using this uncertainty to evaluate the validity of competing interpretations (Jones *et al.*, In press).

An Example of a 3-D Visualisation Model for Geology Students

It has long been recognised that some students have less developed 3-D spatial awareness than others (Boulter, 1989 p2). This problem can become acute for students engaged in field mapping for the first time as it is essential that they build up a 3-D mental picture of their surroundings in order to solve geometrical problems commonly confronted in the earth sciences. This ability is difficult to teach in the laboratory and it consistently remains an aspect of fieldcraft that students either comprehend immediately or struggle with for long periods of time. For the Durham Stage 2 Assynt field course, a series of computer models were constructed in order to aid those students who have difficulty with their 3-D visualisation. The models were introduced during the 2002 field class for 48 students and, based on feedback, have been refined and improved for the 2003 field course (52 students).

To build the 3-D model, a base map was constructed from Ordnance Survey digital data downloaded from Digimap®¹ and loaded into ArcGIS. The base layers comprise a digital terrain model, draped by aerial photographs, remote-sensed images and other cartographic data (Figure 2a). This is then projected into 3-D using ArcScene® software. The lithological boundaries that the students map in the field had previously been accurately surveyed (resolution <30cm) using a Differential Global Positioning System receiver attached to a PDA with mobile GIS. These digital boundaries were then used to create a geological map that was draped onto the digital base map and viewed in 3-D (Figure 2b). Digital field photographs of important features were 'hot-linked' by GPS position into the database so that they could be examined by clicking on the relevant part of the map. During the evening work session, the 3-D model was progressively revealed to students in conjunction with their own mapping of the area by displaying it on a laptop connected to a data projector. Following the formal demonstrations, students were able to access the models individually or in small groups.

a)



b)

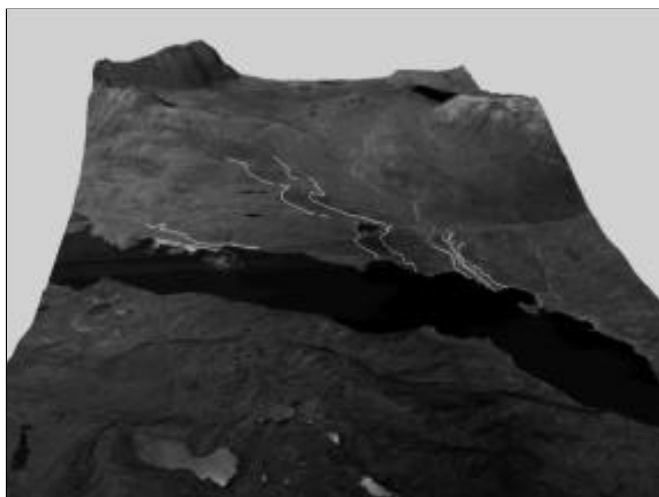


Figure 2. Two static scenes from the Assynt 3-D visualization models. (a) 2-D map version with geological contacts, structural data and 'hotlinked' photograph locations superimposed on an aerial photograph. (b) 3-D version with geological boundaries and aerial photographs 'draped' onto the digital elevation model. Topographic data supplied by Digimap™ © Crown Copyright Ordnance Survey. An EDINA Digimap / JISC supplied service.

The advantage of using the 3-D GIS models in the evening sessions was that it allowed the students to see a virtual 3-D view of the sites they had visited that day and representation of the geology in the context of their earlier work. The students were then able to use this visualisation to reinforce and enhance their own observations, interpretations and mental picture of the geology. They were able to rotate the model; fly around their virtual mapping area and zoom in to places they had been that day, allowing them to revisit their observations and interpretations. The students were directed by staff to think about the geometry of the major structures and the influence this has on the observed outcrop patterns. The students could also see how their small mapping area linked to the regional-scale geology of NW Scotland providing many opportunities to discuss current and past research findings.

Student Feedback

Student feedback on the models was extremely positive (Table 2) and clearly indicated that they found the models helpful in understanding the 3-D geology of their mapping area. Their comments also encouraged us to develop these models further and suggest ways they could be improved. For 2003 we made the models better visually and added extra components to explain the structural geometries more clearly. Following implementation on the 2003 field-course, we were encouraged to see that the main improvement in the questionnaire score was for perceived student understanding of the structural geometries (Q.5 - see Table 1). Other staff on the fieldtrip commented that the computer models provided an excellent tool for reinforcing the main points for each day and explaining the 3-D geometrical concepts. So, our work has assisted both teaching delivery and student learning.

Course	Year	No. of students	Average Response	Q.1*	Q.5*	Q.7***
Stage 2 Assynt	2002	48	91%	4.5	4.1	4.9
Stage 2 Assynt	2003	52	92%	4.6	4.4	4.9

*Q.1 Overall, did you find it helpful to be able to view computer-based models in the evenings? (1 'not helpful' to 5 - 'very helpful')

**Q.5 - Do you think you understand the 3-D structure of the area better as a result of viewing the models? (1 'no better' to 5 - 'much better')

***Q.7 - Do you think it is worthwhile us developing these models further for future field-classes? (1 - 'not worthwhile' to 5 - 'very worthwhile')

Table 2. Student feedback on the GIS Models

Advantages and Disadvantages Compared to Traditional Teaching

Digital mapping provides an efficient integrated framework in which to collect, manage, visualise and analyse field data. The spatial precision of observations and resulting maps is also improved compared to traditional methods. More importantly for student teaching and learning in fieldwork modules is the ability to store many different types of data tied to their geospatial position within a single GIS model. For example, regional geophysical maps, aerial photography, satellite imagery, topographic data, digital structural information, sample catalogues, geochronological data, geochemical data, attribute data, photos, sketches, ideas, notes can all be incorporated. Other advantages include the ability to handle data at all scales relevant to the area under consideration and the capability to display data in 3-D. This ability of a GIS to perform multi-attribute mapping at a variety of scales in 2-D and 3-D allows students to place their field-data and observations in different contexts and also to 'see' the important structural geometries from different vantage points. We think it is equally important that students are aware of how the digital data have been acquired in the first place which was why we demonstrate a variety of digital mapping equipment being used in the field. This promotes an awareness of the types of technologies students might encounter in industry and the issues involved in using them. It also provides an opportunity to introduce additional datasets, geospatial concepts and research findings into field classes and allows exploration of these concepts afterwards in the classroom.

The disadvantages of this technique largely concern the resources needed to provide enough digital mapping equipment to demonstrate to students in small groups. Also, staff and demonstrators generally need training in the necessary IT skills to be able to use the GIS

databases and the 3-D visualisation. In the first year of implementation, we had only one lap-top in the field capable of running the 3-D models thus limiting their accessibility, whereas in 2003 we had three. As a result of the student feedback, we now also provide the data files for the students to access in their own time back on campus via our virtual learning environment. We also now link the analysis of the Assynt 3-D data to ongoing coursework in a Stage 2 Earth Visualisation module after the fieldtrip.

It seems clear that there will be increasing uptake of the use of digital mapping equipment for collecting field data in most subjects that study the natural world and increasingly these will be used by students. Concerns have been voiced about the loss of traditional mapping skills resulting in poorer student understanding of 3-D geological architectures. Our experience is that the opposite is true: that students' understanding and ability is actually improved. Mastering the tools of traditional mapping, the mapping pens and colouring pencils, often detracts from the aim which is to capture and visualise the geological architectures. We see no reason why digital methodologies should not result in more rigorous and quantitative data capture methods adopted by students during fieldwork (Jones et al. in press) and they are more intuitive to students who deal with computers from an increasingly young age. In our experience, more 3-D visualisation of field data on location gives better understanding of geological structure and will improve as software and technology become better and cheaper.

Recommendations to other Practitioners

We have the following recommendations for other academics in earth science and related areas, who might like to consider adopting digital mapping methods and 3-D visualisation techniques in their own courses. They are:

- Our experience has shown that from a small 'foothold' it becomes easy to incorporate the digital mapping and visualisation in most fieldwork-classes that take place in the laboratory or on location.
- A minimum amount of equipment is required to demonstrate digital mapping (e.g.) one GPS unit, a PDA and access to a desktop GIS system.
- Digital mapping and 3-D model construction ideally should be done before the field-class to provide time to build and refine the models.
- It is advisable to have at least one staff member attend a suitable training course such as a GIS or geospatial data course.
- On location, a data projector and a suitably specified lap-top make demonstrations to large groups much easier.
- It is much easier if your institution subscribes to Digimap™ as this will allow access to Ordnance survey digital topographic data. Other datasets such as digital geology or aerial photographs should be purchased separately from appropriate sources.
- Digital mapping and 3-D visualisation are tools to replace and enhance traditional field methods and the emphasis should remain on understanding basic concepts.

To conclude, we have found embedding the above techniques in a geology course at the University of Durham a worth-while experience, which enhances student learning and specifically 3-D visualisation and geometrical problem-solving. Linking undergraduate geology teaching with state-of-the-art research tools also benefits students, since many of them are likely to use similar sophisticated software and hardware in either postgraduate study and/or in the world-of-work.

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Endnotes

¹ Digimap® is an EDINA service delivering Ordnance Survey map data to UK Higher Education. See URL above.

Evaluating a Student Group Project on Creating a Geographic Information System

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Abstract

Geographic Information Systems (GIS) are increasingly contributing to student work. In the project reported in this paper, students formulated their own geographical problem involving spatial data, which had to be answered using a GIS. The student activity brings together both teaching and research. An evaluation of this activity aimed to establish what could be learnt from the student experience which would help future students be more effective in linking their use of the GIS to the research they had undertaken. A combination of questionnaire and focus groups was used. The questionnaire sought to establish what types of spatial data were used, what GIS processes were employed in the analysis and the nature of their results. Focus groups investigated which aspects of the project the participants found interesting and where they identified the greatest challenges and difficulties.

Introduction

The aim of this research was to evaluate student experiences in creating a Geographic Information System (GIS). The evaluation could then be used to help future students to be more effective in linking their use of the GIS to the research they had undertaken and so reach greater levels of understanding.

Pedagogical Considerations

The student projects were set in a problem-based learning situation which effectively links teaching and research. Elton (2001) states that in learning theory, the activity of learning with understanding, referred to as 'deep learning', requires learners to integrate new knowledge with existing knowledge. He concludes that the nature of the link between teaching and research depends primarily on the process of the student curriculum.

This paper describes a student project where the outcome is the creation of a GIS, but underpinning this activity are the scientific processes by which 'geographic phenomena are measured, generalised, and analysed and represented' (Summerby-Murray, 2001). Constructivist pedagogy incorporates the idea that learners construct knowledge for themselves and hence the teacher acts as a facilitator of this process. Summerby-Murray (2001) argues that GIS can serve as a constructivist pedagogy within the many methodologies found at the core of geography by aiding the student's experience of research and highlighting the constructed nature of research problems. His key argument is that GIS technologies are readily incorporated into problem-based enquiry and hence can make a significant contribution to constructivist pedagogy. His paper deals specifically with historical geography but this conclusion can be applied more generally to other geographical pursuits.

Background to the Student Project

Stage three students taking the module 'Applications of GIS and Remote Sensing' in the School of Geography and Environmental Management at the University of the West of England, were asked to create a GIS. The GIS had to incorporate a geographical situation and involve the analysis of spatial data. Working in groups of four, the students identified their topic and the geographical location. The work

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was to be allocated amongst the team so that each student had responsibility for a particular section.

As this was an 'open enquiry' (Unwin, 1997) the students were required to:

1. Identify the scenario;
2. Select and acquire appropriate data;
3. Establish the structure of the GIS;
4. Analyse the data and present their work, through a presentation, to the rest of the students;

In the lecture programme, seminar and laboratory sessions students were provided with:

1. Examples of GIS software functions;
2. Case studies which included examples of GIS applications and methods;
3. Examples of different types of outputs (text, graphics, maps, charts, images);

In addition, there were opportunities for discussion of key GIS concepts and fundamentals such as scale, abstractions, generalisation and quality of output. The students were also referred to the discussion by Nyerges and Golledge (1997) on geographic questions and their relevance to GIS.

As the groups consisted of both human and physical geographers and joint honours students, the range of interests and hence GIS topics was very diverse. Table 1 gives the titles of the projects undertaken by the forty students in ten groups in the 2002 – 2003 cohort.

GIS Projects for 10 groups - 2002-2003

1. Neolithic long barrows in Gloucestershire.
2. Impact of human activity on butterflies.
3. Deprivation in London.
4. Urban Green Spaces in Bristol.
5. Relationships between death rates, deprivation and income.
6. Does where you live affect your health?
7. Traffic flows from a university campus - UWE, Bristol
8. Safe environments – ATMs and street lighting.
9. Relationships between income, deprivation and mortality rates.
10. Availability of safe access to green spaces.

Table 1 GIS projects for the 10 student groups (2002-2003)

The student teams are assessed by means of a presentation where they describe their work and demonstrate their GIS together with a Powerpoint presentation during a class seminar. They are expected to refer to the GIS analyses carried out, report on their conclusions and errors and comment on what they would change if they were to repeat the exercise, which encourages the students to reflect on their work. Each individual member of the team has to contribute to the seminar and in addition provide an individual short report on the whole project.

Methodology

Evaluation of the project was carried out by means of a questionnaire and two focus groups with a sample of the students.

The questionnaire was designed to collect quantitative information (e.g. types of data used, methods of analysis employed, the nature of the results and possible errors) while the focus groups were used to enhance the information gathered from the questionnaire.

Each of the two focus groups was made up of twelve students. Each project team was represented by at least one member in one of the ten groups. The following questions were used as a starting point for the discussion but the approach was essentially informal:

1. What challenges/difficulties did you face?
2. How did you identify a suitable geographic question for a GIS?
3. What processes did you use and what were the specific challenges here?

Results and Discussion

Questionnaire

The most popular GIS operations identified from the questionnaire are listed in Table 2.

- Adding a new field to a database.
- On-screen digitising to create new polygon themes.
- Simple query process e.g. long barrows located at altitude 160m and above?
- A complex query process involving two or more variables.
- Joining of tables to create a new table.
- Creating hotlinks.
- Creating bar or line charts.
- Overlaying contour lines on other layers.
- Using a Global Positioning System (GPS) to collect co ordinates.

Table 2. Most popular GIS operation identified from the questionnaire.

Focus Groups

Due to the relatively open nature of the focus group situation, it was difficult to extract specific contributions by the students as to policy recommendations for future problem-based activities. However, the comments below were the topics most frequently raised by the members of the focus groups and were in response to the question 'What challenges or difficulties did you encounter?':

- Difficulties in making decisions about the requirements of the project in relation to the scale of mapping and information on the maps.
- Not being able to compare data from different sources e.g. from web sites because mapped in different spatial units.
- Not all 2001 National Census datasets were available.
- Queries about data quality and lack of metadata (data about data), e.g. for long term studies was there consistency in data collection?
- Cartographic considerations, e.g. how to put bar charts on a thematic map having polygons of very different sizes.

- Digimap being unavailable or files could not be downloaded successfully.
- Discovering how to translate digital data from one format to another.
- Finding the correct syntax and understanding online help menus for unfamiliar GIS operations.
- Selecting a GIS operation to achieve a particular result.
- Finding suitable times for the group to meet.

Both focus groups concluded that problem-based learning was a valuable exercise and that they learnt more from doing their own research and engaging with a GIS than with more formal methods.

Implications for Teaching and Learning

The learning environment for this exercise was found to be empowered by linking student learning, formal teaching and research. The GIS proved to be an appropriate decision-making support tool and also a means of organising, analysing and displaying the spatial data. Specific problems in theoretical knowledge and technical difficulties were identified by the students and will be communicated to future students. Key to constructivist thinking is that learning is an active process which also involves reflective activity (Hein, 1991). Working together in this team project meant that the students engaged socially and were able to choose their own research methods. Hence, from a pedagogic viewpoint the projects carried out by the students demonstrated that GIS can be used effectively in an independent problem-based learning activity which links both research and teaching.

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Problems, Pollution and Pedagogy – Linking Teaching and Research through a Problem-Based Learning Exercise

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Abstract

Of the links that have been made between teaching and research in GEES disciplines, it has been suggested that Problem-Based Learning satisfies at least two of them, namely engaging students in the research process, and allowing them to appreciate 'state-of-the-art' thinking in a certain subject. Combining these links with an exercise based on the tutor's own research interests further strengthens this juncture. Finally, the change in curricula towards a Problem-Based Learning approach can stem from active engagement with pedagogic research.

This paper documents a first run (for both students and staff) of such a Problem-Based Learning exercise, and shows that this teaching technique can strongly link the two practices of teaching and research in a way that benefits student learning.

Introduction

It has been suggested that the links between teaching and research can be made explicit in a number of ways (LTSN-GEES, 2003). This short paper documents an experimental 4-week class-based activity concerning eutrophication, which was run as part of a Stage 3 module in Marine Pollution Management as part of the Marine Environmental Science BSc in 2003.

Problem-Based Learning (PBL) could be considered as a vehicle for demonstrating and raising awareness of the links between teaching and research with students. Within a PBL exercise students can gain appreciation of research in the discipline by identifying 'state-of-the-art' thinking. Whilst completing the activities set out during a PBL, students can also develop their own research skills by setting aims and objectives, reviewing and critiquing literature and evaluating research findings to consider further areas of work. Finally, by using selected problems, tutors can bring data and findings from their own research to bear upon student learning in a very real sense.

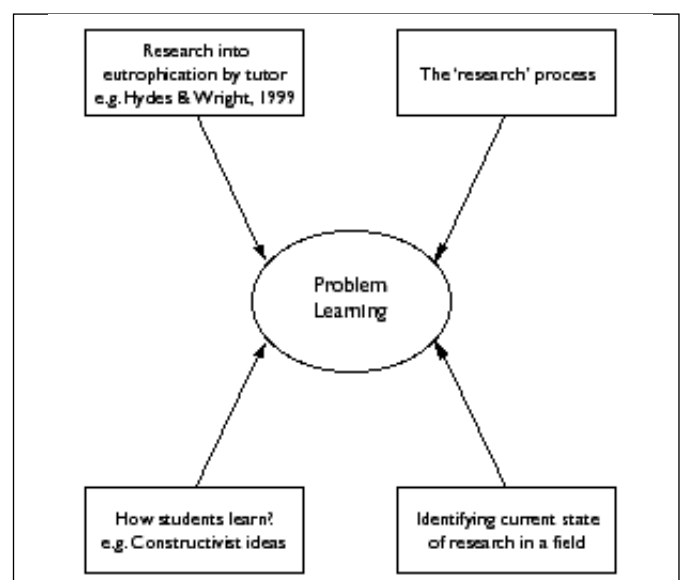


Figure 1. How PBL exercises can link the activities of teaching and research

P L A N E T

Thus, of the seven possible ways that have been identified as linking teaching and research (see Table 1, Healey 2003), PBL can satisfy at least three of these. The links between these identities and this exercise can be summarised in Figure 1.

Interestingly, one link between teaching and research that is not discussed in Healey (2003) is that of the juncture between theory (from educational research) and practice (teaching). Whilst this might not necessarily be the way some academics work, many are increasingly aware of educational theory, and many use this and their own classroom-based research to understand something about what happens to their students when in teaching sessions.

In fact, Figure 1 highlights and strengthens this link by suggesting that this form of the research/teaching nexus is a 'two way street' whereby past research informs how future activities are structured, and evaluation of this work may add to the body of knowledge of how students learn (i.e.) it has a direct impact on the scholarship of practice.

PBL as an educational culture

PBL as a way of approaching both subject and key skill material is becoming a progressively well-utilised teaching method. For example, a whole edition of PLANET was given over to examples of, and reflections on, PBL (LTSN-GEES, 2001). Moreover, the LTSN Generic Centre has also done work in this area.

There are, perhaps, increasing tensions in a more market-driven HE world, where Industrial Liaison Panels feed back to curriculum design groups, and courses, especially in some areas of the HE sector, are seen as increasingly 'vocational' in nature. These more 'operational curricula' (Savin-Baden, 2000) focus on what students can *do* when they leave HE. Compare and contrast, then, the oft-perceived reactionary view of these curricula as being less than academic, where the skills of research, critique, and knowledge accumulation are seen as essentially ignored. This slide, it is suggested, leads to students who can perform but not necessarily think.

Overlying these arguments is a suite of different educational theories, which may well hold sway within individual tutors, subject groups, or institutions. The humanistic view of learning theory suggests that learning is all about allowing students the freedom to learn (Savin-Baden, op. cit.). Bound to raise the hackles of the least ardent traditionalist, the change of focus from product (i.e. subject specific knowledge) to process (i.e. how does this learning thing work then?) is an ongoing and important debate with HE.

The suggestion is that PBL may be a method that allows a student to fulfil both roles, as an active learner who is engaging with their subject area (although, perhaps, not exclusively), whilst appreciating the subtleties of how they learn through a process of reflection and self-assessment. This is done by fostering a culture of learning that is often regarded as cyclical in nature, with students passing through stages of identifying what they know, understanding the gaps in their knowledge, discovery, and a reassessment of knowledge (c.f. Kolb, 1984).

PBL Session Organisation

The step-by-step methodology can be found in Wright (2003). The problem set centred on the wider marine pollution issue of cultural eutrophication. In particular, the main thrust of the problem was trying to explain why two local environments, Southampton Water and Chichester Harbour, experienced different aspects of eutrophication, especially with regard to the formation of algal bloom events (Hydes and Wright, 1999). A little research might allow students to understand the link between nutrient levels in the water and phytoplankton production. However, the twist to the problem was that the key question needed a little more studying. This is because Chichester Harbour, where there are lower levels of essential nutrients, experiences far more of an adverse impact from algal bloom formation and duration.

Before the sessions ran, the whole class had completed tutorial exercises in negotiation skills and 'Mind Mapping'. The former technique was introduced, so as to give students an idea of how to identify and support their learning needs for the coming month: the latter was suggested as a way of organising presently known and unknown information, and a neat way of visualising the way work might be divided up.

After a short twenty-minute introduction to eutrophication, which involved a few definitions, a suggestion of potential causes, and a number of resultant effects, the class broke down into groups of four. Given the uniqueness of this learning experience, it was decided to allow students to select their co-workers. The first session was then spent setting the following weeks learning, by articulating the difference between what they already knew, and what they felt they needed to know. The tutor's role was purely facilitatory, identifying students uncomfortable with the process and helping them, entering into discussions concerning context, relevance, and appropriate academic level.

The following two weeks followed much the same pattern. The fourth week involved a 'wrapping up' of material learned along with a twenty minute exercise to plan a monitoring or surveying strategy, which each group delivered in a five minute presentation.

How PBL might make the link between Teaching and Research

The link between pedagogic research and practice

The idea to run a PBL was borne out of current research into how students learn. For some academics, the tried yet rarely explicitly tested model of 'transmission-based' education, exemplified by the didactic lecture series, has come to represent the anathema of education in a HE system that purports higher cognitive skills development suggested by Bloom (1956) and Biggs (1999).

The emphasis on a constructivist pedagogy centres on the move away from of a model where learning is 'imposed' on students, towards a model where knowledge and skills are acquired through structured learning activities (Biggs, op. cit.) - in this PBL example, active research, group discussions and the formation of a research 'strategy'. These activities allow the students to explicitly construct their own meaning and understanding and foster the deeper learning of material. Finally, there is a move away from the focus on the teacher as 'the holder of knowledge' to one where students are actively constructing their own knowledge with the teacher facilitating the process.

It was planned that this PBL exercise mapped onto this pedagogy well. Students were set off discussing what they already understood about the problem, as they perceived it, or identifying the 'presage' phase (Biggs, op. cit.). They then went onto research the gaps they had identified in their existing knowledge, and discuss these at subsequent meetings (referred to as the 'process' phase). This process was then repeated over the next two weeks, and all artefacts of this process, including a reflection on the process were recorded in a personal Learning Journal. The final week was spent tying up any loose ends, identifying how far along the group had progressed with the problem, and asking them to use all this new knowledge to develop a monitoring strategy to test various ideas that they had about the two environments. These strategies were then presented to the class.

The PBL experience fed back into practice, by the convincing evidence that students had not only learned content, but had started to get to grips with the process of how they had learned. In an evaluation questionnaire, set after the experience, 87% enjoyed the experience with 91% finding it interesting. Moreover, 77% of the class claimed to have learned more from the technique as they felt this method made them "pay attention more" and make it "more interesting". Interestingly, a number of students commented that they felt they had "read around the subject more" and that there was "more time given to the

information". Given that positive feedback, PBL exercises have been introduced into other undergraduate and postgraduate units, some run by enthused colleagues.

The requirements of assessing deep learning implied in the constructivist 3P model of Biggs (op. cit.), have led to the belief that the assessment of the Learning Journal was not quite the correct technique. Many of the journals tended to focus on content rather than links between the content, even though it was clear from discussions that students were able to demonstrate this higher order thinking. This will lead to a unit modification in order to adapt a technique that more explicitly asks for these higher order skills to be demonstrated.

How the exercise allows appreciation of the status of eutrophication research

What is clear from the ideas put forward by Healey (op. cit.) is that one of the links made between teaching and research within GEES subjects is by getting students engaged with a body of literature that represents 'state-of-the-art' thinking.

The weekly meetings and setting of learning agendas meant that students had no choice but to read and work out what was being said in a myriad of sources. Again, the tutor input was minimal, usually suggesting papers to look at, providing a long list of potentially useful papers and websites, and entering into a discussion about appropriateness of level of content and understanding.

This allowed students to set up monitoring strategies that not only detailed the 'whats' and 'whys' of environmental measurement, but also started engaging in the 'hows' and 'wheres'. Some groups had gone to the length of identifying specific state of the art techniques on high temporal and spatial resolution monitoring, identifying possible equipment and relative costs.

A number of groups found research on Chichester Harbour difficult, as good resources are scarce. Discussions could then be had upon the paucity of data, and how you might have to start to 'hypothesise' in order to make up for the lack of direct evidence. Whilst this caused some consternation, some students found this extrapolating beyond the known details an interesting experience. From the tutor's point of view, it was direct evidence of the higher levels of understanding that this exercise was supposed to promote.

How the exercise examines research as a process and skill

Although students examine the 'research cycle' at Stage 2, within the context of a research methods unit, the cycle is rarely explicitly made mention of again. Within the PBL exercise, each week's discussion was framed around the exposition of prior learning, the setting of objectives for the coming week, usually identified in discussions as 'knowledge gaps', and the subsequent filling of those gaps by reading.

Students were practising skills that would stand them in good stead for their dissertation, the reading of a wide body of literature, the synthesising of this knowledge, and the critiquing of the work. At the same time, the reflection within the Learning Journal helped the students to develop a self-critical edge. However, many identified reflection as being the most challenging part of the exercise, with only one third claiming that they did not find it difficult. Some found the lack of writing a "right or wrong answer" difficult, whilst others expressed worries that they "had not done it before". Some felt almost embarrassed doing it, claiming that "you think what you thought may be nonsense" and that their "mind goes blank at the crucial stage". However, not one student felt that reflection was a waste of time. The process allowed students to identify progress and "make clear what I was trying to achieve". Others felt it allowed them to assess what they were learning and their own performance. This evaluative approach would be useful when starting to consider their dissertation work.

Although not a specific outcome of the work, it was clear, as has been mentioned in previous sections, that students were starting to

understand the specific research skills needed to develop their water quality work, such as sampling and monitoring techniques.

How the exercise uses staff research

Finally, the whole exercise was predicated upon previous research work carried out by the tutor (Hydes and Wright, op. cit.). The choice to use this work was based less around the need to demonstrate to students the relevance of research as an activity that impacts on what they learn, but rather as a 'safety net' for the tutor. Running such a new approach to teaching and learning was difficult enough, but creating panic over the material covered would have made the situation difficult.

However, the linkage between tutor research and their teaching does nothing for the student if it is not firmly grounded in identifying what the student can learn from this link. It is not good enough to use personal research for teaching if it does not link with a wider strategy for student learning, but just explicitly link to something the tutor is experienced and interested in. On reflection, it was seen that this fear of not knowing enough about the primary material was rather unfounded, and teacher focussed. Therefore, new PBL exercises have been developed outside of the tutor's research expertise. Running the exercise has shown that the facilitation of learning requires understanding more about the process of student learning than the content of it.

Conclusions

A number of links between teaching and research within GEES subjects have been discussed. A PBL exercise was run concerning eutrophication, which highlighted a number of these links; students studying a subject and using data from the tutor's research, students undertaking part of the research cycle and obtaining specific skills that help in the research of this and other subjects, and students identifying the current thinking in an area of research. Moreover, a link was documented where the stimulus for the move towards a PBL approach stemmed from pedagogic research, and sessions were aligned to fit a constructivist model of student learning. Furthermore, an evaluation of student experiences fed back into the teaching process in a number of ways, which will impact upon future student learning.

Future work with this PBL exercise may need to focus on the management of the experience more fully. This year a 25-minute 'surgery' is being planned for each group, rather than getting everyone together at the same time. It was also clear that student feedback, although positive, suggested that an early adoption of PBL into the curriculum would have helped. Similarly, an early introduction to the process and skills of reflection may have helped assuage some fears over this practice. Finally, tutor support, through peers or from educational developers, for developing this relatively new, but interesting, technique is crucial in order to further enhance the students' learning experience.

Recommendations

For other practitioners considering using this technique, the author can offer the following recommendations:

- Consider introducing the concept of PBL at an early stage in the degree programme before embarking on this sort of exercise;
- Make sure you stress to the students the need to keep their Journal 'live and current';
- Push the need for reflection at all stages;
- Keep an eye on what the students are actually reading;
- Know your stuff, and the wider implications of the problem! Students can end up looking at the strangest things!

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'Talking Heads', Teaching and Research: a View from the Chalk Face

LTSN-GEES

Introduction

During the 2003 LTSN-GEES Residential Conference on linking teaching and research and undertaking pedagogic research, in true Newsnight style, the LTSN-GEES Subject Centre invited a number of guest panelists to share their views with delegates on the conference themes. The four panelists and Chair of the session consisted of current and former Heads of GEES Departments from a range of UK HE Institutions. Between them, the panelists deal on a day-to-day basis with a range of student numbers, research and teaching loads and a diverse student intake, providing a snapshot of the present complexity of HE in the UK.

The session was chaired by Roger Lee [RL], current Head of the Department of Geography at Queen Mary, University of London. The panelists were: Sue Burkill [SB], Head of Educational Development at the University of Plymouth and former Head of the Department of Geography at the College of St. Mark and St. John, Plymouth; Carolyn Roberts [CR], Head of the School of Environment, University of Gloucestershire; Gordon Walkden [GW], Head of the Department of Geology and Petroleum Geology, University of Aberdeen; and Brian Whalley [BW], former Head of the School of Geography, Queen's University Belfast.

This manuscript is structured according to the key questions that Roger Lee posed to the panel. Finally, this article provides only a summary of some of the principal areas of discussion and is not intended to depict quoted speech.

What does the linkage between teaching and research mean to you as a Head of Department?

GW- Speaking as a Geologist working in HE, I would say that the link between teaching and research has always been there. It is a fundamental link that we maybe take for granted, as most geologists are used to incorporating research materials into their teaching. As in other areas of science, geology teaching is example-based. Therefore, as academics, we tend to select areas to teach that match our areas of expertise and draw from our own research experience.

CR- A culture of enquiry pervades both research, teaching and learning, and we want our students to become involved in this too. Research is already deeply embedded into teaching and vice versa, with teaching helping to raise new areas of enquiry, but we need time and effort invested into institutional and departmental practice to strengthen this link and to convey this culture to our students. Paradoxically, if a department consists mainly of researchers, then it is harder to show a clear link between teaching and research: we need to ask ourselves how we can foster synergy between such researchers and the teaching academics.

SB- I don't think we can 'unlink' teaching and research. If you are a researcher, but don't want to communicate your research, then there seems no point in doing that research. Teaching is a very important way of communicating and young teachers need help to gain confidence in their teaching and in linking their research. As a Head of Department, we can help them see that the research they do is important and interesting at all levels within the teaching arena.

BW- There is a historical legacy that links teaching and research, but this is now being eroded. The RAE has become the main driver for funding and kudos within HE and younger teachers often want only to do research. Their areas of expertise, their interest in research is now being brought into teaching only at Stage 3 or beyond. What we need to do is feed this research in at all levels.

Does this shift in thinking on the link between teaching and research matter with respect to the sustainability of departments and subject disciplines or does it also affect the future of HE?

SB - There will be implications for the career prospects of teachers; at many teaching colleges staff are already encouraged not to carry out any research. Despite this 'encouragement' however, staff still do research, subverting the system, as it is essential for their career paths. If you separate teaching and research in this manner, there is a possibility that you will no longer attract staff into the profession if they can only teach.

RL- I would like to add here that both the White Paper² and the Roberts Review of Research Assessment⁴ split teaching and research with an implicit drive towards research: undermining HE and scholarship in the process.

GW- It is misguided to try and divide the wide spectrum of institutions into teaching versus research. With respect to CPD, teachers should have the chance to follow both teaching and research and should not be forced down one path or the other. Their career will not start and end at their first institution.

Given this context, what are the roles of Heads of Department at present?

CR- The roles of Heads of Department within an institution should be seen as two fold: encouraging your staff and setting up a culture where all academic staff are expected to be involved in the full sweep of scholarly activities; and encouraging our own institution to develop this culture via policy decisions so that the right signal is sent out both within the institution and to the outside world.

GW- To achieve research and teaching equalisation, we should reconsider the use of the word 'elite'. There will always be elite institutions at the top of research, but, for example, some of the new universities are elite in pedagogy. This is never mentioned. This lack of balance must be evened out. We need to see pedagogy as a potential measure of "eliteness" as much as research.

CR- There are also issues of funding. For example, can departments afford to carry out pedagogic research as part of their research strategy? Where would an R.A.E. inactive department get funding for this type of research?

SB- There is a lot of money in teaching, but scholarship and pedagogic research does not bring in funding. Much of the money that is available is channelled into subject research. If this funding went to pedagogic research, where it was originally intended, then that would be a start!

RL- I'll now ask the panel some questions brought up by our audience.

What are the barriers and links between teaching and research?

RL- Can a Head of Department with serious RAE intentions allow their academics to carry out pedagogic research?

BW- I thought that pedagogic research was considered as part of the RAE. This brings to my mind a number of questions: if someone is interested in pedagogic research, should we stop them?; is pedagogic research really any different from subject research?; how can we, as academics, get this form of research accepted amongst our peers and the policy makers? We need to ask ourselves: could a Head of Department carry out pedagogic research in a research proactive department?

GW- We also have to consider where the impetus for carrying out pedagogic research comes from. If institutions were pushing departments in that direction, it would be easy for Heads to make that move. But the RAE still drives our work, and there has been no clarification as to how pedagogic research sits in this framework. If there is no place for this type of research within the RAE, then is it a waste of our time?

CR- I would also like to ask whether departments that are no longer RAE active are therefore banned from doing any research? Would this ban, if it exists, include high level pedagogic research? If this is the case, then carrying out such research appears to be a high risk strategy for a department. My feeling is that an institution that pushed pedagogic research over everything else would not be successful, as there is currently not enough funding in this area to make a financial difference.

As teaching practitioners, do we really need to do pedagogic research as well as subject research?

BW- If there is a question and you don't know the answer, then you need to research it. I think that the recent research into the pedagogic value of fieldwork is a good example. We have always assumed fieldwork was worthwhile, yet we are still dealing with threats to fieldwork funding. A scholarly approach to its use with students can only help in building a case for its continued inclusion in the curriculum.

GW- As practitioners, we ask ourselves whether we can afford time on pedagogic research. My answer to this is, if you want to teach better,

then pedagogic research is a tool for achieving this. We therefore need to find ways to develop pedagogic research and place it in the public domain.

So what are departments doing to encourage good teachers and get staff interested in teaching?

GW- At a departmental level, Heads have no control over promotions. In my institution, this is decided at a Faculty level.

CR- I see the 'promotions' issue as an 'end of pipe' solution, once teachers have displayed excellence. We should also ask ourselves how we can engender success in teaching. As Heads of Department we can encourage at an individual department level, but these aims have to be contextualized by the institutional and national climate.

Institutions are now looking for teaching criteria for promotional paths. What should criteria be? Can we, as Heads of Department, shape this?

SB- Most institutions now have at least some criteria for this type of promotional pathway. But most Heads have no knowledge of their institution's human resources policy. I have recently written an article in the Journal of Geography in Higher Education pointing out a number of examples in this area¹ and Graham Gibbs has also carried out research that may be of interest^{2,3}.

CR- Excellence in research, teaching and management are the main promotion criteria, with staff required to list two out of three. Having said that, to be promoted to Professor would certainly require staff to have hit research as one criterion, although this is not made explicit.

Regarding the Post-Graduate Certificate in Higher Education: do you have one and is it any good?

SB- I would say that most individuals do take away benefits and soon all new lecturers will have to go through it as a national standard. However, I do wonder if it comes at a hard time in a teacher's career. We must be realistic about how we assess the course, how much work can be managed by the academics on the course and how much training is actually needed.

BW- I don't have a certificate. I'm too old! As a warning, I do think that some staff gain the certificate and then think that that is all they have to do: that they don't need to reflect or develop their teaching any further. As scholars we should constantly deconstruct and reformulate our teaching and our views on learning.

In Conclusion

RL- I think that as Heads of Department sometimes teaching is at the front of our thoughts, sometimes research. We are constantly dealing with different Deans, different committees and different demands on our time. The current HE system is not organised to deal with teaching and research as a combined part of academic practice: yet we, the academics, have to live with this artificial rift. During this discussion we have made certain presumptions. Have we taken too narrow a view of teaching and research? As scholars, what are we doing about this putative link between teaching and research? Is this split of teaching and research the right one?

The impression we have received from HEFCE is that funding for pedagogic research will be crumbs from the table rather than solid funding. We as academics need to be explicit with regard to teaching and research links for political reasons: we want to encourage large-scale, well-funded pedagogic research into this area, not piece-meal case studies that have not been carried out in a scholarly fashion. I will leave you with a final question: how can we develop support and funding structures when pedagogic research is still not valued at the departmental, institutional or governmental level?

P L A N E T

LTSN GEES would welcome any comments you may have on the issues raised in this article. If you have an interest in the subjects covered in this discussion, please feel free to contact us. Finally, we would like to thank all of our panel members who contributed to this discussion.

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Linking Teaching and Research in the GEES Disciplines: A Guide to Key Reading

This bibliography has been compiled by Mick Healey, LTSN-GEES Senior Advisor for Geography and Joint Leader of the GEES Linking and Teaching Research Project. An annotated version is available on the 'Linking Teaching and Research in the GEES Disciplines' webpage at: <http://www.gees.ac.uk/linktr/bib.htm>.

General References

Below are a few key generic references on linking teaching and research. A longer list is available at: www.brookes.ac.uk/schools/planning/LTRC/bibliog/bib-generic.htm.

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Links

The LTSN-GEES 'Linking Teaching and Research in the Disciplines' webpage provides background to the project and links to discipline-specific case studies: <http://www.gees.ac.uk/linktr/linktr.htm> (see inset in this article of PLANET for full list of case-studies)

The Generic Centre "parent" website holds details on Linking Teaching and Research in other Disciplines: <http://www.brookes.ac.uk/genericlink/>

Change Strategies for institutions and departments to develop teaching /research links: <http://www.brookes/schools/planning/LTRC/change/change-strategies.htm>

Good Practice Guidelines for course teams and institutions: <http://www.brookes/schools/planning/LTRC/guidelines/section4-1.htm>

Booklet on department strategies to enhance Teaching and Research links: http://www.ltsn.ac.uk/application.asp?section=generic&app=resources.asp&process=full_record&id=257

International listing of relevant web sites: <http://www.brookes.ac.uk/schools/planning/LTRC/Links/links.html>

National & International Centres & Projects on Linking Teaching and Research

Linking Teaching and Research in the Disciplines Project (2002- 2003)

This is a project funded by the LTSN Generic Centre – visit www.ltsn.ac.uk/genericcentre and then follow these links Projects > Research & Scholarship > Linking Research & Teaching.

Alternatively, go to <http://www.brookes.ac.uk/genericlink/>

This national project involves:

- Creation of generic support materials to further embed teaching/research links in disciplinary communities;
- (Initially) five subject centres embedding teaching/research links in their communities; Bioscience; Geography, Earth and Environmental Sciences; Hospitality Leisure Sport and Tourism; Health Sciences and Practice; Law, Medicine and English are all involved;
- Providing a framework, ideas, resources and strategies that will also support disciplinary communities world-wide in linking teaching and research;
- A website containing case studies of discipline-based practice; links to relevant discipline-based organisations worldwide and generic materials.

Project Link: Linking Teaching with Research and Consultancy in Built Environment Disciplines (2000- 2004)

<http://www.brookes.ac.uk/schools/planning/LTRC/>

This is an FDTL 4 project being undertaken by Oxford Brookes University, The University of the West of England, University of Westminster and Sheffield Hallam University (UK).

The project is investigating the 'what, where and how' of Linking Teaching with Research and Consultancy in the disciplines of Planning, Land and Property Management, and Building; in 2003-4 it is being extended to other disciplines in the above institutions.

The website contains examples of course design strategies, institutional and department change strategies, reports of focus groups, links to web sites worldwide etc.

A US Centre focusing on Linking Teaching and Research in 'Research Intensive' Universities

The 'Reinvention Centre' at Stony Brook is a national centre focusing on undergraduate education at research universities.
<http://www.sunysb.edu/Reinventioncenter/>

The Centre was born out of the national and international interest generated by the Boyer Commission Report, Reinventing Undergraduate Education: A Blueprint for America's Research Universities (1998). <http://naples.cc.sunysb.edu/Pres/boyer.nsf>

The US Council On Undergraduate Research

The US Council on Undergraduate Research helps to strengthen the research programs of faculty in predominantly undergraduate institutions. Specifically, it promotes research by undergraduate students in all branches of science, mathematics and engineering education. The Council believe that education is best served by faculty-student collaborative research combined with investigative teaching strategies. The Council provides avenues for faculty development and helps administrators to improve and assess the research environments of their institutions. The Council also generates awareness and national support for undergraduate research. <http://www.cur.org/>

The LTSN-GEES Resource Database

A handy one-stop shop for GEES academics.

The database holds information over
450+ resources such as case studies of good practice,
tutorials, journal articles, course
text books and CDs.

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Part B Pedagogic Research

'Enhancing Fieldwork Quality through Pedagogic Research'

Helen King writing on behalf of Mick Healey and Alan Jenkins (research programme leaders); Liz Beaty and Glynis Cousin (pedagogic research consultants); John Bradbeer (researchers); Jenny Blumhof, Brian Chalkley, Steve Gaskin and Geoff Robinson (group members).

An Introduction to the LTSN-GEES-funded Programme

Introduction

Between June 2001 and January 2003, the UK Learning and Teaching Support Network Subject Centre for Geography, Earth and Environmental Sciences (LTSN-GEES) ran a national programme of discipline-based pedagogic research, funded through the LTSN Development Fund. The main aim of the programme was to develop the capacity of staff in the GEES higher education (HE) communities to undertake research into learning and teaching through working together on a set of small projects focused around the common theme of fieldwork.

Rationale

The rationale for the programme was based on the increasing growth of interest in developing the scholarship of teaching, including staff researching their own teaching (e.g. Healey, 2000; 2003; Yorke, 2000), in tandem with the greater importance given to discipline-based approaches (e.g. Rust, 2001; Healey & Jenkins, 2003).

There has been increased emphasis in higher education internationally on the need for learning and teaching developments to be supported by evidence-based practice. In the UK this has been associated with the Dearing Report (1997), the founding of the Institute for Learning and Teaching in Higher Education (ILTHe, 1999), and the establishment of the Higher Education Funding Council for England's (HEFCE)'s Teaching Quality Enhancement Fund which included the development of the LTSN (1999/2000). However, it has been recognised that one of the challenges facing the enhancement of this evidence base in UK higher education is the development of the capacity of academic staff to engage in pedagogic research (e.g. Beckhradnia, 2000).

Such capacity building has so far tended to focus on high level research which is generic in character. However, to raise the capacity of staff to research their own teaching means that this work must be embedded in specific disciplines, as it is in their discipline that academics have their principal communities of practice (Wenger, 1998). Interest in discipline-based approaches to educational research is international as exemplified through the activities of the Carnegie Academy for the Advancement of Teaching in the USA and many of the projects funded by the Committee for the Advancement of University Teaching in Australia.

The interest in pedagogic research within geography, earth and environmental sciences has been widely articulated, for example through the emergence of education sessions at discipline-based research conferences (such as the Geological Society of America and the International Geographic Union), through the development of international organisations (such as the International Geoscience Education Organisation, and the International Network for the Learning & Teaching of Geography in HE), and also through the convening of