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Linking Discipline-Based Research with Teaching to Benefit Student Learning

“... universities should treat learning as not yet wholly solved problems and hence always in research mode” (Humboldt, 1970, quoted by Elton 2005, 110)

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The material in this hand-out has been developed over several years with Mick Healey , Professor Emeritus, University of Gloucestershire , UK; mhealey@glos.ac.uk, www.mickhealey.co.uk Further and more detailed case studies, including institutional and national examples, references and a list of useful web sites may be found at www.mickhealey.co.uk/resources.

Institutional Mission Statements

University of Cyprus aims to establish itself as a Pioneer Research Institution achieving International Scientific Recognition in European Higher Education, offering Competitive Programmes and to become a Centre of Excellence in the wider Euro - Mediterranean Region.

The main objectives of the University are twofold: the promotion of scholarship and education through teaching and research, and the enhancement of the cultural, social and economic development of Cyprus.

In this context, the University believes that education must provide more than simply accumulation of knowledge. It must also encourage students' active participation in the process of learning and acquisition of those values necessary for responsible involvement in the community. The University sets high standards for all branches of scholarship.

Research is promoted and funded in all departments for its contribution to scholarship in general and for its local and international applications. (University web site)

Pronouncements on Teaching /Research Relations

“No issue is more basic in modern higher education than the relationship between research and teaching”
(Clark, 1997, 241)

“Research connects with the subject; in order for teaching to connect with the subject, connect teaching with research” (Hutchings, 2008).

“It is not teaching but the student experience that should be the focus of the teaching research nexus”
(Prosser, 2006)

“Involving students in inquiry - in research - is a way of improving their learning, motivating them more. After all, what motivates large numbers of academics is engaging in the excitement of research. Bringing research and teaching together is a way of enhancing the motivation of both academics and students”
(Brew, in preface to Jenkins *et al.*, 2003, ix)

Structure:

A: Views on the linkage between research and teaching

B: Case studies of linking discipline-based research and teaching in disciplines and departments

C Annexes on Strategies to Link T and R in courses ...national systems.

A: Views on the linkage between research and teaching

Table 1: Different ways of linking research and teaching

- Learning about others' research
- Learning to do research – research methods
- Learning in research mode – enquiry based
- Pedagogic research – enquiring and reflecting on learning

Table 2: Linking research and teaching: Different views

“Our view is that university research often detracts from the quality of teaching. We regret the continuing elevation of research and the systematic neglect of the quality of instruction.” (Pocklington and Tupper 2002, 7 – about Canada)

“Courses taught by those at the cutting edge of research will necessarily be of higher quality than those taught by those merely using the research results of others – whatever the apparent quality of their style of delivery. Furthermore, if teaching is undertaken by researchers the linkage is automatic, even if, as is often the case they are not always teaching about their own narrow research specialism.” (Lee 2004, 9 – with particular reference to geography in UK)

“In all but the most elite academic environments, when you co-locate teaching and research you reduce your efficiency in producing both.” (Lloyd 2009 writing in *The Australian*)

“Research consumes much time and money that could be better spent on teaching students” (Haldane 2010)

The New Zealand Education Amendment Act (1990) defines a university as where “teaching and research are closely interdependent and most of their teaching is done by people who are active in advancing knowledge.” (cited by Woodhouse, 1998; policy audited in the late 1990s but received less emphasis since).

In *Scholarship Reconsidered* Ernest Boyer (1990, xii) challenged US higher education to “break away out of the tired old teaching versus research debate.”

“... we want all students to access the benefits exposure to teaching informed by research can bring.... This will take many forms including pure and applied research that feeds curriculum development; but also research and development that tackle the challenging questions facing professional business, regional and local employers now and in the future. We're doing this because we believe an understanding of the research process – asking the right questions in the right way; conducting experiments; and collating and evaluating information – must be a key part of any undergraduate curriculum; whether or not those involved in delivering it are actively engaged in research activity themselves.” (Bill Rammell, Minister for Higher Education 2006, 3)

“Why does every University, thirty-eight of them, public ones, why do they all have to be doing research, teaching and scholarship and struggling to do it in so many areas? Why can't we have Universities that make a conscious decision to specialise in outstanding teaching and scholarship but do very little research? Why can't we have formal affiliations, one specialising in teaching and another research, between our domestic Universities?” (Brendan Nelson, Minister for Education, Science and Training, Australia, April 2005)

“We are all researchers now ... Teaching and research are becoming ever more intimately related ... In a 'knowledge society' all students – certainly all graduates – have to be researchers. Not only are they

engaged in the production of knowledge; they must also be educated to cope with the risks and uncertainties generated by the advance of science.” (Scott 2002, 13)

“I propose that colleges and universities provide an opportunity for all undergraduates to conduct research — to create knowledge.” (Ellis, 2006; Professor of chemistry at the University of Wisconsin at Madison, on detail as director of the National Science Foundation’s chemistry division through June 2006)

“28. The University considers research-led teaching to be a defining characteristic of its approach to education and it is clear that new courses are often designed around staff research interests. It was also evident from the material presented for the two audit trails that many courses focused on staff employing what could be characterised as a somewhat passive 'research-led' approach through curriculum content conveyed by experts. However, discussions with students during both briefing and audit visits did suggest that certain areas of the University, at least, were concerned to promote a more engaged approach with students as researchers. ...

29. While noting that there are examples of considerable innovative practice across the University the audit team feels that these could be exploited further, and that the University could make further use of initiatives elsewhere in the sector. The audit team, therefore, recommends that it would be desirable for the University to continue to give serious consideration to developing and supporting models of integration between research and teaching across the full range of its curricula.”

(<http://www.qaa.ac.uk/reviews/reports/institutional/Liverpool09/RG513UniLiverpool.pdf>)

“The roles of teaching and research should be afforded parity of esteem, and this should be reflected in resource allocation, in promotion criteria, and in the metrics used to assess performance at individual, institution and system level.” (Department of Education and Skills 2011, 54) Ireland

Table 3: Modes 1, 2 and 3 Knowledge and the research-teaching nexus

Know-ledge	Characteristics and emphases	Research-teaching relationship
Mode 1	Disciplinary; production of knowledge; hypothesis testing; formal knowledge with universal aspiration	Potential that research and teaching may be separated
Mode 2	Interdisciplinary; production and application of knowledge; problem solving; commodification of knowledge; how knowledge is managed, synthesised and adapted; multiple interpretations, creative knowledge in particular situations	Potential for greater integration as involves a wider concept of research including application and communication as well as production of knowledge
Mode 3	Interdisciplinary; integration of production and application; uncertainty dominates; recognises that knowledge produces further uncertainty rather than solutions; supercomplexity; no stable descriptions of the world; categories used for understanding the world and ourselves are contested; need to develop dispositions to learn to live with uncertainty	Potentially greater integration as students may engage with staff in academic communities of practice

Draws on ideas in Barnett (2004); Barrie (2004); Brew (2006); and Jenkins *et al* (2007)

Table 4: Relationships between conceptions of research

Research is oriented towards: ↓	Research aims to: ↓	The researcher is present to, or the focus of, awareness	The researcher is absent from, or incidental to, awareness
External products	Produce an outcome	Trading view	Domino view
Internal processes	Understand	Journey view	Layer view

Source: Brew (2003, 6)

Brew (2003, 6-7), on the basis of interviews with 57 senior Australian academics has identified 4 different conceptions of research (Table 4):

- Trading view – “in the foreground are the products of research: the end points, publications, grants and social networks, i.e. aspects external to the process of doing the research. These are viewed as being linked together in relationships of recognition and reward.”
- Domino view – “the researcher’s focus is on the solutions to problems and the answering of questions, i.e. it is *external* to the activities of doing the research. It looks outside the immediate context of the research.”
- Layer view – “the focus looks inward. It is *internal* because in the focus of awareness are the data containing ideas together with (linked to) hidden meanings. ... Here, research is interpreted as a process of discovering, uncovering or creating underlying meanings”
- Journey view – “in the foreground are the personal existential issues and dilemmas of the researcher, linked through an awareness of the career of the researcher and viewed as having been explored for a long time. ... the researcher is the focal point of awareness. Research is interpreted as a personal journey of discovery possibly leading to transformation.

Definition of Undergraduate Research

At the University of Gloucestershire “Our working definition of undergraduate research includes Boyer’s (1990) scholarships of discovery, integration and application (engagement) and is characterised by breadth: undergraduate research describes student engagement from induction to graduation, individually and in groups, in research and inquiry into disciplinary, professional and community-based problems and issues, including involvement in knowledge exchange activities” (Childs *et al.*, 2007).

“Programmes that seek to encourage or support undergraduate research should actively address all or most of the following.

- Expressly engage with ‘undergraduate research’, ‘community based undergraduate research’, or some such, and recast their understanding of ‘student-centred’ or ‘inquiry-’ or ‘problem-based’... ‘learning’ accordingly.
- Adjust the philosophy/values of their programme so as to actively bring undergraduate students (along with others such as librarians, community activists) into the worlds of research.
- Encourage and enable students to learn in ways that parallel or reflect the ways faculty/staff themselves research/learn in their discipline/professional area.
- Build research opportunities into the formative processes and summative outcomes of course assessment for students in ways that retrace and register how faculty/staff develop and disseminate their own research/learning in their own discipline/professional area, e.g. through undergraduate research journals, student research conferences, exhibitions, recordings and broad/narrow casts.
- Ensure that the programme is clearly visible and recognised as ‘undergraduate research’ by the university communities (in particular students) and parents, the local community, and possible external sponsors and stakeholders” (Jenkins 2008).

LINKING DISCIPLINE-BASED RESEARCH AND TEACHING IN DISCIPLINES, AND DEPARTMENTS

These cases of disciplines and departments focus on links between teaching and *disciplinary* research. With a few exceptions they *exclude* initiatives that encourage research into teaching and learning - although this is a critical and important way in which research and teaching may be linked, it is distinct from links with discipline-based research. In discussing teaching research relations and analysing these case studies, it is important to start from a research-based understanding of what we mean by 'linking teaching and research'; and then use this understanding to consider whether these international case studies fit your particular context at discipline, department, institutional and national levels. The paper is organised under eight main headings:

- 1 Contexts, Transferability and a Framework
 - 2 Linking Research and Teaching in Disciplines
 - 2.1 Biosciences, Physical Sciences, Medicine and Health Sciences
 - 2.2 Social Sciences
 - 2.3 Business, Computing, Law and Tourism
 - 2.4 Geography and Environmental Studies
 - 2.5 Archaeology and Earth Sciences
 - 2.6 Arts, Media, Architecture and Performing Arts
 - 2.7 English
 - 2.8 History
 - 2.9 Education and Philosophy
 - 2.10 Interdisciplinary
 - 3 Linking Research and Teaching in Departments
 - 3.1 Biosciences, Chemistry, Medicine and Health Sciences
 - 3.2 Engineering and Mathematics
 - 3.3 Arts and Social Sciences
 - 3.4 Geography, Earth and Environmental Sciences
 - 3.5 Developing research skills and academic practices
 - 3.6 Re-designing Spaces
 - 4 Linking Research and Teaching in Institutions
 - 4.1 Europe
 - 4.2 Australia
 - 4.3 New Zealand
 - 4.4 United States
 - 4.5 Canada
 - 5 Linking Research and Teaching in Postgraduate Courses on Teaching and Learning in Higher Education
 - 6 Teaching and Learning Courses integrated into Doctoral Programmes
 - 7 Linking Teaching and Research in National Systems
 - 7.1 Research councils support the research-teaching nexus
 - 7.2 Legislative and national quality assurance support
 - 7.3 National support for investigation and promotion of the research-teaching nexus
 - 7.4 National initiatives to broaden conceptualisation of academic work
 - 7.5 National awards for integrating research and teaching
 - 7.6 National designated funding to develop the research-teaching linkage
 - 8 International Initiatives to Promote Research and Teaching Links
 - 9 Sources and Bibliography
- Annex 1: Linking Teaching and Research in Departments: Questions and Strategies
Annex 2 Strategies for Linking Teaching and Research within Courses and Programmes
Annex 3: Institutional Strategies to Link Teaching and Research: A Framework
Annex 4: Possible Strategies for National and International Organisations

1. Contexts and Transferability

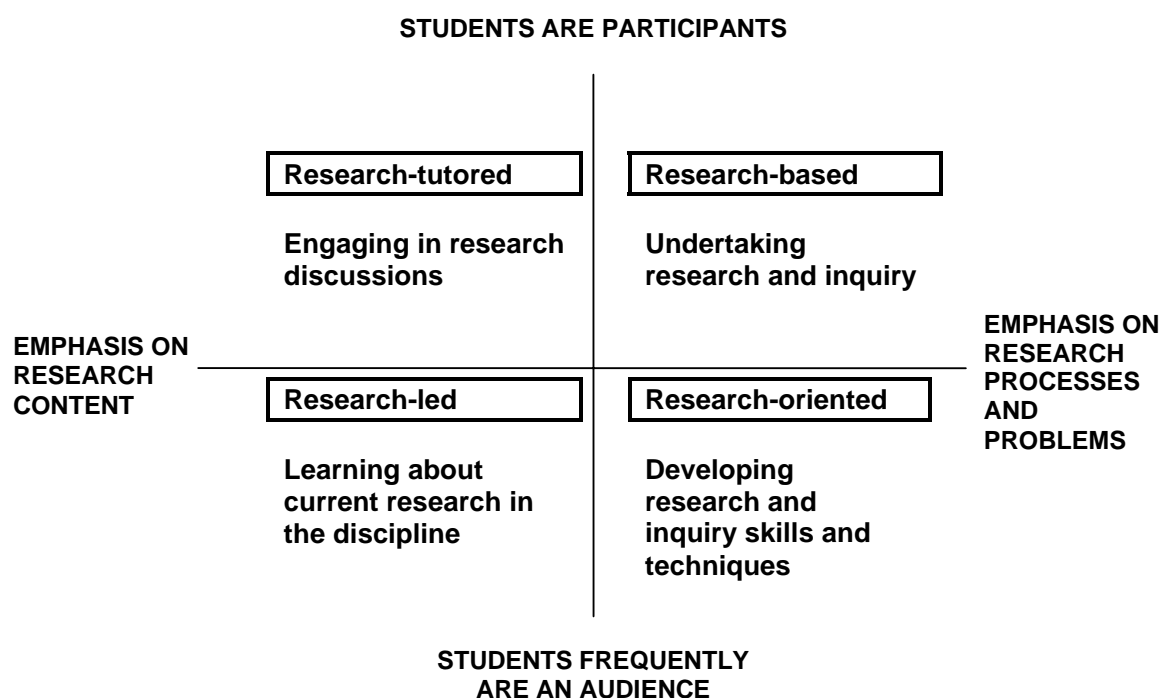
The value of case studies largely lies in the specific ideas they present for adapting elsewhere. We recognise that the form of, and the possibilities for, teaching-research connections will vary between disciplines / departments, institutions and nations. However, the particular forms of teaching-research connections are transferable and adaptable to other contexts. So when looking at the case studies below

also consider how innovations in particular disciplines, institutions and countries can be adapted to your context.

We have found the framework developed **Griffiths (2004)** and **Healey (2005)** effective in supporting staff/faculty to examine both their current courses and institutional policies and practices and in adapting innovations from elsewhere.

- **Research-led:** where students learn about research findings, the curriculum content is strongly shaped by faculty research interests/current research in the discipline.
- **Research-oriented:** where students learn about research processes, the curriculum emphasises as much the processes by which knowledge is produced as learning knowledge that has been achieved, and faculty try to engender a research ethos through their teaching; or
- **Research-based:** where students learn as researchers, the curriculum is largely designed around inquiry-based activities, and the division of roles between teacher and student is minimised.
- **Research tutored ;** where students supported by staff in small group discuss current research (papers) in their discipline.

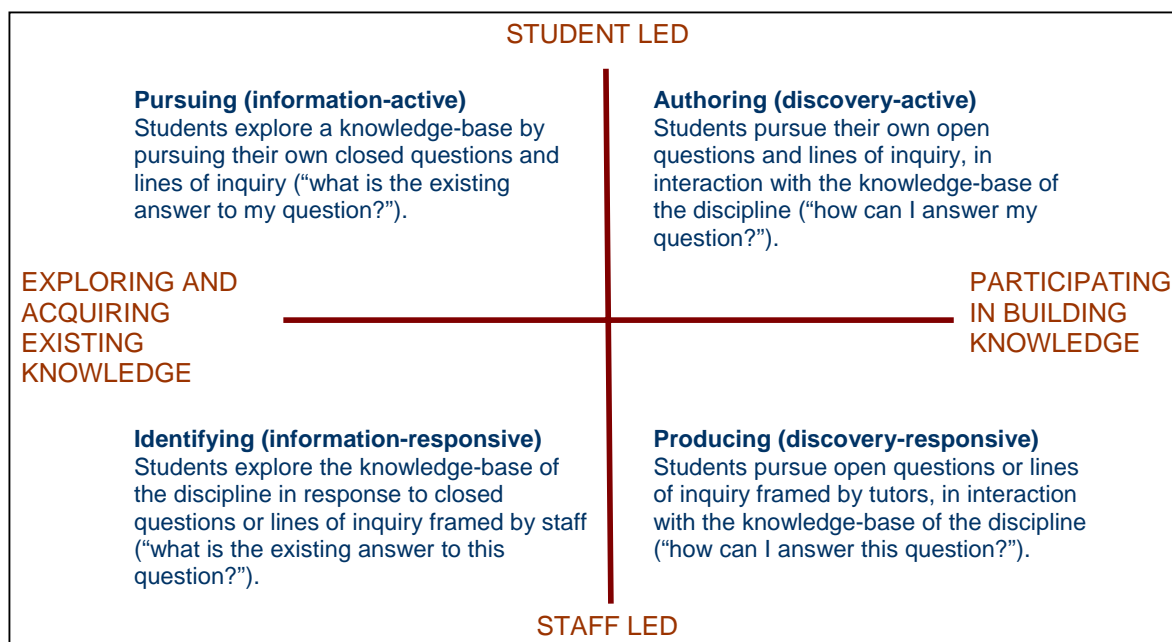
Fig. 1 The nature of student research and inquiry



Source: Healey and Jenkins (2009, 7; amended from Healey, 2005, 70)

Healey (2005) has expressed these differences diagrammatically using two axes (Fig 1). One classifies approaches to linking teaching and research according to the extent to which they are teacher-focused and students are treated primarily as the audience or treat students as participants, while the second axis classifies the approach as emphasising research content or research processes and problems. He identifies a fourth category 'research tutored' where students learn in small group discussions with a teacher about research findings. A variant on this matrix has been proposed by **Levy (2009)**. They also have a staff-led and student-led axis and another axis distinguishing between information-led and discovery-led inquiry in which the former is based on existing knowledge and the latter on new knowledge (Fig 2).

Fig 2 Inquiry-based learning: a conceptual framework



Source: Based on Levy (2009)

Another useful framework for analysing discipline variation is provided by Biglan (1973) identifies different discipline types. He distinguishes between disciplines which are predominantly ‘pure’ and those which are predominantly ‘applied’ and those which are predominantly ‘hard’ or predominantly ‘soft’. The latter refers to the dominant paradigmatic approach whether e.g. quantitative scientific or qualitative interpretative. The opportunities and ease with which research and teaching may be linked varies according to these discipline types. Some differences in students’ experiences by discipline are shown in Table 1.

Table 6 Students’ experiences of learning in a research environment

	Physics	Geography	English
What is research?	Breaking new ground; moving forward; exploration and discovery	Gathering information in the world; answering a question	Looking into; gathering; putting it together; a focus of interest
How visible is it?	Laboratories and machinery (i.e. ‘tools’) but often ‘behind’ closed doors	Most visible ‘in the field’	Not tangibly visible, but apparent in the dialogue
Where is it located?	Out there; at a higher level	Out there in the field	In the library; in the head
Who does it?	Lecturers	Lecturers and (increasingly over time) students	Lecturers and students

Source: Robertson and Blackler (2006, 226). Based on interviews with 36 students (first years to postgraduates) at Canterbury University, NZ

2. Linking Research and Teaching in Disciplines

2.1 Biosciences, Physical Sciences, Medicine and Health Sciences

Undergraduate and postgraduate student conservation science conferences at Cambridge (UK) and Duke (US) Universities

An annual student research conference has been held since 2001 at Cambridge and since 2005 at Duke. The series aims to build links among young conservation scientists from biological, environmental and geography departments of universities as well as conservation and resource management agencies.

Delegates include students from around the world, as well as conservation practitioners from leading international conservation bodies.

Sources: <http://www.sccs-cam.org/>; <http://www.nicholas.duke.edu/news/ns-sccs.html>

Asking questions in plant biology at Australian National University

A practical exercise designed for a Level 2 course involves students: making observations in a botanical garden; coming up with 10 questions each (e.g. why do eucalypt leaves dangle?); sharing one of these questions with a group of other students; coming up as a group with hypotheses based on the question (e.g. Eucalypt trees in arid environments have leaves that dangle at steeper angles than those in wet environments); thinking of ways of testing the hypothesis(es); and writing up individually their 10 questions and one hypothesis as a 750 word mini-proposal for a research project.

Source: www.anu.edu.au/CEDAM/ilearn/inquiry/posing_questions.pdf

At University College London, UK, science undergraduates build on research of previous students

Students on a course on the history of science at UCL are involved in an ongoing pilot project aimed at a full integration of teaching and research at the undergraduate level. The chief innovation is the mechanism of inheritance: each year students receive a body of work produced by the previous group of students and make improvements and additions to it; this process can be repeated until publishable materials are produced. This is part of a system of learning that enables students to function as a real and evolving community of researchers. First developed in a final third year course, the “course will now be open to second years which will enable interested students to continue their work as part of their dissertation, and to strengthen the diachronic community by having the previous year’s students present when the next cohort take the course” (Chang 2007, 21).

Sources: Chang (2005; 2007); Chang and Jackson (2007)

<http://network.nature.com/london/news/Q&A/2007/10/31/wiki-book-on-chlorine-heralds-new-style-of-undergraduate-teaching>; <http://www.ucl.ac.uk/sts/chang/>

At Leicester University, UK, biochemistry undergraduate students are helped to read research articles

The expectation that students in the latter stages of an honours degree will be keeping abreast of developments in a particular field of knowledge requires them to become conversant with research articles. Yet the content of such papers is frequently jargon-rich and impenetrable. In the department of Biochemistry at Leicester University some final third year modules are in effect journal reading clubs around particular research themes. Key components of the first year programme are explicitly structured to introduce them to reading and to writing as researchers. In particular as part of a year-long scientific skills module (c70 students) a set of exercises has students first consider the structure of a scientific report and read and evaluate a given research paper. Subsequently, students are asked to imagine themselves as scientific investigators interested in a specific problem. In tutor-led group discussion, they design an experiment to investigate the problem and then individually write a report based on provided data. Sources: Wilmott *et al.* (2003)

Inquiry Based Learning – or ‘Scale Up’ – in Introductory Science Classes

SCALE-UP or “Student-Centered Active Learning Environment for Undergraduate Programs”, originally developed at North Carolina State University has been widely adopted and adapted in a wide range of US universities, including the Technology Enhanced Active Learning (TEAL) classroom at Massachusetts Institute of Technology (MIT).

The basic idea is of a radically redesigned classroom and linked web supported learning environment. The traditional lecture and linked laboratory format is replaced by “4-6 hours of activity based instruction per week, typically in 2-hour blocks” (Beichner *et al.*, 2007, 3). Students work in groups at round tables with web support and white boards. “Most of the class time is spent on ‘tangibles’ and ‘ponderables’”. Essentially these are hands-on activities, simulations, or interesting questions and problems. There are

also some hypothesis-driven labs where students have to write detailed lab reports.”
(<http://scaleup.ncsu.edu/FAQs.html>)

“In comparisons to traditional instruction we have seen significantly increased conceptual understanding, improved attitudes, successful problem solving, and higher success rates, particularly for females and minorities (Beichner *et al.*, 2007, 1).

Sources: Beichner *et al.* (2007); <http://scaleup.ncsu.edu/>; <http://icampus.mit.edu/projects/TEAL.shtml>

Engaging large classes of first-year students in the professional practices of bioscientists, at The University of Queensland, Australia

Each semester since 2005, 400-900 first-year Human Biology students are introduced to the course content and assessment using a pedagogical model developed around the skills and practices of bioscientists. Practising bioscientists teach all course elements. Content knowledge, scientific reasoning, use and understanding of language, laboratory skills and the importance of partnerships are progressively supported through the following innovations in summative assessment. The initiative was funded as part of an institutional focus on enhancing the first year experience for undergraduates.

The *Personal Response* assignment acknowledges the interests and experiences which diverse groups of students bring to university (Moni *et al.*, 2007a). The task engages them in audio interviews in which scientists describe their cutting-edge research. Students respond to the interviews in short expressive written assignments. Next, students participate in a purposely designed *Biohorizons* eConference modelled around professional conferences. This begins with a face-to-face plenary lecture delivered by an internationally recognised researcher (Moni *et al.*, in press a). Over the next 6 weeks, students self-register into one of ten clusters (of up to 45 pairs) based around biological themes. With the support of online tutors (PhD students), they write and upload a paper (15%) and construct a PowerPoint presentation (10%) in pairs. Students use databases to explore primary literature and research a specific topic of interest within broad cluster themes. Students then individually post formal questions and answers about one another's work (5%). The eTutors mark all three submissions using online criteria sheets and audiofiles to personalise feedback.

All students need to develop core manipulative skills (and confidence) in laboratory classes (Moni *et al.*, in press b). These skills are individually assessed within regular laboratory sessions through a system of mastery learning and feedback. Evaluations indicate high levels of engagement in the course and high levels of academic success across diverse cohorts – Pharmacy, Human Movement Studies and Science degree programs.

Sources: Moni *et al.* (2007a); Moni *et al.* (in press a); Moni *et al.* (in press b)

Teaching final-year Physiology and Pharmacology students to communicate more effectively to non-specialist members of the public, at The University of Queensland, Australia

This case study was premised on the belief that professional scientists and science-trained graduates must learn to more effectively communicate to lay audiences, and that these skills are more meaningfully learned within disciplinary contexts. Over 200 final-year undergraduates enrolled in Human Physiology and Pharmacology in Disease were taught by a journalist to write an opinion editorial based on a recent biomedical publication. In the first phase of study, the “media role” conceptual model was developed to describe the role of mass media as community gatekeepers of new scientific findings (Poronnik *et al.*, 2006). Survey evaluations indicated that students recognised the importance for scientists to effectively communicate their knowledge to non-professional audiences and that the Op-Ed writing task was challenging.

In a follow-up study, the authors demonstrated the effectiveness of explicit teaching of writing from within discipline contexts, using a pre-test/post-test assessment of writing competencies (Moni *et al.*, 2007b). The perceptions of the authors were supported by feedback from the lay public who were asked to assess students writing before and after teaching.

Sources: Moni *et al.* (2007b); Poronnik *et al.* (2006)

Biology start up business final year project, University of Durham, UK

Biology Enterprise is a collaborative venture between Durham Business School and the School of Biological and Biomedical Sciences. This elective module for final year undergraduate students in the School of Biological and Biomedical Sciences aims to introduce science students to the key processes of business start-up and enhance their enterprising skills and behaviours. The module is project-orientated with self-selecting groups of students who generate an idea for a business opportunity that is based on a scientific discovery. Students use their knowledge and understanding of science to develop and research their idea into a technology that can be readily commercialised e.g. a diabetes breath tester, a biodegradable chewing gum. In parallel, the Business School teaches students the necessary skills and knowledge required to develop their idea into a successful business. This course offers science undergraduates an alternative to the traditional laboratory-based project and is useful for those seeking employment in business and commerce. The module was developed by Stefan Przyborski, who is the founder and Chief Scientific Officer of ReInnervate, a biotechnology company founded in 2002 as a spinout from Durham University.

References: <ftp://www.bioscience.heacademy.ac.uk/events/dur05/przyborski.pdf>

Reinvented Enquiry Labs in Year One Chemistry at Warwick University (UK)

A second term year one laboratory course (c100 students) was reinvented from its previous 'traditional' approach to explicitly support more open ended enquiry based learning. The stimulus came from fourth year students doing their final year research project. Looking back at the predecessor of this redesigned course they stated "they did not feel prepared for their final-year projects. The style of the experiments was perceived to be very 'recipe'-like, with little scope for original thought. Additionally, the students felt that the labs ... gave the impression that 'most chemistry works'; after a research project, they appreciated that the reality was somewhat different" (Taylor and Geden, 2008).

The revised course was clearly enquiry based and involved major changes to the laboratory manual and the pre lab activities, though the actual experimental procedures to be followed were largely untouched to minimise resource implications. The manual redesigned each experiment as a problem to be solved, with all references to the expected outcome removed; experimental procedures were changed to be, insofar as was sensible with safety considerations in mind, in the style of methods published in research journals; mark schemes were completely revised to support the revised course goals. In addition the previous whole class didactic pre-lab sessions were revised to a more open discussion and enquiry approach. *References:* Taylor and Geden (2008)

Chemistry 'Concentrated Study' Project at the University of St Andrews, Scotland

This is a core course done by all 3rd year chemistry students (within a 4 year BSc/5year MChem framework); current enrolment is 48. It is taught in the last four weeks of the Spring semester. Students have no other class and are able to spend their full time on this module. Students are divided into (mixed ability) groups of five - six each assigned to an academic supervisor who assigns a topic for investigation. This requires some literature research, experimental planning, experimental work, analysis of results and their presentation. The projects assigned vary but generally fall somewhat short of original research while maintaining substantial scope for student input to the direction of the work and how to best achieve the goal set.

The module has run for the last five years and typically yields grades rather similar to conventional laboratory classes at this level. A consistent observation however is that this really brings out the best in some otherwise weaker students who seem to be inspired by the idea of contributing to the team effort in a way that is not achieved in a more conventional class.

There are parallels between this approach to course design and the experimental physics course at the Massachusetts Institute of Technology researched by King and Parlett (1969); and the current credit and non credit courses in MIT's Independent Activities Period.

Sources: Aitken (2008); King and Parlett (1969); <http://ch-www.st-andrews.ac.uk/teaching/aims/Mod3441/a.pdf>; <http://web.mit.edu/iap/>

Research in action - integrating science with clinical practice - at Peninsula Medical School (PMS), UK

In this fourth-year special study unit (SSU), students 'piggy back' an active research group and experience the process of research. They have the opportunity to try out techniques, analyse data and pose questions. Staff are given some guidance and examples of what is appropriate to give students to do. The SSU involves three one-week blocks across the fourth year. Students are able to choose the type of research group they join, and often there are three or four students with each research group.

After the first contact session, students are asked to produce an overview of the research topic in the form of a *BMJ* critical review. This review is formatively marked, and is set in order to ensure that students have a good understanding of the field. In the second contact week, students are expected to analyse data generated by the research team and use it to produce a research poster. The poster is summatively marked and contributes one-third of the overall mark. Students present their posters at an internal PMS research-in-action poster day, but this is not part of the summative assessment.

At the end of the third week, students are expected to produce a future work proposal, which should build on the data presented in the poster and state where they would take the project in the next 12 months. The future work proposal is summatively marked and provides the remaining two-thirds of the overall mark. The mark contributes to the overall assessment of the SSU modules, of which this is one of three in the fourth year. Students must pass the SSU module, but can compensate marks over the three SSUs.

Source:

http://www.enhancementthemes.ac.uk/documents/ResearchTeaching/Med_Dent_Vet_final_report.pdf, pp.78-9

Employing second year students as laboratory assistants: Biomedical science at University of Newcastle, UK

In 2002 the School of Biomedical Sciences introduced a scheme to offer opportunities to second-year bioscience students to undertake part-time paid work in research laboratories. The aim was to provide students with a greater appreciation of bioscience research, to reinforce their laboratory skills and to encourage them to consider a research-based career. Students work for 8 hours per week during term time and are paid a minimal wage. Hours are negotiated with the supervisor to fit with the student's timetable commitments. The scheme has run for five years employing 74 undergraduates. An evaluation demonstrated positive student and supervisor comments with students reporting a positive effect on their studies and that the experience had encouraged them to consider a career in research. The stimulus to the scheme was the fear that an institutional policy to establish research institutes might lead to structural disconnections between teaching and research and reduce the number of undergraduates seeking research careers.

Source: Hughes *et al.* (2009)

Undergraduate Research Elective in Medicine: Queens University, Canada

At Queen's University, the undergraduate medical curriculum includes a mandatory minimum eight week "Critical Enquiry" elective in year 2. The purpose of this elective is to allow each student a block of time, free from other academic assignments, to pursue in depth a medically-related hypothesis of the student's choice. The area of research may be from the basic, clinical, or social sciences, or the humanities. Students may arrange the elective with the supervisor and at the location of their choice. The elective block is placed immediately prior to the summer vacation to afford the opportunity of extending the project into the summer months.

A central reason for introducing the course was a national concern that few physicians were choosing research careers. Research on the impact of the course has demonstrated a significant increase in the number of students expressing an interest in pursuing a research career – and students (including those not seeking a research career) recognising other benefits including the development of critical thinking skills; and the opportunity to select an area of interest; and develop contacts for postgraduate training.

Sources: Course web site: http://meds.queensu.ca/courses/pbl/phase_ii; Houlden *et al.* (2004)

Use of Podcasts in Research Methods in Nursing Course at Edinburgh Napier University, UK

'Research and Evidence Based Practice' is an upper level course which develops the ability of students to appraise evidence and evaluate its appropriateness for implementation in their future professional practice. The course uses a blended learning pedagogy using a Virtual Learning Environment. In that context podcasts have been integrated into the course materials. These feature interviews with leading researchers in the University who are active researchers but with limited contact with undergraduate nursing students. The interviews in part focus on how their research is shaping professional practice in Scotland and elsewhere. Students enrolled on this module had often reported that they found the research focus quite daunting, with the terminology very difficult to grasp. Having the podcasts was a simple way of conveying some of the research concepts in an 'informal' and less daunting way.

Sources: <http://www.modules.napier.ac.uk/Module.aspx?ID=NMS09100>;
<http://staff.napier.ac.uk/services/academicdevelopment/LTA/resources/Pages/Details.aspx?ItemID=21&Section=>

1,000 biology students are involved in research at University of Sydney, Australia

First year Biology students at the University of Sydney contribute to the understanding of the prevalence of asthma in Sydney. Each student learns to pour an agar plate which they take home and expose in their back yard over a 10 minute period, to collect a sample of airborne fungal spores in the atmosphere. There are 1000 students in the class and they live all over the Sydney metropolitan area. Once the fungi collected have grown into colonies, students learn to use a key to identify the fungi, and the class results are converted into maps showing the distribution of the different species. This generates new knowledge, which they discuss online with an international expert, and which is fed into research programs on allergens. The students involved reported a better awareness of research, and their involvement in it, than students involved in a practical course which had a traditional textbook demonstration practical exercise. Dr Charlotte Taylor describes a thousand students as an 'ideal' size of research team for carrying out research of this nature.

Sources: Taylor and Green (2007); http://www.mq.edu.au/lta/altc/ug_research/research_curriculum.htm

Scientific Communications 101: A student organised science conference at Curtin University, Australia

Students in an introductory year one course with a linked focus on physics and science communication were required to plan and present a one-day Physics conference. The context was an institutional requirement that employment focused communication skills be integrated into disciplinary programmes. The idea of a student-organised science conference, publication of the proceedings, and the reasons for the approach were explained to students in the first Physics class. For the following week, students were asked to decide on a Physics topic they were interested in presenting at the conference, the overall theme for the conference, and how all the students would contribute to the organisation of the conference and the publication. Later in the term the conference took place over a day and staff and students from the department and local high school students and their teachers attended. In the years that the course ran it succeeded in helping students develop more effective communication skills linked to their discipline, introduced them to research debates and helped them begin to think and communicate like physicists.

Sources: Zadnick and Radloff (1995)

2.2 Social Sciences

Inquiry-based learning introductory course for social sciences had a significant impact on students' subsequent performance at McMaster University, Canada

McMaster University has been running a first-year course for social sciences based on inquiry since the late 1990s. This case study discusses this award-winning course as it evolved over the first five years (see Justice *et al.* 2002; 2007a), since then other instructors have taken on the course and is taught to reflect their interests. It is typically taught in groups of no more than 25 students assigned to an

instructor. All of the groups have the same curriculum, reading material, process of assessment, and goals that are outlined in a detailed compendium. The classes meet for 12 three-hour concurrent sessions. Class time consists of a combination of exercises and tasks for building the students' critical abilities and time for students to share ideas about their individual inquiries with other students. Much of class time involves groups of four or five students assisting each other in such things as clarifying understandings or planning research strategies.

All students investigate aspects of a broad social science theme, such as 'self identity' and addressed a common inquiry question, such as: 'Why do images of ethnicity, race, gender, sexuality, age, class, or abilities help to create aspects of personal and community identity?' Students have to propose their own inquiry question, such as: 'Why do some children apparently become violent after watching violent cartoons while others seem to be unaffected?' They have to justify why the question is important in relation to existing literature. They then investigate the question through a process which involved developing and testing hypotheses using secondary sources. The course emphasizes the development of skills, including critical reading and thinking, independent and collaborative learning, information searching and evaluation, analysis and synthesis, oral and written communication, and self and peer evaluation.

Analysis of five years of data (Justice *et al.*, 2007b), comparing students who took the Inquiry course with comparable students who did not, shows that it has had a significant impact on how well students perform during their academic careers. The findings allow for initial differences between the two samples. Taking the Inquiry course is associated with statistically significant positive differences in obtaining passing grades, achieving Honours, staying on the Dean's honour list, and remaining in university.

Recent research investigated in what way(s) Inquiry 1SS3 students changed that might explain their long-term enhanced performance at university. A quasi-experimental study compares a randomly selected group of 54 students who took Inquiry 1SS3 in their first semester with 71 comparable students who did not (Justice *et al.*, 2009). The research goes beyond self-reports of learning and directly measures abilities and performance. Inquiry 1SS3 is associated with meaningfully higher scores in actual performance tests of many intellectual and academic skills and often the magnitude and significance of the difference between groups is comparable to that between upper- and lower-level students (~2 years of university).

Sources: Justice *et al.* (2002, 2007a and b; 2009);
<http://socserv2.mcmaster.ca/Inquiry/CourseOutline.htm>;
http://www.socsci.mcmaster.ca/socsci_inquiry.cfm

Psychology Students Research Students' Quality of Life at York St John University, UK

First year, non-specialist, psychology students undertook an eight-week project in which they collected data from themselves and three other students using four short inventories and a biographical questionnaire in order to research topics related to students' Quality of Life. This project provided students with the opportunity to collect 'live' data, contribute to a developing database, select data for analysis, and write up findings. The topics available for selection by students were linked to the research interests of the lecturer making the project mutually beneficial. A departmental technician provided assistance with questionnaire design, the development and maintenance of a database, data entry, and tutoring on some portions of the project.

Source: http://www.psychology.heacademy.ac.uk/html/teach_land.asp?id=596

A guide for Undergraduate dissertations in Sociology, Anthropology, Politics, Social Policy, Social Work and Criminology at Sheffield Hallam University, UK

This web-resource was prepared to provide support and guidance for students writing dissertations in the social sciences, but it offers useful guidance for any students carrying out research. It deals with some of the common questions, concerns and practical issues that undergraduate students face when planning a piece of social research – such as research design, ethics, access, and writing styles. The resource also provides some useful information for academic staff who are supervising undergraduate dissertations. It provides case studies of dissertation supervision issues and examples of the students' experiences of

completing a project and the 'student voice' should be especially valuable for new supervisors. The content for the site was written by academic and support staff who have a particular interest in this area and have a great deal of experience in supervising undergraduate dissertations in the fields of sociology, anthropology, politics, criminology, social policy and social work. They have not produced this resource with the aim of providing a set of definitive answers; instead they recognise that there are many ways in which the 'journey' through the process can be completed. The notes included here draw on the experiences of dissertation supervisors, academic research into the student and staff experiences of study and supervision, and examples of good practice.

Source: www.socscidiss.bham.ac.uk/s1.html; Todd *et al.* (2004)

Inquiry-based learning in first-year information management at the University of Sheffield, UK

"Inquiry in Information Management" is a first-year, second-semester core module with an enrolment of approx. 30. The course aims to induct students into learning as a community of researchers in the context of a professional applied discipline. Students work in groups on research projects from generating their own valid, practical and worthwhile research questions (e.g. student awareness of the environmental impact of mobile phones) right through to presenting findings at a research 'mini-conference'.

Work on these projects starts in the 4th week, following a series of preparatory workshops which include exploring their conceptions of 'research' and how to pose and investigate research questions in Information Management. In the final week, guests at the mini-conference include PhD students, staff lecturers and researchers, and the Head of Department. All guests contribute to assessment of research posters, using criteria that the first-year students on the module have established previously in collaboration with module tutors.

Sources: <http://www.shef.ac.uk/cilass/cases/informationmanagement.html>; Cox *et al.* (2008)

Librarian Involvement in a Nutrition Undergraduate Research Course at Georgia State, USA

The wider context for this course is the growing emphasis on research evidence based practice in health care. At Georgia State an Introduction to Research course was redesigned to involve library staff fully in both the design and the delivery of the course. The librarian ran sessions on using various research data bases, how to read research article. "By the end of the course, students were more comfortable in libraries and with using library resources; they used the campus library more frequently; they were more confident in their ability to find high-quality information on nutrition-related topics and identify strengths and weaknesses of different information sources." Source: Smith and Penumetcha (2010)

2.3 Business, Computing, Law and Tourism

Barak Obama, *The Harvard Law Review* and Undergraduate Research and Publishing

In 1991 Barak Obama, then 28 years old, became the first black editor of the *Harvard Law Review*. He stated a determination to make it a "forum for debate", bringing in new writers and pushing for livelier, more accessible writing (Butterfield, 1990).

"The *Harvard Law Review* is a student-run organization. Student editors make all editorial and organizational decisions and, together with a professional business staff of three, carry out day-to-day operations. A circulation of about 8,000 enables the *Review* to pay all of its own expenses. ... The *Review* publishes articles by professors, judges, and practitioners and solicits reviews of important recent books from recognized experts. Most student writing takes the form of Notes, Recent Cases, Recent Legislation, and Book Notes. Notes are approximately 18 pages and are usually written by third-year students. Recent Cases and Recent Legislation are normally six pages long and are written mainly by second-year students. Book Notes, also written by second-years, are six-page reviews of recently published books. All student writing is unsigned. This policy reflects the fact that many members of the *Review*, besides the author, make a contribution to each published piece."

Sources: Butterfield (1990); <http://www.harvardlawreview.org/>

Involving students in organisational consultancy, Middlesex University, UK

The module "Consulting to Organisations" aims to provide student with "real life" experience by engaging them directly as consultants with organisations and the issues that those organisations have identified as significant. On organisational premises, and in collaboration with the internal personnel there, a small team of students clarify the issue with their client. Information is then collected, using a variety of research methods, and analysed in the light of both academic theory and the specific organisational context. Recommendations for action, both orally and in writing, are made to the client. As well as experiencing the reality of the organisation, students also experience working with a team of diverse peers to produce credible outcomes. Initially, four developmental workshops are provided: these cover team building, consulting, organisational culture and client contact. Four feedback sessions are organised during the subsequent consultancy phase of the module. The parameters of the module are set out in a handbook, and within these students are expected to take responsibility for their own work and that of their team. This is a Level Two module of eleven weeks, normally undertaken by undergraduates in their second year. It carries the same credit award as any other module and feedback from students, from organisational clients and from a number of external examiners over the fourteen years the module has been in operation has been extremely positive.

Four modes of assessment are employed and they reflect the aims of the module and also provide a range of methods, which is thought to reflect the different strengths and weaknesses of the student group. All students are required to attempt, though not pass, all four of the elements: a written report and oral presentation to their respective clients, a team peer-assessment exercise and an individual learning report. The learning report requires students, on an individual basis, to identify and review their learning from both their experience of the module, with specific reference to their client contacts, and their experience of working in a team. The areas addressed are knowledge, skills, attitudes and emotions.

Sources: Correspondence with Philip Frame, 2006; Frame and O'Connor (2003)

Students participate in a research project on Criminal Justice linked to staff interests at Australian National University

Students at ANU have the opportunity to participate in a research project based on current research being conducted by members of the Faculty of Law, the Australian Institute of Criminology and Research School of Social Science. 'Criminal Justice' is an advanced law elective which critically examines the principal institutions, processes and legal rules relating to the administration of criminal justice. The iLearning project is an assessable option that allows students to devise research projects which have both academic value and practical outcomes.

Source: <http://www.anu.edu.au/CEDAM/ilearn/research/crimjustice.html>

Law students conduct interviews with practicing lawyers at Griffith University, Australia

A 4,000-word research assignment for *Lawyers, Clients & Legal Services*, an elective taken in the fourth or fifth year of a Bachelor of Laws program, involves in-depth interviews with at least two practising lawyers. Every week for a period of six weeks, the lecturer invites one practising lawyer to attend class during which the lawyer is interviewed. In this way, the lecturer models the interview process with six different lawyers, each with different areas of expertise. Students learn about the interview process and also gather research data for their assignments. The written assignment includes:

- Identification and justification of the research question(s) chosen by the student
- Literature review (identification and thorough analysis of relevant sources)
- Methodology employed
 - Presentation and analysis of data with reference to the literature
 - At least two in-depth interviews with practising lawyers
- Reference to data from at least three in-class lawyer interviews
- Conclusions that relate directly to the research question(s)

This applied assignment has several RBL related benefits to students:

- It provides them with experience in conducting research interviews and the skills to carry out basic empirical research. These skills are transferable to the students' professional live as lawyers frequently conduct client interviews.

- It gives them an opportunity for inquiry-based learning through interaction with ‘real-world’ law professionals who provide students with legal practice insights that are not available in the standard Australian legal curriculum.

Source: ALTC Teaching Research Nexus website: www.trnexus.edu.au

Community-based Research in Law at Warwick University, UK

The Centre for Human Rights has one of its aims to facilitate the participation of postgraduate and undergraduate students in human rights research and experiential learning opportunities. It supports undergraduate students through both co-curricula opportunities such as internships and through the formal curriculum to work with various communities local and international. In the Death Penalty Internship Programme selected students have two month internships in Capital Defenders Offices in the USA. Student work on: United States legal research, manage case files, contribute to the briefs filed in state and federal courts, interview witnesses and jurors in appeals cases and visit prisons, including death row. Also in partnership with Coventry Law Centre, Warwick students have helped to deliver advice and information sessions to the local community on issues of discrimination and law. There are related formal courses that provide related student involvement in practice based research. Thus the module Human Rights in Practice combines academic study of human rights and a practical project that exposes students to the notion of applied human rights. Students are organised in groups so as to pursue projects in the local community.

Sources: <http://www2.warwick.ac.uk/fac/soc/law/chrp/aboutthecentre/>;
http://www2.warwick.ac.uk/fac/soc/sociology/rsw/undergrad/cetl/fundingopps/fellowships/fellows/williams_final_report.pdf

Computing Authentic Learning through Student Research Projects at Louisiana State, US

It is difficult in computing to develop industry ‘style’ authentic research projects in the undergraduate curriculum. In industry, projects are likely to involve many staff and operate over a number of years. To meet this challenge, the Computing Science Department at Louisiana State has developed a range of long term projects involving undergraduates, postgraduates, faculty and outside ‘industry’ partners. Ideally each project has a compelling ‘story’ that would interest the students. Second, the project needs to be large enough that it will take the work of many people over several years to complete the project. Third, there has to be useful partitions of the project, so that a single student or small group could complete in one or two semesters. Finally, projects need to be relevant to both undergraduate and master’s level students would need to be available.

One such example is a long term link to develop an effective computer based climate monitoring with a local Watershed Management Institute with a conservation focussed bat habitat. This needed a computer based monitoring of the environment established. This required students to work on a whole range of discipline based issues including network routing, data aggregation and data visualization – all of which could be expanded by students in subsequent employment to related (non-bat) scenarios.

Source: Fife (2010);
<http://portal.acm.org/citation.cfm?id=1734804&dl=GUIDE&coll=GUIDE&CFID=98901409&CFTOKEN=31625115>

Modelling the research experience: tourism students’ virtual conference at University of Lincoln, UK

In May every year, final-year Tourism students at the University of Lincoln participate in a live virtual conference. This is part of their assessment for the semester-long unit (Social and Political Perspectives on Tourism). A conference is a useful vehicle for extending insight into the process and practice of knowledge creation and dissemination and for students to participate as in effect research disseminators. A VLE has made it possible: during the specified timeframe of one week, students do not have to be assembled in one place and can participate at any time. Feedback from them has been extremely positive and encouraging. Two qualified web designers built the site and have been on hand to deal with technical issues. Teaching staff have provided support for the conference throughout the unit. Students submit a full conference paper, but it is only a summary that appears on the conference web site. Each

student is also required to post a comment on another conference paper. Staff monitor participation and contact students as appropriate.

Source: www.cometravel.lincoln.ac.uk

Engaging students in applied research through a community sports development consultancy project at University of Central Lancashire, UK

The final year Community Sports Development module acts as a capstone module for Sports Coaching students. This module is an optional module which is taken in addition to the honours dissertation. Students work as a project team through a consultancy brief with a partner agency and recommend strategies that can be employed to support community development through community sport and coaching initiatives. There are normally 8-12 consultancy briefs divided up among the 40-50 students, with students creating their own consultancy teams. Examples of consultancy projects include:

- A “health check” of football refereeing in Blackburn
- Community Sport and Crime Reduction
- Community Sport (“Street Dance”)

The emphasis is upon the students creating professional working relationships with the client organisations in order to carry out primary research that is directed by the clients and supported by the Academic staff at the University. Students are expected to hold regular review meetings with the clients, carry out interviews with relevant stakeholders; use secondary research to help analyse their findings; and present their work and recommendations to the organisation through the staging of a mini-conference, where all the partner groups are invited. Representatives from agencies provide the feedback on students’ work, judging on the content, feasibility of solutions, and competency in conducting research.

Source: [//resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm](http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm)

2.4 Geography and Environmental Studies

Geography students at Glasgow Caledonian University, UK, submit reviews for publication made available to the local community

Practising Geography, the second year undergraduate Human Geography module, 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). Publication on the project website is conditional on an acceptable referee’s report.

Source: McKendrick *et al.* (2003); <http://www.butegeog.gcal.ac.uk/index.html>

Geography students at University College London, UK, and at Oxford Brookes, UK interview staff about their research and views on contemporary geography

All year one students do an assignment in term one, in which students interview a member of staff about their research.

Each first year tutorial group is allocated a member of staff who is not their tutor.

Tutorial groups are given three representative pieces of writing by the member of staff along with a copy of their CV and arrange a date for the interview.

Before the interview students read these materials and develop an interview schedule.

On the basis of their reading and the interview, each student individually writes a 1,500 word 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*, other interests and geography as a whole (emphasis added).

This curriculum was adapted from one developed for a third-year synoptic course on the philosophy of geography at the then Oxford Polytechnic (now Oxford Brookes), which at the time received little funding for research:

- Students were divided into groups and each group was allocated a member of staff, who gave them a copy of their CV.

A student group then interviewed that member of staff (with the rest of the students attending), about their academic history and views on the nature of contemporary geography.

The student group then wrote up the interview and set that person's view of the discipline in the wider context of the contemporary discipline.

The aim in this teaching-focused department was to develop students' understanding of recent research developments in the discipline. *Sources: Dwyer (2001); Cosgrove (1981)*

Embedding enquiry-based learning in a skills module concerned with sustainability at Gloucestershire, UK

'Skills 4 Sustainability' is a first year course in which enquiry-based learning is embedded in a personal learning and skills module concerned with sustainability. The module is delivered from weeks 1-12 of the first semester by a team of 8 tutors to c150 students with no formal lectures. Students are organised into tutor groups according to their subject specialism with a tutor with relevant specialist skills. The format varies from week to week including tutorials (commonly consisting of time in the classroom followed by independent time for students to explore topics raised), an organised debate for the whole cohort, and presentations.

The aim is to encourage students to take charge of their own learning and develop a community of enquiry within the group as a whole and in smaller groups within which students work on the main enquiry-based component of the course. This is a project where students enquire into and develop a proposal improving the sustainability of the University which they must research and present as a group.

The students are prepared for their enquiry-based project by different activities in the preceding weeks, which encourage students to engage with sustainability through discussion, research into sustainability topics and formulating questions for a Sustainability Question Time debate. Tutors encourage exploration of the skills needed for research and collaborative working and introduce the use of an e-portfolio package to promote reflection and group communication between students and tutors which contributes to the enquiry-based learning (EBL) approach. A module blog is run through the e-portfolio package which further facilitates engagement with issues around sustainability and elicits contributions from both tutors and staff, further strengthening the community of enquiry.

There are 3 points of assessment. The first is concerned with researching, retrieving and presenting information on sustainability in a short essay with full references in the Harvard style. The second is the main enquiry-based project with groups enquiring and putting together the proposal for improving the sustainability of the University and presenting it to the group for tutor and peer assessment. Following this, the best proposal from each tutor group goes forward to the *Green Dragons' Den* for consideration by an expert panel comprising the University Vice Chancellor, Director of Institute for Sustainability and a local business manager. The EBL activity is designed to engage students with a real-world problem and entrepreneurship.

The third assessment, carrying 50% of module marks is the creation of an individual e-portfolio which is built up throughout the module and carried on until near the end of the second semester when it is submitted. The construction of the e-portfolio aids the enquiry process by encouraging students to reflect on sustainability issues, their own position and action they might take to improve their own sustainability, both environmentally and as a learner.

Initial research into the first two years of module delivery is favourable with students enjoying the active learning approach and the promotion of independent enquiry.

Further information: Swansborough *et al.* (2007)

Developing Contacts with Non-academic Organisations: A Live Gender Project Integrating Theory, Fieldwork and Assessment at Queens Belfast, UK

Contacts are developed with a body outside of academia conducting 'research' thus widening the appreciation of how linking theory and practice can be applicable to a range of jobs outside of completing

a degree. Often students find it difficult to think about how the theories they are being presented with will be of relevance to them in the future. In this instance contacts with individuals involved in designing and running a Gender initiative funded by Belfast City Council. The City Council is working with a range of partner employers to address the predominance of men in entry-level jobs such as street cleansing, bus driving, parks maintenance. The aim of the project was to talk to both present employees and potential project beneficiaries to find out what measures employers could take to achieve a more diverse and representative workforce. The project staff intend to use this research to develop future strategies aimed at achieving greater gender representativeness from entry level – to senior management staff. It is also intended that future research will be conducted to address the under-representation of men in 'non-traditional' jobs. Thus the students are engaged in a piece of on-going research, links are developed outside of the University and both researchers and students become engaged in the ongoing research process and policy development – thus a 'stake' in research is developed.

This project is sustainable as it can run with any number of students and can be adapted to any module topic. Overall, issues of theory and practice can be applied to any module. Key to the project, however, is developing links with research Commissioners; finding out if/why they are willing to take part and to recognise the benefits that can be gained by commissioners, academics and students.

Source: Price (2006)

Giving students first-hand experience of research-based consultancy in environmental management at University of Queensland, Australia

Team-based problem-based learning is used in the final year capstone course for the Environmental Management, Rural Management Environmental Tourism and Tropical Forestry degrees at the University of Queensland's Faculty of Natural Resources, Agriculture and Veterinary Science to give students experience of research-based consultancy. It is a year-long course, team taught by an interdisciplinary staff (in recent years, a social scientist and an ecologist for the internal students, a multi-skilled environmental manager taking the external students).

The staff solicit suitable 'problems' and clients among their contacts, for instance from government agencies, non-governmental organisations, or land care groups, or the private sector. The staff may help the client mould the topic to achieve appropriate degrees of difficulty, and equity in workload and difficulty across the student groups. The students work like consultants to their client, coping if the client changes the brief during the year (as many do a couple of times).

They work in groups of about six students. The clients come to campus at least three times, for an initial briefing to their students, and presentations at the ends of first and second semester. They liaise with the students all year, usually off campus at their offices, and by phone and email. The staff give a flexible program of lectures in first semester, to prepare the students with skills they need towards each forthcoming step of their tasks, and in group processes. At the end of the year their report is 'published' (printed and bound) for the clients. Peer and self-assessment are used to distribute group marks among the contributors.

Source: Correspondence with Helen Ross, 2006

Engaging students in environmental health research and outreach at Allegheny College, Pennsylvania, US

This is an example of combining undergraduate research with public engagement as part of the assessed curriculum. It is also a clear example of a faculty-led project in which students gather data on an issue of interest to the member of faculty. At Allegheny College, the junior seminar is a required one-semester course, in the third year of a four year course that provides a window into the research experience and which allows students to develop a thesis proposal. This course prepares students for their thesis project. All students at Allegheny are required to conduct an independent one or two semester thesis project, which allows the student to conduct original research, evaluate it and place it in context with existing professional research. In the interdisciplinary Department of Environmental Science (ES), the junior seminar is taken in the third year, so the students have some cross-disciplinary training, and some early experience into project-based learning. Each junior seminar, which typically has between 8 and 24 students, has a different theme, geared to the faculty and students' interests.

In 2007 in the Junior Seminar in Environmental Health, Justice and Development, students developed and evaluated an environmental health outreach program. This concerned the critical role of indoor home environments on early childhood health in a rural, low-income community. The course leader provided the causes of childhood diseases and health disparities, the class then evaluated effective and ineffective health campaigns. Using this academic foundation, the class planned and implemented an outreach effort. The goal of the outreach was to develop greater awareness among children of health in the home environment. The students compared the efficiency of outreach directly targeted to students in 5th and 6th grade (10-12 years of age) to outreach targeted more broadly through family-oriented community events, such as a children's workshops and a Halloween parade.

Both quantitative survey data, addressing how well participants learned and retained information about Healthy Homes, and qualitative assessments from community partners, were undertaken. Additional measures of impact were evaluated as well, including the number of home assessments that were generated from both types of outreach. Students presented their findings in a public meeting to community partners, teachers, school district administrators, local public health officials, campus administrators and ES department faculty and students. Using feedback from the presentation, the students completed the semester with a single written document with report overview, background, findings and recommendations.

The students enjoyed the program so well that they collectively requested to continue it through independent study, volunteer or outside class projects through the spring semester 2008 and beyond. Enthusiastic comments were also received from the school teachers and community groups involved.

This model is appropriate not only for staff interested in using students to assist piloting new avenues of their research, but also for those who are hoping to find a topic to use and replicate from semester to semester or year to year.

Sources: For further details and a reflection of the issues faced by the course leader see: [//resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm](http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm); for the Healthy Homes-Healthy Children (HHHC) Website see: webpub.alleggheny.edu/employee/c/cwaggett/HHHC.html; for Caryl Waggett's Website see: webpub.alleggheny.edu/employee/c/cwaggett/index.html; for a link to the Course Syllabus and Final Product and Poster see: webpub.alleggheny.edu/employee/c/cwaggett/courseprojects.html.

Helping students to engage more effectively with the research process in undertaking their undergraduate dissertations at Keele University, UK

Undertaking an independent research project in the form of a dissertation can be the most challenging and rewarding part of an undergraduate student's university experience. However, students often suffer from disjuncture expressed as lack of motivation, hesitancy and avoidance when faced with the daunting enormity of the task and the high demands placed on them as independent learners and problem solvers. Robson (2006) undertook a case study of her efforts as a supervisor, using action research, to help students to engage more effectively with the research process. The aim of the research was to make effective changes to improve students' motivation, commitment and achievement with regard to completing a geography dissertation.

It is argued that listening to students and responding to their perceived needs is an effective way to improve supervision practices. Initial findings showed students to be lonely and insecure about their dissertations and the supervisor pressured by a considerable supervisory burden. Four cycles of action research were subsequently conducted with a group of eight dissertation students during one academic year. The research implemented and evaluated four interventions whereby the supervisor-researcher invited the students to

- (i) evaluate their progress
- (ii) learn from examples of completed dissertations
- (iii) share and support each other
- (iv) engage in peer assessment.

Qualitative evidence demonstrates a shift from a status quo of individual supervisory meetings between poorly motivated students and a frustrated supervisor, to highly motivated students effectively

empowered as independent self-learners and peer supporters. It is concluded that given the right circumstances students can be facilitated to 'do it better themselves'.

Source: Robson (2006)

2.5 Archaeology and Earth Sciences

Giving Community College students in US their first experience of research in archaeology

At Cuyahoga Community College, in Cleveland, Mark S. Lewine, a professor of anthropology, established a Center for Community Research 12 years ago. The center has provided more than 2,000 students with their first experience with primary research in the field or laboratory. He encourages graduate students and community college students to work together on archaeological digs. In 2006 he was awarded US Professor of the Year in the community-colleges category.

"We're digging on abandoned church property, abandoned hospital property, doing land-use history of the inner city. The 'aha' response is immediate. They say, Oh my god, this land that we're living on actually has a rich history. They get very interested because it connects to them. They enjoy the subject while learning the process. Too many of our students, unfortunately, are working two or three jobs, have family responsibilities, and just don't have the time. Often the participation begins with an hour in the lab or on the site. Then they'll try to find time on a Saturday. What I tell my students is: If you like it, if you're learning with it, if you're reliable and consistent in your work, I will offer you internships. Plus I tell them: When you come from an urban high school that isn't giving you what your potential really needs, and a graduate school looks at your record and sees primary research, that makes your record stand out."

Sources: Bollag (2006a)

www.usprofessorsoftheyear.org/POY_Display.cfm?contentitemid=6516&pid=PR_Resources

Preparing and defending a consultancy report in environmental geology at Kingston University, UK

Each student in a final year module is given an environmental geophysics problem and is asked to role play being a consultant recruited to address this problem for a client, either a local authority or a private land owner. They are required to design a solution, interpret field data and present their findings in a technical report and verbal format. Time is available within the module for consulting the tutor. However, students must have specific questions to ask, indicating that they have performed some preliminary research. "What techniques should I use?" or "How do I start this?" are not valid questions!

Students are required to prepare and deliver a solo presentation to an open public meeting (20 minute session, including 5 minutes for fielding questions) describing their problem outline, methodology, data interpretation and recommendations. The audience includes Councilors (soon up for re-election) and members of the lay public (staff members and other students) who have a vested interest in the environmental issues. A disruptive group of 'eco-warriors' (usually noisy postgraduate students) also makes an appearance! During their presentations, students must show appropriate local and environmental considerations and effective handling of heckling from concerned local residents and the 'eco-warrior' group.

Source: Thomas (2003)

Student groupwork assignments based on analysis of current Geoscience discipline journal article analyses at the University of Adelaide, Australia

This Do-It-Yourself (DIY) Interactive Multimedia (IMM) project is an exercise in knowledge engineering that has been used in a final year undergraduate structural geology course continually since 1996. The exercise involves groups of 2 or 3 students working collaboratively on development of the multimedia assignment and on the seminar. Students are given an introductory and explanatory session describing the aims, objectives, tools and methods, together with a short hands-on practical class on how to use the available multimedia authoring system (eg Hyperstudio) and how to access the array of digital resources which might be needed to carry out the assignment.

The exercise clearly provides a close link to the teaching of structural geology in this course and the most current research being carried out in the discipline. Students not only have to read and understand one international journal article, 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.

One very important key to the research-teaching link is when the students have to devise a question to the author(s) and to email that question. 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 at a 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 exercise has now been running continuously for eight years and has been carried out by about 400 students. This has left a legacy of about 150 IMM modules providing interesting summaries of much of the last eight years of cutting edge research in structural geology.

Source: James (2003)

2.6 Arts, Media, Architecture and Performing Arts

Introductions to academic practice: humanities and social sciences at Windsor, Canada,

'Ways of Knowing' in the departments of Arts and Social Sciences at the University of Windsor focuses on students developing disciplinary skills in research and critical thinking. Each year a particular theme is identified - generally one that reflects a Windsor community issue - and student teams investigate and present in public the results of their inquiries. Senior student mentors and community members act as mentors to these investigations. There are institutional discussions on extending this 'model' to other departments.

Source: apps.medialab.uwindsor.ca/cfi/reflexions/volume01/issue01/Ways_of_Knowing.htm

Community Outreach Research Project to Produce a Media DVD, at Southern Cross University, Australia

Students in *Advanced Screen Production* taken in either the second or third year of the Bachelor of Media or the Bachelor of Arts (media major) undertake research projects involving working for a community group on a community event in accordance with a supplied brief, to produce a DVD. As part of the project, students undertake research into the topic area, the interviewees, the location, equipment and context. As well as submitting the DVD for assessment, students are required to provide regular progress reports, to document the rationale for their project and discuss the process they went through to produce the DVD.

Source: ALTC Teaching Research Nexus website: www.trnexus.edu.au

Community Project Work in Architecture at University of New South Wales, Australia

A new approach to community-based design projects in the Architecture Program is being trialled by working in association with FBEOutTHERE!, the University of New South Wales, Faculty of Built Environment's outreach program that engages in community-oriented research and learning. With the real prospect of a selected project being constructed, students are asked to design an 'ageing in place' independent living accommodation project. This project responds to needs identified by a social enterprise group that provide community services for people experiencing multiple intellectual disabilities (service users) in rural New South Wales. With an emphasis on enhancing service users' quality of life, students undertake this task by firstly engaging with the literature, interviewing the service users and staff and visiting the service users' homes to understand their needs. Only after the students have reviewed and evaluated the interviews, home visits and literature are they able to commence the design element of their projects, the progress of which is discussed regularly with the community.

In this way, students design with an inquiry evidence based approach, responsive to community needs. In addition, students keep reflective journals which are intended to help them think about the research

findings, their interaction with the service users and their needs, and how these impact upon their design approach to the project. The completed student designs are exhibited. This allows for community feedback on the designs and facilitates discussion about design approaches that best meet the target group's needs. Students receive individual written community feedback about their designs and this collectively informs the interdisciplinary site and context research phase of the project with Landscape Architecture students.

In 2007, 16 students selected this studio project, *Rural Community Wellbeing Enhanced through Design* from a range of design project offerings in the Year 4 core subjects in the Bachelor of Architecture program. Students work in groups to undertake the literature and context/site research phase of the project. They conduct the service user interviews and home visits in pairs. These findings are shared through studio presentations and documented in web folders on the Faculty server. Students undertake the project design individually, informed by shared investigations as well as progressive design studio interaction.

Student evaluations indicated that this course encouraged them to be self-directed learners and to learn how to apply their theoretical knowledge to developing a feasible project.

Source: ALTC Teaching Research Nexus website: www.trnexus.edu.au

Peer Assessment of Creative Work in a Popular Music Program at Griffith University, Australia

In *Popular Music Production* the major study of a Bachelor of Popular Music, students earn 20% of their grade for their effectiveness as panel members assessing fellow students' portfolios of recorded work. Panels consist of one staff member and seven or eight students from all year levels. As each panel considers submissions across year levels, first year students are involved in assessing the work of second and third year students.

Panellists mark each track in the students' portfolios by applying explicit criteria and standards and provide a paragraph of feedback. All panellists' views have equal weight i.e. the marks awarded by the staff member are given the same weighting as those of each student panellist. A staff member assesses the student panel members on their written feedback as panellists. Marks relate to the quality of the feedback and how well it meets the expectations of the course. Punctuality, quantity of feedback and the coherence between the commentary and marks awarded are also taken into account.

This peer-assessment of students' recorded work reflects the values and practices of researchers in several ways:

- Students and staff form a community of practice in which the collective abilities of the students and staff form a valuable learning resource. This mirrors the aims and outcomes of academic research communities of practice.
- This peer-assessment process parallels the peer-review journal publication process. Students learn the value of seeking feedback, learn to make their own judgements about the usefulness of the feedback they receive and to act on selected elements of the peer feedback just as academics do with the feedback they receive from journal article reviewers.
- The peer assessment procedure formalises 'real world' practices as it utilises the kinds of processes that popular musicians use informally to develop their work.

Source: ALTC Teaching Research Nexus website: www.trnexus.edu.au

Theory, Style and Performance in Music at the Royal Scottish Academy of Music and Drama (RSAMD), Scotland

In fine arts disciplines including music there can be tensions and potential links between performance and theory, practice and staff research interests. The RSAMD's BMus degree is a four-year programme that aims to give students a secure foundation for a professional career as a performer or composer. Teaching is split between the 'performance departments', and the 'Department of Academic Studies' which focuses students on 'theoretical and historical studies, as well as generic musical skills'.

Through the first three years of their programme all students explore, through a required set of Style in Performance (SiP) Courses, issues of practice, theory and performance; and, in that context, work with staff with differing foci on performance, 'research in practice', and more theoretical 'research on practice'. In the fourth year, the teaching in SiP takes a more philosophical and critical approach examining a range of issues relating to performance. Students prepare a music work or works for a final recital, but they also study a set of theoretical issues with respect to that music. As well as the final performance, students have a rigorous oral examination which examines theoretical issues with respect to that music.

The course team have experimented with various forms of assessment of this programme and have found it resulted in clearer links for students and staff between issues of practice, performance, theory and research. Stephen Broad (2010, 14), Head of Postgraduate Programmes and Research, states:

"The main piece of advice I would give is to be creative in the means of assessment, because this plays a fundamental role in shaping how students learn. The performance/viva might not be seen as a significant innovation in its own right, but the joint assessment of students' articulation of their learning in speaking and performing – the single grade assigned as a result of the performance/viva - has noticeably changed the way they approach the subject material."

Source: Board (2010)

2.7 English

Involving first year English students in the international research community at University of Gloucestershire, UK

At the University of Gloucestershire, Arran Stibbe allows students to take on the identity of a researcher right from the start of their time at university. In the *EZ102 Language & Ecology* module the students have an opportunity to share their insights with the wider research community. The research community in turn has something to gain from student contributions because students can critically analyse aspects of their language and culture that others have yet to examine. The students are encouraged to take part in the international research community through working with the *Language & Ecology Research Forum* - the main international forum for research in ecolinguistics. The Forum links together a network of scholars, has an online journal, a range of resources, and a dedicated section for the *EZ102* module. The approach works best when students are becoming critically aware of texts that they are familiar with, rather than struggling to understand new genres understood better by the lecturer than students.

Sources:

<http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/activelearningcasestudies/index.cfm> ; <http://www.ecoling.net/courses.html>;

Introducing enquiry-based teaching methods in literary studies at Manchester University, UK

The traditional form of Literary Studies teaching in HE is tutor-centred. In this case study a group of second year students studying Eighteenth Century Literature are introduced to enquiry-based learning in the first week of the first semester. The course consists of a weekly lecture and a weekly seminar. The latter consists of 15 students divided into three groups. During the seminars the tutor acts as a task-giver and thereafter as both an information resource, responding to student requests and as a facilitator moving from sub-group to sub-group helping discussion to develop. For example, in week 1 the students were given a poem by Samuel Johnson, 'On the death of Dr Robert Levet'. The poem was issued to students without annotations or supporting detailed biographical information. Each sub-group was asked to address two questions: 'What kind of language does the poem use?' and 'What belief system, if any, does the poem imply?'. Most groups responded to this task actively by exploring and considering the possibilities from a range of perspectives, establishing and pooling any existing knowledge and assessing its applicability to the task in hand. By emphasising the need to seek other sources to contextualise their answers the facilitator began to establish the research element crucial to moving from 'problem solving' to something more active. Source: Hutchings and O'Rourke (2003)

Introduction to writing research and contemporary cultures at Miami, Ohio, US

Students in the first year core course in 'writing and cultures' investigate how the forms of writing, and the methodologies for researching writing and culture, are being transformed through web-based communication. Through this reading and writing intensive seminar, students investigate how digitized technologies are transforming the forms of writing and communication. The course culminates in a group

assignment where students, using secondary and primary sources, investigate an aspect of contemporary culture (e.g. dating, shopping) and how the forms of communication there are being reshaped by the Internet. They produce a multimodal web site that includes text, digital images, audio, and video. The course fulfils institutional requirements for liberal education goals of critical thinking.

Sources: <http://www.users.muohio.edu/mckeeha/h101-09>; http://www.users.muohio.edu/mckeeha/h101-09/final_project.html;
<http://www.units.muohio.edu/led/principles.htm>

2.7 History

History students contribute research findings to a website at the University of Victoria, Canada

In 2002, John Lutz taught for the first time History 481: Micro History and the Internet, a learner-centred and research-oriented course in which the main activity was primary archival research on various aspects of life in Victoria, British Columbia from 1843 to 1900. Initial course activities include orientation to the historical archives in Victoria and basic web-site creation skills. Students work in small groups on a research project and the final research "product" of the course is a web site and not a standard research paper. The course has been developed with the support of local community groups and another university. It is one of the international innovative examples of digital history where the web is used as a research tool, a means of disseminating research and developing student web skills.

Sources: <http://www.victoriasvictoria.ca/>; <http://web.uvic.ca/~jlutz/courses/hist481/index.html>;
http://en.wikipedia.org/wiki/Digital_history

Students taking a historical methodology course engage in original oral history research at Indiana State University, US

The 30 or so students taking the introductory historical methodology course are engaged in original research. Anne L. Foster, an assistant professor of history, who teaches the course, was eager to find topics in which her students could "become experts" and make a real contribution to local knowledge.

In 2004, the class produced a history of the black community of the Wabash Valley, including Lost Creek, a neighbourhood of Terre Haute, Indiana, the city that is home to the university. Lost Creek was established in the 1820s by freed and runaway slaves with the help of local Quakers. The course stresses oral histories, and that year's project included a video interview with a 104-year-old woman whose grandparents were slaves. Another group of students, in the fall of 2005, interviewed three elderly local men with connections to the Holocaust: a concentration-camp survivor from Latvia, a Jew whose family managed to flee Germany, and a former U.S. soldier who helped liberate a concentration camp in Germany. One student did an independent project that turned the class material into a permanent exhibit at Terre Haute's Holocaust museum. Students would have interviewed more people, but changes in the university's rules on human research subjects made it difficult. Ms. Foster says she expects the university's research board to relax the new rules to facilitate the taking of oral histories.

Source: Bollag (2006b)

2.8 Education and Philosophy

Students in pre-service teacher education for university lecturers at Otago, New Zealand, undertake 'authentic enquiry' using portfolios

Students used portfolios to provide space for 'authentic enquiry' that focused on student self-determination and the process, rather than the outcomes, of learning. The rationale behind the portfolio involved reflections on practice as the curriculum developed during the research cycle. Initially, portfolios were evaluated formatively during supervisory meetings and each student decided what part of their portfolio should remain private and what the tutor might read and comment on. In the second phase of development, formative judgements about work were no longer made and portfolios became private documents. Challenges for student teachers were associated with the novelty of the experience, the time taken for reflection to develop and the individualistic nature of the task. This presents challenges for the

supervisor centred on new methods of supervision and trying to live up to the explicit values that informed the curriculum. *Source:* Harland (2005)

Designery Thought and Action: An investigation into opportunities within the Primary Curriculum at Canterbury Christ Church University, UK

This project engages students within the Faculty of Education in episodes of school-focused research. These episodes will be conducted through school placements. The research will engage our students, our partnership schools and academic staff. As a prelude to a major, externally funded project proposal, we have gained the support of training-based funding agencies such as Smallpiece Foundation.

The proposed development will research the opportunities presented within the primary school curriculum for the development of designery thought and action. This is seen as vital to the needs of an information-rich, knowledge transfer society, moving into what Pink (2005) has called 'The Concept Age'. This would require a re-definition of the Primary curriculum, incorporating a cross-curricular process model. Many primary schools are moving into more topic-based work and we feel it is opportune to document the way in which this relates to other government initiatives concerned with creativity and a more active approach to children's learning. The project is intended initially to run from January 2007 – July 2008. The proposed research development is seen as a pilot study that will develop and hone research instruments to identify the key skills, capabilities and processes that underlie designery thought and action across the curriculum.

For our students, there are clear benefits in terms of personal development as reflective learners/ future practitioners as a consequence of engagement with the delivery, modification and evaluation of research instruments in schools. The students may also develop as critical thinkers and become action-researcher in their future classrooms.

For more information on the project please contact Eric Parkinson (eric.parkinson@canterbury.ac.uk) or Gill Hope (gill.hope@canterbury.ac.uk). *Source:* Based on: <http://www.canterbury.ac.uk/support/learning%2Dteaching%2Denhancement%2Dunit/research-informed-teaching/index.asp>

Learning to think like a philosopher: developing students' research skills in a history of philosophy course, University of Leeds, UK

One aim of most degree courses, at least if they are in a single discipline, is to help students think like, for example, historians, chemists, or planners. Traditionally in philosophy this is attempted by 'sitting at the feet' of experienced philosophers and ploughing through long reading lists. Research into philosophy is seen as something largely reserved for postgraduate study. At the University of Leeds, George MacDonald Ross has developed a more active approach in a final year module, which engages his students directly with a philosophical text – Kant's *Critique of Pure Reason* – and helps them develop key research skills.

He teaches the course by running interactive seminars, rather than lectures, at which students are forbidden to take notes, except for a secretary, who posts minutes on a website within 24 hours. This has the advantage that students focus more on discussion during seminars, and that they treat the minutes as secondary literature, rather than their own intellectual property to be used without acknowledgment. Most of the time is spent discussing the interpretation of key passages projected on a screen. However, most of the students' learning time is taken up by reading the text in conjunction with George's running commentary; preparing short answers to interpretative questions, some of which will form the basis of the following seminar; and writing essays. Researching and writing essays is a small-scale version of what historians of philosophy do as researchers, and it is central to the module. Apart from one final essay, students write three two-page essays during the year. They are given the assessment criteria (presentation, referencing, accuracy, clarity, argumentation, independence, other strengths and weaknesses) before hand and have to self-assess their attempt against them. He does not put the mark on the essay, instead he tells them to guess the mark in the light of his comments, and sign up for a 15-minute individual tutorial at which he reveals the mark, and advises them on how to improve their performance next time.

George has also attempted, though so far with only limited success, to establish 'buddy groups' to mimic the informal networking found in research communities. This means trying to shift a culture of competition in assessment to one of co-operation in research. He has also been given a grant by his university to devise multiple-choice questions (MCQs) which will develop the ability of students to consider reasons for and against different possible interpretations of key texts, and for and against the validity of the ideas and arguments as so interpreted. They won't be told whether they are right or wrong, but they will be forced to think argumentatively about the text they are reading; and the change in activity from mere reading and note-taking to active engagement with an MCQ should improve their motivation. More importantly, the sort of thinking they will be engaged in will be precisely the sort of thinking that is characteristic of the mature historian of philosophy.

Source: Based on a draft case study by George MacDonald Ross 2006

For four examples of the use of **enquiry based learning in education** at the University of Birmingham see case studies 1, 5, 7 and 10 at: <http://www.ebl.bham.ac.uk/index.shtml>. **See also Section 5.**

2.9 Interdisciplinary

Unravelling complexity at Australian National University (ANU)

The course involves final year undergraduate students from each of the seven colleges/faculties examining different disciplinary ways to "unravel complexity". It is the first of what the ANU hopes to be a suite of "Vice-Chancellor" courses where "ANU researchers from different disciplines sharing leading research ideas and discoveries with students."

The number of students taking the course increased from 70 (10 per College) in 2009 to 210 (30 per College) in 2010. They are selected on the basis of outstanding results and interest in and commitment to working in policy areas. The course has a weekly two hour panel of different high profile researchers speaking to the class on how different disciplines deal with complexity. Each panel typically consists of a range of speakers taking different perspectives on an issue, e.g. global financial crises, the collapse of empires, contemporary 'failing' states, pandemics, engineering and network failures and the moral and legal dimensions of these issues. Students in pairs then facilitate a tutorial discussion with about 16 of their classmates on this topic. As the course unfolds students are encouraged to apply methods and insights from different disciplines to each week's case example. Reflective and interdisciplinary thinking is encouraged through a learning portfolio being the major assessment piece for the course – see http://fennergchool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=assessment:learning_portfolio. Strong support was provided by the two highest officers of the University. In 2009 the DVC tutored on the course and the VC participated in some of the final student presentation and social events.

Students commented that the course structure modelled likely work scenarios they were soon to be in – i.e. working in interdisciplinary teams on complex problems that need a diverse range of tools and perspectives to address. The learning portfolios show clear evidence of extensive deep learning. Several of the outstanding students from the 2009 class participated as tutors in the 2010 class.

Its basic philosophy and structure is readily adaptable to other research intensive universities where strong institutional leadership is encouraging the involvement of leading researchers in undergraduate teaching. Aspects of its approach – in particular its focus on seeing complex issues from different disciplinary research perspectives - are also developed in a large introductory course at ANU (Baker and Lupton, 2003). They are a feature of some final year synoptic capstone courses (Jenkins, 2008).

Sources: Baker (2010): <http://insight.glos.ac.uk/tli/resources/toolkit/resources/ugcs/Pages/default.aspx>
Course description: <http://fennergchool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=introduction>
Learning portfolio: http://fennergchool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=assessment:learning_portfolio
http://fennergchool-people.anu.edu.au/richard_baker/teaching.html

Involving Students in Interdisciplinary Interactive Media Consultancy Projects at Miami University, Ohio, US

Interactive Media Studies at Miami University is an interdisciplinary programme (including Computer Science, Engineering, MIS, English, Marketing, Graphic Design, Education, etc.) that brings together students and faculty to investigate how interactive media informs and transforms their disciplinary perspective. The programme has been running since 1996 and uses problem-based learning and team-oriented projects to help students to learn how to apply their theoretical knowledge to innovative digital solutions for a paying client. About 100 students a year take the programme. Demand is high and they have to turn away 2-5 students a day from the programme. With 2-3 sections running each semester; the students work in groups of up to 20. The students themselves decide how to divide up tasks; typically there are groups undertaking development, design and marketing. The programmes are team taught with the last two weeks spent on de-briefing and talking about what they've learnt. The students are typically in class four hours a week, but spend many more hours, for example visiting clients, undertaking research or doing user testing. They make a presentation to their client at the end of the project.

Commercial companies are charged \$20,000 per project paid on delivery; non-profit organisations and charities are typically charged c£5,000. They found the client did not take it as seriously when no charge was made. From the client's perspective, they get out of the box thinking that they would never obtain from a consultant firm. The clients typically end up with something that far exceeds their expectations. The students find it surprising and challenging to manage the changes which commonly occur during the development stage of the project.

Recent completed projects include:

- Healthcare IT asked IMS to create a new logo for their company and build a new Web presence to highlight their state-of-the art hospital tracking systems. IMS assessed needs and built the site, a product demo and a back end administrative system for managing sales and customer support.
- Procter & Gamble's Beauty Care Division contracted with IMS to develop a Web-based expert system that would allow customers to get product recommendations suited to their personal needs. A kiosk was designed to be deployed in a major retail chain.
- The Taft Museum of Art needed a complete Web strategy. IMS developed a web identity for them, put their collection online and created e-commerce capability for their gift shop.

Sources: Interview with Glenn Platt 14 November 2007; <http://student.sba.muohio.edu/ims/>

Inter-disciplinary inquiry-based learning (IDIBL) focused on action research in the workplace at Bolton, UK

The IDIBL framework project at the University of Bolton has developed an undergraduate and postgraduate module framework for inquiry-based learning. The student is seen as an action-researcher who must identify an opportunity in their work-context for improvement. Learners support each other in an online community to combine study with work.

The modules contained within the framework focus on process, and generic concepts and outcomes, rather than subject content. Through a process of negotiation between the individual learner and the course staff, a personalised inquiry is developed to include learning activities and assessment products that meet the module requirements and informed by the learners' professional practice. The student then plans the action they will take, undertakes it in their own work context, evaluates the action, and revises the plan.

Sources: Milwood *et al.* (2007, 2008); idibl.bolton.ac.uk/; inquirypatterns.wordpress.com/resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm

Viet Nam Field School - giving Australian National University undergraduates real research opportunities

In field course disciplines, such as biology, geology and here geography, there are potentially clear connections between the experience of staff carrying out research and students learning through research. The students are often learning in inquiry or research mode and students are focussed on one or two questions in an intense semi-structured experience.

This field course differs in that it takes 20-25 selected ANU students from *across the University* to Viet Nam for an 18 day intensive field course focusing on the interaction between development and environment issues. During the trip each student is part of a group based research project - and is supported by Vietnamese students from Danang University. Each group presents their final research outcomes to the whole class in a day long workshop at the end of the in-country field trip. One of the key features of the course – and one that is transferable is that: “There is strong focus in the course on developing research skills and thinking critically about what research is. Students are required in their introductory learning statements to give a personal definition of what research is and then throughout the course are encouraged to reflect on their changing understandings of what research is. And a key final task is to reflect on what they have learnt about doing research.”

Their learning portfolios indicate what they have gained from the Field School. E.g:

“Vietnam was much more than just six credit points. It was a life changing experience. Through exploring the themes as mentioned above we were able to learn about ourselves, group work, Vietnam and first hand experience the highs and lows of cross cultural research.” (Asian Studies Student, 2008)

“Nobody ever indicated that research would involve walking precariously over endless fields of rice paddies that are practically drowned with pesticides. Nor did anyone think to mention that the process could involve curious children following us, reading our notes and shouting at each other while we were trying to conduct interviews. Nobody talked about how informants may try to sell us things in the marketplace, or about how sad stories have the power to compel one to buy a bunch of bananas. And it seems odd as well that nobody has said that research can involve making friends as I did with many of my informants, especially my billet. But these are all things I think about when I hear the word ‘research’ now.” (Arts Student, 2010)

Sources: Baker (2010):

<http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm>
http://fennerschool-people.anu.edu.au/richard_baker/ENVS2017/index.htm

3. Linking Research and Teaching in Departments

3.1 Biosciences, Chemistry and Health Sciences

At Cornell University, USA, all first year biologists have research experiences

The ‘Explorations Program’, which has been running since 1991, introduces biology first-year undergraduates to research by Cornell staff, in the context of a course of 700-900 students. Large-scale funding has created 100-120 ‘experiences’, each of approximately 3-4 hours, for groups of 6-8 students. Most are designed to introduce students to the kinds of research problems on which the academic staff member works. Programmes take place both in research labs on campus and at field sites near campus. The programme is structured so that each student is required to participate in one ‘Exploration’ per semester. For example, recent explorations have varied from ‘the control of body weight’ to ‘fossil flowers of the dinosaur age’; and from ‘how do you tell if animals have color vision’ to ‘why do sperm swim in circles?’.

Sources: <http://www.reinventioncenter.miami.edu/Spotlights/spotlight.html>; http://biog-101-104.bio.cornell.edu/BioG101_104/explorations/explorations.html

Department undergraduate student research journals in biology at Chester, Leeds Nottingham and Plymouth UK and a national undergraduate research journal

The biology departments at the Universities of Chester, Leeds and Nottingham have developed journals to publish research by undergraduates in their departments. They are based explicitly on the US practice of undergraduate research journals (Kinhead, 2003). Origin (www.chester.ac.uk/origin/) at Chester is paper-based and generally involves selected students rewriting their dissertations or research projects for external publication. Biolog-E at Leeds (www.biolog-e.leeds.ac.uk) is an electronic journal, as is BURN from Biosciences at Nottingham University (www.nottingham.ac.uk/~sbzml/) and The Plymouth Student Scientist (www.theplymouthstudentscientist.org.uk/index.php/pss). These showcase 1st Class undergraduate research and support those undergraduates seeking academic research careers. Drawing

on the expertise of these department journals, in March 2008 the first issue of the UK national undergraduate research *Bioscience Horizons* was published. All papers are written by students and based on final-year research projects. Sources: biohorizons.oxfordjournals.org/; Knight (2006)

Intergenerational student teams support first-year inquiry courses in chemistry at the University of Michigan

Each year the chemistry department at Michigan has c100 students in term time or summer involved in undergraduate research with the c40 Department research groups. In addition, standard undergraduate laboratory instruction courses have been modified in order to create a more deliberate link to more authentic research practices.

An inquiry-based curriculum for first-year students. The large (c1400 students) introductory organic chemistry courses have been significantly revised to focus more on student inquiry, narrowing the gap between how faculty understand chemistry and how students experience chemistry in their coursework.

Authentic laboratory research for many. A subset of c160 students in this first year course self-select into a supplemental instruction program where they spend two additional hours per week engaged in tasks that involve their connecting with, understanding, and transforming information and data from the primary literature. In the laboratory, after spending about half their time developing manipulative skills around small, open questions they take on the design and implementation of limited but authentic laboratory primary research.

Upper level student support and development. This supplemental instruction program is a collaborative activity between the primary faculty member and a team of 8 upper-level undergraduate students (themselves graduates from the first year course) who have co-designed the instructional materials and who are solely responsible, with guidance from the faculty member, to implement these 2-hour sessions. These students are seen as potentially the next generation of teacher-researchers. Source: Coppola (2005)

Co-ordinated interventions in Zoology at University of Tasmania, Australia

The department has developed a set of linked strategies including:

Year One c200 students

- Workshop on the use of animals in research: students are put in the position of researcher, considering experimental design and animal ethics to complete an animal ethics application form.
- Throughout the year, students are encouraged to interact with a web portal (www.zoo.utas.edu.au/rir/rir.htm) with links to 'Hot Topics' in Zoology related to lecture material.

Year Two

- Central to the year two curriculum and assessment is an exercise extending over several weeks. Students are given real unpublished data for analysis, supported by workshop practice sessions and one to one tutorials. The final submission is in the form of a manuscript as for publication.

Year Three

- Courses include group research projects, critical reviews of current literature, writing research grant applications, lectures from scientists outside the school, and training in scientific communication.
- Zoology Research Unit (fcms.its.utas.edu.au/scieng/zoo/unitdetail.asp?lUnitId=3349) individual students are matched with an academic supervisor to complete a semester-long research project.
- Selected students work with staff to prepare a research paper for *Nexus Journal of Undergraduate Science, Engineering and Technology* (<http://www.utas.edu.au/scieng/nexus/>).

Years Two and Three

- All invited to participate in Student Research Volunteers program (<http://www.zoo.utas.edu.au/Staffpg1/summvolunteer3.htm>). Volunteers are matched with mentors, usually Postgraduate or Honours students in the School, for short-term, in-house research placements that may offer either laboratory or field experiences

Years One, Two and Three

- 'Reach into Research' seminars held several times each semester (www.zoo.utas.edu.au/rir/rir2&3.htm). Speakers from industry, collaborating institutions School PhD students present their research, and then all non-undergraduate audience members, except the facilitator, leave the room.

Further information Edwards *et al.* (2007)

Integrating research and learning in the chemistry undergraduate curriculum at Utrecht University, Netherlands

Traditionally undergraduate chemistry in the Netherlands only ended with a “real” research assignment, which students undertake in one of the research groups of the University. However, this model is not very effective in developing the required scientific skills for a chemist, such as presenting their work, critically evaluating their work, and designing new experiments based on the results of previous experiments. Most chemistry students in the Netherlands go on to take the masters in the same university (approx 90% at Utrecht). A few years ago Utrecht opted for a curriculum in which learning research skills and knowledge go hand in hand.

First year - On the first day of their studies students start with a group laboratory project in which they are asked to prepare and characterize a polymer (a kind of plastic). The final material which they have to prepare is clear, however, the route to prepare that material is developed by the students themselves. At the end of the first year ALL the students (approx 70) work for three weeks in groups in one of the research departments.

Second year - In order to keep a link between the students, lecturers and researchers, students visit and carry out experiments in the research departments. At the end of the second year students are involved in a 5 week pre-determined group research project. The goal of their project is discussed with the supervisor (in most cases a senior PhD student). In that way the students are involved in a relevant, authentic research project.

Third year - At the end of the third year all students carry out an individual BSc-thesis research project. Students contribute for 10 weeks to an on-going PhD research projects in which they are assigned to their own sub-project. *Source:* Personal correspondence Harry Bitter, Utrecht University

Research Emphasis Days in Veterinary Medicine at Edinburgh and Florida

Each year the School of Veterinary Studies at University of Edinburgh organises a ‘Research Emphasis Day’ where local researchers present current work to students of all years in a conference style format. In addition the School invites speakers from a variety of potential research employers to an event called VetChoice where students from any year are invited to learn about research opportunities for veterinary undergraduates and graduates. These range from talking about research opportunities within the Veterinary School to opportunities outside the School. The University of Florida College of Veterinary Medicine organises a similar event.

Sources: Struthers *et al.* (2008); <http://www.vet.ed.ac.uk/oldweb/red.htm>; <http://www.vet.ed.ac.uk/Default.htm>; <http://www.wlcastleman.com/ufvetmed/phizeta07/index.htm>

Popularising science research to undergraduates at McGill, Canada

The Science Faculty at McGill have introduced a ‘Soup and Science series’ at the start of each fall and winter term. Each day, 4-6 professors from different disciplines talk about their research, one after the other, for no more than 3 minutes. Then students and professors have lunch together, with opportunities to chat and find out more. The 3-minute max means our professors focus on just the most interesting part without too many details, and the format encourages students to chat with professors to find out more. This has many benefits: professors are demystified and humanized, students discover new fields in various departments, students get a better sense of what research is, and students see that they can be a part of this. An added advantage is that professors may find colleagues in other departments working on related topics.

Source: Correspondence with Victor Chisholm; www.mcgill.ca/science/ours/soupscience/

Ways of knowing and research literacy in undergraduate nursing, health and behavioural sciences at University of Wollongong, Australia

Research subjects are built into each year of undergraduate nursing. By the time students reach the end of their course, some are potential researchers and all are committed to evidence-based practice. The aim is to build research awareness, access and appreciation in students through engaging curriculum design. Approx 200 students on three different sites explore research in three modules over the curriculum:

NURS164, Patterns of Knowing in Nursing

They begin by addressing questions such as: "what is the knowledge you need and where does it come from"? The students then explore where they will find each of Barbara Carper's (1978) four ways of knowing: empirical; aesthetic; personal; and ethical in the curriculum. They look at articles that apply each way of knowing to a topic (elder care). The subject is team-taught, and each way of knowing is woven through the lecture series. We give emphasis to ethical and legal issues, as well as critical thinking and argument. Each student chooses two case studies and then writes a reflective piece on using Carper's model to understand different perspectives of the case studies.

NURS264, Reflection and Practice

In this module students look more deeply into sources of evidence, and further develop critical thinking and reflection skills. In tutorials, students are encouraged to share stories and reflect on the ways of knowing that they contain. They examine arguments and discourses. During the sessions, students work on their ability to present logical arguments and critique the arguments of others. For their assignment, students take a dramatic episode or movie with a health care setting, and draw it as a conceptual map.

NURS364, Research Appreciation and Application

This module is built around the assumption that all graduates need to be able to appreciate and apply research. A registered nurse needs to be aware of how their knowledge informs practice, and appreciate evidence-based practice. They need to know how to find out about new knowledge and implement change management. Students examine literature from an evidence perspective. Which assertions in articles and textbooks are backed up by evidence? During the session, different researchers come in to talk to students about their research. Their first assignment involves them formulating a nursing question on a topic of their choice, carrying out a literature review and drawing a conclusion. For their second, students work in groups and critically analyse the methodology of a published research article.

An evaluation showed improved information literacy skills and enhanced levels of self-confidence in developing search strategies and accessing current research evidence. The other theme that comes through is "retrospective appreciation" where students indicated that they did not fully appreciate the usefulness of the research skills they developed until their final year of study.

Source: <http://teaching.uow.edu.au/ltgp/search.aspx?RT=CS22>

3.2 Engineering and Mathematics

Introducing students to staff research: department of mechanical engineering, Imperial College, London, UK

This activity was a feature of the first year course in Mechanical Engineering at Imperial College London in the 1990s.

- In January of their first year mechanical engineering students were divided into 10-15 groups of 4-5 students
- Each student group was given an engineering 'artefact' e.g. a safety razor; the bottom frame of a bicycle. In the next few weeks these student groups could knock on the doors of any of the department's research groups or staff, and ask questions around the issue of 'what research are you doing that might effect how this artefact will look like and function in c5 years time?'
- Later all student groups presented a poster which provided a summary of their findings
- The poster session was held in large public space in the department with some 700 attending; academic staff, support staff, postgraduates and first year and other students

Source: Correspondence with Eric Meyer (Durham University) who witnessed this as a visitor to the department

Across Department Undergraduate Research Programme in College of Engineering, Maryland, USA

Gemstone is a highly innovative programme for selected 'honors' students in engineering and other disciplines. The programme is now in its eleventh year. Student teams, formed in the freshman year, undertake three-year, student-initiated research projects in which they analyze and propose solutions to

societal problems, which generally involve a significant technology focus. Team members work as a coordinated group, investigating their project from the perspective of individual majors, under the guidance of a faculty mentor. In their first two years students are encouraged to live together on a residence hall floor reserved for Gemstone participants. The research projects e.g. 'a comparative study of erosion control measures in the Chesapeake Bay area and homeowner response to such interventions', are developed in consultation with outside experts and agencies. In their final year student teams present their research to experts in the field or outside agencies and write a team thesis. The learning process mirrors the team based consultancy style research that students are likely to carry out after graduating.

Sources: <http://www.gemstone.umd.edu/>; <http://www.reinventioncenter.miami.edu/spotlight.html>

A department undergraduate research pathway in Mathematics at Ithaca College, US

The Department of Mathematics at Ithaca College, New York, over some 7-8 years radically changed its course offering, its culture and organisation to make "research with students, designed as part of the curriculum... a distinguishing characteristic of mathematics at Ithaca College". There is a blend of inquiry / research for all students – including non majors – and an elective research focus for those interested.

The main components of this overall focus include:

- A first year course for all students *Mathematical Experimentation*. Students use computer software (in particular Mathematica (<http://www.wolfram.com/>)) to conjecture and test mathematical ideas, much like a natural scientist uses the laboratory to test hypotheses. Since these are first year students, there is not an expectation of rigorous proof, but rather to focus on the manner in which mathematicians go about creating new ideas. Examples of student work are at <http://www.ithaca.edu/faculty/dabrown/courses/Math185/>
- A second year course for all students (majors and non majors) – *Sophomore Seminar* brings together all students and all staff to explore mathematics. Groups of students work with staff and give class presentations on particular issues e.g. voting methods, group theory in kinship and so on.
- The main development has been a research sequence of two courses in the junior year. These focus on the pre-graduating class and both supports those honours/major students who wish to take a research thesis in their final year and education majors with mathematics as a minor who wish to take this research focus forward into their role as a teacher.
- The first such course, *Junior Seminar*, is required of all maths majors and introduces students to mathematical research methods, writing and citation. Students in groups also work on small research projects guided by staff.
- *Research Experience in Mathematics* is the main course in the research sequence. It has students working in groups on research questions shaped by staff research interests and those posed by students in previous years' projects. (Note the course is team taught and is rotated around the department to better ensure effective integration of 'undergraduate research' into the department culture. Students investigate "a research question initiated in the Junior Seminar. Completion of the research project involves, in addition to the mathematical arguments, a written report consistent with the standards of publication in mathematics and a public presentation at an academic symposium or conference" (Brown and Yurekli, 2007, 576).

Sources: Brown D personal communication (2008); Brown and Yurekli (2006; 2007)

<http://www.ithaca.edu/hs/depts/math/>

Research summer schools in mathematics and statistics at St Andrews, UK

In the context of a four year degree, selected third year students (those with high scores in the third year January exams –and selected students from other universities) participate in an intensive un-assessed 6-8 weeks 'course'. Students are introduced to topics on the interface between their undergraduate degrees and research interests of the staff involved. It serves as motivation and advertising for PhD courses. In Pure Mathematics, typically lectures occur during the first half of the school and in the second half of the school, the students are set projects relating to research topics. In Applied Mathematics, the schools are conducted more similarly to PhD supervision.

Sources: Quick (2009); <http://www-circa.mcs.st-andrews.ac.uk/CIRCA/summerproj.html>;
<http://www.mcs.st-and.ac.uk/pg/pure/Analysis/Summer.html>

Developing a complete research cycle in science, technology, engineering, and mathematics at University of Maryland East Shore (USA)

The institution is an historically black largely undergraduate institution. In these disciplines faculty have designed a set of linked curricula interventions in the mainstream curriculum to give many students and faculty experience of the whole research cycle, from project design to research dissemination. They argue that “Too often, undergraduate research projects are conducted during summers or other shortened periods, or concluded without determining possible extensions or formally presenting results in scholarly venues including professional meetings, conferences, and journals” (Johnson *et al.*, 2005, 28). A range of initiatives have been built into the curriculum over the four years of the degree to include defining research questions, grant proposal preparation, year round undergraduate research project and research dissemination. This initiative has been supported by bids to the Minority Science and Engineering Improvement Programme of the Department of Education and National Science Foundation.

Source: <http://www.ed.gov/programs/idesmsi/index.html>

Linked degree programme of engineering clinics at Rowan University (USA)

Rowan is a regional largely undergraduate university in New Jersey. Students in its engineering programme can concentrate in Chemical, [Civil & Environmental](#), [Electrical & Computer](#) and [Mechanical](#) engineering. However, all students take ‘Engineering Clinics’, an eight-semester course sequence from the freshman to the senior year. Their common features include an emphasis on ‘design’ or the solution of open-ended problems that challenge students to apply higher-level skills such as analysis, synthesis and evaluation. The clinics focus on multidisciplinary problems often of an applied nature and students and faculty generally work in teams. Through the four years the problems become more complex and research like – with those in the junior and senior year often being supported through external research grants and through research-based consultancies. Research indicates these clinics / programmes are effective in supporting more students into graduate school and supporting high retention, in particular for women students.

Sources: Sukumaran *et al.* (2006); www.rowan.edu/colleges/engineering/programs/

Minority science and engineering improvement program Department of Education (USA)

This program assists predominantly minority institutions in effecting long-range improvement in science and engineering education programs and increasing the flow of underrepresented ethnic minorities, particularly minority women, into science and engineering careers. The program funds are generally used to implement design projects, institutional projects, and cooperative projects. The program also supports special projects designed to provide or improve support to accredited non-profit colleges, universities, and professional scientific organizations for a broad range of activities that address specific barriers that eliminate or reduce the entry of minorities into science and technology fields.

Source: www.ed.gov/programs/idesmsi/index.html

3.3 Arts and Social Sciences

Department and institutional research resources support undergraduate research in history at Virginia

This case study demonstrates how the research resources of a research-intensive university department can support undergraduate research in a large’ course. The course leader, Edward Ayers, is Dean of Arts & Sciences at the University of Virginia and a leading researcher on the American South. The School hosts the Virginia Center for Digital History. The resources of this Center, University and School research archives, research librarians, a postgraduate research and teaching team, support a range of undergraduate research programmes including research in an undergraduate course with an enrolment of c180 students for which Ayers is the course leader. The course involves undergraduate student teams using university archives to research a specific time or place and then publish their research to a web site for use by current and future students and other researchers nationally.

Sources: <http://www.vcdh.virginia.edu/SHD/howtobegin.html>;
<http://www.reinventioncenter.miami.edu/conference2006/edayers/summary.htm>

Scaffolding of Research Tasks in an Applied Theatre Program at Griffith University, Australia

Professor Michael Balfour, who teaches Applied Theatre in the Education program, progressively introduces research tasks at different year levels:

Year one: Students conduct background research for an applied theatre project within set parameters, but do not implement the project. Students undertake a background literature review using journal articles, library sources and informal interviews with people who work with their target group. After this research has been completed, the students develop an idea for an applied theatre performance in consultation with the lecturer and prepare a two-page project proposal.

Year two: Following set guidelines, students undertake a directed performance project under the guidance of the lecturer. For example, one group of students developed a performance workshop and study notes for school children to support and exhibition at the State Library in response to a project brief outlining the Library's requirements. This activity is more challenging than the year one activity because it involves the development and presentation of a performance, but is directed by academic staff members.

Year three: In groups of three or four, students undertake a research project in a much more independent manner. Students:

- select and approach the organisation with whom they want to work
- conduct a background literature review of previous initiatives and practice with their target group
- discuss the project with the organisation's employees
- design and implement a theatre project, and
- reflect on the project's effectiveness with supervision from academic staff members.

Masters level: Students at this level have previous experience in either teaching or drama. They are expected to produce work that demonstrates a deeper level of reflection and analysis. The curriculum covers action research, ethnographic, case study and narrative enquiry research tools to help students engage in and understand the practical work in a more systematic and critical manner.

Source: ALTC Teaching Research Nexus website: www.trnexus.edu.au

A Department Undergraduate Research Scheme: Psychology at York, UK

Department initiatives to formally support undergraduates doing research – in close involvement with staff research – are a feature of many US departments (Kinkead, 2003). A growing number of UK departments are now developing their own undergraduate research programmes (Jenkins, 2006). That in the psychology department at York University was initiated in 2005 and replaced and developed previous informal arrangements. The scheme enables students who wish to gain research experience to volunteer to assist with current department staff projects. Any 1st or 2nd year student can take part in the scheme though preference is normally given to second year students. Third year students are typically busy with their own projects and tend not to participate. Staff enter details of their projects on PsychWeb together with an outline of the research questions, what research assistance is needed and the rate of pay. Generally the payments to students come from research grants.

Source: Goebel and Gennari (2006); www.york.ac.uk/depts/psych/www/research/ures/

Introductions to academic practice: humanities and social sciences at Windsor, Canada,

'Ways of Knowing' in the departments of Arts and Social Sciences at the University of Windsor focuses on students developing disciplinary skills in research and critical thinking. Each year a particular theme is identified - generally one that reflects a Windsor community issue - and student teams investigate and present in public the results of their inquiries. Senior student mentors and community members act as mentors to these investigations. There are institutional discussions on extending this 'model' to other departments.

Source: apps.medialab.uwindsor.ca/cfi/reflexions/volume01/issue01/Ways_of_Knowing.htm

Using undergraduates to evaluate student experiences of teaching and learning in the Sociology Department, University of Warwick, UK

In the Department of Sociology at Warwick selected second and third year Sociology students led an evaluation of their peer's experiences of teaching and learning. They used a variety of social research

methods – including focus groups, interviews and participant observation – to explore the learning experiences of their peers. The results were widely discussed within the department, and at a department away-day, and have led to students being more involved in department academic debates. Clearly it is more transferable to those departments and disciplines such as sociology, education, psychology, management, where students developing research skills ‘match’ the research focus.
Source: Hughes (2005)

Junior Research Bursaries in Social Sciences and Cultural Studies at Sussex (UK)

From 2008 the School of Social Sciences and Cultural Studies at Sussex University is offering competitive awards to selected first and second year students for summer research bursaries at a rate of £200 (not taxed) per week for 8 weeks for summer research projects. Applications must be sponsored by a member of faculty in the School, who must be willing to act as supervisor for the duration of the award. Bursaries are awarded to projects that clearly link to the research agenda of the supervisor and support their Department's research strategy. Bursaries are not awarded for projects that are part of assessed work for a degree (e.g. projects or dissertations), or for projects involving work away from Sussex

Source: <http://www.sussex.ac.uk/soccul/1-7-1.html>

3.4 Geography, Earth and Environmental Sciences

Integrating the development of inquiry and research skills through a whole degree programme: geography and earth sciences at McMaster

Departments have the power and resources to better ensure that the disciplinary case studies that feature in earlier sections of this hand-out are at some point integrated into a coherent structure such that (undergraduate) students are systematically and progressively developed as researchers through their degree. Over the last c10 years, in part response to McMaster's institutional policy to encourage ‘student inquiry, the School of Geography and Earth Sciences has radically redesigned its Earth & Environmental Sciences (EES) programme.

In Level One the development of inquiry and research skills begins in courses where students are introduced to inquiry-based learning through the use of a Socratic, ‘questioning style’ of lecturing and lab assignments that require students to formulate and answer their own research questions. Students also develop introductory oral and written communication skills through research presentations to small groups of their peers and through writing short reports.

Many Level II and III courses involve students in short- term (several weeks) independent or team research projects. Students present the results of their research as a written paper, a poster or an oral presentation.

In Level IV all students are required to undertake some form of individual research project, either as a one term (13 week) research paper, or as a full year (minimum 26 weeks) undergraduate thesis that usually involves gathering of primary data prior to the start of Level IV.

Undergraduate Research. Many thesis students are employed as research or field assistants by faculty during the summer months or on a part-time basis during term-time. Funding is available to help offset the costs of hiring a student through McMaster University and competitive scholarships are available through funding agencies such as NSERC (Natural Sciences and Engineering Research Council of Canada). McMaster University hosts an Undergraduate Research Poster Session each year and many undergraduate students are encouraged to present the findings of their research at national or international conferences and to submit manuscripts (co-authored with their research supervisors) for publication in scientific journals.

Source: Correspondence with Carolyn H. Eyles and Susan Vajoczki, School of Geography and Earth Sciences, McMaster University

Students across all three years of an environmental studies degree course at Sunderland University, UK, work together on local sustainability projects

Students on an Environmental Studies degree at the University of Sunderland undertook local sustainability projects, which brought levels 1, 2 and 3 students together 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)*

Academic Journal Writing as Part of Course / Programme Requirements: Geography at Oxford Brookes, UK

The geography programme at Oxford Brookes has developed a set of linked programme requirements that support all students learning to write research articles. In the second year all students undertake field based research in a range of venues. A third /final year compulsory first semester course 'Geography Research and Practice' has as its main aim "to develop your skills in writing scholarly reports of your own research." The one assessment is for students to "write an article of up to 4000 words from the data that you collected in your (second year) fieldwork. The article will conform to existing academic practice for the preparation and submission of scholarly work."

Relatedly the department has also just initiated an undergraduate e-Journal *Geoversity* <http://www.brookes.ac.uk/schools/social/geoversity/index.html> to publish selected 'high quality' articles by students in the department including articles that were originally written for the module 'Geography Research and Practice. In addition some students take that experience / expertise to revise their article, or the research for their capstone dissertation for publication in the departmental undergraduate research journal *Geoversity*, or even in the linked newly established national geography e-Journal *Geoverse* <http://www.brookes.ac.uk/schools/social/geoverse/>. The author guidelines and requirements for this national journal represent the requirements for all programme students writing their journal article for 'Geography Research and Practice'.

Sources: <http://www.brookes.ac.uk/schools/social/geoversity/index.html>;
<http://www.brookes.ac.uk/schools/social/geoverse/>;
<http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm>.

Developing an undergraduate research culture in earth sciences at Oxford University, UK

Departments have cultures which may unwittingly or purposefully keep students "at arms length" from research (Brew 2006, 52) or bring them into that experience. Field disciplines, such as geology, geography, and biosciences, have the curricula opportunity of fieldwork often for a week or more where the boundaries between students and staff are likely to be 'broken', and also which offer strong opportunities for students to be involved in inquiry or research-based learning. Philip England (2007) of the department of earth sciences at Oxford University, comments on the culture of his department:

"The goal of our course is to give students the analytical and observational apparatus to ... [investigate the] processes that govern the evolution and present state of the planet upon which we live. When we discuss how we try to achieve this goal we rarely discuss teaching strategies or learning outcomes, because we regard the undergraduate experience as more akin to an apprenticeship than to four years of formal teaching.

Fieldwork is a central aspect of Geology and, almost irresistibly, it imposes a flavour upon our teaching. ... A day in the field typically involves more than 12 hours of close-contact teaching, in which the agenda is set by the observations that the students make, and the questions that they pose. Frequently, those questions have no known answer. ...

The informality engendered in field teaching cannot be erased or forgotten back in Oxford. By the time they are in their second year, most undergraduates are on first-name terms with the academic staff A variety of practices underpin this informality in ways that, separately, do not appear particularly powerful but which, because they are valued by all, have a large cumulative effect. Interaction space is highly valued, and it is an (unwritten) guiding principle that anyone can interact with anyone else in the common space (library, staff coffee room, undergraduate common room, etc.)."

That perspective of the department culture is validated by external reviews and performance indicators. Thus Graham Gibbs (in press) analysis of the department as part of a study of "research-intensive departments ... where the teaching is demonstrably outstanding," observed that:

"The report of the most recent internal review of the department notes the way the programmes are 'informed by the department's strong research base' and how it 'brings students into contact with leading scientists in a close-knit community with ample opportunity for students to meet them in an informal context'. ... Earth Sciences has amongst the highest student ratings on a number of scales of the Oxford Student Course Experience Questionnaire. It is rated particularly highly as 'intellectually stimulating'. ... Students believe that they 'benefit from being in contact with active researchers'. ...

The central social space in the department has posters on the walls that have just come back from conferences, and which change regularly. It would not be possible for students to be unaware of what research was being undertaken or who was undertaking it. In this social space, informal discussion of research, with undergraduates involved, seemed to be going on constantly. Students were invited into research projects in the lab or the field in an ad hoc way if they showed interest. Students were being inducted into a 'community of practice' rather than only being taught, and there were blurred distinctions between teaching and research with everyone simply 'doing geology'. This is the most striking example I have encountered of the link between research and teaching being one of joint engagement in shared scholarly activity within a supportive social environment, with students gradually being included in the community as junior members."

Sources: England (2007); Gibbs (2007)

3.5 Developing research skills and academic practices

Auditing and developing student research skills at Adelaide, Australia and Reading, UK

Selected departments at both Adelaide and Reading have systematically audited department based undergraduate and postgraduate programmes for the extent to which they develop student research 'skills'.

Research at Adelaide has developed both a conceptual framework on student research development and based on this a diagnostic tool to support interventions to strengthen student research skill development in courses. Thus two consecutive first year courses in Medical Science have adapted their assessment tasks to explicitly and systematically develop student research skills in accordance with the Research Skill Development (RSD) framework. A broadened application of the framework is being trialled, including with laboratory-based and numeracy-rich research, and to other disciplines and departments, including Petroleum Engineering, Nursing and English. The framework is publicly available for other institutions to adapt.

Within Departments methods to collect data on undergraduates' research skills teaching and learning can be time-consuming and ineffective. At the University of Reading a related electronic 'research skills audit tool' has been developed for staff to systematically map research skills teaching and assessment within their own modules. The tool facilitates quick and easy collation of modular data across entire degree programmes, thus making it a valuable Departmental resource for reviewing undergraduate curriculum design. *Sources:* Willison and O'Regan (2006; 2007); Fraser, *et al.* (2007)

Introductions to academic practice: economics and business at Sydney, Australia

The Faculty of Economics and Business at the University of Sydney has radically rethought its approach to issues of plagiarism and academic honesty. Through a collaborative action research project they have moved from an approach of compliance to inducting students into the nature of academic practice. Starting with a voluntary on-line first year module in 2004, academics are supported to reshape their courses and practices across the faculty in ways that reflect a view of students 'as uninformed, but willing participants in the promotion of academic honesty.' The Faculty's management system has instituted 'multiple linked activities' to promote academic honesty amongst students and engage staff in such discussions. Thus in 2005 the module was made compulsory for all new students before submitting their first assignment. Videos of students talking about academic honesty are used in orientation and induction activities. Faculty are being supported in revising their assessments and course work to more explicitly integrate academic practices re research honesty and ethics into their courses, in part prompted by the institutional commitment to research-enhanced teaching. *Sources:* Freeman *et al.* (2007)

3.6 Re-designing Spaces

Re-designing spaces to support student research and inquiry at Vancouver Island, Canada, and Liverpool and Sheffield, UK

One way departments can enhance the way in which they support student involvement in research-based learning is to (re)design the spaces in which students and staff learn. Such spaces need to recognise the particular forms of research and pedagogy in the disciplines, and departments should seek to, in part, control and shape decisions on building design, room layout and equipment. Thus a study (Narum, 2004, 10) of recent innovative science buildings and classrooms in the USA revealed “spaces uniquely designed for 21st-century ‘sciencing’ ... (which) support learning that is inquiry-based ... recognize the increasingly social character of scientific research, teaching, and learning by facilitating interactions between and among students and faculty.”

The Faculty of Science and Technology at *Vancouver Island University* (previously Malaspina University College), Canada, required the architects currently completing a science centre (in which much of the research is outward-facing and community-based and in part involves faculty and students researching together) to “design spaces that will bring students and the public closer to the research taking place, to include dialogue and seminar rooms and visual access to some of the research laboratories” (Horn, personal communication, 2007).

In England seven research- and inquiry-based Centres for Excellence in Teaching and Learning (CETLs) have large capital sums to build special buildings to support student research and inquiry (Appendix 2). A common theme running through their designs is the development of ‘social learning space’ in which students are encouraged to learn collaboratively with one another, with staff and, in many cases, with students in other institutions and other key people, in informal environments. Thus at *Sheffield University’s CILASS, the Centre for Inquiry-based learning in the Arts and Social Sciences*, a flexible, technology-rich space has been purpose-designed to support inquiry-based learning. Called a ‘collaboratory’, the space is suited specifically to support processes of group-based inquiry within arts and social sciences disciplines. It is conceived as “a classroom as research environment”. Flexible furniture enables a variety of different spatial configurations and facilitates easy flow from one type of activity to another – including, small and large group discussion; working with digital archives and information resources or the University’s virtual learning environment; producing collaborative writing or presentations; engaging in inquiry through musical or dramatic performance.

At a more modest level, a £22,000 University grant has enabled the *Department of Earth and Ocean Sciences at Liverpool University* to redesign their stage 1 programme to support Geology problem-solving and conceptual reasoning. Teaching on two modules has been changed from a standard 12 lecture and 6 practical format to 12 studio sessions. As well as key changes in course materials, the move to more student inquiry was supported by a redesign of the classroom teaching space. This had featured “a large room with tables in rows designed to accommodate about 100 students facing the same way” (Boyle *et al* 2006, 34). The redesigned room allowed students to work in groups at tables with staff able to work alongside them, and gave students better access to research resources. In addition VLE resources were significantly enhanced to include photographs of all specimens used in the studio sessions. The examination format remained constant, thus enabling comparisons between student performance pre- and post-innovations in course design and delivery. Results demonstrated “improving problem-solving abilities without compromising their knowledge and technical skill acquisition” (p36).

Sources: Personal correspondence with Phil Levy, Sheffield University and Jennifer Horn and Nancy Randall, Vancouver Island University, 2007; <http://www.viu.ca/teaching/UnderGradMalWork.asp>; www.sheffield.ac.uk/cilass/learning-spaces; Boyle *et al.* (2006)

9 Sources and Bibliography – For over 300 references a list of useful Web sites which is regularly updated see: Healey, M *Linking Research and Teaching: A selected bibliography* www.mickhealey.co.uk/resources; and on that site there is a fuller copy of this hand-out with all the references in full <http://www.mickhealey.co.uk/wp-content/uploads/2010/10/Linking-RT-Handout-Website1.doc>

Annex 1: Linking Teaching and Research in Departments: Questions and Strategies

Curriculum and research-based learning

- What is your departmental (and disciplinary) understanding or conception of research ‘led’, ‘based’ or ‘informed’ learning?
- What forms of pedagogy and their assessment do you consider appropriate to support these conception
- Can you clearly identify where research-based learning is integrated in the programme?
- Where is current research in your field presented in the programme? Check your:
 - programme design and programme outcomes
 - curriculum content and delivery in the modules
 - assessment methods
- Where are research methods/skills/ethics taught and practiced? Is this progressive? Is a variety of appropriate skills/methods delivered?
- Is the research knowledge/skills the student will have acquired made clear in the module learning outcomes?
- Can/do students participate in departmental research projects as eg research assistants?
- Where is the scope for students to conduct independent research in their programmes? and in what ways do the programmes allow progression?
- How are research skills and the links between teaching and research embedded in monitoring and review of modules and programmes?
- How are students supported in making explicit how this research training/knowledge supports their employability?
- How are undergraduate students made aware of postgraduate research opportunities?

Management, organisational structure and staffing at departmental level

- How does the department’s learning and teaching strategy articulate research and teaching/learning links?
- How does the department’s research strategy articulate teaching and research/learning links?
- How are the teaching and research activities, organised, motivated and resourced? Are they managed for mutual engagement? Are (all) researchers involved in teaching? How are ‘non-research active’ teaching staff mentored and encouraged to develop a research/scholarly profile, and valued for their particular contributions to the nexus?
 - How do research teams and course teaching teams link with each other? How are these links facilitated?
 - Are research 'clusters' also 'teaching teams'?
- How are teaching staff ‘managed’ in developing research and/or scholarly capacity and vice versa?
- How are new staff acculturated into the department values and practices?
- How are incoming students acculturated into the department values and practices?
- How is the staff and student experience of the nexus monitored and the results fed back into policies and practices?

Inclusive culture

Developing the links between teaching and research requires cultural change too:

- What are the mechanisms for disseminating and communicating research outputs and teaching practice development in the Department?
- How is the research culture and activity given visibility to students? How do students come into contact with departmental research?
- What are the strategies to disseminate research-based teaching experience from the module level?
- What profile is given to (discipline based) pedagogic research? How is this research disseminated and applied in programmes?

And finally

- Allow for diversity
- Remember it is the individual’s scholarly engagement with her/his subject and how this is brought to their teaching and research setting which mediates the relationship between teaching and research. You cannot tightly programme the nexus
- Recognise that the relationships between teaching and research are reciprocal.

Source: Based on: Zetter (2002) and Jenkins and Zetter (2002)

Annex 2 Strategies for Linking Teaching and Research within Courses and Programmes

Strategy 1: Develop students' understanding of the role of research in their discipline

- Develop the curriculum to bring out current or previous research developments in the discipline
- Develop students' awareness of the nature of research and knowledge creation in their discipline
- Develop students' awareness of learning from staff involvement in discipline research
- Develop students' understanding of how research is organised and funded in the discipline, institution and profession.

Strategy 2: Develop students' abilities to carry out research

- Students learn in ways that mirror research processes
- Assess students in ways that mirror research processes (e.g. requiring students to have their work assessed by peers according to the house-style of a journal before submitting it to you)
- Provide 'training' in relevant research skills and knowledge
- Ensure students experience courses that require them to do research projects; and that there is a progressive move to projects of greater scale, complexity and uncertainty (Strategy 3)
- Develop student involvement in research
- Develop abilities of students to communicate the results of their research - in ways that are appropriate to the disciplinary community in which they are now participating.

Strategy 3: Progressively develop students' understanding

- Ensure that introductory courses induct students into the role of research in their discipline and present knowledge as created, uncertain and contested
- Ensure that advanced courses develop students' understanding of research, and progressively develop their capacities to do research
- Ensure that graduating year (capstone courses) require students to carry out a major research study and help them to integrate their understanding of the role of research in their discipline.

Strategy 4: Manage students' experience of research

- Limit the negative consequences for students of staff involvement in research; most important here is managing the student experience of the days (and sabbatical terms) when staff are 'away' doing research
- Evaluate students' experience of research and feed that back into the curriculum
- Support students in making clear to them the employability elements of research; 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.

Based on: Jenkins *et al.* (2003, 63-4) and Healey and Jenkins (2006)

Annex 3: Institutional Strategies to Link Teaching and Research: A Framework

Developing institutional awareness and institutional mission

Strategy 1: State linking teaching and research as central to the institutional mission and formulate strategies and plans to support the nexus

Strategy 2: Make it *the* mission and deliver it

Strategy 3: Organise events, research studies and publications to raise institutional awareness

Strategy 4: Develop institutional conceptions and strategies to effect teaching-research links

Strategy 5: Explain and involve students and parents in your institutional conception of teaching-research relations

Developing pedagogy and curricula to support the nexus

Strategy 6: Develop and audit teaching policies and practices and implement strategies to strengthen the teaching-research nexus

Strategy 7: Use strategic and operational planning and institutional audit to strengthen the nexus

Strategy 8: Develop curriculum requirements

Strategy 9: Review the timetable

Strategy 10: Develop special programmes and structures

Developing research policies and strategies to support the nexus

Strategy 11: Develop and audit research policies and implement strategies to strengthen the teaching-research nexus

Strategy 12: Ensure links between research centres and the curriculum and between student learning and staff scholarship

Developing staff and university structures to support the nexus

Strategy 13: Ensure the nexus is central to policies on inducting and developing new staff and for strategies to support the professional development of established staff

Strategy 14: Ensure teaching-research links are central to policies on promotion and reward

Strategy 15: Ensure effective synergies between units, committees and structures for teaching and research

Strategy 16: Link with related university strategies

Strategy 17: Participate in national programmes

Strategy 18: Support implementation at department level

Other strategies you consider appropriate

Source: Jenkins and Healey (2005)

Annex 4 Possible strategies for national and international organisations

Strategy 1: Build it into the statutory / legal definitions of HE institutions and degree and professional requirements

- Build the nexus into statutory definitions of a university
- Build it into any public classifications of universities
- Build it into the (statutory) definitions of a degree
- Professional bodies (both national and international) can also make requirements for students being involved in /doing research / understanding research

Strategy 2: Ensure there are limited negative impacts from research selectivity

Strategy 3: Require research selectivity to support research areas that directly support the nexus

- Support discipline based pedagogic research
- Require applications for research awards and in particular through national research selectivity exercises such as the RAE to identify how undergraduate and postgraduate students benefit from staff research
- Make undergraduate student involvement a condition of some research awards
- Target some competitive grants to institutions to support (undergraduate) student researchers
- Target some competitive grants to institutions to support the nexus
- Ensure that textbooks and educational software are valued
- Selectively build grants / requirements for data from research studies to be widely available to teacher / scholars and students
- Harness the Internet to foster the nexus

Strategy 4: Fund and support all institutions and staff for (discipline-based) scholarly activity

Strategy 5: Develop external reviews of teaching and research which explicitly support the linkage

- Make limited adjustments to separate reviews of teaching and research
- Focus the reviews, or periodic reviews, on the nexus
- Auditing the Teaching / Research Nexus in New Zealand
- At institutional level, reviews should focus on the nexus as it 'professed' by that institution

Strategy 5: National and international disciplinary organisations can support the nexus

Strategy 6: Develop national and international organisations and projects to support the nexus.

Source: Jenkins *et al.* (2003)