

Linking discipline-based research with teaching to benefit student learning

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<http://resources.glos.ac.uk/ceal/>; <http://resources.glos.ac.uk/tli/prsi/current/ugresearch/index.cfm>;
www2.warwick.ac.uk/fac/soc/sociology/research/cetl/

**Further and more detailed case studies, including national examples, references and list of useful
web sites may be found at:**

<http://resources.glos.ac.uk/ceal/resources/index.cfm>

“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)

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

Structure

1. Different ways of linking research and teaching
2. Linking research and teaching: different views
3. Disciplinary perspectives
4. Institutional perspectives
5. Conclusion

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

March 2009

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)

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)

Table 3: Mode 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).

Table 5: Student awareness, experiences and perceptions of research in three universities

CanRI - a research-intensive institution in Canada

UKRI - a research-intensive institution in the UK

UKLRI - a less research-intensive institution in the UK

Percent of students responding ‘yes’ to the question ‘Are you aware of any of the following occurring at the University?’ by institution

	Total	CanRI	UKRI	UKLRI
Research Seminars†‡	341 (66%)	232 (75%)	34 (77%)	75 (46%)
Books, Articles or other research output†‡	335 (65%)	213 (68%)	38 (86%)	84 (52%)
Notice Boards Displaying Research Opportunities	313 (61%)	183 (59%)	34 (77%)	96 (59%)
Research posters/displays †	292 (57%)	193 (63%)	28 (64%)	71 (44%)
Existence of Research Units*†	259 (50%)	223 (72%)	13 (30%)	23 (14%)
Areas with national / international reputations*†‡	220 (43%)	185 (60%)	14 (32%)	21 (13%)

Bold signifies a significant difference between the institutions in crosstab analysis

*signifies significant difference between CanRI and UKRI

†signifies significant difference between CanRI and UKLRI

‡signifies significant difference between UKRI and UKLRI

Percent of students responding ‘yes’ to the question ‘Have you gained experience of any of the following?’ by institution

	Total	CanRI	UKRI	UKLRI
Staff discuss research†‡	390 (76%)	263 (85%)	37 (84%)	90 (55%)
Guest lecturer discuss research*†	337 (65%)	239 (78%)	26 (59%)	72 (44%)
Reading research paper by staff†‡	277 (54%)	186 (60%)	28 (64%)	63 (39%)
Undertaking independent project†	245 (48%)	132 (43%)	24 (55%)	89 (55%)
Undertaking dissertation*†	182 (35%)	21 (7%)	34 (77%)	127 (78%)
Being subject of research*†	167 (32%)	147 (47%)	6 (14%)	14 (9%)

March 2009

Development of research techniques	139 (27%)	84 (27%)	14 (32%)	41 (25%)
Attending research seminar†	122 (24%)	83 (27%)	12 (27%)	27 (17%)
Involved in practical activities/fieldwork	124 (24%)	71 (23%)	11 (25%)	42 (26%)
Contributing to research report or other output†	65 (13%)	53 (17%)	3 (7%)	9 (6%)
Acting as research assistant*†	54 (11%)	52 (17%)	0 (0%)	2 (1%)

Bold signifies a significant difference between the institutions in crosstab analysis

*signifies significant difference between CanRI and UKRI

†signifies significant difference between CanRI and UKLRI‡signifies significant difference between UKRI and UKLRI

Percent of students indicating the following positive impacts of staff who teach them being involved in research

Institution	Total	CanRI	UKRI	UKLRI
Increased understanding†‡	275 (53%)	172 (56%)	33 (75%)	70 (43%)
Stimulated interest and enthusiasm*†‡	241 (47%)	154 (50%)	33 (75%)	54 (33%)
Increased awareness of methodological issues	193 (38%)	124 (40%)	18 (41%)	51 (31%)
Development of research skills	145 (28%)	91 (30%)	12 (27%)	42 (26%)
Motivated me to pursue postgraduate study†‡	130 (25%)	106 (34%)	15 (34%)	9 (6%)

Bold signifies a significant difference between the institutions in crosstab analysis

*signifies significant difference between CanRI and UKRI

†signifies significant difference between CanRI and UKLRI

‡signifies significant difference between UKRI and UKLRI

Percent of students indicating the following negative impacts of staff who teach them being involved in research

Institution	Total	CanRI	UKRI	UKLRI
Lack of interest in teaching and facilitating my learning†	121 (24%)	103 (33%)	7 (16%)	11 (7%)
Lack of availability	97 (19%)	65 (21%)	10 (23%)	22 (14%)
Inability of Staff to explain material*†	90 (18%)	75 (24%)	1 (2%)	14 (9%)
Lack of interest	80	71	5	4

March 2009

in my academic welfare†	(16%)	(23%)	(11%)	(3%)
Research interests distorting what they teach‡	80 (16%)	70 (23%)	6 (14%)	4 (3%)

Bold signifies a significant difference between the institutions in crosstab analysis

*signifies significant difference between CanRI and UKRI

†signifies significant difference between CanRI and UKLRI

‡signifies significant difference between UKRI and UKLRI

Source: Turner *et al.* (2008)

Are students aware of any of the following?

	U of A History Faculty	U of A Student Data
Research seminars or conferences	46%	75%
Books, articles or other research output	46%	68%
Notice boards advertising research opportunities	23%	59%
Existence of Research Centres/Units	18%	72%
Areas with national / international reputations	18%	60%
Faculty are writing for publication	73%	79%
Faculty are supervising research students	46%	81%
Faculty are undertaking funded research	36%	77%
Faculty are supervising UG research assistants	18%	60%

Source: Wuetherick and Berry (2008)

Do you think students have gained experience with any of the following?

	U of A History Faculty	U of A Student Data
Staff discuss research	96%	85%
Guest lecturer discuss research	68%	78%
Reading research paper by staff	86%	60%
Undertaking independent research project (as a part of a course or as a whole course)	77%	43%
Undertaking undergraduate dissertation	59%*	7%
Being subject of research	23%	47%

March 2009

Development of research techniques	59%	27%
Attending research seminar	32%	27%
Involved in practical activities/fieldwork	36%	23%
Contributing to research project outside of class	14%	17%
Attending research conference	27%	19%
Acting as research assistant	36%	17%
Contributing to research conference paper	27%	15%

**Several people qualified by statements that just honours students do this*

Source: Wuetherick and Berry (2008)

CASE STUDIES OF LINKING DISCIPLINE-BASED RESEARCH AND TEACHING IN DISCIPLINES, DEPARTMENTS, INSTITUTIONS AND NATIONAL SYSTEMS

These cases of disciplines, departments, institutions and national systems that have intervened to bring teaching and research together are drawn from Australia, Canada, Denmark, Ireland, Hong Kong, Netherlands, New Zealand, United Kingdom and United States. They 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 and Medicine
 - 2.2 Social Sciences
 - 2.3 Business, 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 and Medicine
 - 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

March 2009

- 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

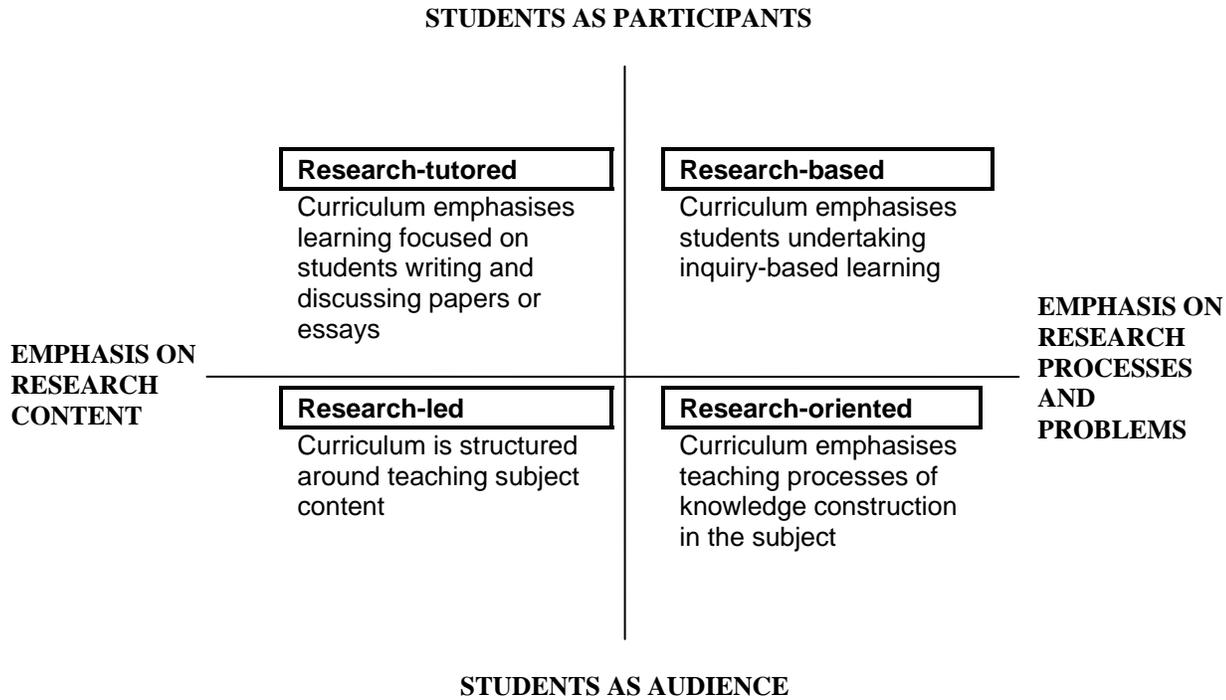
1. Contexts and Transferability

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)** effective in supporting staff/faculty to examine both their current courses and institutional policies and practices and in adapting innovations from elsewhere. According to Griffiths teaching can be:

- Research-led: where students learn about research findings, the curriculum content is dominated by faculty research interests, and information transmission is the main teaching mode;
- 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.

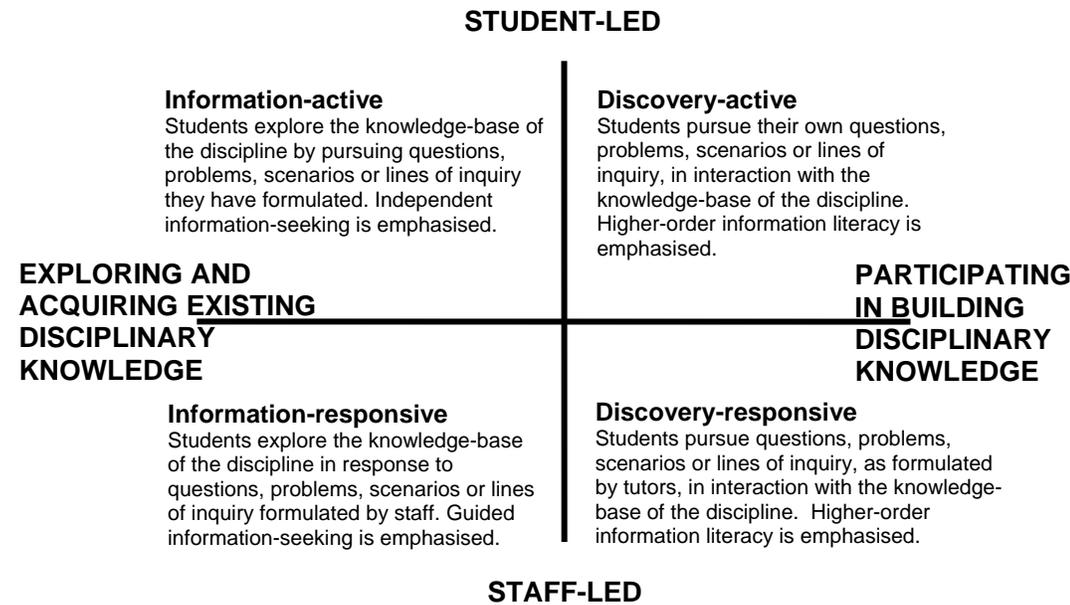
Fig 1 Curriculum design and the research-teaching nexus



Source: Based on 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 as the audience or student-focused and 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 and Petrulis (2007). 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).

Figure 2: Conceptions and modes of student inquiry



Source: Based on Levy and Petrusis (2007, 3)

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 1 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 (ie 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: Drawn from Robertson and Blackler (2006). 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 and Medicine

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

March 2009

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, 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 linked assessments. The first 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. 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.

Sources: Moni *et al.* (2007a, c and d)

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

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.

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>
<http://www.bioscience.heacademy.ac.uk/events/dur05.aspx>
<http://www.cambridge-mit.org/news/article/default.aspx?objid=877>

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

March 2009

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/>

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)

March 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)

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. 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 was important in relation to existing literature. They then investigated the question through a process which involved developing and testing hypotheses using secondary sources.

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. 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 suggests these differences may reflect that the students are 18 months to two years ahead in terms of learning skills (Justice *et al.*, 2009).

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 undertake an eight-week project in which they collect 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

March 2009

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.

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

2.3 Business, 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/>

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. An ICT 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

March 2009

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.

March 2009

- 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 (2001)

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

'Skills 4 Sustainability' is a first year course in which (skills for) enquiry-based learning is embedded in a module on sustainability. The module is delivered from weeks 1-12 of the first semester by a team of 8 tutors to c.150 students with no formal lectures. Students are organised into tutor groups according to their subject specialism with a tutor. 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..

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. 50% of module marks is the creation of an individual e-portfolio which is built up throughout the module which requires 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

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.

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 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 team. 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 students work in groups of c6 like consultants to their client. 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

March 2009

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

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 senior year thesis proposal. Each junior seminar, which typically has between 8 and 24 students, has a different theme, geared to the faculty and students' interests; the example below is based on faculty research interests.

In 2007 Environmental Health, Justice and Development, students developed and evaluated an 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. The class then planned implemented and evaluated an outreach effort, which 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. 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.

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.allegheny.edu/employee/c/cwaggett/HHHC.html; for Caryl Waggett's Website see: webpub.allegheny.edu/employee/c/cwaggett/index.html; for a link to the Course Syllabus and Final Product and Poster see: webpub.allegheny.edu/employee/c/cwaggett/courseprojects.html.

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

March 2009

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 since 1996. 2 or 3 students work collaboratively on the development of a multimedia based analysis of one international journal article, interrogate and summarise 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. Authors generally reply positively to the questions 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/cfl/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.

March 2009

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.

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.

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.

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

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

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

March 2009

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)

2.7 History

History students contribute research findings to a Web site at Victoria University, Canada

In 2002, John Lutz implemented 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. Students worked in small groups to conduct the research and eventually to publish their findings on the website called "Victoria's Victoria". John reports that "The feedback I get often says, that if they remember only one course from university, this (course) will be it ... some alumni contact me to say that the web skills have landed them a job." John notes that the grades in Micro History 481 were approximately 8% higher than the grades that these same students received in other senior history courses that they take from him.

Sources: Anon (2003); <http://web.uvic.ca/vv/>

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)

Designerly 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 designerly 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 designerly thought and action across the curriculum. For their students, there are clear benefits in terms of personal development as reflective learners/ future practitioners as a

March 2009

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.

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

2.9 Interdisciplinary

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

Interactive Media Studies at Miami University is an interdisciplinary minor (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 debriefing 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

March 2009

was made. From the client's perspective, they get out of the box thinking that they would never obtain from a consultant firm. 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.
- 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/>; <http://www.miami.muohio.edu/academics/majorsminors/minors/ims.cfm>

Introducing first year students to interdisciplinary research: linking microbiology and art at Manchester Metropolitan University

First year biology students at Manchester Metropolitan are introduced to interdisciplinary research through an assignment in which they explore the links between microbiology and art, including their contrasting forms of research and inquiry. In an opening plenary the lecturer maps out the many and very diverse links between microbiology and art and their contrasting research dispositions. They are encouraged to use this interdisciplinarity in an associated assignment which requires the deployment of such links in the development of a 'product' (e.g. artwork, teaching aid, model, presentation, research paper).

Sources: [//resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm](http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm); <http://www.sci-eng.mmu.ac.uk/intheloop>

3. Linking Research and Teaching in Departments

3.1 Biosciences, Chemistry and Medicine

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

The 'Explorations Program' 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.

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 and Nottingham, 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 explicitly based on the US practice of undergraduate research journals (Kinkead, 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/). These showcase first class undergraduate research and support those undergraduates seeking academic research careers from these research-intensive departments. 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 <http://biohorizons.oxfordjournals.org/>

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/interventions including:

Year One c200 students

- Workshop on the use of animals in research: students put in the position of researcher, considering experimental design and animal ethics to complete an animal ethics application form
- Throughout the year, students 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

- Over several weeks an assessed task in which real, experimental data is given to the students for guided analysis and preparation as a manuscript 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?UnitId=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

March 2009

students present their research, and then all non-undergraduate audience members, except the facilitator, leave the room

Source: 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/

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. We lack firm details on some of the aspects of this activity. If anyone has them please contact us.

- 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.

March 2009

- 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/>

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>

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/cfl/reflexions/volume01/issue01/Ways_of_Knowing.htm

March 2009

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

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.

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)..

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. Philip England (2007) of the department of earth sciences at Oxford University, comments on the culture of his department:

"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 (2007) analysis of the department observed that:

"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."

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 (Willinson and O'Regan, 2007).

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 (Fraser *et al.*, 2007).

Source: Willison and O'Regan (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

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).

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

March 2009

enables a variety of different spatial configurations and facilitates easy flow from one type of activity to another – including, for example: 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 elements of 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)

4. Linking Research and Teaching in Institutions

4.1 Europe

Undergraduate Research Opportunities Programme (UROP) at Imperial College London (UK)

<http://www3.imperial.ac.uk/urop>

The Undergraduate Research Opportunities Programme (UROP) gives students the chance to take part in the activities of College research groups. Founded in 1980, this is the earliest example of such a programme in the UK and was directly based on the MIT scheme. The scheme focuses on students in year two and is often used to develop ideas for their final year dissertation or project. While most projects are undertaken in the summer they can also take place in term time. Students are awarded bursaries for their work from a variety of sources but most commonly from supervisors’ research funds, general departmental funds or external funds such as the Nuffield Foundation’s Undergraduate Research Science Bursaries. The scheme is also open to students from outside from Imperial. Over 3,300 students have participated since 1980. In 2005-6, 320 students participated of whom 185 were from Imperial (mainly summer 2006).

Undergraduate research at University of Gloucestershire, UK begins at induction

In 2007 over 650 students in the Faculty of Education, Humanities and Science undertook discipline-based inquiry projects during induction week. This involved them working in small groups to collect information from the library and in the field, analyse it, present it to tutors in novel ways, and receive formative feedback. For example, the human geographers and the sociologists researched the experience of Gloucester residents of ‘the Great Flood of 2007’. The Biologists and the Psychologists investigated primate behaviour at Bristol Zoo, while English Literature students visited an arboretum and explored the use of trees in literature. It has proved a significant staff development activity both for the many academic tutors and the library staff who changed their approach to library induction to support the specific student research projects. Over the next two years other Faculties in the University are developing their versions of developing undergraduate research as part of induction.

Source: Further information is available at: <http://resources.glos.ac.uk/ceal/pre-induction/index.cfm>

Integrating staff and students at different levels through 'subject families' at Oxford University, UK

As part of overall institutional planning, Oxford University is using the idea of 'subject families' to help integrate undergraduates and postgraduate students with research staff and academics in the Colleges. Periodically students and staff in related subjects come together for academic and social activities which showcase and discuss current research by College members. These changes have also opened up opportunities to develop inter-disciplinary links and for undergraduates to appreciate better the research done by staff in their college and the prospects for some of them of pursuing research careers. This may be an idea that other institutions could adapt for departmental implementation.

Sources: Correspondence with Claire Stocks; University of Oxford (2005);
<http://www.st-annes.ox.ac.uk/study/undergraduate/subject-families.html>

Southampton Solent University: Advanced scholarship strategy

In 2000 the institution had a special meeting of its then two totally separate committees for teaching and research. The meeting was solely concerned with teaching-research relations at the institution. A 'full and frank discussion' ensued, but from it emerged greater understanding of the issues and the development of a set of 'horizontal strategies' at institutional and faculty levels to bring teaching, research and scholarship together, including the Advanced Scholarship Strategy. This requires and supports all staff to be involved in work that directly focuses their scholarly and research time on scholarship supporting student learning. Such work varies by disciplinary groups across the institution, but has to result in a visible output in the public domain, carry peer esteem and contain an aspect of originality (Brown, 2003).

University of Roskilde (Denmark): Half of the work of all students is spent undertaking projects (www.ruc.dk/ruc_en/about/)

At least 50% of student time in the assessed curriculum in five years from BA to MA is taught through project work. The projects involve students working in groups guided by staff. "Problem-orientated project work ... [is] participant directed indicating that it is the group members that collectively ... take the responsibility for the project. ... The result is a body of knowledge owned for the most part by the students that produced it and not borrowed from the teachers who taught it" (Legge, 1997, p.5). The first two years are interdisciplinary group projects, later projects tend to be within one discipline and sometimes may be undertaken individually.

Oxford Brookes University (UK): Building undergraduate research into the curriculum

From 2007 all Schools / Departments are required to develop a more structured approach to developing all students as researchers in all course programmes in years one and two; and through specialist pathways to support those students who choose a more extended research curriculum. Such pathways may include a focus on community-based undergraduate research. The requirements build on a previous university-wide intervention. In the context of the move to semesters, in 2002-3 all undergraduate and taught postgraduate courses were redesigned with the requirement that they 'demonstrate how the linkages between research and teaching and learning are realised in the formal curriculum and the wider student experience.' This process was overseen by a university-wide steering group, the Redesign Advisory Group.

Source: Huggins *et al.* (2005; 2007a)

Embedding undergraduate research and inquiry at the University of Gloucestershire, UK (<http://resources.glos.ac.uk/adu/clt/taframework/index.cfm>; resources.glos.ac.uk/ceal)

Following a nine-month development and consultation process the University has adopted a new Learning, Teaching and Assessment Strategy. The core value underpinning the Strategy is 'learning for life through active engagement.' Drawing on work of the Centre for Active Learning undergraduate research and inquiry are key elements of the engaged learner. To be inclusive of different academic disciplinary and professional cultures a broad definition of the undergraduate as researcher is used in the university to describe student engagement at all levels in research and inquiry into disciplinary, professional and community-based

March 2009

problems and issues whether individually or in groups and in collaboration with or independently of staff. The strategy is underpinned by research into 'Leading, Promoting and Supporting Undergraduate Research in the New University Sector' (resources.glos.ac.uk/tli/prsi/current/ugresearch/index.cfm).

Integrating staff and students at different levels through 'subject families' at University of Oxford, UK

As part of overall institutional planning, Oxford University is using the idea of 'subject families' to help integrate undergraduates and postgraduate students with research staff and academics in the Colleges. Periodically students and staff in related subjects come together for academic and social activities which showcase and discuss current research by College members. These changes have also opened up opportunities to develop inter-disciplinary links and for undergraduates to appreciate better the research done by staff in their college and the prospects for some of them of pursuing research careers. This may be an idea that other institutions could adapt for departmental implementation.

Sources: Correspondence with Claire Stocks; University of Oxford (2005); <http://www.st-annes.ox.ac.uk/study/undergraduate/subject-families.html>

4.2 Australia

Australian National University: Introduction to Inquiry

(<http://www.anu.edu.au/CEDAM/ilearn/inquiry/index.html>)

The University aims to ensure that ALL their undergraduate students are introduced to inquiry learning from the beginning of their program of study. An inquiry-based approach to learning involves students directing their learning by formulating questions, defining problems and investigating issues relevant to their future roles as researchers and professionals. Examples are presented from courses on The Big Questions in Physics; Human Biology; Resources, Environment and Society; Money, Power, War; Science and Public Awareness; and Introduction to Psychology. The site also includes two examples of inquiry-based learning in more advanced courses.

The University of Queensland, Australia, funds research staff to engage in teaching

Since 2006 the University of Queensland has used some of the money raised through the Enhanced Student Contribution (levied at 25% additional charge to students) to pay for research staff to engage in teaching at undergraduate and/or graduate coursework level for 10 or 25% of their time. In 2009 AUS\$4 million has been set aside for this purpose.

The scheme, named ResTeach, is designed to remove a frequently stated impediment to utilising research staff, namely resource allocation, and thereby:

- expose students to key researchers, who hopefully can convey the excitement of their field;
- improve the student: teacher ratio in an effective and efficient manner;
- provide an opportunity for interested researchers to expand their portfolio;
- strengthen the relationship between research and teaching to improve the student learning experience, and
- reduce the teaching loads of existing T&R academics.

The primary purpose of ResTeach is to improve the learning experience of students, not to be a prime source of funds for centres or institutes or the operating budgets of schools. A review of the scheme in 2008 concluded that "the ResTeach scheme is now a key component of UQ's strategy to link teaching and research and is, in fact, one of the few mechanisms that has effectively supported the teaching-research nexus."

Sources: <http://www.uq.edu.au/teaching-learning/index.html?page=92623f>; Correspondence with Deborah Terry, 30 Oct 2008

Monash University and University of Sydney: Teaching and Research Nexus Benchmarking Project
<http://www.adm.monash.edu.au/cheq/about/cheq-docs/council-rep-04/quality-report-council04-att3.html>;
<http://www.adm.monash.edu.au/cheq/academic/>; <http://www.adm.monash.edu.au/cheq/academic/trn/gw-trn-discussion-paper.pdf>

In 2004 a benchmarking process based investigation between these two research-intensive universities concluded: *“The teaching-research nexus is clearly identified in strategic plans in both universities, but both could benefit from a more integrated approach. The nexus is also reflected in Learning and Teaching Plans, but does not necessarily cascade into all plans.”* The aim of the Benchmarking project was to analyse methods of implementing the teaching-research nexus, and compare performance in nominated areas. A six-stage process was developed:

- establishing the partnership;
- setting the framework (areas of comparison and matrix);
- securing a Memorandum of Understanding between the two institutions;
- applying the framework;
- benchmarking, self evaluating; and
- generating recommendations.

The investigation involved senior staff working in their respective institutions with a limited cross over membership steering the cross institution process. While performance indicators were developed and used in this study, the central view was that the key value of benchmarking was examining and improving policies and processes within the two institutions. The ‘other institution’ and what was seen internationally as ‘best practice’ in effectively linking teaching and research, served as mirrors to examine and to improve each institution’s practices and policies.

Contacts: Dr Jennifer Weir Centre for Higher Education Quality, Monash University (now at Murdoch University); Dr Angela Brew, Institute for Learning and Teaching, University of Sydney

University of Sydney: Strategic use of performance indicators to stimulate linkage of teaching and research

The purpose of the Performance indicators is to provide a mechanism for auditing progress towards reaching the university’s strategic goals for strengthening the relationship between teaching and research, and to encourage the development of research-enhanced teaching.

Examples of performance indicators

- Student awareness of and active engagement with research
- Undergraduate and postgraduate student awareness of the research culture of the university and the research being done in their school/department/faculty
- Curriculum designed to engage students in a variety of research-based activities, induct them into the research community and develop their awareness of research
- Proportion of units where students engage in research-based activities
- Existence of an advertised student research seminar program or evidence of engagement of undergraduate students in departmental seminars
- Audit of research-led teaching carried out on a triennial basis and benchmarked with other Universities

Although these performance indicators for promoting the links between teaching and research were discussed, an implementation policy backed up by redistribution of resources has not been put in place.

Source: Brew and Prosser (2003)

Griffith University: Identifying programmes including research-based learning component

To meet the strategic target that ‘70% of all Griffith programs include a research-based learning component by 2010’ the University has developed a policy to define what evidence is needed for a program to satisfy the minimum requirements to qualify as including a ‘research-based learning component’ and the criteria against which Course Convenors should assess whether their courses contain such components.

March 2009

For a program to contribute to meeting the University's strategic performance indicator for research based learning at least 20% of the student course enrolments are in courses identified as having significant elements of research-based learning. Course Convenors assess their courses against the following categories:

- Systematic introduction of a significant amount of current discipline related research into the course content and teaching
- Use, as the primary pedagogical approach for the course, of inquiry-based processes that are modelled on the research approaches that are common in the discipline or field
- Research methodology courses are included in the undergraduate program.

Development of 'public scholarship' at Griffith University and University of Western Sydney, Australia

www.griffith.edu.au/ua/aa/plans/academic/; www.uws.edu.au/community/in_the_community/oue

Griffith University is using the concept of 'public scholarship' as a distinctive feature of the University's learning activities to refer to "the opportunity (for students) to work with real problems, and in doing so to place their knowledge at the service of our communities. This ... finds expression through our commitment to work-integrated learning and to research based learning" (Griffith University, 2007, 1). They see benefits for both the students and the external agencies with which they interact.

Public Scholarship "is a form of research-based learning that facilitates stronger integration of staff and student research and learning into the lives of communities beyond the university by:

1. providing academic staff with a way to demonstrate how their scholarly research informs and is informed by the needs and values of local, national and international communities; and
2. enabling students and staff to engage effectively with community problems by building reciprocal connections between their university learning and local and global problems" (Green and Krause, 2008, 2).

The University of Western Sydney (UWS) has established an Office of University Engagement. It provides "a focal point for activities that engage the community in the core business of the University. Engagement at UWS is viewed as partnership, for mutual benefit, between the University and its communities, be they regional, national or global. Engagement is also seen as a distinctive way of carrying out research, teaching, learning and service."

Sources: Colbeck and Wharton-Michael (2006); Green and Krause (2008); Griffith University (2007); Krause (2007)

4.3 New Zealand

University of Victoria, Wellington: Awards the teaching-research linkage

<http://www.utdc.vuw.ac.nz/excellence/>

Teaching Awards are 'awarded to applicants who demonstrate excellence in integrating their academic research effectively in their teaching, engaging undergraduate students in research, and or carrying out research on teaching and learning in their disciplines' (Angelo and Azmar, 2005).

Auckland University of Technology: A broad definition of the teaching-research nexus is rewarded

(www.aut.ac.nz/staff/office_of_the_vice-chancellor/awards.htm;

www.aut.ac.nz/resources/staff/academic_quality_office/academic_audit/qualityportfolio_15.pdf)

'Establishing a nexus between teaching and research that enhances students' learning' is one criteria for the VC's Awards for Excellence in Teaching. They adopt a broad definition of what they mean by the teaching-research nexus:

"AUT, in its establishment of a framework for research development has embraced the notion of 'scholarship' as an overarching term that permits it to provide a different perspective on the traditional dichotomies of theory and practice, research and teaching, teacher and student. Thus research, education and development activities are all informed by, and require, scholarly inquiry. This view acknowledges that the conduct of research goes beyond the measures available, for example in the PBRF and assumes that all advanced professional practice undertaken by academic staff – in their various roles as teacher, researchers, professional practitioner, developer, or consultant – is based on investigation and inquiry, but that such inquiry can take a number of forms with varied outputs."

AUT Audit Portfolio 2006, 49

4.4 United States

Massachusetts Institute of Technology: Undergraduate Research Opportunities Program

(<http://mit.edu/urop/>)

The Undergraduate Research Opportunities Program (UROP) supports research partnerships between MIT undergraduates and academic staff. Formed in 1969, it is one of the earliest such programmes. "UROP projects take place during the academic year, as well as over the summer, and research can be done in any academic department or interdisciplinary laboratory. Projects can last for an entire semester, and many continue for a year or more. UROP students receive academic credit, pay, or work on a voluntary basis." MIT is now working with the department of engineering at Cambridge University (UK) to develop an undergraduate research programme there (<http://www.eng.cam.ac.uk/teaching/urops/>). MIT conducts an audit of UROP participation among graduating seniors each year. For the class of 2004, 82 per cent of graduating seniors had participated in UROP at least once during their undergraduate careers (personal communication, 2005).

Mainstreaming Undergraduate Research and Inquiry at Miami University, Ohio, US

Miami University, Ohio is moving from a teaching paradigm to a leaning and discovery paradigm. *The TOP 25 project* calls for innovative approaches that moves learning away from "too much time telling students what we think they need to know, and not enough time using their curiosity to drive their learning." The TOP 25 Project involves the largest recruiting courses (actually 31 of them) being rewritten as inquiry-based courses. Each course has been allocated \$35,000 to fund curriculum revision. Learning technologists and educationalists support the teams of staff involved. Seven or eight courses pa are being redesigned over a four year period. Together the courses account for almost a quarter of total credit hours. All courses with more than 1,000 credit hours are in the programme. Many of the courses are being redesigned using the inverted classroom model in which most of the lectures are provided electronically using, for example, videos, I-pods, and VLEs, while most of the contact time is used for interaction between faculty and students. Some of the physical spaces are being redesigned to provide flexible furniture to encourage discussion.

Sources: Hodge *et al.*, 2007; 2008; http://www.units.muohio.edu/led/Top_25_Project/Index.htm

Undergraduate research programmes to support first year success racial and cultural diversity and widening participation: University of Michigan, US

A number of Undergraduate Research Opportunity Programs (UROPs) focus on what in the UK would be called 'widening participation'. At the University of Michigan there is targeted support for largely Afro-American students from inner-city Detroit. While the University had been successful in recruiting these students, their drop out rate was high. Special UROPs were targeted at these students in year one and two to enhance their integration and academic success. There has since developed related projects to support

March 2009

transfer students into Michigan from community colleges and four-year colleges. Research demonstrates significant positive impacts. In addition linked to the University wide UROP programme a first year residential programme for some 80 students is aimed at culturally and geographically diverse US students and international students. Research is conducted with selected faculty and supported by resident second and third year peer mentors.

Source: Huggins *et al.* (2007); Locks and Gregerman (2008); <http://www.lsa.umich.edu/mrc/index.htm>

The Stanford University Research Communication programme

www.stanford.edu/group/i-rite/

The I-RITE and I-SPEAK programs provide faculty, postdoctoral scholars, and advanced graduate students with time-efficient, intense training in effectively communicating their ideas to a broader audience.

Participants in I-RTIE work on crafting a written statement that describes their research in understandable and compelling ways to high school seniors or university undergraduates, while participants in I-SPEAK produce and practice readily understood oral presentations on their work.

Final Year Project Presentation at Alaska Pacific University

At Alaska Pacific University, a small private university, all students in all disciplines undertake a senior project and present it to the campus community on designated days at the end of each semester. Thus students experience both the experience of doing research, but also communicating it through spoken presentation.

The institution has a strong commitment to active and research based learning and they now market themselves as "The University of Active Learning." They have a strong year one orientation to active learning and a range of required courses in all years involving research techniques and projects which lead into the required final year Senior project. This has a strong applied focus. As well as a formal research paper, students in discipline groups (mainly Environmental Sciences, Human Services, and Business) present their research as a professional public presentation. These end of semester presentations are advertised for the faculty, staff and students, as well as interested members of the public. Other classes are cancelled so that the student body may attend. Often members of the site where the investigation takes place attend. The final assessment is on the 40-60 page research paper, the quality of the presentation and handling of questions at the presentation. While numbers of graduating students are small (c70 per year) the idea of a public presentation as part of the final year project could be adapted by larger departments and institutions.

Sources: Correspondence with Carl Hild; <http://distance.alaskapacific.edu/course/info.php?id=387>
<http://www.alaskapacific.edu/Pages/default.aspx>

Arts of Citizenship Program at the University of Michigan, US

In this program students combine learning and research with practical projects that enhance community life. Each year Arts of Citizenship directly sponsor 8-12 projects, and awards grants for another 8-12 projects. Projects in the arts, the humanities, and design are wide-ranging and include:

- In the Underground Railroad project, Arts of Citizenship has collaborated with the African American Cultural and Historical Museum of Washtenaw County to research 19th-century antislavery activism and African American community life in the area. The youth-oriented historical exhibit, Midnight Journey, has
- In partnership with Detroit's Mosaic Youth Theatre, Arts of Citizenship teams used oral history and archival research to help create 2001 Hastings Street, a nationally touring musical drama about coming of age in 1940s Detroit. The production and an accompanying exhibit were part of the celebration of the Detroit's 300th anniversary in 2001.

David Scobey (2006), the key originator of this programme has now led its adaption to a whole institution initiative, and its adaption to other disciplines - The Harvard Center for Community Partnerships - at Bates College Maine.

Sources: www.artsofcitizenship.umich.edu/about/program.html; www.bates.edu/harward-center.xml

Hampshire College: Linking research and teaching is key element of the college's mission (<http://www.hampshire.edu/>)

Hampshire is a small private liberal arts US college focused on self-initiated, individual research programs of study negotiated by students with academic staff. More specifically:

- *Beginning and Division 1 Requirements:* 'Students must formulate substantive questions on a range of specific subjects and then reflect critically on the implications of the analytical frameworks and methods they used in pursuing the questions' (Prince and Kelly, 1997, p.7).
- *Division 2 Requirements:* 'Working with at least two or three faculty, students ... define a substantive area of study and then specify key questions that will serve as general guides through the concentration... In the second step ... the student designs a program of study, including ... independent study' (ibid., p.8).
- *Division Three and Capstone Requirements:* This is 'primarily devoted to a ... thesis or artistic project' (ibid., p.9).

Southern Illinois University: Paul Simon Award (<http://www.siu.edu/graduate/internalgrants/simon.shtml>)

The Paul Simon Outstanding Scholar award is presented to an SIUE faculty member in order to recognize the role of research and creative activities in excellence in teaching. The Award confirms SIUE's belief that an individual must be a good scholar to be a good teacher. A plaque and a \$5,000 award, routed through the payroll system, is presented to the honoree. The Simon Award will not be given automatically each year; it will only be awarded when a nominee of superior merit is selected. Only one Award will be given annually. The Simon Awardee will be expected to make a presentation for graduate students and faculty about integrating research into teaching activities during the Graduate School Research Symposium.

First-year on-line introduction to research course at Virginia Tech University, US

The Undergraduate Research Institute at the College of Liberal Arts and Human Sciences at Virginia Tech is piloting in 2008-9 an on-line course to introduce students to undergraduate research.

. LAHS 2984: Introduction to Undergraduate Research spans both semesters. Assignments vary from readings that help students understand the culture of a research university and the importance that research plays in university life, to them attending the Undergraduate Research Institute Kickoff and experiencing the Virginia Tech Undergraduate and Prospective Graduate Student Research Conference. Students are not just exposed to what research means in their major field of study, but gain an interdisciplinary perspective by examining the ways that research and creative work is conducted across disciplines.

In its first year enrolment is limited to c30 students – but the intention is to use this 'experiment' to then 'scale-up' the course so that it can support many students by crafting assignments that would be thought provoking and informative but easily evaluated by graduate students and second year students who have passed the course.

Sources: Correspondence with Diana Ridgwell, Director of Student Development and the Undergraduate Research Institute, College of Liberal Arts and Human Sciences, Virginia Tech.
(<http://www.uri.clahs.vt.edu/Student%20Resources.html>)

4.5 Canada

University of British Columbia: University-wide research-based learning experience (<http://www.trek2000.ubc.ca/index.html>; <http://www.research.ubc.ca/UGConf.aspx>)

TREK 2000, 2010 and the University Academic Plan state that every undergraduate should have the opportunity to engage in research should they desire. The Undergraduate Research Committee out of the VP Research Office developed the Multidisciplinary Undergraduate Research Program (MURP) in 2004. Supported by a Teaching and Learning Enhancement Fund Grant (TLEF), MURP's goal is to develop a

March 2009

cohesive undergraduate research program at UBC that will support the enhancement of research experiences for our undergraduate students.

Undergraduate students are selected from all possible disciplines to participate in this novel and exciting program. Students who participate have the opportunity to develop skills to support a research project they are involved in within their discipline (be it through directed studies, honours programs, volunteer work or research assistantships).

University of Alberta: Institution-Wide Project 'Research Makes Sense to Students'

[\(http://www.uofaweb.ualberta.ca/researchandstudents/\)](http://www.uofaweb.ualberta.ca/researchandstudents/)

The University of Alberta has introduced a "Research Makes Sense for Students" initiative under the Office of the VP (Research). Some of the activities undertaken through this initiative have been an 'Integrating Teaching and Research Awareness Week' aimed at faculty and graduate students, promotion of undergraduate research linked to the student orientation week organised in conjunction with the Student Guild, a university-wide environmental scan of teaching-research linkages, and specific policy and funding proposals to strengthen teaching / research connections.

McMaster University: Inquiry-based courses available across the curriculum

<http://www.mcmaster.ca/cil/inquiry/index.htm>

The University has a tradition of innovative problem-based learning in medicine and engineering. In 1998 it launched an initiative to develop an inquiry-based approach across the whole curriculum, starting initially in selected courses in years one and two. "Inquiry courses are skill-driven rather than content-driven, focusing on the skills required to perform effectively at university and well beyond university. These generalizable skills help students hone skills equally useful for advanced levels of academic research." This is supported through the teaching development unit and through programme leadership responsibilities for senior staff. Teaching is done in teams of generally research active, tenure stream staff, with a three-year rotation, reflecting the commitment needed to teach such courses, but also better ensuring that the skills of inquiry teaching are disseminated across the university.

Some 20% of students in year one and two take at least one inquiry-based course and the research evidence is that such students generally achieve well in subsequent courses. The institution is now faced with the challenge of scaling this innovation across the whole institution or keeping it for those students who select these perhaps more demanding courses (Elliot, 2005; Sutherland, 2005).

For details of the research evidence on the beneficial impact of the Social Science Inquiry course see section 2.2 above

University of Toronto: Awards for Linking Teaching and Research

<http://alumni.utoronto.ca/s/731/index.aspx?sid=731&qid=1&pgid=663#frye>

The Northrop Frye Awards are co-sponsored by the University of Toronto Alumni Association and the provost of the university. Annually one individual faculty member and one department or division are recognized with the award for demonstrating exemplary and innovative ways of linking teaching and research.

McMaster University: Petro-Canada Young Innovator Award

<http://www.mcmaster.ca/cil/awards.and.recognition/petro.canada/index.htm>

The Petro-Canada Young Innovator Award is a program that provides the opportunity for McMaster to build on this connection and engage undergraduates in faculty research to deliver greater benefits for undergraduate education. Campus-wide recognition for innovative research achievement by a young faculty member. \$25,000 support for a candidate designed project to make this research accessible to undergraduate students. Under normal circumstances, the project needs to be completed in the year following receipt of the Award.

University of Calgary: Student inquiry strategy

(www.ucalgary.ca/mp2003/AnnualReports/AR2006-07.pdf)

The University has an institutional strategy that sees student inquiry as 'core to a research-intensive university'. The e-learning strategy has been reshaped to directly support student inquiry with a focus on developing 'communities of inquiry' using computer conferencing.

5 Linking Teaching and Research in Postgraduate Courses on Teaching and Learning in Higher Education

University of Plymouth (UK): Teaching Research

(<http://www.plymouth.ac.uk/pages/view.asp?page=17290>)

A 20-credit Masters level module on 'Teaching Research' within the Learning and Teaching in Higher Education course provides the opportunity for both new academics and established members of staff to examine the links between research in their own discipline and their teaching. The intended learning outcomes are that participants should be able to construct theoretically-informed arguments about the relationship between teaching and research, explain and justify their own position with regard to becoming/being a teacher of research and explain the principles and critically appreciate the practices of teaching research.

University of East Anglia (UK): Research-Led Teaching

(<http://www.uea.ac.uk/lhi/rttl/>)

As part of a University wide project on Research led teaching MA in Higher Education Practice comprises six individual units and short courses covering additional topics. Unit 2 focuses on research-led teaching and learning (<http://www.uea.ac.uk/lhi/rttl/ma.html>). Participants produce a reflective report on the development of research-led teaching and learning in their area of practice to include:

- a statement of current practice of 'research-led teaching and learning' in the particular profession or discipline in which you work
- a personal audit of teaching skills based on self-reflection and peer observation
- a description of how research informs teaching in your field currently,
- organisational and other constraints to developing the link between research and teaching more closely, and ways in which you think it might be possible to overcome these
- identifying strategies for enhancing research-led teaching and learning in practice in your field
- an action plan for you to develop your own work.

University of Northumbria (UK): CPD Module

(<http://www.northumbria.ac.uk/static/worddocuments/resdocs/rtmodule.doc>)

Staff at Northumbria can take a module on 'The Link between Teaching and Research.' As well as presenting conceptual frameworks and key research evidence, participants are supported in an initiative in their practice that seeks to enhance the links. Specifically they produce "a 3,000 word report on the development of a project/approach aimed at strengthening the link between teaching and research in your own work contexts. This report will draw on the research evidence, models and conceptual frameworks introduced in the module and contain reflections on the implementation and critical evaluation of the project/approach (or plans for implementation and evaluation)." This module is part of the Academic Practice Programme. The programme offers accredited and unaccredited CPD, comprises a wide range of optional modules and is extremely flexible. Modules can be taken as freestanding units or to contribute to one of the PG awards: PGCert, PGDip, MA and Professional Doctorate. This module is linked to a university wide initiative in linking teaching and research supported by HEFCE's Research Informed teaching fund (<http://northumbria.ac.uk/sd/central/ar/lts/researchandteaching/>)

Source: Above websites and correspondence with Nicola Reimann, University of Northumbria

March 2009

Nottingham Trent University (NTU, UK): Research Informed Teaching

http://www.ntu.ac.uk/apps/pss/courses/cf/60565-1/10/PGDip_Research_Informed_Teaching.aspx

NTU have introduced a Postgraduate Diploma (PGDip) in Research Informed Teaching which helps members of academic staff develop skills in research practice in order to become better placed to teach and to supervise projects at undergraduate / postgraduate / PhD level. It is aimed particularly at those lecturers who have previously worked as practitioners before entering university teaching, and have therefore joined the university sector as teachers in mid-career. It offers a teaching and learning experience for lecturers who wish to familiarise themselves with the skills and perspectives that inform current research practice, and who wish to gain direct experience in conducting high-quality empirical research.

6 Teaching and Learning Courses integrated into Doctoral Programmes

Stanford University (USA)

[\(www.stanford.edu/group/i-rite/\)](http://www.stanford.edu/group/i-rite/)

The I-Rite Program provides training to doctoral students (and mainstream researchers) on how to write and communicate their research to a wider public, including new students in their discipline (Marincovitch and Reis, 2000). See also section 2.1.

Madison University (with Michigan State University and Pennsylvania State University) (USA)

<http://cirtl.wceruw.org/index.html>

The Center for the Integration of Research, Teaching, and Learning in science, technology, engineering, and mathematics focuses on changing the practice and culture of graduate training, through developing their understanding and practice of 'teaching as research' (Mathieu, 2004).

University of Oxford (UK)

<http://www.learning.ox.ac.uk/oli.php?page=196>

The Centre for Excellence in Preparing for Academic Practice, started in September 2005, is adapting the ideas of the US doctoral initiatives above to the UK context. It involves three areas of activity:

- increasing the teaching development support and teaching opportunities for Oxford research students and contract research staff;
- sharing knowledge about preparing future academics across a network of seven institutions;
- a continuous contribution to local and international knowledge through investigations of practice.

Rather than seeing teaching development as an addition to research, the pedagogic intent of the planned programmes is the integrated development of competencies in teaching, research, and graduate transfer skills. Scholarship of teaching will be introduced as an activity aligned with research thinking.