

International perspectives on integrating research and inquiry into the curriculum from the first year onwards

Presentation to University of Sydney Teaching Colloquium

Engaged Enquiry in the Curriculum

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Fig. 1 The nature of student research and inquiry Source: Healey and Jenkins (2009, 7; amended from Healey, 2005, 70)

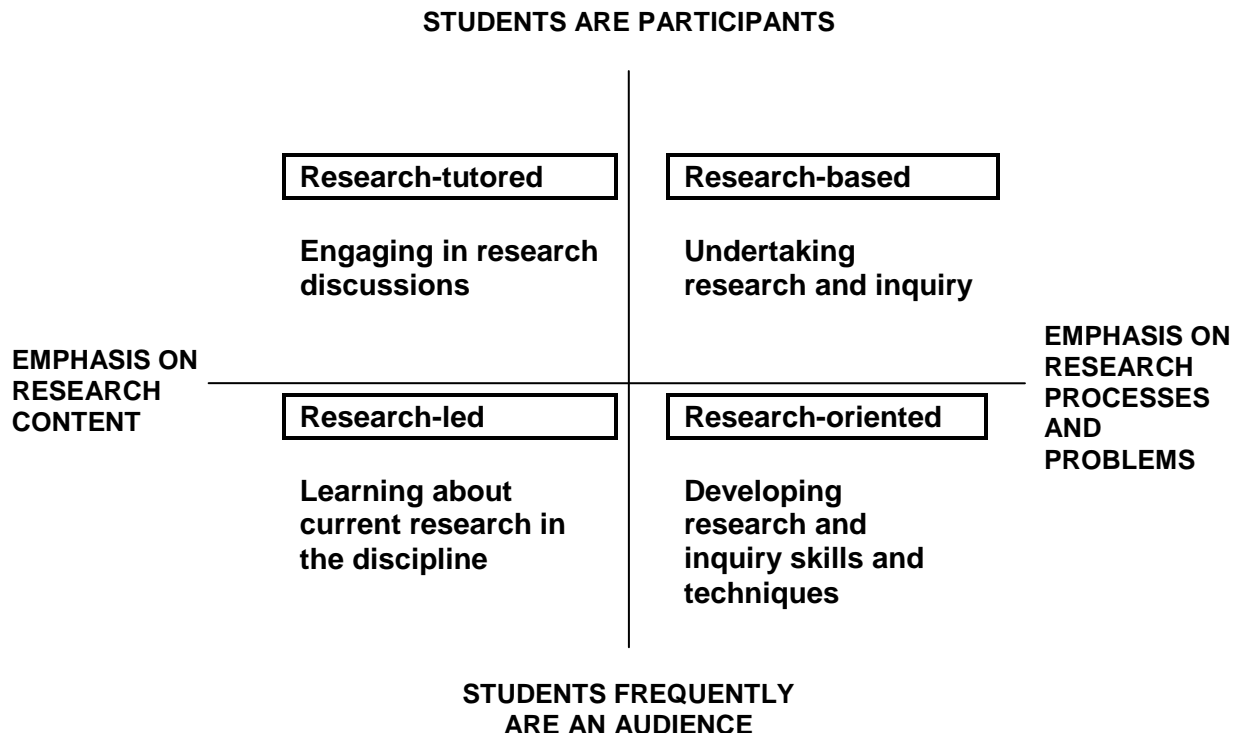
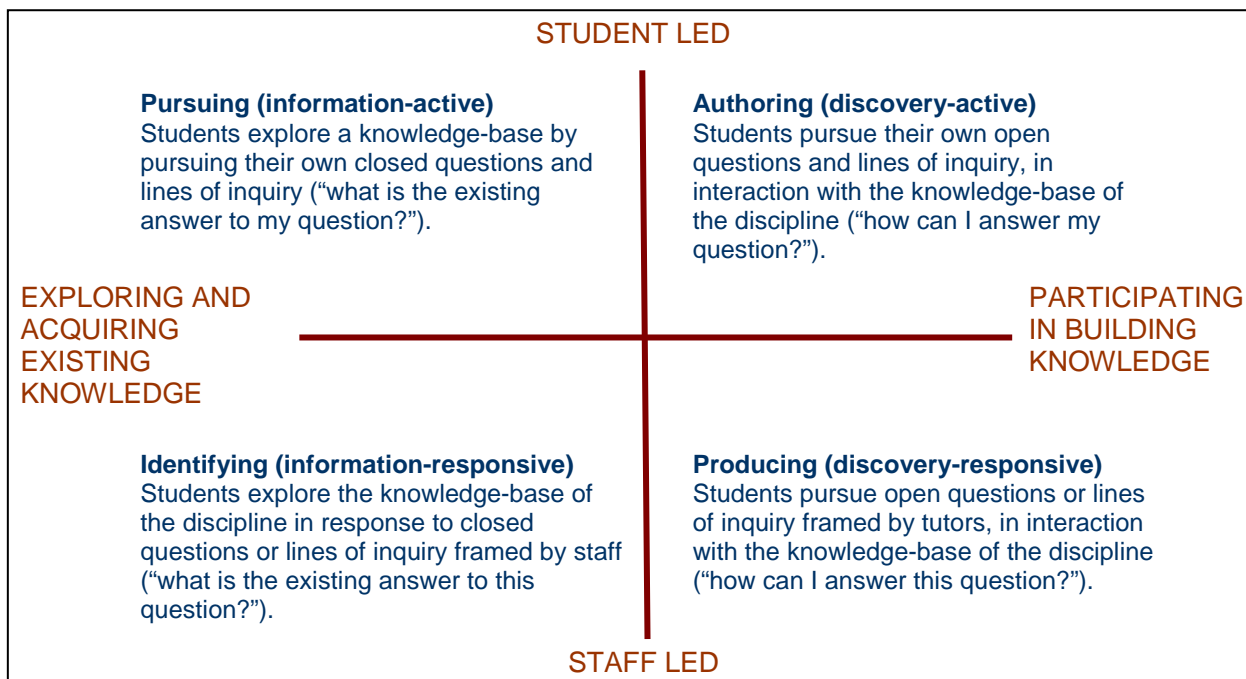


Fig 2 Inquiry-based learning: a conceptual framework Source: Based on Levy (2009)



1: Engaging students in research and inquiry in the first year and introductory courses

1.1 Undergraduate research at the 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. Other faculties in the University are developing their own versions of undergraduate research as part of induction. It has also proved a significant staff development activity both for the many academic tutors involved in designing inquiry-led activities and for the library staff who changed their approach to library induction to support the specific student research projects.

Further information

resources.glos.ac.uk/ceal/pre-induction/index.cfm

1.2 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, who are subdivided into groups of four or five students. 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. Students investigate aspects of a broad social science theme, such as 'self-identity', and address 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 investigate the question through a process that involves developing and testing hypotheses using secondary sources. As detailed in section 8, there is strong research evidence of the positive impact of this inquiry course on the subsequent performances of students at McMaster University.

Further information

Justice *et al.* (2002, 2007a, 2007b, 2009); socserv2.mcmaster.ca/Inquiry/CourseOutline.htm;

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

Students in the first-year core course in 'Writing and Cultures' investigate how the forms of writing, and the methodologies for researching writing and culture, are being transformed through web-based communication. Through this reading and writing intensive seminar, students investigate how digitised technologies are transforming the forms of writing and communication. The course culminates in a group assignment where students, using secondary and primary sources, investigate an aspect of contemporary culture (e.g. dating, shopping) and how the forms of communication are being reshaped by the internet. They produce a multimodal website that includes text, digital images, audio and video. The course fulfils institutional requirements for the liberal education goal of critical thinking.

Further information

www.users.muohio.edu/mckeeha/h101-09; www.users.muohio.edu/mckeeha/h101-09/final_project.html;
www.units.muohio.edu/led/principles.htm

1.4 Psychology students research students' quality of life at York St John University, UK

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

Further information

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

1.5 Inquiry-based learning in first-year Information Management at the University of Sheffield, UK

'Inquiry in Information Management' is a first-year, second-semester core module with an enrolment of about 30. The course aims to induct students into learning as a community of researchers in a professional applied discipline. Students work in groups on research projects from generating their own valid, practical and worthwhile research questions (e.g. student awareness of the environmental impact of mobile phones) through to presenting findings at a research 'mini-conference'. Work on these projects starts in the fourth week, following a series of preparatory workshops, which include exploring their conceptions of 'research' and how to pose and investigate research questions in Information Management. In the final week, guests at the mini-conference include PhD students, lecturers and researchers, and the Head of Department. All guests contribute to assessment of research posters, using criteria that the first-year students on the module have established previously in collaboration with module tutors.

Further information

www.shef.ac.uk/cilass/cases/informationmanagement.html; Cox *et al.* (2008)

1.6 All first-year biologists have research experiences at Cornell University, US

The 'Explorations Program', which has been running since 1991, introduces Biology first-year undergraduates to research by Cornell faculty in the context of a course of 700 to 900 students. Large-scale funding has created 100 to 120 'experiences', each of approximately three to four hours, for groups of six to eight students. Most are designed to introduce students to the kinds of research problems on which the faculty member works. Programmes take place both in research labs on campus and at field sites near campus. The programme is structured so that each student is required to participate in one 'Exploration' per semester. For example, recent explorations have varied from 'how do you tell if animals have color vision?' to 'why do sperm whales swim in circles?'

Further information

www.reinventioncenter.miami.edu/Spotlights/spotlight.html; biog-101-104.bio.cornell.edu/BioG101_104/explorations/explorations.html

1.7 Improving interactions between first-year science students and researchers through an informal networking program at The University of Queensland, Australia

The Undergraduate Science Students Experience in Research (USSER) Network is an extracurricular program welcoming first year undergraduate science students to the research culture of The University of Queensland (UQ) from their first semester. The primary aims are to increase the frequency and quality of interactions between undergraduate science students and UQ researchers, to help students understand what a career in research entails, and the specific research being conducted by scientists at UQ. Of the three components to the USSER Network (lunches, tours and placements), the main component is the "Meet the Researcher" lunches, during which researchers meet with groups of undergraduate students over informal lunches each semester. These lunches take a round robin a 'speed dating' format, where 3-5 students and a researcher have a 10-15 minute conversations about research and career paths. Once time

September 2011

is up, the researcher moves to the next table to meet with a second, and finally, a third group of students. At the end of these three rounds, each researcher provides a short biography for the entire group, and students are able to mingle with the researchers they have common interests with for the remainder of the lunch. The design has been shown to foster conversations amongst small groups, and thus provide numerous, personalised interactions between the researchers and over 100 new science students at each event. In addition, students are invited to undertake guided tours of research facilities on the campus, and are supported in gaining work experience with research groups through a placement program.

Further information

Farrand and Myatt (2009); www.science.uq.edu.au/usser

1.8 1,000 biology students are involved in research at University of Sydney, Australia

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

Further information

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

1.9 Introducing students to academic staff research: Department of Geography, University College London (UCL)

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

- Each first year tutorial group is allocated a member of academic 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 a date is arranged 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; and c) how the interviewee's research relates to his or her teaching, other interests and geography as a whole.

Further information

Dwyer (2001)

1.10 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 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

September 2011

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 by the students.

Further information

www.ecoling.net/courses.html;

resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/activelearningcasestudies/index.cfm

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

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

Further information:

Zadnick and Radloff (1995)

2. Final year and capstone projects

2.1 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) A “health check” of football refereeing in Blackburn; b) Community Sport and Crime Reduction; and c) 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)

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

In May every year, final-year Tourism students at the University of Lincoln participate in a live virtual conference. This is part of their assessment for the semester-long unit (Social and Political Perspectives on Tourism). A conference is a useful vehicle for extending insight into the process and practice of knowledge creation and dissemination and for students to participate as in effect research disseminators. A VLE has made it possible: during the specified timeframe of one week, students do not have to be assembled in one place and can participate at any time. Feedback from them has been extremely positive and encouraging.

September 2011

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

2.3 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.

Sources: <http://ch-www.st-andrews.ac.uk/teaching/aims/Mod3441/a.pdf>

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

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

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

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

Team-based problem-based learning is used in the final year capstone course for the Environmental Management, Rural Management Environmental Tourism and Tropical Forestry degrees at the University of Queensland’s Faculty of Natural Resources, Agriculture and Veterinary Science to give students experience of research-based consultancy. It is a year-long course, team taught by an interdisciplinary staff (in recent years, a social scientist and an ecologist for the internal students, a multi-skilled environmental manager taking the external students). The staff solicit suitable ‘problems’ and clients among their contacts, for instance from government agencies, non-governmental organisations, or land care groups, or the private sector. The staff may help the client mould the topic to achieve appropriate degrees of difficulty, and equity in workload and difficulty across the student groups. The students work like consultants to their client, coping if the client changes the brief during the year (as many do a couple of times). They work in groups of about six students. The clients come to campus at least three times, for an initial briefing to their students, and presentations at the ends of first and second semester. They liaise with the students all year, usually off campus at their offices, and by phone and email. The staff give a flexible program of lectures in first semester, to prepare the students with skills they need towards each forthcoming step of their tasks, and in group processes. At the end of the year their report is ‘published’ (printed and bound) for the clients. Peer and self-assessment are used to distribute group marks among the contributors.

Source: Correspondence with Helen Ross, 2006

2.6 Bioscience students at Durham University have a choice of three different types of final year project

(a) Laboratory-based project

The laboratory-based project provides an opportunity to participate in the research being carried out by staff in the School. Many students are able to work in the research laboratories, alongside postgraduate and postdoctoral researchers, and all students have access to the full array of research facilities in the School. The project currently takes place over 5 weeks of full time research, and students are given a piece of work that can lead to concrete results in this period. Many undergraduate projects have generated data that has subsequently been incorporated into scientific papers, with the student as a named author. The project is assessed through a report, written in the form of a mini-thesis, and a short presentation. This module gives the student a taste of scientific research, and exemplifies the School's commitment to providing research-led education.

(b) Biology Enterprise

Biology Enterprise (BE) is project-orientated module, based on research in a commercial context, with self-selecting groups of 5 or 6 students working together. The learning context for BE follows the real-life scenario of the formation of a biotechnology spin-out company from an academic biosciences research group. Within this context BE aims to introduce students to: key processes of business start-up, specifically in the context of a spin-out of an innovation generated as a result of biological research; key factors and considerations that influence the decision making process of the commercialisation of biotechnological innovation; the necessary skills, knowledge and resources required to take biological innovation from concept through to credible commercial propositions; the purpose of a Business Plan and, using a self-generated idea, how to prepare and present a Plan for a research-led biotechnology spin-out. A core component of BE is an in-depth desk study of a biological topic to collate, review, critically appraise and present the scientific research evidence that underpins the self-generated idea for the biotechnological product or process. The content of this module will provide an introduction to key business processes such as ideas generation; market research; protection of intellectual property; raising finance, in addition to developing individuals' team working, project planning, time management and transferrable skills

(c) Biology into Schools

For students who see their future in science education, or other communication-based activities such as journalism, the Science into Schools module may provide an attractive option. As for the other research project options, it is research-led, but in this case the research takes the form of a systematic inquiry into the teaching and learning process. Students are required to prepare materials for teaching science in secondary schools, and to interact with teachers and pupils. After an initial training period, students spend at least 4h per week for 10 weeks in a local school. They are expected to graduate from classroom observation, to assistance in teaching, to an opportunity to undertake whole class teaching. They will also devise a special Biological Sciences project for the school, which they implement and assess. The module is assessed through a journal of activities, reports, a presentation, and a report by the host teacher. This module is focussed towards developing communication skills, as well as team working and interpersonal skills. This module is only available to a limited number of students, determined by participating schools.

Source:

http://www.dur.ac.uk/biosciences/undergraduate/courses/content/level3/lab_project_enterprise_schools/

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

Each student in a final year module is given an environmental geophysics problem and is asked to role play being a consultant recruited to address this problem for a client, either a local authority or a private land owner. They are required to design a solution, interpret field data and present their findings in a technical report and verbal format. Students are required to prepare and deliver a solo presentation to an open public meeting (20 minute session, including 5 minutes for fielding questions) describing their problem outline, methodology, data interpretation and recommendations. The audience includes Councilors (soon up for re-election) and members of the lay public (staff members and other students) who have a vested interest in the

September 2011

environmental issues. A disruptive group of 'eco-warriors' (usually noisy postgraduate students) also make an appearance! During their presentations, students must show appropriate local and environmental considerations and effective handling of heckling from concerned local residents and the 'eco-warrior' group.

Source: Thomas (2003)

2.8 Community-based Senior Capstone at Portland State University, US

During the final year each undergraduate student is required to participate in a Senior Capstone, the culmination of the University Studies program. The Senior Capstone is a community-based learning experience that:

- Provides an opportunity for students to apply the expertise they have learned in their major to real issues and problems in the community;
- Enhances students ability to work in a team context necessitating collaboration with persons from different fields of specialization;
- Encourages students to become actively involved in this community.

Each student works with a team of students and faculty. Each Senior Capstone must result in some form of summation, closing project, or final product that puts closure to the students' experience. Senior Capstones vary in length ranging from one term to three terms, depending on the specific nature of the Capstone.

Sources: www.pdx.edu/unst/senior-capstone;
www.oirp.pdx.edu/portweb/published_pages/prototype/themes/cp/capstone/

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

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

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

2.10 Unravelling complexity at Australian National University (ANU)

The final year synoptic capstone course involves students from each of the seven colleges/faculties examining different disciplinary ways to "unravel complexity". It is the first of what the ANU hopes to be a suite of "Vice-Chancellor" courses where "ANU researchers from different disciplines sharing leading research ideas and discoveries with students." The number of students taking the course increased from 70 (10 per College) in 2009 to 210 (30 per College) in 2010. They are selected on the basis of outstanding results and interest in and commitment to working in policy areas. The course has a weekly two hour panel of different high profile researchers speaking to the class on how different disciplines deal with complexity. Each panel typically consists of a range of speakers taking different perspectives on an issue, e.g. global financial crises, the collapse of empires, contemporary 'failing' states, pandemics, engineering and network failures and the moral and legal dimensions of these issues. Students in pairs then facilitate a tutorial discussion with about 16 of their classmates on this topic. As the course unfolds students are encouraged to apply methods and insights from different disciplines to each week's case example. Reflective and interdisciplinary thinking is encouraged through a learning portfolio being the major assessment piece for the course. Students commented that the course structure modelled likely work scenarios they were soon to be in – i.e. working in interdisciplinary teams on complex problems that need a diverse range of tools and perspectives to address.

Source: <http://insight.glos.ac.uk/tli/activities/ntf/urproject/casestudies/Pages/default.aspx>

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

Interactive Media Studies at Miami University is an interdisciplinary programme (including Computer Science, Engineering, MIS, English, Marketing, Graphic Design, Education, etc.) that brings together students and faculty to investigate how interactive media informs and transforms their disciplinary perspective. The programme has been running since 1996 and uses problem-based learning and team-oriented projects to help students to learn how to apply their theoretical knowledge to innovative digital solutions for a paying client. About 100 students a year take the programme. 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 was made. From the client's perspective, they get out of the box thinking that they would never obtain from a consultant firm. The clients typically end up with something that far exceeds their expectations. The students find it surprising and challenging to manage the changes which commonly occur during the development stage of the project.

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

3 Strategies to mainstream undergraduate research and inquiry through the curriculum

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

The department has developed a set of linked strategies including:

Year One c200 students

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

Year Two

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

Year Three

- Courses include group research projects, critical reviews of current literature, writing research grant applications, lectures from scientists outside the school, and training in scientific communication.
- Zoology Research Unit (fcms.its.utas.edu.au/scieng/zoo/unitdetail.asp?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 students present their research, and then all non-undergraduate audience members, except the facilitator, leave the room.

Further information

Edwards *et al.* (2007)

3.2 Junior Research Associate Bursaries in Social Sciences and Cultural Studies at the University of Sussex, UK

From 2008 the School of Social Sciences and Cultural Studies at the University of Sussex 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 eight weeks for Summer research projects. Applications must be sponsored by a member of academic staff 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 the University of Sussex.

Further information

www.sussex.ac.uk/soccul/1-7-1.html

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

Traditionally undergraduate Chemistry in the Netherlands only ends with a 'real' research assignment, which students undertook 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 ones. Most Chemistry students in the Netherlands go on to take a Masters in the same university (approximately 90% at Utrecht University). A few years ago Utrecht University opted for a curriculum in which learning research skills and knowledge go hand in hand. Laboratory technicians and postgraduates play a key role in supporting students at different levels.

First year - On the first day of their studies students start with a group laboratory project in which they are asked to prepare and characterise a polymer (a kind of plastic). The final material that 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 (approximately 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 five-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 ten weeks to an ongoing PhD research project in which they are assigned to their own sub-project.

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

In the Department of Sociology at the University of Warwick, selected second- and third-year Sociology students led an evaluation of their peers' 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 and Management, where students developing research skills 'match' the research focus.

Further information

Hughes (2005)

3.5 Developing an undergraduate research culture in Earth Sciences at the University of Oxford, UK

Departments have cultures that may unwittingly or purposefully keep students “at arms length” from research (Brew 2006, 52) or bring them into that experience. Philip England (2007, 8) of the Department of Earth Sciences at the University of Oxford, 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. ... 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, 9) 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.”

Further information

England (2007); Gibbs (2007)

3.6 Department and institutional research resources support undergraduate research in History at the University of Virginia, US

This case study demonstrates how the research resources of a research-intensive university department can support undergraduate research and inquiry in a large course. The first course leader was Edward Ayers, then 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 and a postgraduate research and teaching team, support a range of undergraduate research programmes, including research in an undergraduate course with an enrolment of about 180 students, for which Ayers was 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 website for use by current and future students and other researchers nationally.

Further information

www.vcdh.virginia.edu/SHD/howtobegin.html;

www.reinventioncenter.miami.edu/conference2006/edayers/summary.htm

3.7 Encouraging self-authorship in introductory human geography via student-created, collaborative, place-based case studies, Miami University Ohio, US

The Department of Geography at Miami recently redesigned its introductory human geography course, *Global Forces/Local Diversity*. The primary goal was to provide support for undergraduate geography students along the journey to self-authorship by involving them in their own learning. This is accomplished by moving away from traditional teaching modes (e.g. lectures, textbook reading assignments, exams) toward an approach based on weaving student-created case study inquiries into everyday teaching and learning. Students are asked to do conceptual and thematic research in collaborative groups on real issues in particular places. They then share their multi-media projects with other students enrolled in the class (digitally and in person) and these student-created geographical portraits are ultimately incorporated into class discussions.

September 2011

Students learn about their own place in a changing and complex world by exploring globalization as it unfolds in local places and current events. Thematic case studies forming the center point of this course can easily be adapted, expanded, and/or revised by new faculty or graduate student instructors over time. This not only allows the class to be taught by a variety of diverse faculty, it also keeps course content up-to-date.

Self-authorship is also encouraged in the course by (1) conveying to students that knowledge is complex and socially constructed; (2) validating learners' 'capacity to know' by trusting in their ability to conduct collaborative research and sharing in mutually constructed meaning; and (3) showing students how to develop a framework for authoring and analyzing multiple perspectives.

Geography is only one of several introductory courses which have been converted to inquiry-based learning as part of the 'Top 25' project at Miami (Hodge *et al.*, 2008b).

Further information:

Moore *et al.* (2011); http://www.units.muohio.edu/celt/engaged_learning/top25/proposals/round1/geo%2
http://www.units.muohio.edu/celt/engaged_learning/top25/

3.8 A curriculum designed to facilitate a student's journey toward self-authorship, Samford University, US

The geography department at Samford University recently redesigned their department's curriculum guided by goals of increasing student engagement with the discipline, improving their practical skills, and enhancing their ability to solve complex problems and engage in critical thinking. Core modules provide basic instruction, but these introductory modules incorporate case studies, problem-solving, and active engagement with the subject matter. Students then proceed through a series of elective courses and finally to a series of courses called "Geography in Practice". Here students have the option of doing a supervised externship, acting as a teaching assistant for an introductory class, or doing an independent research project.

These experiences provide students with an opportunity to link their prior coursework with practical workforce skills. Finally all students complete a capstone experience where they may either undertake a client-based project, or may elect to do a traditional research paper. With the client-based projects, students work in teams with an outside client to define a problem, devise a work plan and create some distinct output. As examples, students have produced a series of maps for a local bicycle club, worked with the university's disability services on an accessibility map of campus, and collaborated with an environmental agency to study sedimentation in a river.

All capstone students are assessed on a range of skills, as well as informational and quantitative literacy. As students progress through the curriculum they are expected to take increased responsibility for their own learning and to develop the intellectual skills necessary to move beyond the campus and into society.

Further information:

Moore *et al.* (2011); <http://howard.samford.edu/geography/>

3.9 Simulating Research Using Electronic Laboratories at MIT and Purdue, USA

Online laboratories can support many students and often at many locations worldwide to carry out simulated research experiments. Such may not have the authentic value of working in a real laboratory, but can support such real world experience and/or for institutions coping with large numbers provide an experience that in part gets close to authentic lab based research. Two such initiatives are:

i Labs at MIT. From their own computers at any time of the day or night, students in science and engineering can use these remote lab setups to conduct experiments, working remotely with instruments housed at MIT to complete course assignments with curriculum materials that combine remote experiments and Open Course Ware content.

Simulation-led Learning in Nanotechnology at Purdue. Founded in 2001 with support from the National Science Foundation, this Web portal features more than 50 high-performance, interactive tools let users input their own data and parameters to run complex experiments from their desktops. Much as the MIT

September 2011

iLabs Shared Architecture lowers the barrier of participation by providing students with access to instruments at remote locations.

Further information:

Lombardi and Oblinger (2007); <https://wikis.mit.edu/confluence/display/ILAB2/Home>;
<http://nanohub.org/home>

3.10 Auditing and developing student research skills at the University of Adelaide, Australia and the University of Reading, UK

Selected departments at the Universities of Adelaide and Reading have systematically audited department-based undergraduate and postgraduate programmes for the extent to which they develop student research 'skills'. The University of 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 explicitly and systematically to 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, as well as with other disciplines and departments, including Petroleum Engineering, Nursing and English.

The framework is publicly available for other institutions to adapt. Within departments methods to collect data on undergraduates' research skills teaching and learning can be time-consuming and ineffective. At the University of Reading a related electronic 'research skills audit tool' has been developed for academic staff to map systematically research skills teaching and assessment within their own modules.

Further information

Willison and O'Regan (2006, 2007); Fraser *et al.* (2007)

3.11 Science undergraduates build on research of previous students at University College London, UK

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).

Further information

Chang (2005, 2007); Chang and Jackson (2007); www.ucl.ac.uk/sts/chang/

3.12 Students across all three years of an Environmental Studies degree course worked together on local sustainability projects at the University of Sunderland, UK

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.

Further information

Hughes *et al.* (2001)

3.13 Embedding Research in the Curriculum at University of Western Australia

In 2008 a review of the University Courses – *Education for Tomorrow's World* – recommended extensive changes to the undergraduate and postgraduate curriculum, including the proposal that “*that every undergraduate major include a demonstrable emphasis on enquiry-based learning and research skill development through direct engagement with the research culture of the relevant discipline*”. The University endorsed this proposal and in 2009 the University agreed an implementation framework for this. This framework included the following requirements on all majors seeking approval for course validation.

“The following elements, along with other discipline content, should be explicitly taught, practised by the students, and formally assessed:

- The evolution of the discipline, including its history, philosophy and theorising.
- The methods of enquiry that the discipline uses, including methods of research ethics.
- The practice of enquiry-based thinking relevant to the discipline.
- The discourse conventions of the discipline. ...

The embedding of the research must be reflected in three aspects:

- Curriculum content (what has to be learnt – e.g. discourse conventions must be taught)
- Pedagogy (how the learning occurs – e.g. field work, lab classes)
- Assessment (how students demonstrate what they have learnt – e.g. critical reviews, exams).”

Further information:

Markwell (2008); University of Western Australia (2009)

3.14 Engaging students in research into teaching and learning

‘There is a subtle, but extremely important, difference between an institution that ‘listens’ to students and responds accordingly, and an institution that gives students the opportunity to explore areas that they believe to be significant, to recommend solutions and to bring about the required changes. The concept of ‘listening to the student voice’ – implicitly if not deliberately – supports the perspective of student as ‘consumer’, whereas ‘students as change agents’ explicitly supports a view of the student as ‘active collaborator’ and ‘co-producer’, with the potential for transformation’ (Dunne in Foreword to Dunne and Zandstra, 2011).

Here are two examples, of engaging students as producers and change agents, one from The University of Western Australia and the other from Exeter University.

The Undergraduate Learning and Teaching Research Internship Scheme (ULTRIS) was conceived at The University of Western Australia (UWA) to introduce undergraduate students to authentic research outside their chosen discipline. By focusing their research on a teaching and learning issue of identified priority for the University, students are able to make significant contributions to the understanding of the problem and provide insights to inform future changes in policy and practice. Beyond the benefits to the institution and the individual students, this model of undergraduate research heralds an opportunity for research into teaching and learning to gain acceptance and interest amongst a new and previously uninvolved cohort of investigators.

At the **University of Exeter** students are engaged as partners in shaping and leading their own educational experiences through their '**students as change agents**' initiative. The key concept is that students themselves take responsibility for bringing about change, based on their own research on aspects of learning and teaching. The approach enables students to be actively engaged with the processes of change, often taking on a leadership role. They are engaged deeply with the institution and their subject areas, and the focus and direction is, to a greater extent, decided by students. The most important aspect is the focus on research, and building change on evidence-based foundations.

September 2011

Students from across the university have contributed to this initiative, carrying out a series of research projects on their learning and teaching environment, selecting concerns raised through student-staff liaison committees (SSLCs), and providing recommendations and solutions to improve their experience. A small amount of funding was made available from the University's learning and teaching budget to support this initiative. Students worked as apprentice researchers; their research methods included focus groups, informal interviews and questionnaire surveys. Outcomes were presented at a student-staff conference, which resulted in institutional engagement with key research findings. Each small project has also been captured through a case study.

Student research has driven organisational change, contributed to student engagement in shifts of policy and practice within the University, and supported students' graduate skills in the areas of research, project management and presentation of outcomes, leadership and understanding organisational development.

Further information

Lee and Sandover (2010); Kay *et al.* (2010); Dunne and Zandstra (2011)