

Engaging Undergraduate Students in Research and Inquiry
Faculty Workshops University of Sydney, 24 September 2010

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<http://insight.glos.ac.uk/tli/activities/ntf/ntfellows/Pages/mh.aspx>

<http://insight.glos.ac.uk/tli/activities/ntf/creativehops/pages/default.aspx>

www2.warwick.ac.uk/fac/soc/sociology/research/cet/

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

<http://insight.glos.ac.uk/tli/resources/toolkit/resources/Pages/default.aspx>

and there is more analysis in Healey M and Jenkins A (2009) *Developing Undergraduate Research and Inquiry* which may be downloaded free from the Higher Education Academy website at:

<http://www.heacademy.ac.uk/assets/York/documents/resources/publications/DevelopingUndergraduateFinal.pdf>.

QUOTES

"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, 1810 translated 1970, quoted by Elton, 2005, 110)*

"In an age of 'supercomplexity' (Barnett 2000), and given the increased significance of the knowledge economy and the growth of interdisciplinarity, 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)*

"For the students who are the professionals of the future, developing the ability to investigate problems, make judgments on the basis of sound evidence, take decisions on a rational basis, and understand what they are doing and why is vital. Research and inquiry is not just for those who choose to pursue an academic career. It is central to professional life in the twenty-first century." *(Brew, 2007, 7)*

"Developing the Student as Scholar Model requires a fundamental shift in how we structure and imagine the whole undergraduate experience. It requires, as a minimum, the adoption of the Learning Paradigm in everything from the first introductory course through the final capstone experience. It requires a culture of inquiry-based learning infused throughout the entire liberal arts curriculum that starts with the very first day of college and is reinforced in every classroom and program." *(Hodge et al., 2007, 1)*

"We need to encourage universities and colleges to *explore new models of curriculum*. ... There are several models that we might explore. They should all: ... *Incorporate research-based study for undergraduates (to cultivate awareness of research careers, to train students in research skills for employment, and to sustain the advantages of a research-teaching connection in a mass or universal system)* ..."

(Paul Ramsden, Chief Executive of the Higher Education Academy, in his invited contribution to the Department of Innovation, Universities and Skills' Debate on the Future of Higher Education, 2008, 10-11, emphasis added)

INTRODUCTION

This 'project' grows out a long standing interest in the wider issue of bringing together 'teaching', particularly at undergraduate level, and discipline-based research. But here our focus is centrally on the *learning that follows through engaging students in some form of 'inquiry' or 'research'*. This work is influenced by US undergraduate research programmes, where selected students in selected institutions learn through doing research, often outside the formal timetable and curriculum. A number of similar programmes are now available in the UK (Jenkins and Healey, 2007a). Our main interest is in mainstreaming student inquiry and research for *all / many* students in *all* higher education institutions (Healey and Jenkins, 2008; 2009; Jenkins and Healey 2007b; 2009; Jenkins 2007).

Our focus here is on issues facing disciplines, departments and institutions. We have commented on some of the initiatives to link research and teaching in national systems elsewhere (Healey and Jenkins 2007). This is very much work in progress and we would welcome comments and in particular case studies of interesting practices in which you are involved. If you are interested please contact the authors.

A: CONCEPTUAL AND POLICY ISSUES

1. Conceptions and Perspectives on Teaching-Research Relations

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: Examples of ways in which learners may be engaged with Boyer's four scholarships

Types of Scholarship	Illustrative example of ways of engaging learners
Scholarship of discovery	Engage in inquiry-based learning; undergraduate research and consultancy projects; co-research projects with staff
Scholarship of integration	Engage in integrating material from different sources, including across disciplines; integrate life and work experience with academic studies; reflect on implications of studies for personal development
Scholarship of application / engagement	Engage with local, national, and international community service projects; volunteering; knowledge exchange projects; apply knowledge and skills in work-based placements
Scholarship of teaching and learning	Engage in mentoring; peer support and assessment; collaborative group work; learners as explicit partners in educational development and inquiry

Source: Healey and Mason O'Connor (2007, 8)

Table 3: Educational paradigms

Paradigm	Approach
Teaching	Telling students what they need to know
Learning	Engaging students in learning how to learn; emphasis on learning what they need to know
Discovery	Encouraging students to seek and discover new knowledge

Source: Hodge *et al.* (2007, 3)

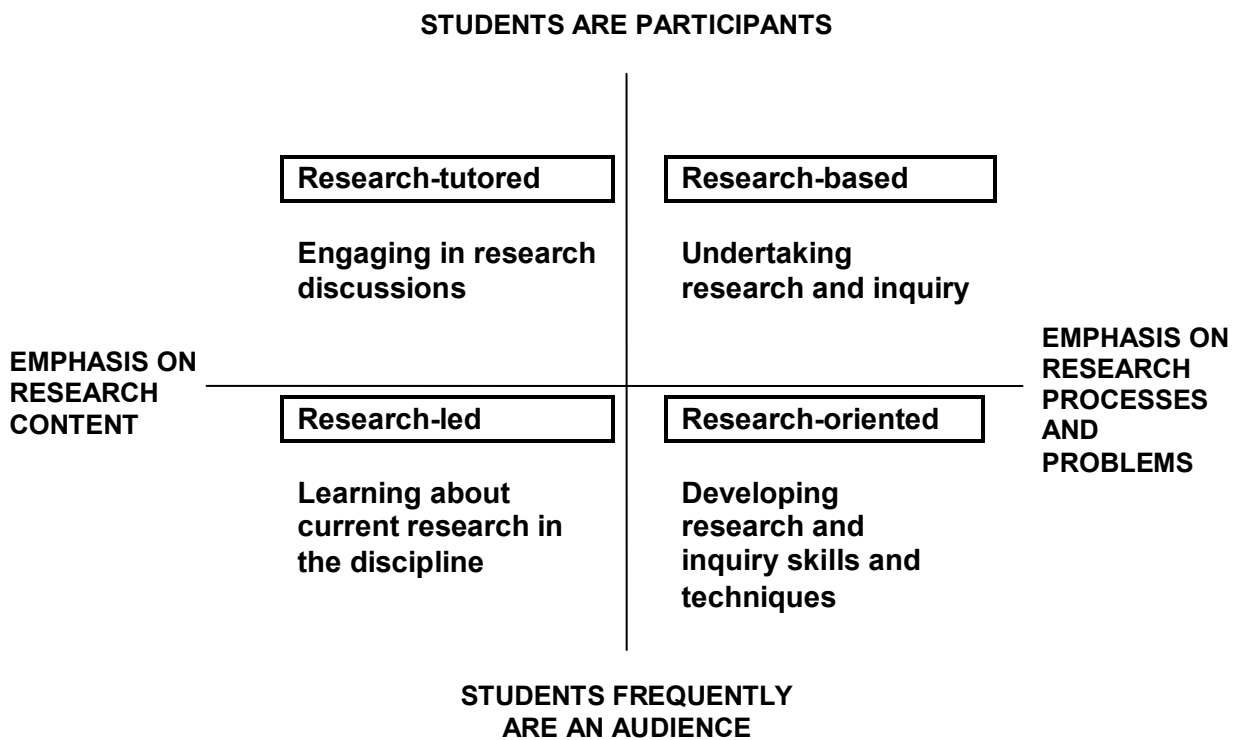
2. Curriculum Design and Teaching-Research Relations

We have found the framework developed by **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;
- **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.

Healey (2005) has expressed these differences diagrammatically using two axes. One classifies approaches to linking teaching and research according to the extent to which students are treated mainly as the audience or as participants, while the second axes 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. A variant of this model is shown in (Fig 1).

Fig. 1 The nature of student research and inquiry



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

Table 6 The developmental journey of the student

Developmental Level	Student traits
Reliance on external references [Foundations]	Knowledge viewed as certain Reliance on authorities (e.g., professors, parents) as source of knowledge Externally defined value system and identity Act in relationships to acquire approval
At the crossroads [Intermediate Learning]	Evolving awareness of multiple perspectives and uncertainty Evolving awareness of own values and identity and of limitations of dependent relationships
Self-authorship [Capstone]	Awareness of knowledge as contextual Development of internal belief system and sense of self capacity to engage in authentic, interdependent relationships

Source: Hodge *et al.* (2008)

An excellent example of mainstreaming undergraduate research and inquiry comes from Miami University Ohio. Drawing in part on the work of Baxter Magolda (2001), they have mapped out the student developmental journey (Table 6). Though as students go through these stages at different rates and many may not reach the self-authorship stage by the end of their undergraduate course, there remains a challenge in converting this framework into the curriculum.

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 below.

Table 7 Students’ experiences of learning in a research environment

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

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

3. Student Experiences of Research

“staff research interests gave students ‘the opportunity to see their teachers as real people and to be able to glimpse what they do, how and why’ (Neumann, 1994, 335).

‘students value highly the experience of studying in a research environment but clearly there is a policy gap between policy intention and student perceptions at UEA (University of East Anglia). While students value being close to research, and to the idea of a university as a research community in which they are included, there are many ways in which they feel excluded (Zamorski 2000, 1).

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Jenkins, Blackman, Lindsay and Paton-Saltzberg (1998) carried out focus-group discussions with undergraduate students in a range of disciplines at Oxford Brookes University, and then replicated the study with postgraduates (Lindsay, Breen and Jenkins, 2002). Students who perceived staff members' involvement in research as being incorporated into their teaching tended to see their courses as current and as stimulating intellectual excitement. However, many students did not see themselves as *stakeholders* in staff research – university research was seen as quite separate from them.

A questionnaire-based study at Oxford Brookes (Breen and Lindsay, 1999) analysed student views of staff research in the context of their motivations for study and for attending university. Students who came to university for social contacts or to gain a useful qualification were indifferent to staff research.

A questionnaire of the awareness, experiences and perceptions of final year undergraduate students at the University of Gloucestershire (Healey *et al.*, forthcoming) was taken up by the University of Alberta and Royal Holloway. Although students at all three universities agreed that being involved in research activities was beneficial, they did not perceive that they had developed their research skills (Turner *et al.*, 2008). Generally students at the more research intensive universities were more *aware* of the research that went on in their institutions, but there was no significant difference in the *experience* they had of undertaking research themselves.

“Overwhelmingly, students define UR as a powerful affective, behavioral, and personal discovery experience whose dimensions have profound significance for their emergent adult identity, sense of career direction, and intellectual and professional development” (Hunter *et al.*, 2007, 69).

4. Definitions of undergraduate research and inquiry

These vary widely. For example, definitions of undergraduate research include:

“An inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline”
Centre for Undergraduate Research

“Undergraduate research is original work conducted by undergraduate students working in collaboration with a faculty mentor”
University of Central Florida

“Discovery Learning”
University of Alberta

“Student engagement at all levels in research and inquiry into disciplinary, professional and community-based problems and issues whether individually or in groups and in collaboration with or independently of staff”.
University of Gloucestershire

“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.

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- 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 8 Dimensions of undergraduate research

Student, process centred	Outcome, product centred
Student initiated	Faculty initiated
Honors students	All students
Curriculum based	Co-curricular fellowships
Collaborative	Individual
Original to the student	Original to the discipline
Multi-or interdisciplinary	Discipline based
Campus/community audience	Professional audience
Capstone/final year	Starting year one
Pervades the curriculum	Focussed

(Source: Adapted from Beckham and Hensel, 2009)

Definitions of Inquiry

There is considerable overlap between definitions of undergraduate research and inquiry, particularly between the broader definitions.

“Enquiry and Research-Based Learning (EBL and RBL) are terms used to describe a method of teaching and learning based on self-directed enquiry or research by the student. EBL provides a strongly student-centred approach to teaching and learning, enhancing students’ learning experience during their time at university.”

University of Reading, CETL in Applied Research Skills [www.reading.ac.uk/cetl-ours/LinkingTeachingandResearch/Enquiry-BasedLearning/What_is_Enquiry_Based_Learning_\(EBL\).asp](http://www.reading.ac.uk/cetl-ours/LinkingTeachingandResearch/Enquiry-BasedLearning/What_is_Enquiry_Based_Learning_(EBL).asp)

Most forms of undergraduate research would also meet most definitions of inquiry, but not everyone would include all forms of inquiry, particularly those engaged into enquiring into existing knowledge, as undergraduate research.

At McMaster University, inquiry-based courses are offered to all first year students. The following is how this institution defines inquiry-based learning:

“Inquiry is a form of Self-Directed Learning and follows the four basic stages defining self-directed learning. Students take more responsibility for:

- Determining what they need to learn
- Identifying resources and how best to learn from them
- Using resources and reporting their learning
- Assessing their progress in learning”

Source: www.mcmaster.ca/cil/inquiry/whats.unique.about.inquiry.htm

For an exploration of the term ‘enquiry-based learning’ see: Hutchings (2007).

Undergraduate research and job opportunities

In North America adverts for university jobs sometimes specify engaging undergraduates in research. Three examples of jobs advertised on the Council for Undergraduate Research list in September-October 2008 stated that:

“The Department of Biological Sciences at Eastern Illinois University is seeking a Fisheries Biologist (tenure track) position. ... Successful candidates will be expected to develop a productive and funded research program involving both undergraduate and M.S. students.”

“Widener University (Pennsylvania) invites applications for a tenure-track assistant professor in synthetic organic chemistry. ... Engagement of undergraduate students in research is required.”

B: CASE STUDIES OF UNDERGRADUATE RESEARCH AND INQUIRY IN DISCIPLINARY, DEPARTMENTAL, AND INSTITUTIONAL CONTEXTS

These cases of undergraduate research and inquiry in disciplines, departments and institutions are drawn from Australia, Canada, Denmark, Ireland, Hong Kong, Netherlands, New Zealand, United Kingdom and United States. They are a subset of a wider set of case studies of links between teaching and *disciplinary* research. They represent work in progress and the intention is to add further case studies in the future. If you know of interesting examples please contact the authors. Apart from Section 2 the following case studies are taken from Healey and Jenkins (2009).

1: Engaging students in research and inquiry at the beginning of their academic studies

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

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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

2. Engaging students in research in interdisciplinary courses

Unravelling complexity at Australian National University (ANU)

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

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

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

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

Sources: [Baker \(2010\)](#):

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

Course description:

<http://fennerschool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=introduction>

Learning portfolio: [http://fennerschool-](http://fennerschool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=assessment:learning_portfolio)

[lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=assessment:learning_portfolio](http://fennerschool-lectures.anu.edu.au/lectures/2010/VCUG3001/doku.php?id=assessment:learning_portfolio)

http://fennerschool-people.anu.edu.au/richard_baker/teaching.html

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

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

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

Recent completed projects include:

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

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

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

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

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

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

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

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

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

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

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

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

Sources: Baker (2010):

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

http://fennerschool-people.anu.edu.au/richard_baker/ENVS2017/index.htm

3 Strategies for engaging students with research in disciplines

Here we use the four categories shown in Figure 1 as a framework for structuring the case studies. Each way of linking research and teaching is associated with a different way of engaging students with research:

- research-led: *learning about current research in the discipline;*
- research-oriented: *developing research skills and techniques;*
- research-based: *undertaking research and inquiry;* and
- research-tutored: *engaging in research discussions.*

As we noted in section 1, despite the extent to which students are participants being one of the dimensions of the model, the examples explored in this paper are primarily active and exciting experiences. Hence most belong in the top half of the model.

3.1 Research-led: learning about current research in the discipline

Students can be engaged with current research in the discipline in a variety of ways, including through lectures, academic staff-led seminars, laboratories and course work. The examples below focus on strategies that clearly put students in active mode as they encounter current research in their subject.

Biochemistry undergraduate students are helped to read research articles at the University of Leicester, UK

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 initially impenetrable. In the Department of Biochemistry at the University of Leicester 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 a set of exercises has the 70 or so 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.

Further information
Wilmott *et al.* (2003)

Introducing students to academic staff research: Department of Geography, University College London (UCL), and Department of Mechanical Engineering, Imperial College London, UK

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.

In the first-year Mechanical Engineering course at Imperial College London in the 1990s:

- Engineering students were divided into 10 to 15 groups of four to five students in the January;
- 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 academic 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 about five years time?';
- later all student groups presented a poster that 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.

Further information

Dwyer (2001)

Research emphasis days in Veterinary Medicine at the University of Edinburgh, UK and the University of Florida, US

Each year the School of Veterinary Studies at the 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.

Further information

Struthers *et al.* (2008); www.wlcastleman.com/ufvetmed/phizeta07/index.htm

3.2 Research-oriented: developing research skills and techniques

Assisting undergraduates to develop research skills and techniques is a key aspect of the intellectual journey of students as they develop as researchers. It is rather worrying though, that in one study only between a quarter and a third of final-year students at both research-intensive and less research-intensive institutions report that they feel have developed these skills, despite most of them having undertaken compulsory courses in research techniques (Turner *et al.*, 2008). Course lectures, practical and laboratory classes and course work are common modes of teaching in which research skills and techniques are particularly emphasised. The examples that follow illustrate other ways in which they may be developed.

Asking questions in Plant Biology at the Australian National University

A practical exercise designed for a level 2 course involves students: making observations in a botanical garden; coming up with ten questions each (e.g. why do eucalypt leaves dangle?); sharing one of these questions with another group of 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; and writing up individually their ten questions and one hypothesis as a 750-word mini-proposal for a research project.

Further information

<http://cedam.anu.edu.au/communities-practice/research-cop/examples/activities>

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.

Further information

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

Embedding inquiry-based learning in a skills module concerned with sustainability at the University of Gloucestershire, UK

'Skills 4 Sustainability' is a first-year course in which skills for inquiry-based learning is embedded in a module on sustainability. The module is delivered from weeks 1 to 12 of the first semester by a team of eight tutors to about 150 students with no formal lectures. Students are organised into tutor groups according to their subject specialism. Students inquire into and develop a proposal for improving the sustainability of the University, which they must research and present as a group. The students are prepared for their inquiry-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, the Director of Institute for Sustainability and a local business manager. Half the module marks are given for the creation of an individual e-portfolio, 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.

Further information

Swansborough *et al.* (2007)

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.

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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)

3.3 Research-based: undertaking research and inquiry

Probably the most obvious way for undergraduate students to engage in research is to undertake final-year dissertation or capstone research and inquiry projects. In the examples below we look at other ways in which students may be involved in research projects from the first year onwards, both within the curriculum and outside it. We also give examples of ways that the outcomes of these research projects may be celebrated.

Introducing inquiry-based teaching methods in Literary Studies at University of Manchester, 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 inquiry-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 subgroup to subgroup 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 subgroup was asked to address two questions: 'What kind of language does the poem use?' and 'What belief system, if any, does the poem imply?'. Most groups responded to this task actively by exploring and considering the possibilities from a range of perspectives, establishing and pooling any existing knowledge and assessing its applicability to the task in hand. By emphasising the need to seek other sources to contextualise their answers, the facilitator began to establish the research element crucial to moving from 'problem solving' to something more nuanced.

Further information

Hutchings and O'Rourke (2003)

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/

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 on 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. Information technology has made it possible: during the specified time frame of one week, students do not have to be assembled in one place and can participate at any time. Feedback from them has been very 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

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the unit. Students submit a full conference paper, but it is only a summary that appears on the conference website. Each student is also required to post a comment on another conference paper. Staff monitor participation and contact students as appropriate.

Further information

www.cometravel.lincoln.ac.uk

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

Further information

Anon (2003); web.uvic.ca/vv/

3.4 Research-tutored: engaging in research discussions

Engaging in discussion is a key way to develop understanding. Traditionally in higher education this takes place through staff-led academic tutorials and seminars. Here we consider other ways in which undergraduates may engage with research through discussion.

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 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

Student group work 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. Two or three 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 that 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.

Further information

James (2003)

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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)

This framework provides a useful way to talk about the nature of undergraduate research and inquiry in different disciplines, because it is inclusive of different pedagogies for engaging students. Some individuals, course teams, departments and even whole institutions have used the framework to audit their practice to see if they have, what they consider in their context to be, an appropriate balance of activities (see also section 1). In the next section we explore how course teams and departments have developed practices and strategies to engage students in undergraduate research and inquiry.

4 Departmental and course team strategies to mainstream undergraduate research and inquiry

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

The department has developed a set of linked strategies/interventions including:

Year one (approximately 200 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.
- 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

- An assessed task over several weeks, 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.
- In the Zoology Research Unit individual students are matched with an academic supervisor to complete a semester-long research project.
- Selected students work with academic staff to prepare a research paper for *Nexus Journal of Undergraduate Science, Engineering and Technology* (www.utas.edu.au/scieng/nexus/).

Years two and three

- All invited to participate in Student Research Volunteers programme (www.zoo.utas.edu.au/volunteers/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 and 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)

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

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.

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)

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)

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