Strategies for developing an active research curriculum

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

Further and more detailed case studies, including national examples, references and list of useful web sites may be found at:
http://resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm

and 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/DevelopingUndergraduate_Final.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*
(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

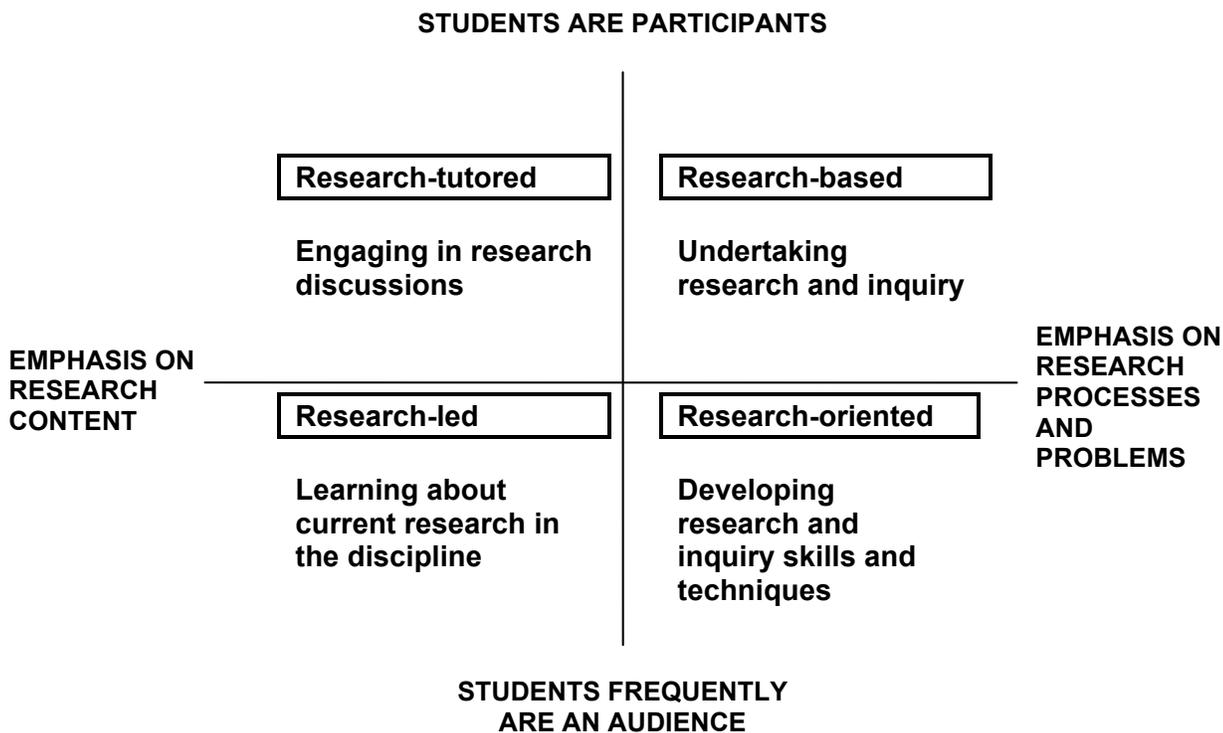| Paradigm	Approach
Teaching	Telling students what they need to know
Learning	Engaging students in learning how to learn; emphasis on learning what they need to know
Discovery	Encouraging students to seek and discover new knowledge

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

STUDENTS ARE PARTICIPANTS

Research-tutored	**Research-based**
Engaging in research discussions	**Undertaking research and inquiry**

EMPHASIS ON RESEARCH CONTENT / EMPHASIS ON RESEARCH PROCESSES AND PROBLEMS

Research-led	**Research-oriented**
Learning about current research in the discipline	**Developing research and inquiry skills and techniques**

STUDENTS FREQUENTLY ARE AN AUDIENCE

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).

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.
- 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-aurs/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/cll/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."

"The Department of Earth and Environmental Science in the College of Liberal Arts at Mercer University (Macon, GA) announces its search to fill a tenure-track position at the rank of Assistant Professor. The primary instructional responsibilities will be introductory environmental science, geology, environmental geology, Geographic Information Systems, and an upper-division course in the candidate's specialty. Additional responsibilities will include mentoring of undergraduate student research, and service in support of the department and College."

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. The following sections 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 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 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.

2.1 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

2.2 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.

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)

2.3 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 the 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 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 that 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/

2.4 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)

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.

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

Most of the case studies in this section represent curricula explicitly designed to bring students into the worlds of research. Here we suggest how such interventions can be structured by course teams and departments (see also Jenkins *et al*., 2003; Jenkins and Healey, 2007a, 2009; Jenkins, 2008a, 2008b).

3.1 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)

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

4 Institutional strategies to mainstream undergraduate research and inquiry

A. Develop supportive institutional strategies and policies

1. *Embed in vision and teaching and learning and research strategies of university.*
2. *Develop supportive institutional curricula frameworks and structures.*
3. *Link undergraduate research and inquiry to institutional policies for employability.*
4. *Link undergraduate research and inquiry to institutional policies for widening participation.*
5. *Link undergraduate research and inquiry to institutional policies for civic and community engagement.*

B. Encourage and support student awareness and experience of undergraduate research and inquiry

6. *Embed undergraduate research and inquiry from day students enter university.*
7. *Raise students' awareness of research.*
8. *Provide opportunities for* selected *students to undertake undergraduate research and inquiry within and outside the curriculum.*
9. *Provide opportunities for* all *students to undertake undergraduate research and inquiry within and outside the curriculum.*
10. *Have students investigate issues that are of importance to the university or other students.*
11. *Value the role that student organisations can play in supporting undergraduate research.*
12. *Celebrate undergraduate research and inquiry.*
13. *Provide support and encouragement to students undertaking undergraduate research and inquiry.*

C. Ensure institutional practices support undergraduate research and inquiry policies

14. *Ensure quality assurance, quality enhancement and institutional assessment processes and policies support students as researchers.*
15. *Ensure appropriate learning spaces are available to support undergraduate research and inquiry.*
16. *Align student support from library, information and communication technology services and laboratories with needs of students undertaking undergraduate research and inquiry.*

D. Encourage academic staff awareness and support and reward engagement with undergraduate research and inquiry

17. *Increase academic staff awareness of undergraduate research and inquiry.*
18. *Provide support to academic staff with regard to professional development so that they are encouraged to become engaged in undergraduate research and inquiry.*

19. *Provide incentives and rewards for academic staff to support undergraduate research and inquiry, particularly through workload planning, institutional and departmental recruitment, criteria for appointment, performance review and promotion processes.*

4.1 Develop supportive institutional strategies and policies

Strategy 1: Embed in vision and teaching and learning and research strategies of university
Before undergraduate research and inquiry can be effectively mainstreamed, it is helpful for colleagues and students to discuss what they mean by the term (see section 2). This may well result in variations between different disciplines across the institution, but the understandings will then be owned by those who have to implement practice. Some institutions may choose to widen what counts as 'research' by students. This approach has been used by the University of Gloucestershire (see section 2). Griffith University, Australia has also expanded the definition to incorporate the concept of 'public scholarship' as a distinctive feature of the University's learning activities. They use the concept to refer to "the opportunity (for students) to work with real problems, and in doing so to place their knowledge at the service of our communities. This … finds expression through our commitment to work-integrated learning and to research based learning" (Griffith University, 2007, 1).

Undergraduate research is an ideal way of bridging the gap between teaching and research in the structures of most universities. It is important that strategies and support are not restricted to one or the other sides, as, for example, at the University of Central Lancashire.

Undergraduate research at University of Central Lancashire (UCLAN), UK is supported from both the teaching and the research strategies

At UCLAN undergraduate research appears in both the University's Learning and Teaching Strategy and its Research Strategy. In 2008 they funded an undergraduate research student internship scheme over the Summer, which sponsored 44 students to work with academic staff on projects with real research outputs.

Further information
www.uclan.ac.uk/information/services/sds/strategy/index.php

Strategy 2: Develop supportive institutional curricula frameworks and structures
As we have argued at several points in this paper, the key way to mainstream undergraduate research and inquiry is to integrate it into the curriculum. Many of the case studies elsewhere in this paper illustrate this; for example, at Miami University, Ohio, they have instituted a Top 25 project in which over a four-year period the largest recruiting courses, mainly at first-year level, are being supported to convert to inquiry-based learning (case study 6.1), while McMaster University has optional inquiry courses (case study 1.2). Indiana University-Purdue University Indianapolis is another institution encouraging its first-year students to engage in undergraduate research and inquiry (see below).

One particular intervention is to rethink the overall institutional timetable; for example, by creating a particular period of the year when students can focus entirely on an undergraduate research project; this, in part, mimics the experience of faculty with a research project or sabbatical. This can readily be achieved outside the normal university calendar, as, for example, in the many undergraduate research Summer enrichment programmes and the practice in many fieldwork disciplines for week-long intensive field courses in vacations. At MIT the four weeks before the second semester is the Independent Activities Period (IAP), where "students are encouraged to set their own educational agendas, pursue independent projects … (and) faculty are free to introduce innovative educational experiments as IAP activities" (MIT, n.d.).

The university curriculum timetable can also be changed to ensure *all* students have dedicated time for research; for example, by adjusting the timetable across the whole year or for a limited period. Thus instead of a one-hour block, the curriculum can be delivered over two- to four-hour blocks; such blocks of time both encourage and allow inquiry-based learning activities to take place (e.g. case study 1.2). There can also be a

period of, say, one to two weeks where students can focus on one central investigation; for example, part of the final year can be solely devoted to the dissertation or capstone. In some countries a whole term or semester or the whole of the fourth year may be given over to undertaking an Honours dissertation.

Experiential learning for all at Indiana University-Purdue University Indianapolis (IUPUI), US

In 2008, IUPUI launched an initiative to encourage all students to undertake experiential learning activities in two of four areas: undergraduate research (defined within each department); service learning; international experience; or other experiential active work. The work must be within a course and pass muster, as meeting the University's broad definition of 'undergraduate research'. The Assistant Vice-Chancellor for Research "expect(s) this initiative to increase student research on campus and looks forward to it ultimately being required for all students. Right now only some of our departments require this" (Wilson, 2009).

Further information
Wilson (2009); www.iupui.edu/administration/acad_affairs/rise/;
www.iupui.edu/administration/acad_affairs/rise/rise_proposal.pdf

Strategy 3: Link undergraduate research and inquiry to institutional policies for employability
It can be helpful not to envisage the development of undergraduate research and inquiry as a separate policy, but rather one that contributes to delivering other institutional policies, such as employability (see also departmental employability strategies in section 4). Northwest Missouri State University and the University of York, for example, have linked undergraduate research to their policies to encourage the employment of undergraduates on campus, as does the Universities of Warwick and York skills certificate. The emphasis by QAA Scotland and the Australian Learning and Teaching Council on linking research and teaching to deliver key graduate attributes also gives a focus on the benefits for employability of engaging students in undergraduate research and inquiry.

On campus undergraduate research employment: Northwest Missouri State University, US and the University of York, UK

Undergraduate students being employed in a variety of roles, including academic roles, on campus is an important feature of many US universities. The scheme at Northwest Missouri State University is a strong example of such structured programmes – with approximately 40% of University employees (over 540) being students. Some have roles of considerable responsibility and their employment is an integral part of their learning experience. In the UK and elsewhere there is strong pressure from government to expand and link employment and higher education. The University of York, through its careers service and supported by a National Teaching Fellowship, aims to expand the breadth and number of part-time and temporary higher level employment opportunities available to its students – in part shaped by the Northwest Missouri State University example. The project involves scoping and prototyping a comprehensive on-campus student employment scheme, with a particular focus on higher skilled work, and to explore the application of this scheme with local businesses. The University of York is particularly interested in exploring how the scheme may be used to involve students in a variety of forms of undergraduate research.

Further information
DIUS (2008); catpages.nwmissouri.edu/m/lgmf/documents/

Institutional research skills certificate at the Universities of Warwick and York, UK

Many UK institutions have strategies, including Personal Development Planning (www.heacademy.ac.uk/ourwork/learning/pdp) to help students record their developing employment related skills and achievements, including research skills. The Universities of Warwick and York have developed institutional (research) skills certificate awards to help students identify and develop the graduate attributes and skills developed through involvement in research.

Further information

Strategy 4: Link undergraduate research and inquiry to institutional policies for widening participation

By linking undergraduate research and inquiry to other appropriate institutional strategic priorities, wider support and greater embedding is likely. This approach could, of course, lead to different emphases being placed on the nature of undergraduate research and inquiry in different institutions. For example, the University of Michigan has devised special undergraduate research opportunity programmes (UROPs) for African-American students in years one and two in an attempt to reduce the relatively high drop-out rates from this group.

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

A number of Undergraduate Research Opportunities Programs (UROPs) focus on what in the UK would be called 'widening participation'. At the University of Michigan there is targeted support for largely African-American students from inner-city Detroit. While the University had been successful in recruiting these students, their drop-out rate was high. Special UROPs were targeted at these students in years one and two to enhance their integration and academic success. There have since developed related projects to support transfer students into the University of Michigan from community colleges and four-year colleges. Research demonstrates significant positive impacts (Locks and Gregerman, 2008). In addition, linked to the University-wide UROP programme, a first-year residential programme for some 80 students is aimed at culturally and geographically diverse US students and international students. Research is conducted with selected faculty and supported by resident second- and third-year peer mentors.

Further information
Huggins *et al.* (2007a); Locks and Gregerman (2008)

Strategy 5: Link undergraduate research and inquiry to institutional policies for civic and community engagement

Yet another way of linking undergraduate research and inquiry to institutional policies is through civic and community engagement. In the US many institutions have developed a range of programmes and initiatives that connect the university with the wider and local communities in a scholarly way, often referred to as the 'scholarship of engagement' (Boyer, 1996). Some of these initiatives, as with the case study of Bates College, the University of Michigan and Penn State University below, are effectively, in part, undergraduate research programmes. A discipline-based example, 'The Scholarship for Engagement for Politics', was mentioned in section 4.

Undergraduate research and the scholarship of engagement at Bates College, the University of Michigan and Pennsylvania State University, US

At Bates College, the Harward Center seeks to build long-term projects founded in community needs and student and faculty research interests that enable students and faculty to work with community partners within semester-based courses on issues of common concern. Thus, one project has local museum staff working with humanities students and faculty to develop a travelling exhibit about Lewiston's mills and millworkers in the 20th century. This includes students learning and using oral history research methodologies to interview former millworkers.

At the University of Michigan, the Ginsberg Center is funded through central university funds and endowment income. At any one time it has a range of long-term projects developed through community needs and faculty, student or donor interests. These projects are then supported by a range of grants, credit frameworks in departments and student volunteering.

Penn State University has developed a 'Civic and Community Engagement Minor'. Although a central university initiative, the core courses are in the disciplines and departments, but are centrally recognised as

'public scholarship', e.g. a Summer field course in Geography where students research with a Philadelphia inner-city community issues of concern to that community. To be awarded a minor, students need to do one such field-based course – i.e. a capstone (similar to a dissertation and required for most programmes) that is community-based – and three courses from their discipline that have been recognised by the Public Scholarship minor committee as public scholarship.

Further information
Huggins *et al.* (2007a)

4.2 Encourage and support student awareness and experience of undergraduate research and inquiry

Strategy 6: Embed undergraduate research and inquiry from day students enter university
Rather than leaving the experience of doing research to the final-year dissertation or capstone project, it is more effective to engage students in a variety of research and inquiry projects from the beginning of their studies (see case studies 1.2). McMaster University has a set of optional inquiry-based courses in each faculty available in years one and two, which have proved effective in developing study skills at an early stage and hence helping students perform better in later courses.

Inquiry-based courses available across the curriculum at McMaster University, Canada

The University has a tradition of innovative problem-based learning in Medicine and Engineering. In 1998 it launched an initiative to develop an inquiry-based approach across the whole curriculum, starting initially in selected courses in years one and two. "Inquiry courses are skill-driven rather than content-driven, focusing on the skills required to perform effectively at university and well beyond university. These generalizable skills help students hone skills equally useful for advanced levels of academic research" (Center for Leadership and Learning, n.d.). This is supported through the teaching development unit and through programme leadership responsibilities for senior staff. Teaching is done in teams of generally research-active, tenure-stream staff, with a three-year rotation, reflecting the commitment needed to teach such courses, but also better ensuring that the skills of inquiry teaching are disseminated across the University. Some 20% of students in year one and two take at least one inquiry-based course and the research evidence is that such students generally achieve well in subsequent courses.

Further information
Centre for Leadership and Learning (n.d.); Knapper (2007); see also Social Science case study at McMaster University in case study 1.2 and discussion in section 8

Strategy 7: Raise students' awareness of research
Raising students' awareness, understanding and engagement in research is a critical part of bringing them into the research community of the university. Students in research-intensive universities generally have a greater awareness of research than students in teaching-focused institutions, which would be expected given the greater amount of research happening in the former. However, there is some research evidence that the level of engagement in doing research may not vary by institutional type (Turner *et al*., 2008). To increase awareness of students of research, the research-intensive University of Alberta has an institution-wide project entitled 'Research Makes Sense for Students'.

Institution-wide project 'Research Makes Sense for Students' at the University of Alberta, Canada

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

Further information
www.uofaweb.ualberta.ca/researchandstudents/

Strategy 8: Provide opportunities for** selected **students to undertake undergraduate research and inquiry within and outside the curriculum

A growing number of universities are providing opportunities for *selected* undergraduates to engage in research either within or outside the curriculum. Selection is most commonly based on intellectual merit, aptitude and interest, such as in ANU's Advanced Studies course (see below), Utah State University's Undergraduate Research Fellowships (Kinkead, 2008) and the University of Warwick and Oxford Brookes University's Undergraduate Research Scholarship Scheme (www2.warwick.ac.uk/services/ldc/funding/urss/; www2.warwick.ac.uk/fac/soc/sociology/rsw/undergrad/cetl/fundingopps/urssbrookes/). However, undergraduate research opportunities in some institutions are also used as part of their widening participation programmes, such as at the University of Michigan (see strategy 3).

A few courses are entirely built around research. For example, in the UK Anglia Ruskin University and the University of Bolton have a complete degree based around undergraduates undertaking action research in the workplace (see case study 4.6). Where a selected group of students gain the experience of undergraduate research, it is important that ways are found to communicate their achievements to the rest of the university community.

Advanced Study Courses at Australian National University (ANU)

In 2003 ANU established the Bachelor of Philosophy degree to provide a research based education for elite students. They undertake research at a high level from the beginning of their undergraduate degree through the inclusion of six or more research-led projects during years one to three of their degree (Wilson *et al.*, 2007, Newitt 2007). These research projects replace lecture based courses and "may consist of a reading course with a world-leading scientist or joining a research team to assist in the advance of knowledge" (ANU, 2009). These students then take an Honours year which normally involves both course work and a substantial piece of original research. Those 'teaching' on the programme include specialist researchers from ANU's Institute of Advanced Studies. There is a university wide forum that supports spreading insights and resources from this programme to more 'mainstream' courses at ANU (Centre for Educational Development and Academic Methods, nd).

Further information
ANU (2009); Centre for Educational Development and Academic Methods (nd);; Wilson *et al*. (2007); Newitt (2007)

Strategy 9: Provide opportunities for** all **students to undertake undergraduate research and inquiry within and outside the curriculum

A few universities have gone for institution-wide approaches, which effectively provide opportunities for all students to engage in undergraduate research and inquiry. For example, at Roskilde University in Denmark half of the curriculum for all students is based around project work; while over 80% of students at MIT undertake at least one undergraduate research opportunity programme, mostly in addition to their studies.

Half of the work of all students is spent undertaking projects at Roskilde University, Denmark

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

Further information
www.ruc.dk/ruc_en/about/

Undergraduate Research Opportunities Program at the Massachusetts Institute of Technology (MIT), US

The Undergraduate Research Opportunities Program (UROP) supports research partnerships between MIT undergraduates and academic staff. Formed in 1969, it is one of the earliest such programmes. "UROP projects take place during the academic year, as well as over the summer, and research can be done in any academic department or interdisciplinary laboratory. Projects can last for an entire semester, and many continue for a year or more. UROP students receive academic credit, pay, or work on a voluntary basis." MIT is working with the department of engineering at the University of Cambridge (UK) to develop an undergraduate research programme there. MIT conducts an audit of UROP participation among graduating seniors each year. For the class of 2004, 82% of graduating seniors had participated in UROP at least once during their undergraduate careers (Huggins *et al.*, 2007a).

Further information
mit.edu/urop/; www.eng.cam.ac.uk/teaching/urops/

Strategy 10: Have students investigate issues that are of importance to the university or other students
A further way in which to engage students in undergraduate research and inquiry is to involve them in investigating issues that are of importance to the university or other students. A good example at department level is illustrated in case study 5.4, where selected Sociology students at the University of Warwick evaluate their peers' experiences of teaching and learning. At the University of Exeter, students undertake action research into issues faced by other students in their programmes and act as agents of change. At Utah State University, students have investigated writing across the curriculum (case study 4.1).

Student representatives investigate issues that need addressing in their programmes at the University of Exeter, UK

Students from ten subject areas across the University have been engaged as a pilot project (2008-09) in a variety of action-research activities with the purpose of improving learning and teaching within their Schools. This has been a collaborative project involving Education Enhancement and the Guild of Students, with student representatives from Staff-Student Liaison Committees (SSLCs) taking responsibility for promoting evidence-based change. Student-selected topics include assessment and feedback, the quality of seminar provision, shared learning spaces, peer mentoring for language teaching, inter-campus teaching and employability. Data have been collected via focus groups, informal interviews of staff and students, and questionnaire surveys. Findings will be presented via presentations at a student-led conference. SSLCs and programme managers are expected to take responsibility for embedding recommendations for change into strategic planning and action.

Further information
https://blogs.exeter.ac.uk/studentprojects/

Strategy 11: Value the role that student organisations can play in supporting undergraduate research
Involving student unions and organisations in institutional interventions can ensure both that student concerns are central to such interventions and that student leaders have an informed understanding of undergraduate research to bring to institutional policy discussions. As we show in section 7, in Scotland, student organisations and institutional leaders have played a key role in institutional discussions on graduate research attributes.

Student Union involvement in institutional interventions at the University of East Anglia (UEA), UK

To support its commitment for the interaction between research and scholarship with teaching, UEA investigated the reality of University rhetoric about the relationship between research and teaching. The University's Centre for Applied Research in Education worked in co-operation with the UEA Student Union to

recruit 12 student researchers to research the student experience of research at UEA. "Members of the Student Union played an active part in the management and execution of the project work" (Zamorski, 2000, 6), as well as in the subsequent policy decisions to ensure students benefited from, and were involved in, the University research environment.

Further information
Zamorski (2000, 2002)

Strategy 12: Celebrate undergraduate research and inquiry
We are rather diffident, in the UK at least, of celebrating the work of our students. Apart from the best final-year dissertations, which are usually put in the library, and the end-of-year shows, common in art and design courses, the only people who see most student work are the students themselves and their assessors. A number of institutional and discipline-based undergraduate research journals have been founded recently in the UK (case studies 3.6 and 3.7). As undergraduate research and inquiry become more common on this side of the Atlantic, more departments and institutions are introducing a range of ways of celebrating the work of their students. Student research conferences are growing in number, but we have yet to reach the level of embeddedness in some North American colleges and universities (case study 6.3). Hunter *et al.* (2010) show that celebrating the work of undergraduate researchers may have powerful lasting effects.

Undergraduate research has become part of the institutional culture at the University of New Hampshire, US

In 2008 the University of New Hampshire celebrated its 9th undergraduate research conference; over 800 students participated in 23 events over nine days. Parents, friends and students applying for entry to the University are invited to join in the events.

Further information
www.unh.edu/urc/

Strategy 13: Provide support and encouragement to students undertaking undergraduate research and inquiry
Undertaking research and inquiry is a new experience for most undergraduate students; hence, apart from financial awards, which are covered in strategy 8, they need support and encouragement if it is to be a successful experience. Often this will come from their tutors and members of academic staff responsible for the particular project, but where undergraduate research is well embedded a central office is often established to co-ordinate the research opportunities and administrate the process. Some institutions have undergraduate research advisory boards.

One group, who are too often forgotten when it comes to giving support, are other students. This may be informal support from peers going through the same experience, or more formal support by arranging for senior students who have previously undergone similar experiences to act as mentors. McMaster University has a peer tutor scheme where students who have been taught in inquiry mode can take a credit-bearing course that involves them peer tutoring in inquiry courses, while Hunter *et al*. (2010) document several examples of peer support in undergraduate research in the sciences and engineering. A specific example is the Chemistry Department at the University of Michigan, which has senior students supporting first-year inquiry courses.

Intergenerational student teams support first-year inquiry courses in Chemistry at the University of Michigan, US

Each year the Chemistry Department at the University of Michigan has approximately 100 students in term time or Summer involved in undergraduate research with the 40 or so Department research groups. In addition, standard undergraduate laboratory instruction courses have been modified in order to create a more deliberate link to more authentic research practices.

- *An inquiry-based curriculum for first-year students.* The large (approximately 1400 students) introductory Organic Chemistry courses have been significantly revised to focus more on student inquiry, narrowing the gap between how faculty understand Chemistry and how students experience Chemistry in their coursework.

- *Authentic laboratory research for many.* A subset of about 160 students in this first-year course self-select into a supplemental instruction programme where they spend two additional hours per week engaged in tasks that involve their connecting with, understanding and transforming information and data from the primary literature. In the laboratory, after spending about half their time developing manipulative skills around small, open questions, they take on the design and implementation of limited, but authentic laboratory primary research.

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

Further information
Coppola (2005)

4.3 Ensure institutional practices support undergraduate research and inquiry policies

***Strategy 14: Ensure quality assurance, quality enhancement and institutional assessment processes and policies support students as research*ers**
If institutional initiatives for promoting and supporting undergraduate research and inquiry are to be sustainable they are best embedded in the university's quality assurance and enhancement and institutional assessment policies and procedures. For example, at Griffith University, Australia for a programme to contribute to meeting the University's strategic performance indicator for research-based learning, at least 20% of the student course enrolments are in courses identified as having significant elements of research-based learning. Course Convenors assess their courses against the following categories:

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

At Oxford Brookes University all undergraduate and taught postgraduate courses need to demonstrate how the linkages between research and teaching and learning are realised.

Building undergraduate research into the curriculum at Oxford Brookes University, UK

From 2007 all Schools and Departments have been required to develop a more structured approach to developing all students as researchers in all course programmes in years one and two, as well as through specialist pathways to support those students who choose a more extended research curriculum. Such pathways may include a focus on community-based undergraduate research. The requirements build on a previous university-wide intervention. In the context of the move to semesters, in 2002-03 all undergraduate and taught postgraduate courses were redesigned with the requirement that they demonstrate how the

linkages between research and teaching and learning are realised in the formal curriculum and the wider student experience. This process was overseen by a university-wide steering group, the Redesign Advisory Group.

Further information
Huggins *et al*. (2005, 2007b)

Strategy 15: Ensure appropriate learning spaces are available to support undergraduate research and inquiry

With the development of undergraduate research and inquiry activities the kind of learning spaces needed changes. There has been a growth in interest in the development of social learning spaces in higher education, which enhance collaborative learning (Joint Information Systems Committee, 2008). In the sciences different demands are made on the use of laboratory space as the following example from Vancouver Island University illustrates.

Building design to link research and teaching at Vancouver Island University (VIU), Canada

The institution is planning for a new Integrated Science Centre. This provides the Faculty of Science and Technology with the opportunity to link research and teaching into the design of the facilities. Students will take specific courses with a strong research component, often requiring extended use of laboratory spaces, instead of the traditional three-hour classroom sessions. New lab spaces will be designed to accommodate this. Faculty research areas will be places where students will engage in research with their teachers using an apprenticeship model combined with problem-based teaching. The new building will also contain many spaces where students can work in groups, with each other and with academic staff, on research projects, both inside and outside the laboratories.

Strategy 16: Align student support from library, information and communication technology services, and laboratories with needs of students undertaking undergraduate research and inquiry

As well as appropriate learning spaces students undertaking undergraduate research and inquiry need different forms of support from staff working in the library, information and communication technology services and laboratories.

Library staff change the way that they support students undertaking inquiry-based projects at induction at the University of Gloucestershire, UK

Rather than the conventional library tour introducing new students to the facilities and services available in the Learning Centre, staff at the Francis Close Hall campus support the students undertaking inquiry projects during induction week by focusing on the resources and ways of accessing them relevant to the specific disciplinary projects in which they were involved. Such just-in-time support means that the students begin to develop information literacy skills relevant to their projects as and when they need them.

Further information
Case study 1.1

4.4 Encourage academic staff awareness and support and reward engagement with undergraduate research and inquiry

Strategy 17: Increase academic staff awareness of undergraduate research and inquiry

Raising staff awareness of the role of undergraduate research and inquiry, both within and outside the curriculum, is just as important as raising the awareness of students. A few postgraduate certificates for new teaching staff in the UK, for example at the Universities of East Anglia, Northumbria and Plymouth, include specific modules on the relationships between teaching and research. The use of focus groups, swap shops and audits was mentioned in the last section as effective ways of raising awareness. Nottingham Trent University has a postgraduate diploma aimed at supporting staff, particularly those who come in from the professions, to supervise research projects.

Research Informed Teaching diploma at Nottingham Trent University (NTU)

NTU have introduced a Postgraduate Diploma in Research Informed Teaching, which helps members of academic staff develop skills in research practice in order to become better placed to teach and to supervise projects at undergraduate/postgraduate/PhD level. It is aimed particularly at those lecturers who have previously worked as practitioners before entering university teaching, and have therefore joined the university sector as teachers in mid-career.

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

Strategy 18: Provide support to academic staff with regard to professional development so that they are encouraged to become engaged in undergraduate research and inquiry
Teaching certificates and diplomas in higher education are primarily aimed at new academics in UK and Australasia. For other academics, and for new faculty in North America, various forms of professional development, such as workshops and curriculum development support, may be provided by educational developers to inform, inspire and support staff to engage with undergraduate research and inquiry. Sometimes these sessions may be run by external academic developers (for example, the authors of this paper frequently run workshops on this topic in universities around the world); other times, academic staff may be sent on courses and conferences run by professional bodies, such as the Council on Undergraduate Research; and sometimes the support is provided internally (e.g. Spronken-Smith and Harland, 2009). A major source of professional support for lecturers in England is provided by the Centres for Excellence in Teaching and Learning, seven of which are particularly focused on undergraduate research and inquiry.

Seven Centres for Excellence in Teaching and Learning (CETLs) in England support undergraduate research and inquiry

HEFCE established 74 CETLS in 2005 each of which received up to £2.35m capital and £0.5m recurrent expenditure per annum for five years. Several are centrally concerned with supporting undergraduate research and inquiry:

1. Sheffield Hallam University, the Centre for Promoting Learner Autonomy (extra.shu.ac.uk/cetl/home.html).
2. University of Gloucestershire, the Centre for Active Learning (resources.glos.ac.uk/ceal/).
3. University of Manchester, Centre for Excellence in Enquiry-Based Learning (www.manchester.ac.uk/ceebl).
4. University of Reading, Centre for Excellence in Teaching & Learning in Applied Undergraduate Research Skills (www.reading.ac.uk/cetl-aurs/).
5. University of Sheffield, Centre for Inquiry-based Learning in the Arts and Social Sciences (CILASS) (www.shef.ac.uk/cilass/).
6. University of Surrey, Surrey Centre for Excellence in Professional Training and Education (SCEPTrE) (www.surrey.ac.uk/sceptre/).
7. Universities of Warwick and Oxford Brookes, the Reinvention Centre for Undergraduate Research (www2.warwick.ac.uk/fac/soc/sociology/research/cetl/).

These have formed the Learning Through Enquiry Alliance (LTEA) (www.ltea.ac.uk).

Further information
www.hefce.ac.uk/cetl

Strategy 19: Provide incentives and rewards for academic staff to support undergraduate research and inquiry, particularly through workload planning, institutional and departmental recruitment, criteria for appointment, performance review and promotion processes

Supporting academic staff involved with undergraduate research and inquiry is a good way of developing links between research and teaching. However, the reward system of most universities tends to treat these two areas separately. If Human Resource (HR) policies are to be aligned with policies to promote undergraduate research and inquiry, it is important that engagement in this area is recognised for workload planning purposes; for example, mentoring and supervising is counted when the students are undergraduates as well as graduates. HR policies also need include undergraduate research explicitly in performance review, merit pay and promotion processes.

Including the expectation of involvement with undergraduate research in adverts for academic posts is one way of explicitly identifying the activity; encouraging research staff to engage with undergraduates is another. At the University of Queensland research staff are funded through central institutional funds to undertake teaching for up to a quarter of their time.

Research staff are funded to engage in teaching at the University of Queensland, Australia

Since 2006 the University of Queensland has used some of the money raised through the Enhanced Student Contribution (levied at 25% additional charge to students) to pay for research staff to engage in teaching at undergraduate and/or graduate coursework level for 10% or 25% of their time. In 2009 AUS$4 million has been set aside for this purpose. The scheme, named *ResTeach*, is designed to remove a frequently stated impediment to utilising research staff, namely resource allocation, and thereby:

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

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

Further information
www.uq.edu.au/teaching-learning/index.html?page=92623&pid=0

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Some Resources on Developing Undergraduate Research and Inquiry

These are a few useful references extracted from: Healey, M (2010) *Linking Research and Teaching: A selected bibliography* resources.glos.ac.uk/ceal/resources/litreview.cfm; Key ones are marked with a *

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