Institutional practices and strategies to develop undergraduate research and inquiry

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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 discipline, department and 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)*

"new models of curriculum … should all … incorporate research-based study for undergraduates (to cultivate awareness of research careers, to train students in research skills for employment, and to sustain the advantages of a research-teaching connection in a mass or universal system) …"
(Ramsden, 2008:10-11)

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; 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)

Table 4: Relationships between conceptions of research

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

Source: Brew (2003, 6)

Brew (2003, 6-7), on the basis of interviews with 57 senior Australian academics has identified 4 different conceptions of research (Table 4):
- Trading view – "in the foreground are the products of research: the end points, publications, grants and social networks, i.e. aspects external to the process of doing the research. These are viewed as being linked together in relationships of recognition and reward."
- Domino view – "the researcher's focus is on the solutions to problems and the answering of questions, i.e. it is *external* to the activities of doing the research. It looks outside the immediate context of the research."
- Layer view – "the focus looks inward. It is *internal* because in the focus of awareness are the data containing ideas together with (linked to) hidden meanings. … Here, research is interpreted as a process of discovering, uncovering or creating underlying meanings"
- Journey view – "in the foreground are the personal existential issues and dilemmas of the researcher, linked through an awareness of the career of the researcher and viewed as having been explored for a long time. … the researcher is the focal point of awareness. Research is interpreted as a personal journey of discovery possibly leading to transformation.
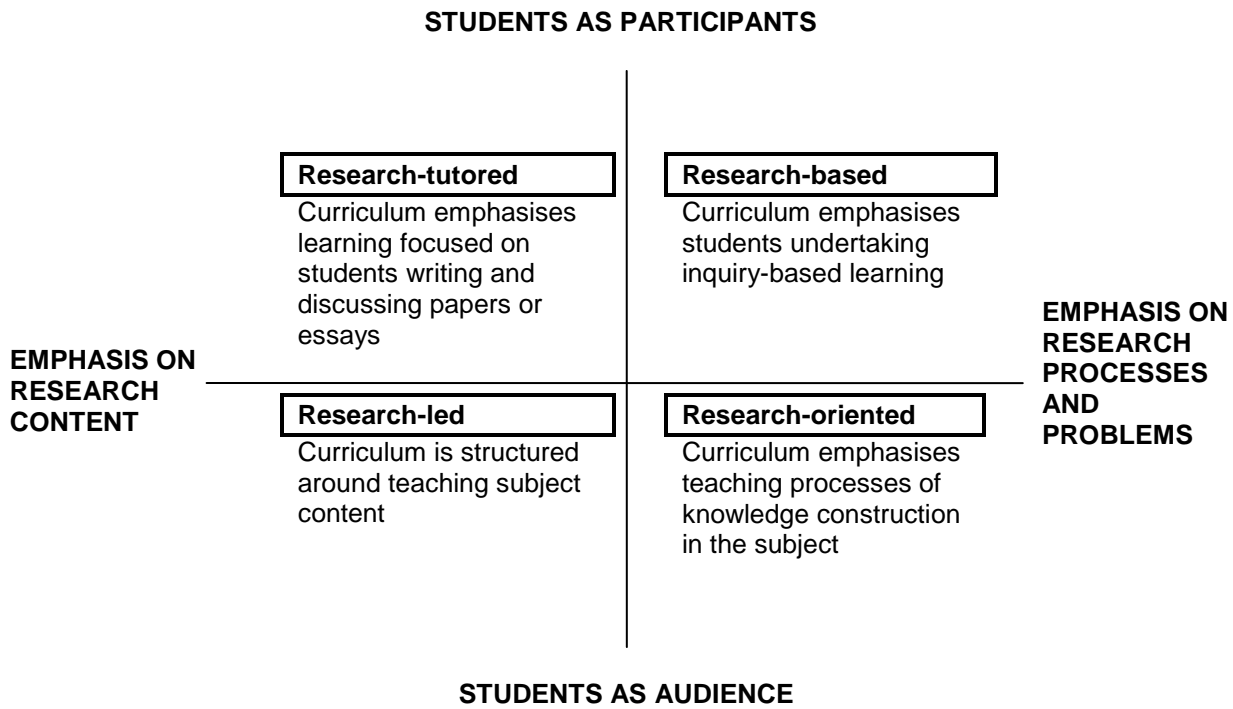

2. Curriculum Design and Teaching-Research Relations

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.
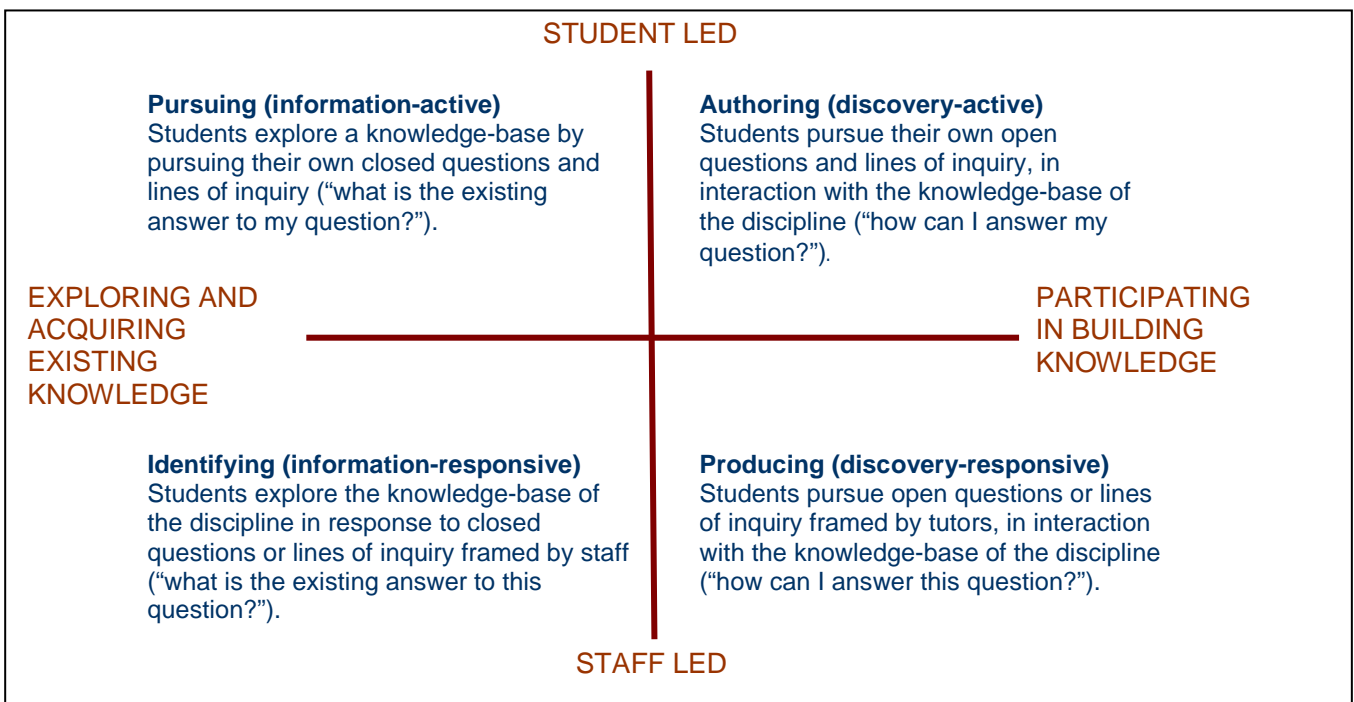
Healey (2005) has expressed these differences diagrammatically using two axes (Fig 1). One classifies approaches to linking teaching and research according to the extent to which they are teacher-focused and students are treated as the audience or student-focused and treat students as participants, while the second 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 findings. A variant on this matrix has been proposed by Levy and Petrulis (2007). They also have a staff-led and student-led axis and another axis distinguishing between information-led and discovery-led inquiry in which the former is based on existing knowledge and the latter on new knowledge (Fig 2).

Fig 1 Curriculum design and the research-teaching nexus

STUDENTS AS PARTICIPANTS

Research-tutored	Research-based
Curriculum emphasises learning focused on students writing and discussing papers or essays	Curriculum emphasises students undertaking inquiry-based learning

EMPHASIS ON RESEARCH CONTENT

EMPHASIS ON RESEARCH PROCESSES AND PROBLEMS

Research-led	Research-oriented
Curriculum is structured around teaching subject content	Curriculum emphasises teaching processes of knowledge construction in the subject

STUDENTS AS AUDIENCE

Source: Based on Healey (2005, 70)

Fig 2: Inquiry-based learning: a conceptual framework

STUDENT LED

Pursuing (information-active)
Students explore a knowledge-base by pursuing their own closed questions and lines of inquiry ("what is the existing answer to my question?").

Authoring (discovery-active)
Students pursue their own open questions and lines of inquiry, in interaction with the knowledge-base of the discipline ("how can I answer my question?").

EXPLORING AND ACQUIRING EXISTING KNOWLEDGE

PARTICIPATING IN BUILDING KNOWLEDGE

Identifying (information-responsive)
Students explore the knowledge-base of the discipline in response to closed questions or lines of inquiry framed by staff ("what is the existing answer to this question?").

Producing (discovery-responsive)
Students pursue open questions or lines of inquiry framed by tutors, in interaction with the knowledge-base of the discipline ("how can I answer this question?").

STAFF LED

Based on Levy (2009)

Table 5 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 6 Students' experiences of learning in a research environment

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

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

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"

<div align="right">Centre for Undergraduate Research</div>

"Undergraduate research is original work conducted by undergraduate students working in collaboration with a faculty mentor"

<div align="right">University of Central Florida</div>

"Discovery Learning"

<div align="right">University of Alberta</div>

"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".

<div align="right">University of Gloucestershire</div>

"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 7 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, 2007)

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).

B 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.*

A   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
www2.warwick.ac.uk/study/csde/usp/wsc/; www.york.ac.uk/services/careers/skills.cfm

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)

B 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, 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)

C   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 researchers

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

D   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