Developing Strategies for Linking Teaching and Research: Institutional and department strategies to engage students in research and inquiry

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Institutional Mission Statement
University of Cyprus aims to establish itself as a Pioneer Research Institution achieving International Scientific Recognition in European Higher Education, offering Competitive Programmes and to become a Centre of Excellence in the wider Euro - Mediterranean Region.

The main objectives of the University are twofold: the promotion of scholarship and education through teaching and research, and the enhancement of the cultural, social and economic development of Cyprus.

In this context, the University believes that education must provide more than simply accumulation of knowledge. It must also encourage students' active participation in the process of learning and acquisition of those values necessary for responsible involvement in the community. The University sets high standards for all branches of scholarship.

Research is promoted and funded in all departments for its contribution to scholarship in general and for its local and international applications. (University web site)

Key Quotations

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

"The University's account argues strongly for the continuing and crucial value of the link between teaching and research … In practice …the audit team found that there was very little systematic reflection within the University about just what was meant by the claimed interdependence of research and teaching." UK Higher Education Quality Council (1997: 3) Audit of Exeter University.

"The research universities have often failed, and continue to fail, their undergraduate populations, thousands of students graduate without seeing the world - famous professors or tasting genuine research." Boyer Commission on Educating Undergraduates in the Research University (1998 :3).

"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,

Structure:

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A: Views on the linkage between research and teaching

Table 1: Different ways of linking research and teaching

- Learning about others' research
- Learning to do research – research methods
- Learning in research mode – enquiry based
- Pedagogic research – enquiring and reflecting on learning

Table 2: Linking research and teaching: Different views

"Our view is that university research often detracts from the quality of teaching. We regret the continuing elevation of research and the systematic neglect of the quality of instruction." (Pocklington and Tupper 2002, 7 – about Canada)

"Courses taught by those at the cutting edge of research will necessarily be of higher quality than those taught by those merely using the research results of others – whatever the apparent quality of their style of delivery. …. Furthermore, if teaching is undertaken by researchers the linkage is automatic, even if, as is often the case they are not always teaching about their own narrow research specialism." (Lee 2004, 9 – with particular reference to geography in UK)

"In all but the most elite academic environments, when you co-locate teaching and research you reduce your efficiency in producing both." (Lloyd 2009 writing in *The Australian*)

"Research consumes much time and money that could be better spent on teaching students" (Haldane 2010)

The New Zealand Education Amendment Act (1990) defines a university as where "teaching and research are closely interdependent and most of their teaching is done by people who are active in advancing knowledge." (cited by Woodhouse, 1998; policy audited in the late 1990s but received less emphasis since).

In *Scholarship Reconsidered* Ernest Boyer (1990, xii) challenged US higher education to "break away out of the tired old teaching versus research debate."

"… we want all students to access the benefits exposure to teaching informed by research can bring…. This will take many forms including pure and applied research that feeds curriculum development; but also research and development that tackle the challenging questions facing professional business, regional and local employers now and in the future. We're doing this because we believe an understanding of the research process – asking the right questions in the right way; conducting experiments; and collating and evaluating information – must be a key part of any undergraduate curriculum; whether or not those involved in delivering it are actively engaged in research activity themselves." (Bill Rammell, Minister for Higher Education 2006, 3)

"Why does every University, thirty-eight of them, public ones, why do they all have to be doing research, teaching and scholarship and struggling to do it in so many areas? Why can't we have Universities that make a conscious decision to specialise in outstanding teaching and scholarship but do very little research? Why can't we have formal affiliations, one specialising in teaching and another research, between our domestic Universities?" (Brendan Nelson, Minister for Education, Science and Training, Australia, April 2005)

"We are all researchers now … Teaching and research are becoming ever more intimately related … In a 'knowledge society' all students – certainly all graduates – have to be researchers. Not only are they engaged in the production of knowledge; they must also be educated to cope with the risks and uncertainties generated by the advance of science." (Scott 2002, 13)

"I propose that colleges and universities provide an opportunity for all undergraduates to conduct research — to create knowledge." (Ellis, 2006; Professor of chemistry at the University of Wisconsin at Madison, on detail as director of the National Science Foundation's chemistry division through June 2006)

"The roles of teaching and research should be afforded parity of esteem, and this should be reflected in resource allocation, in promotion criteria, and in the metrics used to assess performance at individual, institution and system level." (Department of Education and Skills 2011, 54) Ireland

B. Engaging students in discipline based research and inquiry : The Griffiths / Healey models explored
We have found the framework developed **Griffiths (2004)** effective in supporting staff/faculty to examine both their current courses and institutional policies and practices and in adapting innovations from elsewhere. According to Griffiths teaching can be:

- **Research-led**: where students learn about research findings, the curriculum content is dominated by faculty research interests, and information transmission is the main teaching mode;
- **Research-oriented**: where students learn about research processes, the curriculum emphasises as much the processes by which knowledge is produced as learning knowledge that has been achieved, and faculty try to engender a research ethos through their teaching; or
- **Research-based**: where students learn as researchers, the curriculum is largely designed around inquiry-based activities, and the division of roles between teacher and student is minimised.

Fig. 1: The nature of student research and inquiry
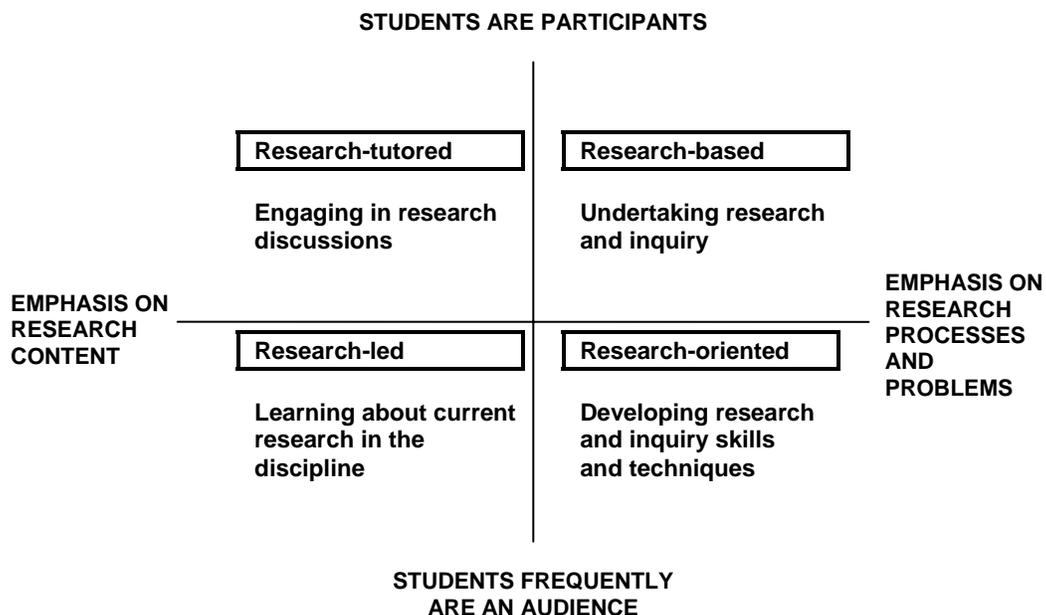
Source: Healey and Jenkins (2009, 7; amended from Healey, 2005, 70)
Despite the extent to which students are participants being one of the dimensions of the model, the examples explored in this paper are primarily active and exciting experiences. Hence most belong in the top half of the model.

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C :Disciplinary Case Studies Organised with Reference to the Griffiths /Healey models

1.1 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

1.2 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: No longer available on the website*

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)

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

Introducing inquiry-based teaching methods in Literary Studies at University of Manchester, UK

The traditional form of Literary Studies teaching in HE is tutor-centred. In this case study a group of second-year students studying Eighteenth Century Literature are introduced to inquiry-based learning in the first week of the first semester. The course consists of a weekly lecture and a weekly seminar. The latter consists of 15 students divided into three groups. During the seminars the tutor acts as a task-giver and thereafter as both an information resource, responding to student requests, and as a facilitator moving from subgroup to subgroup helping discussion to develop. For example, in week 1 the students were given a poem by Samuel Johnson, On the death of Dr Robert Levet. The poem was issued to students without annotations or supporting detailed biographical information. Each subgroup was asked to address two questions: 'What kind of language does the poem use?' and 'What belief system, if any, does the poem imply?'. Most groups responded to this task actively by exploring and considering the possibilities from a range of perspectives, establishing and pooling any existing knowledge and assessing its applicability to the task in hand. By emphasising the need to seek other sources to contextualise their answers, the facilitator began to establish the research element crucial to moving from 'problem solving' to something more nuanced.
Further information: Hutchings and O'Rourke (2003)

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

Students on a course on the History of Science at UCL are involved in an ongoing pilot project aimed at a full integration of teaching and research at the undergraduate level. The chief innovation is the mechanism of inheritance: each year students receive a body of work produced by the previous group of students and make improvements and additions to it; this process can be repeated until publishable materials are produced. This is part of a system of learning that enables students to function as a real and evolving community of researchers. First developed in a final third-year course, the "course will now be open to second years which will enable interested students to continue their work as part of their dissertation, and to strengthen the diachronic community by having the previous year's students present when the next cohort take the course" (Chang 2007, 21).
Further information: Chang (2005, 2007); Chang and Jackson (2007); www.ucl.ac.uk/sts/chang/

Modelling the research experience: Tourism students' virtual conference at Universities of Lincoln and Wolverhampton, UK

In May every year, final-year Tourism students at the Universities of Lincoln and Wolverhampton participate together in a live virtual conference, as part of their final-level assessment. 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 across two campuses can come together at times of their choosing to participate in a joint effort to disseminate research findings and engage in dialogue about their research.

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. Students submit a full conference paper, but it is only a summary discussion paper that appears on the conference website. Each student is also required to post a comment on another conference paper, in true conference dialogue tradition.
Further information: www.tsvc.lincoln.ac.uk; http://www.tsvc.lincoln.ac.uk

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

In 2002, John Lutz taught, for the first time, History 481: Micro History and the Internet, a learner-centred and research-oriented subject in which the main activity was primary archival research on various aspects of life in Victoria, British Columbia from 1843 to 1900. Initial subject activities include orientation to the historical archives in Victoria and basic web-site creation skills. Students work in small groups on a research project and the final research 'product' of the subject is a web site, not a standard research paper. The subject has been developed with the support of local community groups and another university. It is one of the international innovative examples of digital history where the web is used as a research tool, a means of disseminating research and developing student web skills.
Further information:
http://www.victoriasvictoria.ca/; http://en.wikipedia.org/wiki/Digital_history;
http://web.uvic.ca/~jlutz/courses/hist481/index.html

1.4 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; http://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)

D Strategies for Linking Teaching and Research within Courses and Programmes

Strategy 1: Develop students' understanding of the role of research in their discipline
- Develop the curriculum to bring out current or previous research developments in the discipline
- Develop students' awareness of the nature of research and knowledge creation in their discipline
- Develop students' awareness of learning from staff involvement in discipline research
- Develop students' understanding of how research is organised and funded in the discipline, institution and profession.

Strategy 2: Develop students' abilities to carry out research
- Students learn in ways that mirror research processes
- Assess students in ways that mirror research processes (e.g. requiring students to have their work assessed by peers according to the house-style of a journal before submitting it to you)
- Provide 'training' in relevant research skills and knowledge
- Ensure students experience courses that require them to do research projects; and that there is a progressive move to projects of greater scale, complexity and uncertainty (Strategy 3)
- Develop student involvement in research
- Develop abilities of students to communicate the results of their research - in ways that are appropriate to the disciplinary community in which they are now participating.

Strategy 3: Progressively develop students' understanding
- Ensure that introductory courses induct students into the role of research in their discipline and present knowledge as created, uncertain and contested

- Ensure that advanced courses develop students' understanding of research, and progressively develop their capacities to do research
- Ensure that graduating year (capstone courses) require students to carry out a major research study and help them to integrate their understanding of the role of research in their discipline.

Strategy 4: Manage students' experience of research
- Limit the negative consequences for students of staff involvement in research; most important here is managing the student experience of the days (and sabbatical terms) when staff are 'away' doing research
- Evaluate students' experience of research and feed that back into the curriculum
- Support students in making clear to them the employability elements of research; this is particularly important for those students whose focus is on using a degree to get employment, and who may not otherwise appreciate the value of a research-based approach.

Based on: Jenkins *et al.* (2003, 63-4) and Healey and Jenkins (2006)

E : Linking Teaching and Research in Departments: Questions and Strategies

Curriculum and research-based learning
- What is your departmental (and disciplinary) understanding or conception of research 'led', 'based' or 'informed' learning?
- What forms of pedagogy and their assessment do you consider appropriate to support these conception
- Can you clearly identify where research-based learning is integrated in the programme?
- Where is current research in your field presented in the programme? Check your:
    - programme design and programme outcomes
    - curriculum content and delivery in the modules
    - assessment methods
- Where are research methods/skills/ethics taught and practiced? Is this progressive? Is a variety of appropriate skills/methods delivered?
- Is the research knowledge/skills the student will have acquired made clear in the module learning outcomes?
- Can/do students participate in departmental research projects as eg research assistants?
- Where is the scope for students to conduct independent research in their programmes? and in what ways do the programmes allow progression?
- How are research skills and the links between teaching and research embedded in monitoring and review of modules and programmes?
- How are students supported in making explicit how this research training/knowledge supports their employability?
- How are undergraduate students made aware of postgraduate research opportunities?

Management, organisational structure and staffing at departmental level
- How does the department's learning and teaching strategy articulate research and teaching/learning links?
- How does the department's research strategy articulate teaching and research/learning   links?
- How are the teaching and research activities, organised, motivated and resourced? Are they managed for mutual engagement? Are (all) researchers involved in teaching? How are 'non-research active' teaching staff mentored and encouraged to develop a research/scholarly profile, and valued for their particular contributions to the nexus?
    - How do research teams and course teaching teams link with each other? How are these links facilitated?
    - Are research 'clusters' also 'teaching teams'?
- How are teaching staff 'managed' in developing research and/or scholarly capacity and vice versa?
- How are new staff acculturated into the department values and practices?
- How are incoming students acculturated into the department values and practices?
- How is the staff and student experience of the nexus monitored and the results fed back into policies and practices?

Inclusive culture
Developing the links between teaching and research requires cultural change too:
- What are the mechanisms for disseminating and communicating research outputs and teaching practice development in the Department?

- How is the research culture and activity given visibility to students? How do students come into contact with departmental research?
- What are the strategies to disseminate research-based teaching experience from the module level?
- What profile is given to (discipline based) pedagogic research? How is this research disseminated and applied in programmes?

And finally
- Allow for diversity
- Remember it is the individual's scholarly engagement with her/his subject and how this is brought to their teaching and research setting which mediates the relationship between teaching and research. You cannot tightly programme the nexus
- Recognise that the relationships between teaching and research are reciprocal.

Source: Based on: Zetter (2002) and Jenkins and Zetter (2002)

F . Some departmental case studies on linking teaching and research

2.1 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); http://www.utas.edu.au/zoology/

2.2 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: http://www.sussex.ac.uk/lasi/teaching/bursaries

2.3 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)

2.4 Encouraging self-authorship in introductory human geography via student-created, collaborative, place-based case studies, Miami University Ohio, US
The Department of Geography at Miami recently redesigned its introductory human geography course, *Global Forces/Local Diversity*. The primary goal was to provide support for undergraduate geography students along the journey to self-authorship by involving them in their own learning. This is accomplished by moving away from traditional teaching modes (e.g. lectures, textbook reading assignments, exams) toward an approach based on weaving student-created case study inquiries into everyday teaching and learning. Students are asked to do conceptual and thematic research in collaborative groups on real issues in particular places. They then share their multi-media projects with other students enrolled in the class (digitally and in person) and these student-created geographical portraits are ultimately incorporated into class discussions.
Students learn about their own place in a changing and complex world by exploring globalization as it unfolds in local places and current events. Thematic case studies forming the center point of this course can easily be adapted, expanded, and/or revised by new faculty or graduate student instructors over time. This not only allows the class to be taught by a variety of diverse faculty, it also keeps course content up-to-date.

Self-authorship is also encouraged in the course by (1) conveying to students that knowledge is complex and socially constructed; (2) validating learners' 'capacity to know' by trusting in their ability to conduct collaborative research and sharing in mutually constructed meaning; and (3) showing students how to develop a framework for authoring and analyzing multiple perspectives.
Geography is only one of several introductory courses which have been converted to inquiry-based learning as part of the 'Top 25' project at Miami (Hodge *et al.*, 2008b).
Sources and Further information: Moore *et al.* (2011); http://www.units.muohio.edu/celt/engaged_learning/top25/

2.5 A Curriculum Designed to Facilitate a Student's Journey toward Self-Authorship, Samford University, US
The geography department at Samford University recently redesigned their department's curriculum guided by goals of increasing student engagement with the discipline, improving their practical skills, and enhancing their ability to solve complex problems and engage in critical thinking. Core modules provide basic instruction, but these introductory modules incorporate case studies, problem-solving, and active engagement with the subject matter.   Students then proceed through a series of elective courses and finally to a series of courses called "Geography in Practice". Here students have the option of doing a supervised externship, acting as a teaching assistant for an introductory class, or doing an independent research project.
These experiences provide students with an opportunity to link their prior coursework with practical workforce skills. Finally all students complete a capstone experience where they may either undertake a client-based project, or may elect to do a traditional research paper.   With the client-based projects, students work in teams with an outside client to define a problem, devise a work plan and create some distinct output. As examples, students have produced a series of maps for a local bicycle club, worked with the university's disability services on an accessibility map of campus, and collaborated with an environmental agency to study sedimentation in a river.
All capstone students are assessed on a range of skills, as well as informational and quantitative literacy. As students progress through the curriculum they are expected to take increased responsibility for their own learning and to develop the intellectual skills necessary to move beyond the campus and into society.
Sources and Further information: Moore *et al.* (2011); http://howard.samford.edu/geography/

2.6 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)

2.7 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)

2.8 Students run the *Journal of Non-Significant Differences* at Grand Canyon University, USA

The *Journal of Non-Significant Findings* is a student-run, peer-reviewed journal designed to provide learners with a comprehensive understanding of the research cycle and the publication process. It started as a university-wide initiative in the doctoral college, but now includes students at all levels (undergraduate, masters, doctoral) in both the process of managing the journal as well as in the paper submissions. In 2013 the journal was re-launched and submissions are open to students from any university or college. Central to the journal is an understanding that research does not have to be significant to provide valuable insight into scholarship. As such, articles are evaluated according to the soundness of the research process and the ability to contextualize the importance of non-significant findings.

Source: Correspondence with Jean Mandernach (jean.mandernach@gcu.edu);
http://cirt.gcu.edu/research/nonsignificant

2.9 Preparation for the dissertation begins in year 1 of the Childhood Studies degree at Nottingham Trent University, UK

In year 1 of the Childhood Studies degree course, students are introduced to inquiry based learning approaches in a module called 'Becoming an Active Learner', where they reflect on their own learning through a number of individual and collaborative reflective tasks. During the summer break, before the students enter year 2, the students are required to do directed readings to support their knowledge and understanding of research. In year 2 they take a 'Becoming an Active Researcher' module. For the first few weeks of the year 2 module they take dedicated seminars relating to research methods and ethics. All student groups are required to complete a research proposal and an ethics form before they embark on an inquiry in small research groups.

Working with academics in a range of disciplines, the groups of students follow a rigorous ten-week schedule where they undertake the research inquiry, write a research report and present their findings at a student-led conference. Students complete the module with a reflective account of the research process and what they have learned about becoming a researcher. Some students go on to present at conferences and to managers in relevant organisations.

As a result of the modules the students are prepared well for their final year independent dissertations through improving their confidence and ability to undertake collaborative and independent research. Engaging students in research inquiry, both strengthens communities of practice in higher education and the transference of skills and knowledge to professional working environments.

Sources: Ovens *et al*. (2011); http://www.ntu.ac.uk/apps/pss/course_finder/113014-
1/7/ba_(hons)_childhood_studies.aspx; Cyndy.hawkins@ntu.ac.uk

2.10 Research project-based teaching in engineering: a departmental strategy at Taylor's University, Malaysia
The curriculum in the School of Engineering had adopted a project-based learning approach where the students are required to take a Design module each semester for the first three years of their four-year study, and then a final-year capstone project. All the projects require students conducting a variety of inquiry-based, design and build activities in groups. Staff research groups are organised around the Grand Challenges themes identified by the (US) National Academy for Engineering (NAE) in 2008. Staff in these research groups are expected to perform the following duties:

1. adopt related core and elective modules. This includes developing, updating and teaching these modules. Staff members are encouraged to include aspects of their own research findings into the modules;
2. offer group design projects to the students in years one to three;
3. offer final-year research projects. Every fourth-year student is required to undertake a major research project and write a conference paper as a requirement for graduation. Their research findings are presented at the school's annual Engineering Undergraduate Research Catalyst Conference (EURECA).
   This departmental strategy is now under consideration as an institution-wide strategy. Distinctive, but generalisable features of this strategy are that: here research is broadly conceived to include staff consultancy and advanced professional practice; the staff research does clearly support students' research understanding and future employability; and there is an overall departmental vision to bring together the different aspects of the student and staff experience.

Sources: Al-Atabi et al. (2013); http://www.taylors.edu.my/en/university/schools/engineering;
http://www.taylors.edu.my/en/university/schools/engineering/why_taylors;
http://www.taylors.edu.my/en/university/schools/engineering/why_taylors;
http://www.taylors.edu.my/EURECA/2013/; http://www.taylors.edu.my/en/university/schools/engineering/research

G Institutional Strategies to Link Teaching and Research: A Framework
Developing institutional awareness and institutional mission

Strategy 1: State linking teaching and research as central to the institutional mission and formulate strategies and plans to support the nexus

Strategy 2: Make it *the* mission and deliver it

Strategy 3: Organise events, research studies and publications to raise institutional awareness

Strategy 4: Develop institutional conceptions and strategies to effect teaching-research links

Strategy 5: Explain and involve students and parents in your institutional conception of teaching-research relations

Developing pedagogy and curricula to support the nexus

Strategy 6: Develop and audit teaching policies and practices and implement strategies to strengthen the teaching-research nexus

Strategy 7: Use strategic and operational planning and institutional audit to strengthen the nexus

Strategy 8: Develop curriculum requirements

Strategy 9: Review the timetable

Strategy 10: Develop special programmes and structures

Developing research policies and strategies to support the nexus

Strategy 11: Develop and audit research policies and implement strategies to strengthen the teaching-research nexus

Strategy 12: Ensure links between research centres and the curriculum and between student learning and staff scholarship

Developing staff and university structures to support the nexus

Strategy 13: Ensure the nexus is central to policies on inducting and developing new staff and for strategies to support the professional development of established staff

Strategy 14: Ensure teaching-research links are central to policies on promotion and reward

Strategy 15: Ensure effective synergies between units, committees and structures for teaching and research

Strategy 16: Link with related university strategies

Strategy 17: Participate in national programmes

Strategy 18: Support implementation at department level

H. Some institutional case studies on linking teaching and research

3.1 Student as Producer is the organising principle for learning across the University at Lincoln, UK
Student as Producer is now the organising principle for the learning landscapes at the University of Lincoln. The focus of Student as Producer is the undergraduate student, working in collaboration with other students and academics in real research projects, or projects which replicate the process of research in their discipline. Undergraduate students work alongside staff in the design and delivery of their teaching and learning programmes, and in the production of work of academic content and value. Staff and students can apply for development funds to the Undergraduate Research Opportunities Scheme (UROS) and the Fund for Educational Development (FED). Student as Producer is making research-engaged teaching an institutional priority. As courses come up for validation staff and students are asked to consider Student as Producer in terms of the following key features:

- Discovery: Student as Producer
- Technology in Teaching: Digital Scholarship
- Space and Spatiality: Learning Landscapes in Higher Education
- Assessment: Active Learners in Communities of Practice
- Research and Evaluation: Scholarship of Teaching and Learning
- Student Voice: Diversity, Difference and Dissensus
- Support for research based learning through expert engagement with information resources
- Creating the Future: Employability, Enterprise, Beyond Employability, Postgraduate

Further information: http://studentasproducer.lincoln.ac.uk/; http://researchengaged.blogs.lincoln.ac.uk/ Neary with Winn (2009); Neary (2010; 2011)

3.2 Undergraduate research begins at induction at the University of Gloucestershire, UK
In 2007, over 650 students in the Faculty of Education, Humanities and Science undertook discipline-based inquiry projects during induction week before starting their university courses. 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: http://insight.glos.ac.uk/tli/resources/toolkit/wal/sustainable/Documents/Induction.pdf

3.3 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. 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; For more recent versions of the course see: http://www.youtube.com/watch?v=i9idE_uCIpc ;
http://cte.uwaterloo.ca/research_on_teaching_and_learning/TBRG/OND/2011/Presentations/Vine.pdf

3.4 Mainstreaming undergraduate research and inquiry at Miami University, Ohio, US
Miami University, Ohio is moving from a teaching and learning paradigm to a discovery paradigm. The TOP 25 project begun in 2007 has introduced innovative approaches that moves learning away from "too much time telling students what we think they need to know, and not enough time using their curiosity to drive their learning" (Hodge 2006, 3). Over a four year period the TOP 25 Project involved the largest recruiting courses (actually 29 of them) being rewritten as inquiry-based courses. Each course was allocated $35,000 to fund curriculum revision. Learning technologists and educationalists supported the teams of faculty involved. Together the courses account for almost a quarter of total credit hours. Many of the courses were redesigned using the inverted classroom model in which most of the lectures are provided electronically using, for example, videos, iPods and VLEs, while most of the contact time is used for interaction between faculty and students. Some of the physical spaces are being redesigned to provide flexible furniture to encourage discussion.

Responses to survey questions show that the Top 25 courses are promoting active, engaged learning. Compared to students in the traditional sections, students in the redesigned sections report:
- More frequently discussing ideas from class with others outside of the classroom;
- Spending much more time working with other students on projects during class time;
- Spending less time memorizing facts and ideas, and
- Spending more hours on their course work and working harder than they thought they would to meet faculty expectations.

Top 25 courses also have more emphasis on higher-level thinking skills. Compared to students in the traditional sections, students in the redesigned sections report more frequently:
- Supporting their ideas and beliefs with data or evidence;
- Making judgments about the value of information, arguments, or methods by examining how others gathered and interpreted data and assessing the soundness of their conclusions;
- Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships; and
- Working on a project or paper that requires integrating ideas from various sources.

Many faculty not involved in the Top 25 project are also adopting similar changes. Because the redesigned courses are creating new expectations among students they are now arriving in class expecting to be challenged and ready to take more responsibility for their own learning.

The challenges in maintaining this 'project' include reduced financial support because of problems in the national and thus institutional economy, in maintaining the momentum. The visibility of the Top 25 project and its support at the highest levels of the university have encouraged the development and expansion of programs that support student engagement. For example, the First Year Research Experience (FYRE) program has been established to offer incoming students an opportunity to engage in research and to establish early contact with a faculty mentor.

Further information: Hodge (2006); Hodge *et al.* (2007; 2008; 2011); Taylor *et al*. (2012)
http://www.units.miamioh.edu/celt/engaged_learning/top25/;
http://www.units.muohio.edu/oars/undergrad_research/first_year_research_experience/fyre_info.php

3.5 Developing a group project based engineering design curriculum at Olin College, USA
Olin is an innovative small private institution that admitted its first students in 2003. It was founded by a foundation whose aim is to transform engineering education. From an intensive weekend selection of potential students the curriculum is built around group project based entrepreneurial engineering design projects. Early projects are shaped by faculty but later projects are student designed with faculty support. A final year capstone involves students in teams of 5-7 developing an entrepreneurial innovation with a commercial sponsor. There is a strong focus on interdisciplinary education and this is supported by Olin's strong curricula links with neighbouring Babson (an entrepreneurial business college) and Wellesley (liberal arts, women only). Olin's Curriculum expires every five years, and must undergo an internal curriculum review to ensure that the college maintains a culture of change and continuous improvement. The issue of transferability, including to less endowed institutions, has been central to Olin College since it started. The Initiative for Innovation in Engineering Education (I2E2) in part helps other institutions to adapt Olin's principles, but its central focus is helping other engineering institutions and departments to develop strategies to meet *their* curricula agendas. The Initiative runs a summer institute to support engineering departments to reshape their curricula. A major current project is Olin supporting the College of Engineering at Southern Illinois University's I Foundry Initiative.

Further information: Kearns *et al.* (2004) http://www.aei.org/files/2010/06/03/Richard%20Miller.pdf; http://i2e2.olin.edu/; http://en.wikipedia.org/wiki/Franklin_W._Olin_College_of_Engineering; http://www.youtube.com/watch?v=i2LkjjUOY-Q; http://globale3.studioabroad.com/_customtags/ct_FileRetrieve.cfm?File_ID=11952; http://i2e2.olin.edu/summer/applicationform.html; http://ifoundry.illinois.edu/about/

3.6 From research-led to research-based education at University College London, UK

"At University College London, our top strategic priority for the next 20 years is to close the divide between teaching and research. We want to integrate research into every stage of an undergraduate degree, moving from research-led to research-based teaching"

Michael Arthur, president and provost of University College London, 30 April 2014: 22

UCL are developing a 'Connected Curriculum' initiative, as the means by which in five years all undergraduate programmes of study will have a profile of 'research-based' characteristics. Research-based education is the focus of UCL's initiative: "entitling all students, through well-designed programmes of study, to benefit from participating in enquiry alongside UCL's world-leading researchers" (Fung 2014, 2). Seven dimensions of connectivity are identified:

1. Students connect with the discipline through participation in research
2. Programmes include a connected 'throughline' of learning activities and assessments, which require students to synthesise different elements of their learning
3. Students make connections across subject disciplines and outwards into local and global communities and organisations
4. Students can connect explicitly their academic learning with their wider learning and skills for future employment
5. Students can connect with an external audience and external partners through producing assessment 'outputs'
6. Students can connect closely with staff
7. Students can connect closely with one another and with alumni.

This will also require changing the criteria for promotion, so that excellence in education is as significant to advancement as excellence in research and innovation. The implementation will involve reviewing all programmes and designing "clear strategies for developing closer partnership with students, who can work with us as partners and agents of change" (Fung 2014, 4). *Sources:* Arthur (2014); Fung (2014)

3.7 Unravelling complexity at Australian National University (ANU)

The final year synoptic capstone course involves students from each of the seven colleges/faculties examining different disciplinary ways to "unravel complexity". It was the first of a suite of "Vice-Chancellor" courses where ANU researchers from different disciplines sharing leading research ideas and discoveries with students. The number of students taking *Unravelling Complexity* has been limited to 10 from each of ANU's seven Academic Colleges. They are selected on the basis of outstanding results and interest in and commitment to working in policy areas.

The course has a weekly two hour panel of different high profile researchers speaking to the class on how different disciplines deal with complexity. Each panel typically consists of a range of speakers taking different perspectives on an issue, e.g. global financial crises, the collapse of empires, contemporary 'failing' states, pandemics, engineering and network failures and the moral and legal dimensions of these issues. Students in pairs then facilitate a tutorial discussion with about 16 of their classmates on this topic. As the course unfolds students are encouraged to apply methods and insights from different disciplines to each week's case example. Reflective and interdisciplinary thinking is encouraged through a learning portfolio being the major assessment piece for the course. Students commented that the course structure modelled likely work scenarios they were soon to be in – i.e. working in interdisciplinary teams on complex problems that need a diverse range of tools and perspectives to address.

Its basic philosophy and structure is readily adaptable to other research intensive universities where strong institutional leadership is encouraging the involvement of leading researchers in undergraduate teaching. Aspects of its approach – in particular its focus on seeing complex issues from different disciplinary research perspectives - are also developed in a large introductory course at ANU (Baker and Lupton, 2003). They are a feature of some final year synoptic capstone courses (Healey *et al.*, 2013).

Sources: http://vc-courses.anu.edu.au/; http://vc-courses.anu.edu.au/uc/example-work-4/; http://vc-courses.anu.edu.au/uc/weekly-topics/; http://www.i2sconference.org/program/digital-posters/#discuss-poster; http://insight.glos.ac.uk/tli/activities/ntf/urproject/casestudies/Pages/default.aspx

3.8 Students from across the university work on Group Research Opportunity Undergraduate Projects (GROUPS) at London School of Economics, UK

LSE GROUPS provides undergraduates at the London School of Economics and Political Science with the opportunity in the final two weeks of summer term to work full-time in cross-disciplinary, cross-year groups on an inquiry-based research project of their choice under the umbrella of a broad theme - these have included 'Community in London and/or at the LSE' and 'Identity and Place in London and/or the LSE'. During the two-week period the students come up with their own research questions, carry out a literature review, design their methodology, conduct their research and then write up their papers culminating in their presentation at an academic conference on the last day of the project. Each group of students is supported in this process by a research supervisor as well as through qualitative and quantitative resource sessions which run throughout the two-week period. The supervisors who are advanced PhD students or have recently completed their doctorates work with the programme directors in advance of LSE GROUPS exploring the nature of enquiry-based learning and research supervision in this context. The two winning groups (the best paper and the best presentation) have the opportunity to present their work at the British Conference on Undergraduate Research (BCUR) annual conference. During the two weeks of LSE GROUPS students learn a great deal about the research process itself as well as the challenges and opportunities of working in groups. The LSE GROUPS 2014 conference saw 70 undergraduate students presenting their research into identity and place.
Further information: http://www.lse.ac.uk/intranet/LSEServices/TLC/undergraduateMScStudents/lseGroups.aspx includes a feedback film from LSE GROUPS 2013; Dr Claire Gordon, LSE GROUPS Programme Director c.e.gordon@lse.ac.uk<mailto:c.e.gordon@lse.ac.uk

3.9 Igniting a Learning Revolution: Student-led higher education for sustainability and students as a force for renewal at Uppsala University and Swedish University of Agricultural Sciences, Sweden

The Centre for Environment and Development Studies (CEMUS) is a student-initiated and primarily student-led university centre, straddling the two universities in Uppsala. Since its inception in the early 1990s, the Centre has initiated and greatly expanded the space for trans-disciplinary student-led higher education as well as research and collaboration that transcends traditional academic disciplines and boundaries between academia and society at large. Around 700 students enroll annually in one or more of the 20 current undergraduate, graduate and PhD courses offered at CEMUS. The courses are organized and led by students, usually recruited from the current pool of students at CEMUS, and are hired on a 9-month project-basis as course coordinators. Often working in pairs of two, the course coordinators lead the process of planning, running and evaluating each course, and do so in close partnership with a selected multidisciplinary group of researchers and teachers as well as practitioners and educational developers, who contribute to the course as guest lecturers, examiners and advisors. Over the years, several hundreds of students have worked as course coordinators, thousands of researchers, teachers and guest lecturers have been engaged and well over 10,000 students have taken one or more of the many courses offered by CEMUS.

The educational model has served as an emancipatory force for students that continue to be amazed at what they are capable of creating when given responsibility and freedom. It has also served as an oasis of creativity and pedagogical experimentation for university teachers that has inspired educational development, including new courses in their own departments.

As CEMUS itself is in constant renewal, with just a handful of permanent staff and between 5 and 10 new course coordinators hired every year, a major challenge has been to maintain sufficient continuity and institutional memory to navigate and manage the evolution of the Centre. In the last two years this has sparked an increased collaboration with a number of new partners, both within and outside the university, nationally and internationally. The two-year project "Active Student Participation in Higher Education at Uppsala University" in collaboration with the Department of Quality Enhancement and Academic Teaching and Learning, and with strategic funds from the vice-chancellor of Uppsala University, aims to inspire and support students to become active co-creators of higher education. The installment of guest professorships and the development of new research fields, inspired by themes from CEMUS courses and made possible by co-funding from philanthropic organizations, is another example. Recent projects also include collaborations with students and educational developers at universities from several different continents.
Further information: Stoddard (2012, 2013); Hald (2011); Nitsch (2014); Reiser (2014)

3.10 Engaging students in research into teaching and learning at the University of Western Australia and University of Exeter

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

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

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

Further information: Partridge and Sandover (2010); Kay *et al*. (2010); Dunne and Zandstra (2011)

For many more case studies of students as change agents see: www.mickhealey.co.uk/resources

I . Institutional strategies to mainstream undergraduate research and inquiry

Amended extract from: Mick Healey and Alan Jenkins (2009) *Undergraduate research and inquiry* York: HE Academy. pp.80-101
http://www.heacademy.ac.uk/assets/York/documents/resources/publications/DevelopingUndergraduate_Final.pdf

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.*

J. Case Studies of Institutional strategies to mainstream undergraduate research and inquiry

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).

Research-led Education Programme Requirements at Durham University, UK
In March 2011 Senate - the governing body of the University - required research-led education - understood "as in its broadest sense encompassing all four types of research-led education" (ie research-led, -oriented, -based and -informed, as in Griffiths, 2004) to be embedded within the curriculum of all programmes of study in a three year implementation plan. Other required curricula principles are employability and skills, and internationalisation. Specific requirements include:

- "Research-led education will be … a coherent, progressive and explicit strand at all stages of a programme. The University will expect that this begins at Level 1 of undergraduate programmes (and Level 0 for those programmes incorporating a foundation year) and immediately in taught postgraduate programmes."
- "All degree programmes will include a major research project, dissertation or equivalent where students are able to demonstrate the development of their own research and independent study skills, as well as their expertise in their chosen field of study. This major research project will provide a 'capstone' to their Durham education that allows students to demonstrate their ability as independent learners and researchers."

Further information: http://www.dur.ac.uk/learningandteaching.handbook/4/4/5/
http://www.dur.ac.uk/learningandteaching.handbook/10/10.2/

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: Kathryn J. Wilson, Assistant Vice Chancellor for Research, Indiana University-Purdue University Indianapolis (IUPUI), posting to Council on Undergraduate Research web site 30 January 2009; http://crl.iupui.edu/

Block teaching and final two year research project at Quest University, Canada
Quest University British Columbia, which held its inaugural class in 2007, is Canada's only private, secular non-profit university. In 2012 it had 425 students. The school was founded in 2002 by David Strangway, a geophysicist and former president of the University of British Columbia.
The curriculum emphasis is on student inquiry and research. Staff student ratios are high. Much teaching is seminar based with maximum class size of 20. There are no lecture theatres or lectures. Quest uses the block system, in which students take one course at a time for a month. In their second year, students spend an entire block, with 15 peers and a tutor, formulating a central question. Students spend their last two years focused on that question. Usually, it is answered in the form of a thesis but alternative research outputs are supported e.g. an original play or a graphic novel. Faculty are required to undertake standard discipline based research or pedagogic research.
In the 2011 National Survey of Student Engagement, in which most Canadian universities participated, for both first-year and senior students, Quest was first for year one and senior students in five key benchmark categories 1. Level of Academic Challenge; 2. Inclusion of Enriching Educational Experiences; 3. Intensity of Student-Faculty Interaction; 4. Use of Active and Collaborative Learning; and 5. Existence of a Supportive Campus Environment.
Further information: : Miller (2012); http://www.questu.ca/; http://en.wikipedia.org/wiki/Quest_University http://www.youtube.com/user/questuniversity; http://www.questu.ca/about_quest/a_quest_degree.php; http://www.questu.ca/academics/concentration_program/index.php; http://www.questu.ca/pdfs/_uploads/content/quest_learning_outcomes.pdf; http://www.questu.ca/admission/nsse_survey_results.php

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:* http://www2.warwick.ac.uk/services/scs/skills/usp; https://www.york.ac.uk/students/work-volunteering-careers/skills/york-award/

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 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.

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);

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/;
http://www.uofaweb.ualberta.ca/researchandstudents/nav01.cfm?nav01=19717

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; Wilson and Howitt 2012). 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); Kiley *et al.* (2009); Newitt (2007); Strazdins (2007); Wilson *et al.* (2007); Wilson and Howitt (2012)
http://studyat.anu.edu.au/courses/SCNC1101;details.html

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: Legge (1997); http://www.ruc.dk/en/education/full-degree-graduate/interdisciplinarity-and-project-work/

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/

From problem based learning (PBL) to undergraduate research at Maastricht University, Netherlands

Problem Based Learning (PBL) has been central to all programmes at Maastricht since it was founded in 1976. Students work in small groups (10 to 13 students) on actual or simulated problems under the supervision of a staff member. While these experiences have an element of student research, the problems are generally 'old problems' and the inquiries are generally of two week duration. In 2010 Maastricht, through competitive national funding (Sirius) to support high ability students, established a programme – MARBL (Maastricht Research Based Learning) to support undergraduate research in all faculties. Two main differences with the well established PBL are the amount of time

actually spent on just one research question – this can be five months; and that students are working on authentic problems, presented by external clients or as a part of a large research project at the university. Entry to such programmes is competitive. Most participants in the new programmes are in their third (final) year in the bachelor's programme. On average 200 students (8 percent of the approximately 2,500 third-year students) participate in different research projects each academic year. Preliminary research is positive on the impact of the programme from both student and faculty perspective. In addition MARBL is impacting on the mainstream curriculum for all students. Two faculties have revised their curricula, embedding more research elements. A third faculty has introduced a research-based curriculum for all students, with the undergraduate research project available for the top 20 percent of the students in their third year. *Further information:* Bastiaens and Nijhuis (2012) http://www.siriusprogramma.nl; http://www.maastrichtuniversity.nl/web/Faculties/SBE/Theme/Education/MARBLEProgramme.htm.

Independent Study Programme at the College of Wooster, USA

Independent Study (IS) is an integral part of the Wooster degree. Students are given opportunities to develop their skills, to support them in the completion of their IS, from their first year. Students are exposed to research opportunities in the second semester of their first year. They are also offered an opportunity to participate in Wooster's Summer Research Program; which can act as an apprenticeship. The IS programme allows students to demonstrate skills and abilities that employers value. IS is a year-long project conducted by all senior students at Wooster. It is an individual study which is completed in consultation with a mentor. The project can take different forms; depending on the research area and student's interests. IS can culminate in a major research paper, an art exhibit or a performance. Students are required to present their initial ideas in front of professors and peers. It is as a result of this process that mentors are chosen; ensuring that students are given appropriate support. Students meet with their mentor in weekly, hour-long, one-on-one meetings.

Students are required to conduct a literature review and plan and conduct research in an appropriate environment (i.e. lab, theatre, or studio). At the end of their project students are required to orally defend their research. There are also opportunities for celebration. There is the hand in deadline, IS Monday, which ends with an IS parade that provides students with a final focus. The Senior Research Symposium, a celebration of IS, allows students, staff, peers, parents and community members to celebrate the accomplishments of students in their senior year. It is a day where students' classes are cancelled and they hold presentation, art exhibits, research posters, etc., to demonstrate their knowledge and achievements. *Further information:* http://www.wooster.edu/Independent-Study
http://insight.glos.ac.uk/tli/activities/ntf/creativehops/examples/Pages/ExamplesofCreativeHonoursprojectsfromScience,Technology,EngineeringandMathematics.aspx

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 by 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.

Students are engaged as partners in shaping and leading their own educational experiences through their 'students as change agents' initiative at the University of Exeter, UK

The key concept is that students themselves take responsibility for bringing about change, based on their own research on aspects of learning and teaching. The approach enables students to be actively engaged with the processes of change, often taking on a leadership role. They are engaged deeply with the institution and their subject areas, and the focus and direction is, to a greater extent, decided by students. The most important aspect is the focus on research, and building change on evidence-based foundations. Students from across the university have contributed to this initiative, carrying out a series of research projects on their learning and teaching environment, selecting concerns raised through student-staff liaison committees, and providing recommendations and solutions to improve their experience. A small amount of funding is available from the University's learning and teaching budget to support this initiative. Students work as apprentice researchers; their research methods included focus groups, informal interviews and questionnaire surveys. Outcomes are presented at a student-staff conference, which results in institutional engagement with key research findings. Each small project is also captured through a case study. Student research has driven organisational change, contributed to student engagement in shifts of policy and practice within the University, and supported students' graduate skills in the areas of research, project management and presentation of outcomes, leadership and understanding organisational development. For example, student projects in the Business School on the benefits students have gained from implementation of technologies in the classroom have contributed significantly to streamed

video being now far more widespread, and 4000 voting handsets being distributed to undergraduate and Master's students. *Further information:* Kay *et al.* (2010); Dunne and Zandstra (2011)

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. 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. 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 2013 the University of New Hampshire celebrates its 14th undergraduate research conference; over 1000 students will participate over a fortnight. 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 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: http://insight.glos.ac.uk/tli/activities/activelearning/Documents/CeAL%20Self-evaluation%20Document.pdf

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:* http://www.educaedu.co.uk/pgdip-research-informed-teaching-postgraduate-28250.html

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/).

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; Correspondence with Deborah Terry, 30 Oct 2008

Vice Chancellor Award Medal for Teaching and Research Integration at University of Technology Sydney, Australia

As one of seven annual Vice Chancellor Awards for Research Excellence, this award recognises researcher(s) for the successful integration of research and teaching and learning as outlined in the UTS Strategic Plan. Nominations should address:

- Integration into the curricula – Demonstrate how research methods or outcomes have become embedded in subject/course and learning provision at UTS.
- Excellence in design and innovation in course design – Describe the methods used to apply the research methods/outcomes in the curricula and how they support key learning areas in the discipline.
- Student impact – Describe the benefit, or potential benefits, for students as a result of the influence of this research in teaching practices i.e. improved graduate attributes for their specific industry or workplace.

Further information: http://www.research.uts.edu.au/awards/categories.html#teach

K Possible strategies for national and international organisations

Strategy 1: Build it into the statutory / legal definitions of HE institutions and degree and professional requirements

- Build the nexus into statutory definitions of a university
- Build it into any public classifications of universities
- Build it into the (statutory) definitions of a degree

- Professional bodies (both national and international) can also make requirements for students being involved in /doing research / understanding research

Strategy 2: Ensure there are limited negative impacts from research selectivity

Strategy 3: Require research selectivity to support research areas that directly support the nexus
- Support discipline based pedagogic research
- Require applications for research awards and in particular through national research selectivity exercises such as the RAE to identify how undergraduate and postgraduate students benefit from staff research
- Make undergraduate student involvement a condition of some research awards
- Target some competitive grants to institutions to support (undergraduate) student researchers
- Target some competitive grants to institutions to support the nexus
- Ensure that textbooks and educational software are valued
- Selectively build grants / requirements for data from research studies to be widely available to teacher / scholars and students
- Harness the Internet to foster the nexus

Strategy 4: Fund and support all institutions and staff for (discipline-based) scholarly activity

Strategy 5: Develop external reviews of teaching and research which explicitly support the linkage
- Make limited adjustments to separate reviews of teaching and research
- Focus the reviews, or periodic reviews, on the nexus
- Auditing the Teaching / Research Nexus in New Zealand
- At institutional level, reviews should focus on the nexus as it 'professed' by that institution

Strategy 6: National and international disciplinary organisations can support the nexus

Strategy 7: Develop national and international organisations and projects to support the nexus.

Source: Jenkins *et al.* (2003)