Institutråd (Institutrådsmøde 01.09.23)

01-09-2023 10:00 - 11:30

KST3 2.107 /ACM15 (A) 2.3.015

Indhold

Punkt 1: Godkendelse af dagsorden

Punkt 2: Orientering v. Keld

Punkt 3: Økonomipunkt

Vi arbejder aktuelt på at finde så gode løsninger som muligt for instituttets økonomi. Fakultetet har lagt an til en drøftelse af vedhæftede bilag. Meget af det, der er noteret, er forhold, vi allerede arbejder med på instituttet. På mødet vil vi drøfte fordele og ulemper ved de forskellige mulige tiltag, og der kan være andet, I tænker vil være relevant. Det er vigtigt at understrege, at det er en bruttoliste, som skal lægge op til drøftelse i de forskellige udvalg på tværs af fakultetet med henblik på at give in put til et katalog over mulige tiltag og besparelser.

AALBORG UNIVERSITET

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Arbejdet med at sikre en økonomi i balance på SSH

Baggrund

SSH står i en økonomisk presset situation, både ift. indeværende år, og også når vi ser fremad på de kommende år. Dette skyldes forskellige faktorer. For 2023 særligt en nedgang i STÅ, en nedjustering af takst 1 forhøjelsen samt en række interne beslutninger på universitetet om prioritering af ressourcer til bl.a. et nyt studieadministrativt system, øget datasikkerhed, digitalisering mv. For de kommende år er der derudover udfordringer pba. en rammereduktion, som er besluttet af bestyrelsen for at sikre opbygning af AAU's disponible egenkapital i 2024 og 2025, nedgang i uddannelsesindtægter på grund af lukning af uddannelser i København og allerede besluttede dimensioneringer.

På nuværende tidspunkt ser det ud til, at SSH kommer til at mangle omkring 25 mio. kr. allerede i 2023. Det forventede resultat for 2025 er i øjeblikket et underskud på ca. 40 mio. kr. med de rammer, vi kender nu. Det kan dog ikke udelukkes, at beløbet kan blive større, når vi kender optaget, resultatet af kandidatreformen mv.

For at skabe en økonomi i balance på fakultetet i 2024 og derefter, er der igangsat et arbejde med en genopretningsplan, hvor der bl.a. arbejdes med fortætning, reduktion af forbrugsudgifter samt et kvalificeret ansættelsesstop på fakultetet. Disse tiltag er dog ikke nok til at imødegå de økonomiske udfordringer, og der igangsættes derfor nu et arbejde ift. at identificere og prioritere øvrige besparelsestiltag på fakultetet.

Fakultetets institutter står forskellige steder, når det kommer til de økonomiske udfordringer. Nogle institutter ser ind i større udfordringer end andre, og besparelsesbehovene falder på forskellige tidspunkter over de kommende år. Der kan derfor ikke laves én fælles proces for gennemførelse af besparelser på tværs af fakultetet. Udover beslutning om tværgående besparelsestiltag er det derfor vigtigt, at der på det enkelte institut udarbejdes konkrete procesplaner for, hvordan det sikres, at instituttets økonomi kommer i balance i 2024, 2025 og 2026.

Åbenhed og inddragelse

På SSH-fakultetet ønskes en høj grad af gennemsigtighed og rettidighed i vores interne kommunikation[1], og det er derfor vigtigt, at det fra starten indtænkes, hvordan det sikres, at de rette medarbejdere og udvalg inddrages og orienteres på de mest hensigtsmæssige tidspunkter. Inddragelsen skal ske på både institut- og fakultetsniveau, via både institutråd, institutternes samarbejdsudvalg, Akademisk Råd, FSU samt mere generelle medarbejderorienteringer via nyhedsbreve og medarbejdermøder.

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[1] SSH Kommunikationsstrategi 2023-2026

Bruttoliste over forslag til besparelsesområder

Allerede besluttet:

- Ansættelsesstop på tværs af fakultetet (Til udgangen af 2023)
- Fortætning af fakultetets medarbejdere og studerende
- Reduktion af forbrugsomkostninger (I 2023)

Forslag til yderligere besparelsesaktiviteter:

Uddannelsesportefølje:

- Gennemgang af fakultetets uddannelsesportefølje med udgangspunkt i økonomisk bæredygtighed
- Færre specialiseringer, færre valgfag

Timer og VIP/DVIP:

- Mere helhedsorienteret tilgang til timeudmelding per STÅ, eksempelvis således at der tildeles forskelligt timeantal til uddannelser bl.a. på baggrund af størrelse.
- Forøgelse af undervisningsnorm for VIP
- Justering af forberedelsesnormer/Generel justering af normer
- Gennemgang af VIP/DVIP balance på uddannelserne
- Mindre ambitiøs grænseværdi for VIP/DVIP, da dette vil give større fleksibilitet, bl.a. i form af mulighed for frikøb i en situation med mere ekstern funding.

Undervisning/vejledning:

- Større undervisningshold/reduktion af individuel vejledning
- Projektfri semester
- Billigere eksamensformer
- Kortere projekter og specialer
- Større projektgrupper
- Øget samlæsning
- Flere studenterdrevne øvelsestimer
- Undervisning i ydertimer
- Klyngevejledning

Censur:

- Ekstern censur på 1/3 af ECTS
- Mindsket honorar for censur af specialer

Forskning:

- Styrkelse af eksternt hjemtag af projekter

Ph.d:

- Afskaffelse af timereduktion i undervisningsforpligtigelsen ved ph.d.-vejledning
- Begrænsning i antal af ph.d.-programmer.

Punkt 4: Efter- og videreuddannelsesområdet

Rådet drøfter samspillet mellem instituttets EVU-aktiviteter og den nye EVU-administration på SSH.

Bilag: Dekanens orientering vedr. EVU-området 23.06.23 og Oversigt - videre proces mod en ny fælles EVU-administration 23.06.23

Kære alle

EVU-området er et strategisk indsatsområde for SSH og AAU generelt både nu og fremadrettet. Samtidig er det et område, hvor vi vil opleve stadig større konkurrence fra de øvrige danske universiteter, UC'er og private udbydere.

På SSH har vi i dag majoriteten af EVU på AAU (85 %), og vi er i mange tilfælde en foretrukket partner for offentlige organisationer og private virksomheder.

Ambitionen er, at vi på SSH skal fastholde og konsolidere vores markedsposition og videreudvikle vores allerede stærke EVU-portefølje med nye korte kurser og enkeltfag samt robuste masteruddannelser af relevans for arbejdsmarkedet. Vi skal samtidig sikre, at vi ikke parallelopbygger, og nogle af vores EVU-udbud på fakultetet kannibaliserer på andre. Og vi skal i endnu højere grad se på helheden af vores EVU-portefølje på fakultetet, herunder sammenhænge, stordrift og synergier mellem vores fagligheder og administration.

For at kunne nå i mål med de store ambitioner på EVU-området på SSH nedsatte Fakultetsledelsen i starten af året en arbejdsgruppe bestående af studieledere, administrative medarbejdere, SN-forpersoner fra masteruddannelserne og sekretariatschefer, som sammen med prodekanen for eksternt samarbejde og en ekstern konsulent skulle drøfte og komme med forslag til en ny fælles EVU-organisering på fakultetet. I denne forbindelse er både administrationen og studienævnsstrukturen på EVU-området blevet drøftet.

Tre grundprincipper har været gennemgående for arbejdsgruppens arbejde:

- Vi skal i endnu højere grad udnytte mulighederne for at vækste og udbyde EVU inden for efterspurgte fagområder

- Vi skal i endnu højere grad samarbejde og udnytte ressourcerne på tværs af EVU-området - både administrativt og fagligt

- Vi skal i endnu højere grad være efterspørgselsdrevne i vores EVU-aktivitet, herunder en tættere dialog og samarbejde med markedet

Arbejdet har været struktureret omkring tre møder med indledende oplæg, gruppediskussioner og plenumdrøftelser. Input fra møderne er efterfølgende blevet kvalificeret og suppleret skriftligt på baggrund af drøftelser i de enkelte institutledelser.

Arbejdsgruppen har peget på flere mulige modeller for en fremtidig studienævnsstruktur på EVU-området på SSH. Alle modeller har fordele og ulemper, og Fakultetsledelsen har tilsluttet sig en model, hvor der ikke for nuværende ændres på fakultetets studienævnsstruktur på EVU-området. Efter en årrække kan EVU-studienævnsstrukturen genbesøges mhp. at vurdere, om der skal laves fælles EVU-studienævn.

På SSH er der i dag stor forskel på volumen af institutternes EVU-portefølje, alle har potentialer og ambitioner på området, men ikke alle har det rette administrative set up til at komme videre med ambitionerne. Der er i Fakultetsledelsen tilslutning til, at der med virkning fra 1. januar 2024 etableres en ny fælles EVU-administration på SSH, herunder alt fra studieadministration til salg, som placeres på fakultetsniveau, da det vurderes, at denne model bedst understøtter ambitionsniveauet for hele fakultetet.

En ny fælles EVU-administration skal bl.a. sikre:

- Én indgang til fakultetets EVU-udbud.

- Volumen og stordrift som kan frigøre administrative ressourcer til markedsrettet aktivitet – markedsføring, salg, behovsafdækning mv. – og understøttelse af faglig udvikling.

- Et særligt fokus på EVU som forretningsområde - professionalisering og specialisering.

- Endnu bedre service, sparring og support til fagmiljøerne i forhold til drift af eksisterende EVU-udbud og udvikling af nye tilbud og bedre mulighed for at sikre nye faglige synergier og koordination på tværs af miljøer.

- Endnu bedre betingelser for at alle faglige miljøer får adgang til administrative specialister på EVU-området i forhold til studieudvikling, markedsføring, studieadministration mv.

- Større driftssikkerhed og robusthed, backup-funktioner og mindre sårbarhed ved jobskifte, sygdom og høj arbejdsbelastning.

- Videndeling, samarbejde og sparring – vi kan i endnu højere grad lære/udvikle best practices af og med hinanden og drage endnu større fordel af hinandens viden og ekspertise på EVU-området.

Den fremtidige EVU-organisering på SSH blev drøftet i FSU den 20. juni. Næste skridt er involvering af og et spørgemøde for alle TAP, som i dag arbejder med EVU. På spørgemødet vil der bl.a. blive informeret nærmere om processen for bemanding af den nye fælles EVU-administration, jf. vedlagte procesoversigt. Processen indebærer bl.a. løbende orientering og inddragelse af FSU og de lokale SU hen over efteråret.

Spørgemødet afholdes den 21. august kl. 11-12 (Fibigerstræde 5, mødelokale 35) efter en velfortjent sommerferie.

Hvis du har spørgsmål, er du meget velkommen til at kontakte Kasper Strandvig på kas@adm.aau.dk eller 99402199.

De bedste hilsner
Rasmus Antoft

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Oversigt: Videre proces mod en ny fælles EVU-administration på SSH

- **21. august 2023**: Spørgemøde for alle TAP, som i dag arbejder med EVU, samt præsentation af den videre proces for bemanding den nye fælles EVU-administration
- **August/september 2023**: Workshop med fakultetets sekretariatschefer om opgaver og kompetencer i en ny fælles EVU-administration
- **September-november 2023**: Opgave- og kompetenceafklaring samt løbende orientering og inddragelse af FSU og lokale SU
- **November 2023**: Ny leder af den nye fælles EVU-administration tiltræder
- **December 2023**: Endelig udmelding om bemanding af den nye fælles EVU-administration
- **1. januar 2024**: Ny fælles EVU-administration træder i kraft

Punkt 5: Institutseminar

Rådet drøfter form og indhold til institutseminar; vi har nogle forskellige tanker og ideer til institutseminaret. Disse drøftes i IR, ligesom der vil være mulighed for at komme med input til det.

Punkt 6: Samspillet mellem uddannelse og forskning

Samspillet mellem uddannelse og forskning er vigtigt for os. Der er selvfølgelig de formelle kategorier med VIP/DVIP-dækning, som vi kender fra kvalitetssikringssystemet – altså at en væsentlig del af undervisningen skal varetages af aktive forskere. Men der er også andre måder at gå til det på. Vi vil gerne skærpe opmærksomheden på dette og arbejde videre med det i forskellige sammenhænge. Derfor tager vi en indledende drøftelse af det.

Bilag: Jenkins og Healey som inspiration

Developing undergraduate research and inquiry

Mick Healey and Alan Jenkins

June 2009

Contents

List of case studies

Preface

The Academy is very pleased to present this piece of work, commissioned as part of the series looking at the relationship between teaching and research[1]. Mick Healey and Alan Jenkins build on their already substantial contribution in this area by focusing on undergraduates' engagement in research and inquiry, and the potential implications of this in a wide variety of HE practice and in a range of contexts (with respect to discipline, institution, and nation). They suggest here a fundamental conceptual shift from the notion of students as a passive audience for the research output of individual academics, to the idea of students as active stakeholders in a research community in which their experience of research within the core curriculum mirrors that of their lecturers.

Here you will find a fascinating study that explores key issues around the nature of undergraduate research and inquiry, considers the potential of opportunities for and strategies to support student engagement in research, looks at different national policy approaches to this area, and draws upon extant evidence of impact. The authors provide a useful range of case studies and exemplars that may be usefully adapted and applied, together with suggestions for further research in this large and important element of students' learning experiences.

This paper is available via the Academy's EvidenceNet, where you will also find a brief summary of its contents. We look forward to providing spaces for dialogue about the notion of undergraduates as researchers, and to future contributions to the evidence base via EvidenceNet and associated activity.

Rachel Segal
Assistant Director (Research and Evaluation)
The Higher Education Academy

May 2009

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1. Previous works by the authors include: Jenkins, A. and Healey, M. (2005) *Institutional strategies for linking teaching and research*. York: The Higher Education Academy. Available from: www.heacademy.ac.uk/assets/ York/documents/resources/resourcedatabase/id585_institutional_strategies_to_link_teaching_and_ research.pdf [last accessed 11 May 2009] and Jenkins, A., Healey, M. and Zetter, R. (2007) *Linking teaching and research in departments and disciplines*. York: The Higher Education Academy. Available from: www. heacademy.ac.uk/ourwork/research/teaching [last accessed 11 May 2009].

Executive summary

This paper argues that all undergraduate students in all higher education institutions should experience learning through, and about, research and inquiry. In undergraduate research, students learn and are assessed in ways that come as close as possible to the experience of academic staff carrying out their disciplinary research.

The origins of our paper lie, in part, in previous published work worldwide – including our work – on bringing together teaching and disciplinary research. In particular, the paper stems from the United States undergraduate research movement, which started by providing research opportunities for selected students in selected institutions. We argue, as does much recent US experience, that such curricular experience should and can be mainstreamed for all or many students through a research-active curriculum. We argue that this can be achieved through structured interventions at course team, departmental, institutional and national levels. The argument is complemented by a large selection of mini case studies, drawn particularly from the UK, North America and Australasia.

This paper addresses four main audiences:

— Academic staff (or faculty in North America) who are interested in engaging their students in research, either as part of the curriculum or as co-researchers;
— Course leaders, department heads and staff with faculty and institutional responsibilities for research and teaching and learning who wish to develop strategies and practices to support undergraduate students undertaking and understanding the nature of research;
— Staff engaged in educational and research development in universities, including Academy staff in the Subject Centres and in Academy York, who support staff in developing linkages between research and teaching;
— Institutional and national higher education policy makers, including professional bodies and those giving research grants, who are concerned to develop policies to encourage undergraduates to become involved with research.

We are very grateful to the many colleagues around the world on whose inspirational attempts to engage undergraduate students in research and inquiry and to understand the processes the students and staff have experienced, we have drawn in this paper. We are hopeful that this paper will provide a wide context that will inform future work on

1.   Argument, origins and scope

"… universities should treat learning as not yet wholly solved problems and hence always in research mode."

— Wilhelm von Humboldt on the future University of Berlin (1810, cited by Elton, 2005, 110)

"We need to encourage universities and colleges to <u>explore new models of curriculum</u>. Government and funding bodies should incentivise and support the radical realignment of undergraduate curricula: we require curricula that are transdisciplinary, <u>that extend students to their limits, that develop skills of inquiry and research,</u> and that are imbued with international perspectives. … There are several models that we might explore. They should all: … <u>Incorporate research-based study for undergraduates (to cultivate awareness of research careers, to train students in research skills for employment, and to sustain the advantages of a research-teaching connection in a mass or universal system)</u> …"

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

"We want all students to access the benefits exposure to teaching informed by research can bring. … 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."

— Bill Rammell MP, Minister of State for Lifelong Learning, Further and Higher Education (2006, 3)

Our intellectual starting point is Humboldt's vision for higher education, but that vision needs to be translated into the needs of a mass higher education system. We argue that the task now is to reinvent or reinvigorate the curriculum to ensure that all undergraduate students in all higher education institutions should experience learning through and about research and inquiry. The key strategy for us is to facilitate the integration of undergraduate research and inquiry into the curriculum.

Our interest in developing students as researchers originated through our explorations over the last few years into ways to enhance the linkage between teaching and discipline-based research. These we have expressed in previous papers published by the Higher Education Academy (Jenkins and Healey, 2005; Jenkins *et al.*, 2007). Our perspective here is that one of the most effective ways to do this is to engage our students in research and inquiry. With regard to our previous work on linking teaching and research, our goal here is to move more curricula in the direction of developing students as participants in research and inquiry, so that they are producers, not just consumers of knowledge.

For us the key to developing undergraduate research and inquiry is to mainstream it and integrate it into the curriculum for all students. In attempting to do this we feel that there is a lot we may learn from the undergraduate research programmes in the US, which, although changing, are traditionally for selected students and may well be outside the formal curriculum; for example, in Summer enrichment programmes.

There are four main ways of engaging undergraduates with research and inquiry:

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

These are shown in Figure 1.1.

Figure 1.1: The nature of undergraduate research and inquiry

STUDENTS ARE PARTICIPANTS

Research-tutored	**Research-based**
Engaging in research discussions	**Undertaking research and inquiry**
Research-led	**Research-oriented**
Learning about current research in the discipline	**Developing research and inquiry skills and techniques**

EMPHASIS ON RESEARCH CONTENT

EMPHASIS ON RESEARCH PROCESSES AND PROBLEMS

STUDENTS FREQUENTLY ARE AN AUDIENCE
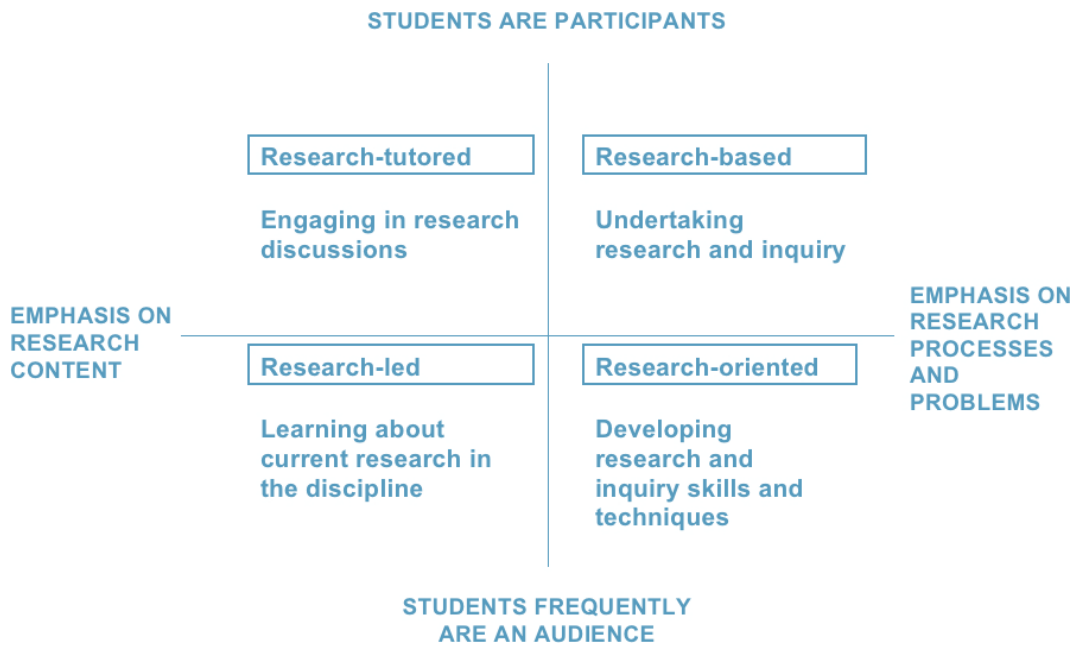
Source: Amended from Healey (2005, 70)

This model, amended from the one in Healey (2005), has two axes, one classifies the ways students may be engaged in research and inquiry according to the extent to which students are treated primarily as the audience or as participants, while the second axis classifies the approach as emphasising research content or research processes and problems. It is useful because it gives a language for people to talk about the different ways in which they may introduce their students to research and inquiry. It is inclusive of different pedagogies for achieving that aim.

All four ways of engaging students with research and inquiry are valid and valuable, and we think curricula should contain elements of all of them. Our general view is that in much of higher education relatively too much teaching and learning is in the bottom half of the model, and that most students would benefit from spending more time in the top half. We would not want, however, students to spend nearly all their time in the top half, as tends to happen in some problem-based learning courses. Our earlier work emphasises that using a wide variety of methods of learning and

assessment is a sensible strategy to respond to the mixture of different preferred learning styles that characterise the students in our courses (Healey and Jenkins, 2000; Healey *et al.*, 2005).

The four ways of engaging students with research and inquiry are, of course, not independent; for example, undertaking research and inquiry and engaging in research discussions are effective ways to learn about current research in the discipline and develop research and inquiry skills and techniques. The way the four approaches are interlinked together is critical in the design of effective courses and programmes, as is illustrated in the example below.

Course teams may find it useful to discuss whether they have the appropriate balance between the four activities for teaching and learning their discipline in their institutional and national context and how that balance may change as students progress through their programme (see also sections 2 and 4). It is quite possible that course teams may come up with different definitions of the four ways of engaging students in research and inquiry that are more appropriate for their context. The process of discussing and auditing their activities is where the value lies.

Students engage in research and inquiry in an interlinked way in a Social Work course
University of Surrey, UK
A second-year lecturer at the University of Surrey designed an exercise that took her students in Social Work through each of the four ways of engaging students in research and inquiry shown in Figure 1.1.

1. Spent the first half of a lecture outlining a research problem and setting it in a theoretical context (research-led).
2. Seamlessly went on to outline some of the different methods and techniques that might be used to investigate the research question (research-oriented).
3. Sent her students in small groups to the library to undertake a literature-based investigation of the research problem and how it had been addressed (research-based).
4. Discussed with the students in their small groups the following week how they had gone about searching the library, the methods used in the research studies they had found, the main findings and unresolved issues (research-tutored).

Although for many students research-led and research-oriented ways of engaging them with research and inquiry are fairly passive experiences, where they are predominantly lectured about the latest research or instructed about research methods and techniques, the examples explored in this paper are primarily active and exciting experiences. Hence most of the examples we use arguably also 'belong' in the top half of the model, as the students are active participants. Despite overlaps we think the distinction in the four ways of engaging students in research and inquiry is a useful one, and we would advocate the use of active ways of doing so wherever possible.

Valuing undergraduate research and inquiry

While recognising that there is much good practice in the UK and elsewhere in the world in bringing together teaching and discipline-based research, we argue that seeing these issues through the lens of undergraduate research is a powerful way to reinvent or reinvigorate the undergraduate curriculum because:

— the focus is on the student as a learner;
— it explicitly brings the student into the worlds of research;
— it views the student as a potential producer of knowledge;
— it potentially values all academic and support staff;
— it may help to break down institutional firewalls between teaching and research;
— it challenges what is research.

This paper addresses four main audiences:

— Academic staff (or faculty in North America) who are interested in engaging their students in research, either as part of the curriculum or as co-researchers;
— Course leaders, department heads and staff with faculty and institutional responsibilities for research and teaching and learning who wish to develop strategies and practices to support undergraduate students undertaking and understanding the nature of research;
— Staff engaged in educational and research development in universities, including Academy staff in the Subject Centres and in Academy York, who support staff in developing linkages between research and teaching;
— Institutional and national higher education policy makers, including professional

bodies and those giving research grants, who are concerned to develop policies to encourage undergraduates to become involved with research.

The paper draws together much of the international experience in developing undergraduate curricula focused on student research and inquiry. The text is liberally referenced with mini case studies of interesting practices and strategies in different disciplines, departments, institutions and nations. Most of these are drawn from Australia, Canada, New Zealand, the United Kingdom and the United States (see also CeAL, n.d.). For example, in this section some mini case studies are presented that focus on engaging undergraduates in research and inquiry experiences at the beginning of their academic studies, while at the end of the next section there are some mini case studies about engaging students in research and inquiry later in their academic studies. In later sections of the paper strategies are suggested for different disciplines, departments and course teams, and institutions. First we need to address two key questions:

— What is undergraduate research and how is it related to inquiry?
— Is undergraduate research suitable for all students, and if so, what are the broad implications for curriculum design?

These questions are addressed in the next two sections.

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

1.1 Undergraduate research begins at induction
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. This involved them working in small groups to collect information from the library and in the field, analyse it, present it to tutors in novel ways and receive formative feedback. For example, the human geographers and the sociologists researched the experience of Gloucester residents of 'the Great Flood of 2007'. The biologists and the psychologists investigated primate behaviour at Bristol Zoo. Other faculties in the University are developing their own versions of undergraduate research as part of induction. It has also proved a significant staff development activity both for the many academic tutors involved in designing inquiry-led activities and for the library staff who changed their approach to library induction to support the specific student research projects.

Further information

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

1.2 Inquiry-based learning introductory course for Social Sciences had a significant impact on students' subsequent performance
McMaster University, Canada

McMaster University has been running a first-year course for Social Sciences based on inquiry since the late 1990s. It is typically taught in groups of no more than 25 students assigned to an instructor, who are subdivided into groups of four or five students. All of the groups have the same curriculum, reading material, process of assessment and goals that are outlined in a detailed compendium. The classes meet for 12 three-hour concurrent sessions. Class time consists of a combination of exercises and tasks for building the students' critical abilities and time for students to share ideas about their individual inquiries with other students.

Students investigate aspects of a broad social science theme, such as 'self-identity', and

address a common inquiry question, such as: 'Why do images of ethnicity, race, gender, sexuality, age, class, or abilities help to create aspects of personal and community identity?' Students have to propose their own inquiry question, such as: 'Why do some children apparently become violent after watching violent cartoons while others seem to be unaffected?' They have to justify why the question was important in relation to existing literature. They then investigate the question through a process that involves developing and testing hypotheses using secondary sources. As detailed in section 8, there is strong research evidence of the positive impact of this inquiry course on the subsequent performances of students at McMaster University.

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

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

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

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

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

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

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

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

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

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

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

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

Further information

www.reinventioncenter.miami.edu/Spotlights/spotlight.html

biog-101-104.bio.cornell.edu/BioG101_104/explorations/explorations.html

2.   Nature of undergraduate research and inquiry

*"In the fall of 1969 MIT [Massachusetts Institute of Technology]
extended an open invitation to all of its undergraduate students
to join the professional research activities of the faculty."*

— Cohen and MacVicar (1976, 199)

*"The basic idea of learning as inquiry is the same as the idea of
research; even though advanced research occurs at advanced
levels, undergraduates beginning in the freshman year can
learn through research."*

— Boyer Commission (1998, 17)

*"Enquiry-based learning enables students to take increasing
control of their own learning as they progress through their
degree programmes. … It views students initially as active
participants in the learning process, and once equipped with
the right tools, as active participants in the investigation and
analysis of problems, issues and evidence."*

— The University of Birmingham (2007, emphasis in original)

*"But for the moment let us be clear. There is no one thing, nor
a set of things which research is … It cannot be reduced to any
kind of essential quality."*

— Brew (2001, 21)

Clearly in seeking to, in effect, proselytise the relevance of undergraduate research and
inquiry we need to define or, perhaps better, explore what we, and more critically you
the reader, mean by undergraduate research and whether you agree with our linking it
in this paper with inquiry. In this section we present a series of lenses through which
to understand the nature of undergraduate research and through that understanding,
examine and enhance the current curricula in our departments and institutions.

We first look at the US origins of undergraduate research; we then set that in the context of the UK undergraduate dissertation, before exploring the relationship of undergraduate research with inquiry-based learning. We conclude by analysing two contrasting statements about the nature of undergraduate research and inquiry.

2.1 US origins and practice

The term undergraduate research and its integration into the curriculum grows out of US practice; in particular through innovations pioneered at the Massachusetts Institute of Technology (MIT) through the leadership of Margaret MacVicar, physicist, and from 1985-90 MIT's Dean of Undergraduate Education. In 1969 MIT started the Undergraduate Research Opportunities Program (UROP). This developed as a cross-institutional initiative that supported selected students to work on student-initiated and faculty-supported research projects. Students received academic credit or sometimes payment for the research they carried out (Cohen and MacVicar, 1976; MIT Libraries, n.d.). Other research-intensive US institutions, such as Michigan, then developed their own programmes. Following a visit by MacVicar to Imperial College London, a similar scheme was initiated there in 1980 (Goodlad, 1998). In 1978 the Council on Undergraduate Research (CUR) was founded to support undergraduate research in US undergraduate institutions, i.e. outside the research elite. Internationally there are now a range of institutions that have developed these US-style programmes. In the US in the last ten years or so there has been a significant increase in such programmes (Boyer Commission, 2003; Katkin, 2003), in part, stimulated by the influential Boyer Commission's (1998) critique of the elite research-intensive institutions.

> *"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 (1998, 3)

The Commission argued that research universities "need to take advantage of the immense resources of their graduate and research programs to strengthen the quality

Developing undergraduate research and inquiry

of undergraduate education" and make "research based learning the standard." (Boyer Commission, 1998, 7, 15)

While there are variations in the form and scale of these US undergraduate research programmes, they often have these features:

— mainly located in research-elite universities or in small private liberal arts colleges institutions with high fees and small classes;
— supported by central and sometimes departmental undergraduate research offices;
— for selected students, generally those with high grades;
— often outside the formal curriculum; for example, in Summer enrichment programmes;
— stronger in the sciences than in the arts or other disciplines;
— have a strong focus on one-to-one faculty student mentoring;
— may well result in student publication and or dissemination of their research; for example, through undergraduate research journals and or research conferences;
— often financially supported by endowment income or through competitive grants from national organisations, such as the National Science Foundation (see section 7).

However there is also a growing development of US undergraduate research programmes that:

— are outside the research elite, in State-level institutions, in undergraduate-focused institutions and increasingly in community colleges (what we in the UK would term higher education in further education);
— have an explicit focus on bringing unrepresented groups into higher education, including African Americans, and women into science; and
— are explicitly focused on reinventing or reshaping the mainstream curriculum.

We return to these issues in section 3, where we focus on whether undergraduate research is something for selected students in selected institutions, or something that all students should experience.

In the US much of the literature and practice sees undergraduate research as students having to produce *original* perhaps *cutting-edge* knowledge, suitable for publication in external refereed journals. This is particularly the case in the sciences. Others, however, define or conceive undergraduate research as students learning through courses that are

designed to be as close as possible to the research processes in their discipline. The focus then is on the student learning and being assessed in ways that parallel or mimic how research is conducted in that discipline. In these cases, what is produced and learned may not be new knowledge per se, but it is new to the student and, perhaps more significantly, transforms their understanding of knowledge and research. An example of this tension can be found on the website of the Council on Undergraduate Research (CUR, n.d.). The website states that CUR focuses on supporting "learning through research", but also offers this definition of undergraduate research: "An inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline." Note here how CUR, in effect, both promotes undergraduate research as a learning process that shifts the students understanding of knowledge, irrespective of whether that knowledge is 'new' public knowledge, and then, by contrast, emphasises that undergraduate research should make an original contribution.

Growing out of our commitment to bring together teaching and discipline research (section 1), we have systematically investigated the literature and practice in this area (e.g. Hakim, 2000; Hu *et al.*, 2008; Karukstis and Elgren, 2007; Kinkead, 2003, 2009; Taraban and Blanton, 2008), and through visits with colleagues we have studied a range of programmes and institutional policies in the US and elsewhere in the Western world (Huggins *et al.*, 2007a; Centre for Active Learning, n.d.).

Particularly important to our thinking was a visit we made to a number of US institutions in 2001. This followed attending the 2000 Conference of the American Association for Higher Education with its focus on the impact of Boyer's (1990) *Scholarship Reconsidered* and the Boyer Commission (1998). At that conference a recurrent theme of institutional presentations was their development of undergraduate research programmes in response to the Boyer critique. Our trip in 2001 was to investigate a range of such initiatives. The programmes we visited were impressive – particularly on their impact on the students involved. For example, at Miami University, Ohio, Marcia Baxter Magolda told us of her research, which demonstrated the positive impacts on student epistemological development through their involvement in a Summer ten-week independent research programme (Baxter Magolda *et al.*, 1998). We were enthused about this form of curriculum design in offering a dynamic and effective way of bringing undergraduate students into the worlds of research. This positive perception was enhanced by discussions in Washington DC with senior staff in the Council on Undergraduate Research and the National Science Foundation.

Our visits to these institutional programmes were accompanied by visits to selected departments. Here, with exceptions, the overall impression we drew was rather different. Too often the department curricula still seemed to 'echo' the critique of the Association of American Colleges (AAC) that "the major in most colleges is little more than a gathering of courses taken in one department … emphasising content in the neglect of the essential *style of enquiry* on which the content is based" (AAC, 1985, 1–3). Furthermore the impact of the institutional undergraduate research programmes at that time on many of these departments appeared to be minimal or non-existent. However, as we will show in the following sections, recent US developments show significant shifts to make undergraduate research part of the mainstream curriculum for many or all students. For example, see the case study of current developments at Miami University, Ohio (case study 6.1).

2.2 The UK dissertation and undergraduate research

In the UK, undergraduate research has traditionally taken on a different form from that found in the US. Within the UK there is an emphasis on the final-year dissertation. Here we explore its main features and suggest some ways in which it may be enhanced to bring it more closely in line with different disciplinary practices and to give the students undertaking the dissertation an experience more closely related to that of researchers in those disciplines, including ways of disseminating the outcomes.

Most UK higher education institutions mandate, or strongly encourage, some final-year research project as a requirement for graduation at Honours level; and in the UK most students graduate with an Honours degree. Within the UK there is an emphasis on the final-year dissertation as a 'capstone' research experience; generally in the form of an extended written report featuring a discussion of research methodology and results. Indeed in the UK, national 'requirements', or rather expectations through the Quality Assurance Agency (QAA) for Honours degree level work and disciplinary benchmark statements, demonstrate a cultural expectation for such programme requirements at undergraduate level (Quality Assurance Agency, n.d.). 'Honours' level higher education has different meanings in the US and Australia (Austin, 1991; Kiley *et al.*, 2009).

UK final-year research projects are often underpinned by programme requirements for research methods courses and upper level courses based around staff research interests.

Most UK academics see the dissertation as providing students with a capstone research experience. However, this focus on the final-year 'research experience' may not support students in seeing themselves as stakeholders in the worlds of university research nor best support them becoming, even if peripherally, members of a disciplinary research community. The international research evidence strongly supports the idea (section 8) that at present many undergraduate students feel, in Brew's (2006, 52) powerful phrase, "at arms length" from the university research community and do not see themselves as stakeholders in that research. Relatedly the form of the UK dissertation is generally that of a written account that is only read by the student, the supervisor and the second marker. That may not be the most effective way of making a student part of a community of disciplinary research practice. Thus, this form of the dissertation does not include research dissemination. Whereas the Boyer Commission (1998, 24) argued that "dissemination of results is an essential and integral part of the research process".

Perhaps surprisingly, one can find many US institutions, including the research elite, that do not have any such final-year research requirement; although many are now mandating such 'capstone' courses. In any event, what current US experience seems to confirm is the importance of UK universities holding onto the widespread dissertation requirement or expectation. Hitherto this has been traditional, particularly for single subject Honours, although it is now under pressure because of class sizes and competing demands on staffing and supervision caused by postgraduate expansion and commitment to the Research Assessment Exercise.

What cross-Atlantic comparison also suggests is that the UK institutions could do well to be more imaginative and consider developing alternative forms to the dominant individually written dissertation. Relatedly UK institutions and departments should extend and diversify dissertations and final-year capstone research experiences so that they more closely relate to processes of knowledge creation and knowledge dissemination in the disciplines and professional areas. The key issue of disciplinary forms of undergraduate research is explored in section 4. Here again US practice is relevant. In response to the Boyer Commission (1998) and related critiques, many US institutions are now mandating or encouraging senior-year capstone courses (Berheide, 2007; Fanter, 2006; Henscheid, 2000). These often take the form of disciplinary or cross-disciplinary research experiences, sometimes in the form of the UK-based individual research paper, but often in alternative forms. For example, Portland State University, in their requirements for the senior capstone, state that:

"Students bring together the knowledge, skills, and interests developed to this point through all aspects of their education, to work on a community project. Here students from a variety of majors and backgrounds work as a team, pooling resources, and collaborating with faculty and community leaders to understand and find solutions for issues that are important to them as literate and engaged citizens."

— Portland State University, n.d.

We note that in contrast to the dominant UK individually written dissertation, these Portland State University students work and research in teams, often with faculty and with people from outside the University. Furthermore, being cross-disciplinary, there are opportunities to create curricula that require or support students in confronting research paradigms from contrasting disciplines they have studied throughout their degree (Jenkins, 2008a). This Portland State University example also opens up opportunities to rethink the format of research dissemination to include conference presentations and exhibitions and explicitly bring students into research communities. At Alaska Pacific University, all students in all disciplines undertake a senior project and present it to the campus community and the general public on designated days (case study 6.2).

In parallel to these US developments, a number of UK institutions and disciplinary communities have rethought, or are in process of rethinking, the form of the final-year dissertation. For example, when in 2003–04, Oxford Brookes University redesigned all programmes to link teaching and research; institutional Honours level requirements were changed to enable alternative final-year dissertations or projects, such as putting on an exhibition in Fine Arts and research-based consultancies in Business (Huggins *et al.*, 2005). The UK Bioscience community, in part faced with the problem of supporting large numbers of students doing lab-based dissertations, has been innovative in reinventing the dissertation, including in some cases giving greater attention to research dissemination (Centre for Bioscience, 2003; Luck, 2008). For example, the University of Glasgow Bioscience students, as an alternative to the traditional lab-based dissertation, can undertake a consultancy project with a local bioscience company. "They usually involve some market research for a new product … research on potential competitors. ... For example, one project researched the market for two new herbal medicines" (Tatner and Tierney, 2008, 51). At the University of Kent, bioscience final-

year students can take a Science Communication project, which involves students writing a 6,000-word report on a "topical, controversial, or poorly understood area of science" (Lloyd, 2008, 57). The students also undertake an assessed oral presentation on their chosen issue in a local school and prepare a magazine article, museum display or website communicating the research issue to a wider public. Another example is Durham University's Bioscience enterprise project outlined in case study 3.4.

Rather than commenting further on supporting, and perhaps reinventing, the form of the dissertation and associated research methods courses, the remainder of this paper focuses on how undergraduate research and inquiry may be embedded across the curriculum from year one; first we need to comment on the relationship between undergraduate research and inquiry.

2.3 Inquiry-based learning and undergraduate research

A further issue of definition is the extent to which well-designed investigative course work can be seen as 'undergraduate research'. Thus a recent well-received publication by the US Council on Undergraduate Research, *How to design, implement, and sustain a research-supportive undergraduate curriculum* (Karukstis and Elgren, 2007), is in large measure an account of student investigative course work that is now well established internationally in many courses and institutions.

The extent to which, and how, *inquiry-based learning* and *undergraduate research* are conceptually and operationally linked is contentious. We suggest that, even if not identical or to be casually confused, they are certainly complementary and mutually reinforcing.

The various formulations of inquiry-based learning (e.g. Hutchings, 2007; Spronken Smith *et al.*, 2008) focus on students learning in an active manner with a focus on developing student intellectual dispositions and sometimes research skills. Adding the various forms of problem-based learning and case-based learning further adds to this complexity of conceptions of 'inquiry' (Savin-Baden and Major, 2004; Spronken Smith *et al.*, 2008).

Such inquiries vary in the extent to which both the questions asked, and the manners of inquiry adopted, are open to the students to decide. Thus Spronken Smith *et al.* (2008) differentiates between three 'modes of inquiry': *structured* – where lecturers provide

an issue or problem and an outline for addressing it; *guided* – where lecturers provide questions to stimulate inquiry, but students are self-directed as regards exploring these questions; and *open* – where students formulate the questions themselves as well as going through the full inquiry cycle.

We see 'undergraduate research' as similarly focused on the student learning in an active manner. In relation to Figure 1.1, both undergraduate research and inquiry approaches are focused particularly on the 'research-based' section of the quadrant, where students become producers, not just consumers of knowledge; however, as we argued in the last section, the other three quadrants present other valid ways in which students may engage in research and inquiry, all of which are necessary to support students producing knowledge.

However, in undergraduate research *per se* there may well be more emphasis on students:

— learning the epistemologies and forms of *discipline-based* inquiry;
— learning particular disciplinary research methodologies;
— linking the questions and forms of inquiry explicitly to academic staff research interests and current research foci in the disciplines; and
— producing work that mimics the forms of knowledge creation and dissemination in their disciplines and professional areas.

While the open form of inquiry-based learning may have some or all of these features, in undergraduate research programmes and courses they are a significant and, perhaps, central element of what, and how, students learns (see below).

Selected perspectives on undergraduate research

Perspectives from US National Conferences on Undergraduate Research (NCUR) and the Council on Undergraduate Research (CUR)

"… we advocate a pedagogy and academic outlook that:

— *combines teaching and research, two historic poles of a professional dichotomy, into one integrated pedagogy and system of performance. In undergraduate research,*

scholarship and teaching may not be as separable as conventionally thought or practiced. In undergraduate research, teaching and scholarship become parts of one simultaneous, overlapping, shared process.

— *replaces traditional archetypes of teacher and student with a collaborative investigative model, one using research done with a mentor or done jointly by students and teachers - a new vision portending a major shift in how scholarship in the academy is practiced in a broad range of disciplines.*

— *replaces competitive modes of inquiry with ones more focused on collective and collaborative work, offering an enlivening and exciting new heuristic.*

— *motivates students to learn by doing. With faculty mentors, students engage directly in practicing the work of their discipline while they avoid passively acquiring knowledge that that discipline has produced.*

— *promotes both new research and a student's analytical and communicative skills from the student's first days within the college experience.*

— *creates internal networks to support these collaborative learning efforts. Any campus that motivates its students to learn through individual and collaborative research - and can find ways to support these intellectual journeys with the necessary human and material resources – provides its students with a first-rate education."*

Source: National Conferences on Undergraduate Research and Centre on Undergraduate Research (2005)

Perspectives from some US science faculty

"When asked 'What are the essential features of undergraduate research projects?' science faculty from three undergraduate institutions responded that students should:

— *read scientific literature*
— *design some aspect of the project*
— *work independently*
— *feel ownership of the project*
— *use careful and reproducible lab techniques*
— *have a meaningful research question*
— *strive to produce a significant research finding*
— *have an opportunity for oral communication*

— *have an opportunity for written communication*
— *work in a good state of the art environment."*

Source: Based on Lopatto (2003), cited by Taraban and Blanton (2008, 12).

Perspective of some New Zealand educational developers

"The working definition for IBL (Inquiry based learning) at the outset of this project was that IBL was a pedagogy which best enables students to experience the processes of knowledge creation. The core ingredients of an IBL approach included:

— *learning stimulated by inquiry, i.e. driven by questions or problems;*
— *learning based on a process of seeking knowledge and new understanding;*
— *a student-centred approach to teaching in which the role of the teacher is to act as a facilitator;*
— *a move to self-directed learning with students taking increasing responsibility for their learning;*
— *the development of skills in self-reflection.*

… We now see the key to IBL as being an approach which effectively enables students to experience the processes of knowledge creation."

Source: Spronken-Smith *et al.* (2008)

Perspectives from faculty centrally responsible for inquiry
McMaster University, Canada

"Teaching through 'inquiry' involves engaging students in the research process with instructor support and coaching at a level appropriate to their starting skills. Students learn discipline specific content but in doing so, engage and refine their inquiry skills.
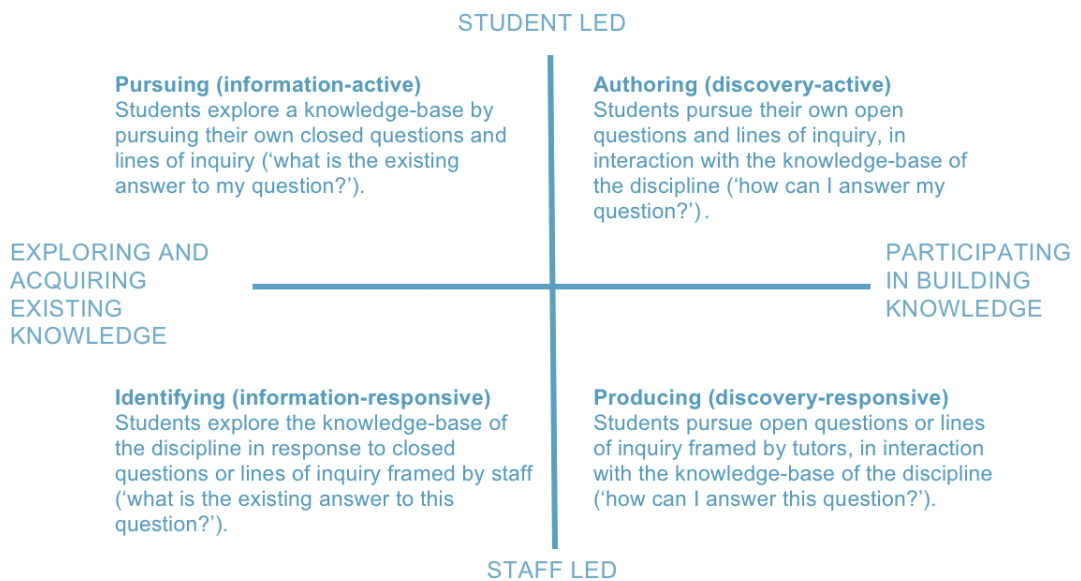
An inquiry course:

— *Is question driven, rather than topic or thesis driven.*
— *Begins with a general theme to act as a starting point or trigger for learning.*

— *Emphasizes asking good researchable questions on the theme, and coaches students in doing this.*
— *Builds library, interview, and web search skills, along with the critical thinking skills necessary for thoughtful review of the information. Coaches students on how to best report their learning in oral or written form.*
— *Provides some mechanism (interviews, drafts, minutes of group meetings, benchmark activities, etc.) to help students monitor their progress within the course.*
— *Draws on the expertise and knowledge of the instructor to model effective inquiry and to promote reflection.*

… Inquiry is closely related to what we do when engaging in research …"

Source: Roy *et al.* (2003)

Figure 2.1: Inquiry-based learning: a conceptual framework

STUDENT LED

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

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

EXPLORING AND ACQUIRING EXISTING KNOWLEDGE

PARTICIPATING IN BUILDING KNOWLEDGE

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

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

STAFF LED

Source: Based on Levy (2009)

Another way of conceptualising inquiry-based learning, which is inclusive of undergraduate research, is that proposed by the Centre for Inquiry-based Learning in the Arts and Social Sciences at the University of Sheffield (Figure 2.1). In developing the Healey (2005) model they make a distinction between whether the students are using inquiry to explore existing knowledge or to discover new knowledge, and whether the question is their own question or one framed by academic staff.

At the University of Reading, questions were added to a student survey, which attempted to map their learning experience onto the Healey (2005) and Levy (2009) models. Several questions asked about how student-centred or staff-centred the teaching was, and about how much time students spent engaged in different types of activities, such as memorising (emphasis on research content), or analysing and synthesising (emphasis on the research process or problems). The results showed that on average across the University there was a gradual move from research-led (identifying knowledge) to research-based (authoring knowledge) teaching as students progressed from part 1 through to taught Masters programmes. However, this overall trend masked significant variations between degree courses. Some were highly research based all the way through, whereas one or two were highly didactic. This visual mapping of research engagement has been a powerful tool in getting course teaching teams to reflect upon their own provision (Creighton *et al.*, 2008).

However, we recognise that some readers may consider that we have drawn too close a connection between research and inquiry and relatedly that some of the case studies presented in this paper, although forming interesting course designs, do not reach the level of 'research' to be described as 'undergraduate research'. We recognise such doubts, but in part challenge them for perhaps taking a too limited a conception of research (Brew, 2001) and for failing to see inquiry forms of pedagogy and curriculum design as potentially leading students into the worlds of research.

2.4 Defining undergraduate research and inquiry

In recognising the tensions discussed above, we offer two contrasting, although overlapping, statements about the nature of undergraduate research and inquiry, which we have, in part, created. Hopefully they may help you, the reader, in developing your conceptions of these issues and in reading this paper. Further dimensions of undergraduate research are illustrated in Table 3.1.

The University of Gloucestershire defines undergraduate research and inquiry as "student engagement from induction to graduation, individually and in groups, in research and inquiry into disciplinary, professional and community-based problems and issues, including involvement in knowledge exchange activities" (Childs *et al.*, 2007). Arguably the great strength of this definition lies in its inclusivity, explicitly linking research and inquiry and knowledge exchange. It is also more inclusive in that it does not depend or focus on the university being a centre of high level research. It is thus appropriate to its context and therefore readily deliverable across the higher education sector.

For Jenkins (2008b), programmes that seek to encourage or support undergraduate research and inquiry should actively address all or most of the following:

— Expressly engage with 'undergraduate research', 'community-based undergraduate research', or some such, and recast their understanding of 'student-centred' or 'inquiry-' or 'problem-based learning' accordingly;
— Adjust the philosophy and values of their programme so as to actively bring undergraduate students along with others, such as librarians and community activists, into the worlds of university research;
— Encourage and enable students to learn in ways that parallel or reflect the ways academic staff themselves research and learn in their discipline or professional area;
— Build research opportunities into the formative processes and summative outcomes of course assessment for students in ways that retrace and register how academic staff develop and disseminate their own research and learning in their own discipline or professional area, e.g. through undergraduate research journals, student research conferences, exhibitions, recordings and broadcasts;
— Ensure that the programme is clearly visible and recognised as 'undergraduate research' by the university communities, students and parents, the local community, and possible external sponsors and stakeholders.

Arguably the strength of this definition is that it signals to both academic staff and students the focus on research processes and outcomes. This may help find it support with discipline-based staff, particularly in research-intensive institutions. Some may then suggest that this conception or definition of undergraduate research can only be for selected students in research-intensive institutions.

This section has attempted to highlight some of the different perspectives on the nature

of undergraduate research and inquiry and how they relate to national, institutional and disciplinary contexts. The two different statements about the nature of undergraduate research and inquiry with which we ended the section provide a link with the next section in which we focus on whether undergraduate research and inquiry should be for all students.

Case studies 2:
Engaging students in research and inquiry later in their academic studies

2.1 Giving students first-hand experience of research-based consultancy in Environmental Management
University of Queensland, Australia

Team-based problem-based learning is used in the final-year capstone course at the University of Queensland's Faculty of Natural Resources, Agriculture and Veterinary Science to give students experience of research-based consultancy. It is a year-long course, team taught by an interdisciplinary team. Staff solicit suitable 'problems' and clients among their contacts, for instance from government agencies, non-governmental organisations, land care groups or the private sector. Students work in groups of about six as consultants. The clients come to campus at least three times, for an initial briefing to their students and for presentations at the ends of the first and second semester. They liaise with the students all year, usually off campus at their offices, and by phone and email. The academic staff give a flexible programme of lectures in the first semester, to prepare the students with skills they need towards each forthcoming step of their tasks. At the end of the year the students' reports are published for the clients.

2.2 Undergraduate research elective in Medicine
Queens University, Canada

At Queen's University, the undergraduate medical curriculum includes a mandatory minimum eight-week 'Critical Enquiry' elective in year two. This elective provides each student with a block of time, free from other academic assignments, to pursue in depth a medically related hypothesis of the student's choice. The area of research may be from the basic, clinical or social sciences, or the humanities. Students may arrange the elective with the supervisor at the location of their choice. The elective block is placed immediately prior to the Summer vacation to afford the opportunity of extending the project into the Summer months.

A central reason for introducing the course was a national concern that few physicians were choosing research careers. Research on the impact of the course has demonstrated a significant increase in the number of students expressing an interest in

pursuing a research career; and recognising other benefits, including the development of critical thinking skills, and developing contacts for postgraduate training.

Further information
meds.queensu.ca/courses/pbl/phase_iie
Houlden *et al.* (2004)

2.3 Chemistry 'concentrated study' project

University of St Andrews, Scotland

This is a core course done by all third-year Chemistry students (within a four-year BSc/five-year MChem framework); current enrolment is 48. It is taught in the last four weeks of the Spring semester. Students have no other class and are able to spend their full time on this module. Students are divided into (mixed ability) groups of five to six, each allocated to an academic supervisor who assigns a topic for investigation. This requires literature research, experimental planning, experimental work, analysis of results and their presentation. The projects assigned vary, but generally fall somewhat short of original research while maintaining substantial scope for student input to the direction of the work.

The module has run for the last five years and typically yields grades rather similar to conventional laboratory classes at this level. A consistent observation, however, is that this really brings out the best in some otherwise weaker students who seem to be inspired by the idea of contributing to the team effort in a way that is not achieved in a more conventional class. There are parallels between this approach to course design and the experimental Physics course at MIT researched by King and Parlett (1969), as well as the current credit and non-credit courses in MIT's Independent Activities Period.

Further information
Aitken (2008)
King and Parlett (1969)
ch-www.st-andrews.ac.uk/teaching/aims/Mod3441/a.pdf
web.mit.edu/iap/

2.4 Student poster conference linked to dissertation in Psychology
St Mary's University College, UK

The Psychology department at St Mary's University College has integrated a required poster session into the dissertation requirements. The research project, some 5,000 words, is submitted in the April of their final year. This counts for 80% of the final mark on that course. As with many other UK institutions, work on this project is meant to start in the second year. At St Mary's there is a required poster session in May of their second year, where students present and discuss an initial outline of their work. This counts for 20% of the final grade on the project and is assessed on visual content and presentation, and student answers to questions on their project. The poster session is run in the form of an academic conference, with all academic staff attending as well as first-year and third-year students. Involving first-year students both increases the number of questions second-year students have to answer, and, perhaps most significantly, orients first-year students to how to carry out their research.

3. Issues of inclusiveness

"Attending a top-20 public research university has its advantages. You are able to utilize the facilities that hundreds of millions of dollars in annual research funding provides. At The Honors College you will benefit from all these resources while experiencing the nurturing climate and elite peer group typical of a small liberal arts college."

— University of Arizona (n.d.)

"I propose that all colleges and universities provide an opportunity for all undergraduates to conduct research – to create knowledge. … Research promotes critical and creative thinking, the habits of mind that nurture innovation; creates a sense of intellectual excitement and adventure; and provides the satisfaction of real accomplishment."

—Ellis (2006, B20)

"Ultimately if this were a regular paper I wouldn't recommend publication as it stands. The study is quite short so the value of the information is questionable […] However saying that it is a good student study so it all depends on how high you want to set the bar."

— Reviewer quoted by Hanley *et al.* (2008)

Promoting, as we do, the importance of reshaping university curricula to emphasise undergraduate research and inquiry raises hard questions of inclusiveness; in short are such curricula only, or particularly, for the most academically able students in research-intensive institutions?

To answer that question we need to explore many different issues. First, there are important conceptual issues as to what we mean by undergraduate research and inquiry, which we explored in the last section. There are also practical issues of resources,

equipment, academic staff time and, in some institutions, academic staffs' capabilities as research supervisors. There are also issues of student ability and motivation as to the role and importance of research in their conceptions of higher education. Furthermore, there are ethical issues with respect to undergraduate students carrying out research, particularly in some disciplines. Gaining such clearance may be simply impractical given the numbers involved and the timescale of undergraduate courses. These issues need also to be put into national contexts. Thus in the US, a central reason that research-intensives, such as the Universities of Arizona and Michigan, develop undergraduate research programmes is that they face major competition from high quality liberal arts and science colleges for the most able students and their parents' dollars. For such colleges can guarantee undergraduate students and their parents small classes taught by highly scholarly, teaching-focused faculty right from year one and opportunities for them to be involved in undergraduate research. That is competition the UK research-intensives do not face, which may mean they do not feel the same pressure to develop undergraduate research programmes.

One way to explore these issues is to see them through the lens of the undergraduate research journals, which are often an important part of the US undergraduate movement and now increasingly so in the UK and elsewhere (www.cur.org/ugjournal.html; Walkington and Jenkins, 2008). At one level, one could argue that an undergraduate research journal is a misnomer. If the research is good enough it will be published in a mainstream research journal. Alternatively, one can see such undergraduate research journals as stepping stones to postgraduate research and research careers for those very few, highly academically able and motivated students. Thus there is value in developing undergraduate research journals ensuring that they have high research standards, and with selected students seeing their work published. For example, this is the approach of the new UK and Ireland national undergraduate research journal, *Bioscience Horizons* (case study 3.6) and the UK national *Reinvention: A Journal of Undergraduate Research*.

Alternatively one could argue, as did the Boyer Commission (1998), that all undergraduate students should learn through disseminating or publishing their research. One can now argue that electronic forms of communication makes this much more practically possible for all, or at least many, students. The final-year course 'Geography Research and Practice' at Oxford Brookes University and the linked departmental journal *Geoverse* are attempts to give all students taking the course some experience of publishing their research (case study 3.7).

3.1 Undergraduate research and inquiry and students' understanding of knowledge complexity

The argument as to whether undergraduate research and inquiry is for all or selected students is in part a *political* question – to whom and for what, do national systems and institutions allocate resources, in particular academic staff time? For us, however, it is largely an *educational* and/or *philosophical* question as to the nature of *higher* education.

We are persuaded by Barnett's (2000a, 2000b) argument that the central role of the university should be to help all students cope with 'supercomplexity'. He argues that this derives from the supercomplex worlds in which graduates will seek to live and work.

> "A <u>complex</u> world is one in which we are assailed by more facts, data, evidence, tasks and arguments than we can easily handle <u>within</u> the frameworks in which we have our being. By contrast, a <u>supercomplex</u> world is one in which the very frameworks by which we orient ourselves to the world are themselves contested."

> — Barnett, 2000a, 257, emphasis in original

For Barnett the curricula implications are clear: "the issue is whether lecturers adopt teaching approaches that are likely to foster student experiences that *mirror the lecturers' experiences as researchers*" (Barnett, 2000b, 163, emphasis added).

If this philosophical view of higher education is accepted then the international research on student intellectual development, in particular the work of Baxter Magolda, suggests ways forward for curriculum design, and for us provides strong arguments for incorporating undergraduate research and inquiry into the curricula for all students.

3.2 The work of Baxter Magolda and curricula to support all students' understanding of knowledge complexity

In section 2 we briefly referred to Baxter Magolda *et al.*'s (1998) research on student development through a selective Summer undergraduate research scheme. That research relates to a much wider and substantive research programme by Baxter

Magolda on the impact of higher education on student intellectual development and conceptions of knowledge. Her research is part of a largely US-based research theme of student epistemological development during and after college (in particular Baxter Magolda, 1992, 1999, 2008).

Her central research project is a detailed interview-based study of student intellectual development during the four years of college and after graduation, interviewing these students annually since they entered college in 1986. From that and related research she has argued that university curricula need to support student and citizen development from:

> *"… <u>absolute knowing</u> [where] students view knowledge*
> *as certain; their role is to obtain it from authorities … (to)*
> *<u>contextual knowing</u> [where] students believe that knowledge is*
> *constructed in a context based on judgement of evidence; their*
> *role is to exchange and compare perspectives, think through*
> *problems, and integrate and apply knowledge."*
>
> — Baxter Magolda, 1992, 75

However, too often curricula "frame learning as the passive acquisition of knowledge" (Baxter Magolda, 2008, 155). She calls for curricula that exemplify three broad principles – "validating learners' ability to know, situating learning in learners' experience, and defining learning as mutually constructed meaning" (p.150) – and for curricula where "teachers model the process of knowledge construction in their disciplines, teach that process to students, and give students the opportunities to practice it" (Baxter Magolda, 1999, 9).

Baxter Magolda's research provides strong evidence of the positive impact on students' intellectual development during their college years and later in their lives. However, there are hard messages in her research – in particular that many students from her sample graduate with 'absolute' conceptions of knowledge. For some that might suggest that only selected students could undertake undergraduate research or open inquiry style courses. However, Baxter Magolda, like ourselves, sees the issues through the lens of what we perceive to be the goals of higher education and the means to achieving them; that is to ensure that all students experience the process of knowledge construction in their disciplines (Baxter Magolda, 2008).

Guided by the research of Baxter Magolda, Miami University, Ohio is redesigning curricula across the University (case study 6.1) with the focus on supporting the 'student as scholar' where the aim is:

> *"… not simply to advance undergraduate research and creativity, but more importantly, to cultivate the 'Student as Scholar', where scholar is broadly conceived as an attitude, an intellectual posture, and a frame of mind derived from the best traditions of an engaged liberal education. Although some students will produce original scholarship in their discipline or field, what is more crucial is that they gain the internal value system, maturity, and foundational competencies of their discipline and a liberal education to succeed in today's complex, ever-changing world. … [This] requires a culture of inquiry-based learning infused throughout the entire liberal arts curricular and co-curricular experience that starts with the very first day of college and is reinforced in every classroom and program. … progressing from an <u>instructional paradigm</u> that emphasizes telling students what they need to know, to a <u>learning paradigm</u> that emphasizes inquiry in shaping how students learn what they need to know within the traditional academic context, and culminating in a <u>discovery paradigm</u> that encourages students to seek and discover new knowledge, emphasizing inquiry with no boundaries."*

> — Hodge *et al.*, 2008, 2–3, emphasis added

To aid this process of curriculum redesign, following Baxter Magolda's research, the University has mapped the student developmental journey (Table 3.1). While students will go through these stages at different rates and many will not reach 'self-authorship' by the end of their undergraduate course, this schema gives a framework for course teams and departments to shape their curricula that supports inquiry and undergraduate research from year one courses to final-year capstone curricula. In section 5 we offer specific suggestions to course teams and departments to ensure that all students learn through research and inquiry being a central feature of the way courses are designed, delivered and supported by faculty and departmental resources.

Table 3.1: The developmental journey of the student

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

Source: Based on Hodge *et al.* (2008)

3.3 Undergraduate research as a means of shaping social inclusiveness of higher education

Clearly there are tensions in the undergraduate research movement as to whether undergraduate research is for all students or just for selected students in elite institutions. Thus, to return to the Boyer Commission (1998, 15, 17), which has shaped so much practice in the US and internationally, they did see making "research based learning the standard", but the focus was on the "able undergraduate" in research-intensive institutions. However, US practice also asks questions about who these able students are and how undergraduate research can be used to support a more socially inclusive higher education system.

A range of undergraduate research programmes at institutional level and supported by State governments and national funders, such as the National Science Foundation, have been initiated, for instance, to bring more African Americans into higher education,

and to ensure that women enter and succeed in science courses. For example, the University of Michigan supports African-American students to enter and succeed in the University (see section 6) and the US national organisation SACNAS, supports Hispanic, Chicano and Native Americans into science careers (see section 7). Such interventions, we think, could be readily adapted in the UK to use undergraduate research as a means of opening up UK higher education to under-represented groups. We would also point to how some US State level and national funders have directed funding to support undergraduate research in community colleges, what we in the UK would call higher education in further education, thus further extending undergraduate research to many students.

Whether you agree with our view that all students in higher education should experience undergraduate research, or whether you think it should be extended to selected students, the overall message is that this requires a set of linked structured interventions at course team, department, institutional and national levels. Sections 4 to 7 set out our views as to how that can be achieved.

Case studies 3:
Undergraduate research and inquiry in science, technology, engineering and mathematics (STEM) disciplines

3.1 Engaging large classes of first-year students in the professional practices of bioscientists
University of Queensland, Australia

Each semester since 2005, 400 to 900 first-year Human Biology students are introduced to the course content and assessment using a pedagogical model developed around the skills and practices of bioscientists. Practising bioscientists teach all course elements. Content knowledge, scientific reasoning, use and understanding of language, laboratory skills and the importance of partnerships are progressively supported through linked assessments. The first task engages them in audio interviews in which scientists describe their cutting-edge research. Students respond to the interviews in short written assignments. Next, students participate in a purposively designed *Biohorizons* eConference modelled around professional conferences. This begins with a face-to-face plenary lecture delivered by an internationally recognised researcher. Over the next six weeks, students register into one of ten clusters (of up to 45 pairs) based around biological themes. With the support of online tutors (PhD students), they write and upload a paper (15%) and construct a PowerPoint presentation (10%) in pairs. Students use databases to explore primary literature and research a specific topic of interest within broad cluster themes. Students then individually post formal questions and answers about one another's work (5%). The eTutors mark all three submissions using online criteria sheets and audiofiles to personalise feedback.

Further information
Moni *et al.* (2007a, 2007b, 2007c)

3.2 Reinvented Chemistry inquiry labs in year one
University of Warwick, UK

A second-term year one laboratory course (approximately 100 students) was reinvented from its previous traditional approach to support explicitly more open-ended inquiry-based learning. The stimulus came from fourth-year students doing

their final-year research project. Looking back at the predecessor of this redesigned course they stated "they did not feel prepared for their final-year projects. The style of the experiments was perceived to be very 'recipe-like', with little scope for original thought. Additionally, the students felt that the labs … gave the impression that 'most chemistry works'; after a research project, they appreciated that the reality was somewhat different" (Taylor and Geden, 2008, 30).

The revised course was clearly inquiry-based and involved major changes to the laboratory manual and the pre-lab activities, although the actual experimental procedures to be followed were largely untouched to minimise resource implications. The manual redesigned each experiment as a problem to be solved, with all references to the expected outcome removed; experimental procedures were changed to be, insofar as was sensible with safety considerations in mind, in the style of methods published in research journals; mark schemes were completely revised to support the revised course goals. In addition the previous whole class didactic pre-lab sessions were revised to a more open discussion and inquiry approach.

Further information
Taylor and Geden (2008)

3.3 Inquiry-based learning, or 'SCALE-UP', in introductory science classes

SCALE-UP or 'Student-Centered Active Learning Environment for Undergraduate Programs', originally developed at North Carolina State University has been widely adopted and adapted in a wide range of US universities, including the Technology Enhanced Active Learning (TEAL) classroom at MIT.

The basic idea is of a radically redesigned classroom and linked web-supported learning environment. The traditional lecture and linked laboratory format is replaced by "4-6 hours of activity based instruction per week, typically in 2-hour blocks" (Beichner *et al.*, 2007, 3). Students work in groups at round tables with web support and white boards. "Most of the class time is spent on 'tangibles' and 'ponderables'. Essentially these are hands-on activities, simulations, or interesting questions and problems. There are also some hypothesis-driven labs where students have to write detailed lab reports" (scaleup.ncsu.edu/FAQs.html).

*"In comparisons to traditional instruction we have seen
significantly increased conceptual understanding, improved
attitudes, successful problem solving, and higher success rates,
particularly for females and minorities."*

— Beichner *et al.*, 2007, 1

Further information
Beichner *et al.* (2007)
scaleup.ncsu.edu/; icampus.mit.edu/projects/TEAL.shtml

3.4 Biology start-up business final-year project
Durham University, UK

Biology Enterprise is a collaborative venture between Durham Business School and
the School of Biological and Biomedical Sciences. This elective module for final-year
undergraduate students in the School of Biological and Biomedical Sciences aims to
introduce science students to the key processes of business start-up and enhance their
enterprising skills and behaviours. The module is project-orientated with self-selecting
groups of students who generate an idea for a business opportunity that is based on
a scientific discovery. Students use their knowledge and understanding of science to
develop and research their idea into a technology that can be readily commercialised,
e.g. a diabetes breath tester, a biodegradable chewing gum. In parallel, the Business
School teaches students the necessary skills and knowledge required to develop their
idea into a successful business. This course offers science undergraduates an alternative
to the traditional laboratory-based project and is useful for those seeking employment
in business and commerce. The module was developed by Stefan Przyborski, who is the
founder and Chief Scientific Officer of ReInnervate, a biotechnology company founded
in 2002 as a spin-out from Durham University.

Further information
ftp://www.bioscience.heacademy.ac.uk/events/dur05/przyborski.pdf
www.bioscience.heacademy.ac.uk/events/dur05.aspx
www.cambridge-mit.org/news/article/default.aspx?objid=877

3.5 A cross-department undergraduate research programme

College of Engineering, University of Maryland, US

Gemstone is an innovative programme for selected 'honors' students in engineering and other disciplines. Student teams, formed in the freshman year, undertake three-year, student-initiated research projects in which they analyse and propose solutions to societal problems, which generally involve a significant technology focus. Team members work as a co-ordinated group, investigating their project from the perspective of individual majors, under the guidance of a faculty mentor. In their first two years students are encouraged to live together on a residence hall floor reserved for Gemstone participants. The research projects, e.g. a comparative study of erosion control measures in the Chesapeake Bay area and homeowner response to such interventions, are developed in consultation with outside experts and agencies. In their final year, student teams present their research to experts in the field or outside agencies and write a team thesis. The learning process mirrors the team-based consultancy style research that students are likely to carry out after graduating.

Further information

www.gemstone.umd.edu

ws.cc.stonybrook.edu/Reinventioncenter/spotlight.html

3.6 Department undergraduate student research journals in Biology

Universities of Chester, Leeds, Nottingham and Plymouth, UK and a national undergraduate research journal

The Biology departments at the Universities of Chester, Leeds, Nottingham and Plymouth have developed journals to publish research by undergraduates in their departments. They are based explicitly on the US practice of undergraduate research journals (Kinkead, 2003). Origin (www.chester.ac.uk/origin/) at Chester is paper-based and generally involves selected students rewriting their dissertations or research projects for external publication. Biolog-E at Leeds (www.biolog-e. leeds.ac.uk) is an electronic journal, as is BURN from Biosciences at Nottingham University (www.nottingham.ac.uk/~sbzml/) and The Plymouth Student Scientist (www.theplymouthstudentscientist.org.uk/index.php/pss). These showcase first-class undergraduate research and support those undergraduates seeking academic research careers. Drawing on the expertise of these department journals, in March 2008 the

first issue of the UK national undergraduate research *Bioscience Horizons* was published. All papers are written by students and based on final-year research projects.

Further information
biohorizons.oxfordjournals.org/
Knight (2006)

3.7 Academic journal writing as part of programme requirements in Geography
Oxford Brookes University, UK

The Geography programme at Oxford Brookes University has developed linked programme requirements that support all students learning to write research articles. In the second year all students undertake field-based research in a range of venues. A final-year compulsory first semester course, Geography Research and Practice, has as its main aim "to develop your skills in writing scholarly reports of your own research". The one assessment is for students to "write an article of up to 4000 words from the data that you collected in your (second-year) fieldwork. The article will conform to existing academic practice for the preparation and submission of scholarly work." Relatedly the department has also just initiated an undergraduate e-journal *Geoversity* to publish selected 'high quality' articles by students in the department including articles that were originally written for the module, Geography Research and Practice. In addition some students take that experience to revise their article, or the research for their capstone dissertation for publication in the departmental undergraduate research journal *Geoversity*, or in the linked, newly established national geography e-journal *Geoverse*. The author guidelines and requirements for this national journal represent the requirements for all programme students writing their journal article for Geography Research and Practice.

Further information
www.brookes.ac.uk/schools/social/geoversity/index.html
www.brookes.ac.uk/schools/social/geoverse/

3.8 Employing second-year students as laboratory assistants in Biomedical science
University of Newcastle, UK

In 2002 the School of Biomedical Sciences introduced a scheme to offer opportunities to second-year Bioscience students to undertake part-time paid work in research laboratories. The aim was to provide students with a greater appreciation of bioscience research, to reinforce their laboratory skills and to encourage them to consider a research-based career. Students work for eight hours per week during term time and are paid a minimal wage. Hours are negotiated with the supervisor to fit with the student's timetable commitments. The scheme has run for five years employing 74 undergraduates. An evaluation demonstrated positive student and supervisor comments with students reporting a positive effect on their studies and that the experience had encouraged them to consider a career in research. The stimulus to the scheme was the fear that an institutional policy to establish research institutes might lead to structural disconnections between teaching and research and reduce the number of undergraduates seeking research careers.

Further information
Hughes *et al.* (2009)

3.9 A department undergraduate research pathway in Mathematics
Ithaca College, US

The Department of Mathematics at Ithaca College, New York, over some seven to eight years, radically changed its course offering, its culture and organisation to make "research with students, designed as part of the curriculum … a distinguishing characteristic of mathematics at Ithaca College". There is a blend of inquiry and research for all students – including non majors – and an elective research focus for those interested. The main components of this overall focus include:

—   a first-year course for all students, *Mathematical Experimentation*. Students use computer software, in particular Mathematica (www.wolfram.com) to conjecture and test mathematical ideas, much like a natural scientist uses the laboratory to test hypotheses. Since these are first-year students, there is no expectation of rigorous proof, but rather a focus on the manner in which mathematicians go about creating new ideas. Examples of student work are at www.ithaca.edu/faculty/dabrown/courses/Math185/;

— a second-year course for all students (majors and non majors), *Sophomore Seminar*, brings together all students and all faculty to explore mathematics. Groups of students work with faculty and give class presentations on particular issues, e.g. voting methods, group theory in kinship and so on;

— the main development has been a research sequence of two courses in the junior year. These focus on the pre-graduating class and support both those Honours/major students who wish to take a research thesis in their final year and education majors with Mathematics as a minor who wish to take this research focus forward into their role as a teacher;

— the first such course, *Junior Seminar*, is required of all Mathematics majors and introduces students to mathematical research methods, writing and citation. Students in groups also work on small research projects guided by faculty;

— *Research Experience in Mathematics* is the main course in the research sequence. It has students working in groups on research questions shaped by faculty research interests and those posed by students in previous years' projects. (Note the course is team taught and is rotated around the department better to ensure effective integration of 'undergraduate research' into the department culture). Students investigate "a research question initiated in the Junior Seminar. Completion of the research project involves, in addition to the mathematical arguments, a written report consistent with the standards of publication in Mathematics and a public presentation at an academic symposium or conference" (Brown and Yurekli, 2007, 576).

Further information
Brown and Yurekli (2006, 2007)
www.ithaca.edu/hs/depts/math

4. Disciplinary practices and strategies

*"In constructing links between research and teaching the
discipline is an important mediator."*

— Healey (2005, 67)

*"Students in the arts and humanities generally work on their
own project and their mentor provides necessary guidance and
expertise. Works of art and scholarly contributions generated
from this type of research is usually credited only to the student.
In the sciences, mathematics and technology, undergraduates
can work on a piece of their mentor's larger research project or
they can work on projects of their own design."*

— Buffalo State University (n.d.)

*"In high paradigm consensus disciplines (like Physics), knowledge
tends to be cumulative. … In low paradigm consensus
disciplines (like English), the 'flatter', more accessible structure
of knowledge means that it is possible for students to engage
with that knowledge earlier and through their own research. …
For example, undergraduate Physics students in our study find
research conceptual, esoteric and remote. Its exclusivity lies in its
incomprehensibility – it is 'another language'. … In responding
to the question: 'What is research?', English students were as
likely to comment from a personal perspective (i.e. to describe
their own engagement in research) as to describe research as an
activity in which others engaged."*

— Robertson and Blackler (2006, 224–5)

*"In these active learning situations, history teachers … work
side-by-side with their students in a collaborative investigation of
historical problems, much as masters and apprentices in a craft."*

— Roth (2005, 3)

Most academics, and to an extent their students also, identify themselves in relation to their discipline or sub-discipline (Becher and Trowler, 2001; Donald, 2002; Healey *et al.*, forthcoming; Huber, 2006; Kreber, 2008; Lucas *et al.*, 2009; Robertson and Bond, 2001; Robertson and Blackler, 2006; Turner, *et al.*, 2008). Hence it is not surprising that the discipline is seen by many as a key level for the analysis of undergraduate research and inquiry and the devising of effective strategies. We have explored much of this territory in our earlier work (Healey and Jenkins, 2003; Healey and Jenkins, 2006; Jenkins *et al.*, 2007), so we only summarise and update the key features here. To complement our previous work we use the framework for curriculum design outlined in section 1 for examining disciplinary practices and strategies for developing undergraduate students as researchers. Further examples of disciplinary case studies may be found in section 3.

4.1 Key research findings

Research on disciplines has found that:

— Discipline cultures affect the nature of teaching and learning (Neumann *et al.*, 2002). Moreover, as many academics believe their disciplines are different from others, there is a strong pragmatic reason for focusing on disciplines and departments in developing practices and strategies. However, some researchers question the extent to which discipline pedagogies vary (e.g. Gibbs, 2000) and others point to considerable inter- and intra-discipline variation in conceptions of teaching and research (e.g. Brew, 2003). More recently there has been a growth in the literature emphasising the importance of disciplinary context (e.g. Jones, 2009), signature-pedagogies (Shulman, 2005; Gurung, *et al.*, 2008) and discipline-specific pedagogical knowledge (Berthiaume, 2008).

— For academic staff disciplinary cultures shape the conceptions of what is 'research', the research methodologies employed and the forms of research distribution. For example, this is well seen in the debates as to whether, and how, arts practice and performance can be considered as research (Borgdorf, 2007). These disciplinary conceptions of research for academic staff are then reflected in how students experience both the relative importance of research and the forms of research in the curriculum. Thus in arts, undergraduate final-year research projects often focus on students producing new knowledge in the form of artwork, performance

and creative works, and reflecting on their processes. Other, more conventional, forms of research, such as the independently researched dissertation often form a complement to such projects (de Freitas, 2007). In contrast, in the biosciences student research projects strongly follow the conventions of faculty research with a focus on positivistic research methodologies, experimental design and the 'objective' writing up of research results (Luck, 2008). These disciplinary differences help explain the conclusion of Gibbs *et al.* (2008, 23), from examining leadership in excellent departments in research-intensive universities, that: "Any advice about leadership of teaching should take into account these disciplinary characteristics and cultures or it is likely to risk being not just irrelevant but inappropriate." Brew (1999), moreover, argues that linking research with student learning is easier where knowledge construction is seen as a product of communication and negotiation rather than an empirical objective process separate from the knower.

— Engaging students in undergraduate research and inquiry is one of the most effective ways to help students to begin to think like a chemist, historian or engineer, which arguably is one of the core graduate attributes for most discipline-based degree programmes (e.g. Healey, 2005; Roth, 2005). Moreover, there is strong evidence that students involved in research-based inquiries develop more sophisticated levels of intellectual development as we explore in sections 3 and 8 (Baxter Magolda, 1999; Hodge *et al.*, 2008). A number of North American analyses of the nature of undergraduate research in particular disciplines are coming available, such as in English and Psychology (Kinkead, 2009; Miller *et al.*, 2008). There is an opportunity here for UK Subject Centres to carry out their own analyses.

— One of the reasons undergraduate research began in the science disciplines, and is less embedded in the humanities, is the tradition of team-work in many of the sciences, compared to the more individualistic approach to research common in the humanities (Colbeck, 1998; Kinkead, 2003). Hence undergraduates in the sciences may make a small, but recognisable contribution to a team, but lack the breadth of knowledge and understanding to do this on their own. On the other hand, the less hierarchical nature of the cumulative construction of knowledge in the humanities than in the sciences means that it is arguably easier for undergraduates to engage in research and inquiry at an earlier stage (Healey, 2005; Robertson and Bond, 2001). This point is well illustrated by the quote at

the beginning of this section from Robertson and Blackler's (2006) exploratory study comparing the experience of research of 36 undergraduate and postgraduate students in three different disciplines (Table 4.1).

— In professional subjects there is lively debate among academic staff about the relevance of students undertaking research (e.g. Booth and Harrington, 2003; White and Taylor, 2002). This debate is shaped in part by some students in these disciplines questioning the importance of research to their future careers. In part this comes back to the issue of what counts as 'research'. With the growth of Mode 2 knowledge more emphasis is being placed in the curriculum on applied research and knowledge transfer through consultancy (Durning and Jenkins, 2005; Gibbons *et al.*, 1994). Recognition that engagement in these activities by students is an appropriate way to develop research skills in the professions may be a way forward. However, accreditation requirements in some professional and vocational subjects encourage "curriculum creep" (Webster, 2002, 16), which can restrict the time for students to engage in forms of inquiry-based learning.

— There is, as yet, limited research on how students in different disciplines experience research, although Robertson and Blackler's (2006) study, mentioned above, suggest there are significant differences. Interestingly, preliminary findings in the history department at the University of Alberta suggest that faculty generally underestimate their students' awareness of research, but overestimate their experience of engaging with research (Wuetherick and Berry, 2008).

Table 4.1: Students' experiences of learning in a research environment

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

Source: Robertson and Blackler (2006, 226)

Strategies for engaging students with research

In section 1 we discussed Healey's (2005) model of curriculum design and the research-teaching nexus. Here we use the four categories shown in Figure 1.1 as a framework for structuring the case studies. Each way of linking research and teaching is associated with a different way of engaging students with research:

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

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

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

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
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

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

Australian National University

A practical exercise designed for a level 2 course involves students: making observations in a botanical garden; coming up with ten questions each (e.g. why do eucalypt leaves dangle?); sharing one of these questions with another group of students; coming up as a group with hypotheses based on the question (e.g. eucalypt trees in arid environments have leaves that dangle at steeper angles than those in wet environments); thinking of ways of testing the hypothesis; and writing up individually their ten questions and one hypothesis as a 750-word mini-proposal for a research project.

Further information

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

A guide for undergraduate dissertations in Sociology, Anthropology, Politics, Social Policy, Social Work and Criminology

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
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

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)

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

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

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
University of Lincoln, UK

In May every year, final-year Tourism students at the University of Lincoln participate in a live virtual conference. This is part of their assessment for the semester-long unit on Social and Political Perspectives on Tourism. A conference is a useful vehicle for extending insight into the process and practice of knowledge creation and dissemination and for students to participate as, in effect, research disseminators. Information technology has made it possible: during the specified time frame of one week, students do not have to be assembled in one place and can participate at any time. Feedback from them has been very positive and encouraging. Two qualified web designers built the site and have been on hand to deal with technical issues. Teaching staff have provided support for the conference throughout the unit. Students submit a full conference paper, but it is only a summary that appears on the conference website. Each student is also required to post a comment on another conference paper. Staff monitor participation and contact students as appropriate.

Further information
www.cometravel.lincoln.ac.uk

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

In 2002, John Lutz implemented History 481: Micro History and the Internet, a learner-centred and research-oriented course in which the main activity was primary archival research on various aspects of life in Victoria, British Columbia from 1843 to 1900. Students worked in small groups to conduct the research and eventually to publish their findings on the website called 'Victoria's Victoria'. John reports that "The feedback I get often says, that if they remember only one course from university, this (course) will be it. ... some alumni contact me to say that the web skills have landed them a job." John notes that the grades in Micro History 481 were approximately 8% higher that the grades that these same students received in other senior History courses that they take from him.

Further information
Anon (2003)
web.uvic.ca/vv

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
University of Gloucestershire, UK

At the University of Gloucestershire, Arran Stibbe allows students to take on the identity of a researcher from the start of their time at university. In the *EZ102 Language & Ecology* module the students have an opportunity to share their insights with the wider research community. The research community in turn has something to gain from student contributions because students can critically analyse aspects of their language and culture that others have yet to examine. The students are encouraged to take part in the international research community through working with the *Language & Ecology* Research Forum – the main international forum for research in ecolinguistics. The Forum links together a network of scholars, has an online journal, a range of resources and a dedicated section for the *EZ102* module. The approach works best when students are becoming critically aware of texts that they are familiar with, rather than struggling to understand new genres understood better by the lecturer than by the students.

Further information
www.ecoling.net/courses.html
resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/activelearningcasestudies/
index.cfm

Student group work assignments based on analysis of current Geoscience discipline journal article analyses

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

University of Sunderland, UK

Students on an Environmental Studies degree at the University of Sunderland undertook local sustainability projects, which brought levels 1, 2 and 3 students together in small research groups to work in collaboration with Sunderland City Council's Local Agenda 21 personnel, and other local environment and development agencies.

Further information
Hughes *et al.* (2001)

This framework provides a useful way to talk about the nature of undergraduate research and inquiry in different disciplines, because it is inclusive of different pedagogies for engaging students. Some individuals, course teams, departments and even whole institutions have used the framework to audit their practice to see if they have, what

they consider in their context to be, an appropriate balance of activities (see also section 1). In the next section we explore how course teams and departments have developed practices and strategies to engage students in undergraduate research and inquiry.

Case studies 4:
Undergraduate research and inquiry in humanities, social sciences and interdisciplinary studies

4.1 Investigating 'writing across the curriculum'
Utah State University, US

At Utah State University, undergraduate students with outstanding communication skills are selected to serve as rhetoric associates to support student writing. This institutional strategy came out of a project that reviewed the amount and kinds of writing in over 700 syllabi at the undergraduate level. It was undertaken by about 20 undergraduates as part of a seminar on tutoring writing across the curriculum. "Although the research problem – what is the nature of writing assignments at this institution – was not one developed by the students, they engaged in the research process and decision making from thereon" (Kinkead, 2009). They started by studying current research on writing across the curriculum and, guided by the instructor, devised common research protocols and methodologies, which were each then separately applied to particular departments and shared the results and proposed interventions.

Further information
Kinkead (2009)
www.usu.edu/raprogram/

4.2 Engaging Politics students in research-based placements, UK

The Scholarship for Engagement for Politics project developed and tested a variety of models for embedding research-based placement learning within the formal curriculum of Politics and International Relations. Placements ran between one and eight weeks, mostly alongside a student's second-year programme, and ranged widely including undertaking research in an MP's office, a County Council and an NGO Drug Charity. Glynis Cousin, Higher Education Academy Adviser for the project, notes that: "It enlivened students' experiences, connected concepts with practices, raised motivation and excitement and positioned students as contributors." The project website provides resources on developing research-based placements.

Further information

www.politicsinaction.ac.uk

www.politicsinaction.ac.uk/images/newlogoimages/FDTL_ProjectBrochure.pdf

4.3 Introduction to academic practice: humanities and social sciences

University of Windsor, Canada

'Ways of Knowing' in the Departments of Arts and Social Sciences at the University of Windsor focuses on students developing disciplinary skills in research and critical thinking. Each year a particular theme is identified – generally one that reflects a Windsor community issue – and student teams investigate and present in public the results of their inquiries. Senior student mentors and community members act as mentors to these investigations. There are institutional discussions on extending this model to other departments.

Further information

apps.medialab.uwindsor.ca/cfl/reflexions/volume01/issue01/Ways_of_Knowing.htm

4.4 Engaging students in environmental health research and outreach

Allegheny College, Pennsylvania, US

At Allegheny College, the junior seminar is a required one-semester course, in the third year of a four-year course, that provides a window into the research experience and allows students to develop a senior-year thesis proposal. Each junior seminar, which typically has between eight and 24 students, has a different theme, geared to the faculty and students' interests; the example below is based on faculty research interests.

In 2007 in Environmental Health, Justice and Development, students developed and evaluated an outreach program. This concerned the critical role of indoor home environments on early childhood health in a rural, low-income community. The course leader provided the causes of childhood diseases and health disparities, the class then evaluated effective and ineffective health campaigns. They then planned, implemented and evaluated an outreach effort, which compared the efficiency of outreach directly targeted to students in fifth and sixth grade (10 to 12 years of age) to outreach targeted more broadly through family-oriented community events, such as a children's workshop and a Halloween parade. Students presented their findings in a public meeting to community partners, teachers, school district administrators, local public health officials, campus

administrators and Environmental Science department faculty and students. Using feedback from the presentation, the students completed the semester with a single written document with report overview, background, findings and recommendations.

Further information
resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm
webpub.allegheny.edu/employee/c/cwaggett/HHHC.html
webpub.allegheny.edu/employee/c/cwaggett/index.html
webpub.allegheny.edu/employee/c/cwaggett/courseprojects.html

4.5 Engaging students in applied research through a Community Sports Development consultancy project
University of Central Lancashire, UK

'Community Sports Development' is a final-year capstone module for Sports Coaching students. This module is optional and taken in addition to the Honours dissertation. Students work as a project team through a consultancy brief with a partner agency and recommend strategies that can be employed to support community development through community sport and coaching initiatives. There are normally eight to 12 briefs divided up among the 40 to 50 students, with students creating their own consultancy teams. Examples of projects include:

— A 'health check' of football refereeing in Blackburn;
— Community Sport and Crime Reduction; and
— Community Sport ('Street Dance').

The emphasis is upon the students creating professional working relationships with the client organisations in order to carry out primary research that is directed by the clients and supported by the academic staff at the University. Students are expected to hold regular review meetings with the clients; carry out interviews with relevant stakeholders; use secondary research to help analyse their findings; and present their work and recommendations to the organisation through the staging of a mini-conference, where all the partner groups are invited. Representatives from agencies provide the feedback on students' work, commenting on the content, feasibility of solutions and competency in conducting the research.

Further information
resources.glos.ac.uk/ceal/resources/casestudiesactivelearning/undergraduate/index.cfm

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

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

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

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

4.7 Involving students in interdisciplinary Interactive Media Consultancy projects
Miami University, Ohio, US

Interactive Media Studies (IMS) is an interdisciplinary minor (including Computer Science, Engineering, IMS, English, Marketing, Graphic Design and Education) that brings together students and faculty to investigate how interactive media informs and transforms their disciplinary perspective. The programme has been running since 1996 and uses problem-based learning and team-oriented projects to help students to learn how to apply their theoretical knowledge to innovative digital solutions for a paying client.

About 100 students a year take the programme and work in project teams. The programmes are team taught with the last two weeks spent on de-briefing and talking

about what they have learnt. The students are typically in class four hours a week, but spend many more hours, for example, visiting clients, undertaking research or doing user testing. They make a presentation to their client at the end of the project.

Commercial companies are charged $20,000 per project paid on delivery; non-profit organisations and charities are typically charged approximately $5,000. They found the client did not take it as seriously when no charge was made. From the client's perspective, they get 'out of the box' thinking that they would never obtain from a consultant firm. Recent completed projects include:

— Healthcare IT asked IMS to create a new logo for their company and build a new web presence to highlight their state-of-the art hospital tracking systems.
— The Taft Museum of Art needed a complete web strategy. IMS developed a web identity for them, put their collection online and created e-commerce capability for their gift shop.

Further information
student.sba.muohio.edu/ims
www.miami.muohio.edu/academics/majorsminors/minors/ims.cfm

5. Departmental and course team practices and strategies

"If teaching and research are as inseparable as many participants claimed, the lack of explicit strategies to promote this synergy is interesting. The discussions with heads of department and other managers of staff time indicated that on a managerial level, it is more convenient for teaching and research to be treated as separate activities. On an intellectual level, however, academic managers would rather perceive the two to be synergistic. What seems to be missing is an intellectual perception of teaching and research as integrated. For example, we visited many departments where Research Committees and Teaching Committees had been established, but these two bodies worked independently of each other."

— Coate e*t al.* (2001, 162, emphasis added)

"Teachers were enthusiastic about PBL but experienced a variety of problems during the transition. Those new to teaching had particular difficulty taking on the PBL role of 'facilitator'. All teachers struggled to work within the 'rules' of PBL. Of specific concern was the varied input teachers provided for their tutor groups and possible inequalities for student learning."

— Spronken-Smith and Harland (2009)

"Curriculum change is a good mechanism for encouraging change in department culture. … Changes in students, institutional demands, and staff can quickly make specific changes in curriculum redundant. The more lasting change is a transformation in how a given department thinks about curriculum and teaching. Departmental consensus, a scholarly approach, and an emphasis on how students learn are key elements for an approach that results in lasting changes, well beyond the life of any specific project."

— Roy e*t al.* (2007, 31)

We now move from individual disciplines to examine the departments in which academic and support staff are based and the course teams that implement undergraduate research and inquiry in the curriculum. Departmental culture is an important influence on the way academic staff and students perceive and experience research and teaching and the relationships between them (Lucas *et al.*, 2009). As the American scholar Clark (1993, 1997) noted, the department is the key level at which practices and strategies are enacted. Here is where faculty roles and workloads are generally defined, and often where courses are managed. An important distinction may be made between research-intensive and teaching-focused departments as the need for, opportunities for and appropriateness of different strategies varies (Jenkins and Healey, 2007a). Many of the institutional strategies discussed in section 6 are also relevant, with modification, at the department and course team levels.

The department is a key site for development of scholarly communities of practice and networks, both formal and informal. If one wants to shape and change the culture, it is important to work with these communities to achieve change. In particular, curriculum and assessment design are primarily developed at the department level, hence the importance of capturing the minds of those providing learning leadership at this level. Postgraduates and many support staff, in particular laboratory technicians, are also organised at department level in many universities. They can be key people in making a success of undergraduate research programmes (see, for example, case study 5.3).

In comparison with disciplines, relatively less work has been undertaken specifically about the role of departments and course teams in the engagement of students in research, but three key findings from the more general literature on teaching and research relations and change management in higher education suggest that:

— Departmental-level research and teaching are often organised separately, hence there are structural and perceptual barriers in integrating undergraduates into the departmental research community and involving them in research and inquiry (Coate, *et al.*, 2001; Durning and Jenkins, 2005; Lucas, 2006; McNay, 1999);
— Broader definitions of what counts as research in teaching-focused departments and universities paradoxically may make it easier for academic staff to link their research and teaching and to engage undergraduates in research and inquiry (Colbeck, 1998; Jenkins and Healey, 2007a; Lucas *et al.*, 2009; Rowland, 1996);
— Programme leaders have been identified as the pivotal players in achieving substantive and sustainable institutional change (Scott *et al.*, 2008). This highlights

the importance of ensuring that programme leaders understand and are supported at the local level if one wishes to see cultural change taking place in relation to how undergraduate research and inquiry are embedded in the curriculum.

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

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

Table 5.1, which we have amended from the work of colleagues involved with the Carnegie Academy's Leadership of Undergraduate Research project, emphasises the variety of dimensions that course teams may adopt in integrating undergraduate research and inquiry into the curriculum. These may also vary according to different national, institutional, departmental and discipline contexts.

Table 5.1: Dimensions of undergraduate research and inquiry

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

Source: Adapted from Beckham and Hensel (2007)

Review understanding and practice of undergraduate research and inquiry

Different institutions and departments within them have different conceptions of the ways in which to engage students in research and inquiry (Jenkins *et al.*, 2007; Jenkins and Healey, 2009; Zubrick *et al.*, 2001). The different ways of defining undergraduate research and inquiry are discussed in section 2.

Focus groups and swap shops (which involve academics exchanging interesting and practices about teaching and learning in groups of threes and fours) have been used effectively to develop departmental understanding of practices (Botterill, 2003; Healey and Roberts, 2004). One of the authors has developed a questionnaire for examining the student perception of research, which has been used in several different HEIs and countries (Healey *et al.*, forthcoming; Turner *et al.*, 2008; http://trnexus.edu.au/uploads/downloads/TR%20 Questionnaire.pdf). A related approach is to hold focus groups of students organised in disciplinary teams (Jenkins *et al.*, 1998; Lindsay *et al.*, 2002). The case study below of Sociology at the University of Warwick shows selected undergraduates researching their and their peers' learning and presenting the results of that research to the department (case study 5.4). Another approach is to audit existing practices. This method was used by the Universities of Adelaide and Reading to identify student research skill development and to map the teaching and assessment of research skills (see details in section 4).

Develop a set of related curricula interventions

Departments and, in particular, their leaders can do much to support undergraduate students engaging in research and inquiry through structured inventions to support individual academic staff and course teams in designing and delivering the curriculum. For us, the curriculum is the key potential area of intervention; it is here where academic staff's experience and expertise in research can potentially most effectively support student learning, or alternatively it may remain separate from the student experience. Focusing on the curriculum and departmental support moves discussion and intervention away from an almost exclusive focus on the research expertise of individual academics, to how a department organises its varied resources, particularly academic staff, to support student learning about and through research.

The Boyer Commission on *Educating Undergraduates in the Research University* (1998,

15–22, 27–28) called for ten key changes in undergraduate education, four of which directly call for organisational changes at department and institutional level to strengthen the undergraduate experience of research:

"1. Make Research-Based Learning the Standard – Learning is based on discovery guided by mentoring. Inherent in inquiry-based learning is an element of reciprocity: faculty can learn from students as students are learning from faculty.

2. Construct an Inquiry-Based Freshman Year – The first year of a university experience needs to provide new stimulation for intellectual growth and firm grounding in inquiry-based learning and communication of information and ideas.

3. Build on the Freshman Foundation – The freshman experience must be consolidated by extending its principles into the following years. Inquiry-based learning, collaborative experience, writing and speaking expectations need to characterize the whole of a research university education.

7. Culminate with a Capstone Experience – The final semester should focus on a major project and utilize to the full the research and communication skills learned in the previous years."

This report, "which has energised and transformed all types of institutions of higher learning, is based on the principle that research-based learning should inform all levels of undergraduate education" (Kinkead, in submission).

Several of the case studies below illustrate ways in which departments make a set of co-ordinated interventions in the curriculum, including the Zoology department at the University of Tasmania (case study 5.1) and the Chemistry department at Utrecht University (case study 5.3). The Earth Sciences department at the University of Oxford is an excellent example of how undergraduates are integrated into the research culture of the department (case study 5.5).

Offer undergraduate research and inquiry as a pervasive and early element of the curriculum

The UK dissertation is something traditionally undertaken in the final year (section 2). Undergraduate research is potentially something that can culminate not only in a capstone course, but also start on entry. In case studies 1, we outlined several examples of engaging students in research and inquiry at the beginning of their academic studies. Realistically many departments may start undergraduate research and inquiry in particular parts of their programmes for selected students. The challenge then is to 'scale up' (Coburn, 2003) so

that dimensions of undergraduate research and inquiry are embedded throughout the way programmes are taught and assessed and are central to the department culture.

Give students experience of undertaking research and inquiry with different levels of independence

In section 2 we noted that Spronken-Smith *et al.* (2008) argue that it is important to distinguish between structured, guided and open modes of inquiry. For example, the revised Ecology degree at the University of Otago progressively develops inquiry skills in four core papers. At stage 1 and 2, most inquiry activities are built into the laboratory programme leading to an 'open' inquiry course at stage 3 (//akoaotearoa. ac.nz/project/inquiry-based-learning/resources/books/case-study-ecology-degree).

It is fitting that the projects students undertake should have different degrees of scaffolding, but it is too simple to conceptualise this as simply a linear process from highly structured to highly independent, although this may be the general trajectory. There is much to be said to giving students a fair degree of independence in an early project to build up their motivation. Later projects can be more structured, as the students are more likely to realise the need for rigorous methods and techniques from issues that have arisen in the earlier project, before returning to open inquiry towards the end of the course. This moves away from the three-stage model of developing independence (Hughes, 2003):

1. capacity building;
2. letting go of control;
3. freedom to learn;

to a slightly more nuanced four stage version:

1. build motivation through experience of guided and open inquiry;
2. develop capacities by focusing on methods and techniques;
3. give greater control to students to undertake independent projects.

The latter model is closer to the McMaster University approach of starting with open inquiry, although heavily scaffolded (see case study 1.2), followed by more structured and guided forms in the second and third year, before returning to open inquiry,

although much less scaffolded, in a capstone course in the fourth year (Spronken-Smith *et al.*, 2009).

Link undergraduate research and inquiry to student employability

If the concept of a 'knowledge economy' has any validity then undergraduate education for all has to include some understanding of, and ability to do or use, research. Calling this 'undergraduate research' and making explicit to students the fact that this may well aid their employability, can both help them to appreciate better the role of research in the university and support their future employability. The example of Miami University's Interactive Media Consultancy provides a good illustration of the development of skills of research applications to industry-based problems (case study 4.7). A further illustration is the involvement of undergraduate students at the University of Central Lancashire in applied research through a community sports development consultancy project (case study 4.5).

Ensure assessment practices and policies support students as researchers

Another strategy to mainstream undergraduate research and inquiry is to build research opportunities into the formative processes and summative outcomes of course assessment for students. This can be done in ways that retrace how academic staff develop and disseminate their research and learning in their own discipline or professional area, for example, through undergraduate research journals and student research conferences and exhibitions (Jenkins, 2008b; Walkington and Jenkins, 2008). Several of the cases discussed in section 3 illustrate this strategy (e.g. case studies 3.6 and 3.7).

Include all and be selective

While clearly involving all students in some form of research, course teams may also choose to offer special undergraduate opportunities to selected students. The issue of inclusivity was discussed in section 3. For example, the Department of Mathematics at Ithaca College, New York, redesigned its programme to make research with students a distinguishing characteristic of the course for all students, while also creating a specialist pathway for selected students (case study 3.9).

Case studies 5:
Undergraduate research and inquiry in departments and course teams

5.1 Co-ordinated interventions in Zoology
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)

5.2 Junior Research Associate Bursaries in Social Sciences and Cultural Studies
University of Sussex, UK

From 2008 the School of Social Sciences and Cultural Studies at the University of Sussex
is offering competitive awards to selected first- and second-year students for Summer
research bursaries at a rate of £200 (not taxed) per week for eight weeks for Summer
research projects. Applications must be sponsored by a member of academic staff in the
School, who must be willing to act as supervisor for the duration of the award. Bursaries
are awarded to projects that clearly link to the research agenda of the supervisor and
support their Department's research strategy. Bursaries are not awarded for projects
that are part of assessed work for a degree (e.g. projects or dissertations), or for projects
involving work away from the University of Sussex.

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

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

Traditionally undergraduate Chemistry in the Netherlands only ends with a 'real'
research assignment, which students undertook in one of the research groups of
the University. However, this model is not very effective in developing the required
scientific skills for a chemist, such as presenting their work, critically evaluating their
work and designing new experiments based on the results of previous ones. Most
Chemistry students in the Netherlands go on to take a Masters in the same university
(approximately 90% at Utrecht University). A few years ago Utrecht University opted
for a curriculum in which learning research skills and knowledge go hand in hand.

Laboratory technicians and postgraduates play a key role in supporting students at different levels.

First year

On the first day of their studies students start with a group laboratory project in which they are asked to prepare and characterise a polymer (a kind of plastic). The final material that they have to prepare is clear; however, the route to prepare that material is developed by the students themselves. At the end of the first year all the students (approximately 70) work for three weeks in groups in one of the research departments.

Second year

In order to keep a link between the students, lecturers and researchers, students visit and carry out experiments in the research departments. At the end of the second year students are involved in a five-week pre-determined group research project. The goal of their project is discussed with the supervisor (in most cases a senior PhD student). In that way the students are involved in a relevant, authentic research project.

Third year

At the end of the third year all students carry out an individual BSc-thesis research project. Students contribute for ten weeks to an ongoing PhD research project in which they are assigned to their own sub-project.

5.4 Using undergraduates to evaluate student experiences of teaching and learning
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)

5.5 Developing an undergraduate research culture in Earth Sciences
University of Oxford, UK

Departments have cultures that may unwittingly or purposefully keep students "at arms length" from research (Brew 2006, 52) or bring them into that experience. Philip England (2007, 8) of the Department of Earth Sciences at the University of Oxford, comments on the culture of his department:

> *"Fieldwork is a central aspect of Geology and, almost irresistibly, it imposes a flavour upon our teaching. … A day in the field typically involves more than 12 hours of close-contact teaching, in which the agenda is set by the observations that the students make, and the questions that they pose. Frequently, those questions have no known answer. … By the time they are in their second year, most undergraduates are on first-name terms with the academic staff. … A variety of practices underpin this informality in ways that, separately, do not appear particularly powerful but which, because they are valued by all, have a large cumulative effect. Interaction space is highly valued, and it is an (unwritten) guiding principle that anyone can interact with anyone else in the common space (library, staff coffee room, undergraduate common room, etc.)."*

That perspective of the department culture is validated by external reviews and performance indicators. Thus Graham Gibbs' (2007, 9) analysis of the department observed that:

> *"The central social space in the department has posters on the walls that have just come back from conferences, and which change regularly. It would not be possible for students to be unaware of what research was being undertaken or who was undertaking it. In this social space, informal discussion of research, with undergraduates involved, seemed to be going on constantly. Students were invited into research projects in the lab or the field in an ad hoc way if they showed interest. Students were being inducted into a community of practice rather than only being taught."*

Further information
England (2007)
Gibbs (2007)

5.6 Department and institutional research resources support undergraduate research in History

University of Virginia, US

This case study demonstrates how the research resources of a research-intensive university department can support undergraduate research and inquiry in a large course. The first course leader was Edward Ayers, then Dean of Arts & Sciences at the University of Virginia, and a leading researcher on the American South. The School hosts the Virginia Center for Digital History. The resources of this Center, University and School research archives, research librarians and a postgraduate research and teaching team, support a range of undergraduate research programmes, including research in an undergraduate course with an enrolment of about 180 students, for which Ayers was the course leader. The course involves undergraduate student teams using University archives to research a specific time or place and then publish their research to a website for use by current and future students and other researchers nationally.

Further information
www.vcdh.virginia.edu/SHD/howtobegin.html
www.reinventioncenter.miami.edu/conference2006/edayers/summary.htm

6. Institutional practices and strategies

Institutions and departments should "make it possible for every student to participate in <u>at least two high-impact activities</u> during his or her undergraduate program, one in the first year, and one taken later in relation to the major field. … Ideally, institutions would structure the curriculum and other learning opportunities so that <u>one high-impact activity is available to every student every year</u>."

— Kuh (2008, 19-20, emphasis added)

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

— Hodge *et al.* (2007, 1)

"In considering the balance and relation between institutional and department strategies for strengthening the teaching-research nexus: while departments are often where (linked) disciplinary allegiances are strong, and policies re linking teaching and research which build on these values and practices should be department based, other strategies such as requirements for graduation, how courses and staff are reviewed and appraised, and how the timetable and curriculum are structured, are often institution based."

— Jenkins *et al.* (2003, 81)

As the quotes above indicate, mainstreaming undergraduate research and inquiry across an institution involves making it part of the institutional culture. The key strategy for us is to facilitate the integration of undergraduate research and inquiry into the curriculum. In this section we explore 19 strategies that institutions could consider adopting if they wish to embed undergraduate research in their practices and strategies. It pulls together some of the ideas we have discussed previously (Jenkins *et al.*, 2003; Jenkins and Healey, 2005, 2009) and develops them with additional ideas into a clear framework (Table 6.1). The strategies are illustrated with examples of institutions that have put them into practice.

Table 6.1: Institutional strategies to mainstream undergraduate research and inquiry

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

B.	Encourage and support student awareness and experience of undergraduate research and inquiry
6.	Embed undergraduate research and inquiry from day students enter university.
7.	Raise students' awareness of research.
8.	Provide opportunities for selected students to undertake undergraduate research and inquiry within and outside the curriculum.
9.	Provide opportunities for all students to undertake undergraduate research and inquiry within and outside the curriculum.

10.	Have students investigate issues that are of importance to the university or other students.
11.	Value the role that student organisations can play in supporting undergraduate research.
12.	Celebrate undergraduate research and inquiry.
13.	Provide support and encouragement to students undertaking undergraduate research and inquiry.

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

D.	Encourage academic staff awareness and support and reward engagement with undergraduate research and inquiry
17.	Increase academic staff awareness of undergraduate research and inquiry.
18.	Provide support to academic staff with regard to professional development so that they are encouraged to become engaged in undergraduate research and inquiry.
19.	Provide incentives and rewards for academic staff to support undergraduate research and inquiry, particularly through workload planning, institutional and departmental recruitment, criteria for appointment, performance review and promotion processes.

6.1 Develop supportive institutional strategies and policies

Strategy 1: Embed in vision and teaching and learning and research strategies of university

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

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

Undergraduate research

University of Central Lancashire (UCLAN), UK

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

Further information

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

Strategy 2: Develop supportive institutional curricula frameworks and structures

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

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

The university curriculum timetable can also be changed to ensure all students have dedicated time for research; for example, by adjusting the timetable across the whole year or for a limited period. Thus instead of a one-hour block, the curriculum can be delivered over two- to four-hour blocks; such blocks of time both encourage and allow inquiry-based learning activities to take place (e.g. case study 1.2). There can also be a period of, say, one to two weeks where students can focus on one central investigation; for example, part of the final year can be solely devoted to the dissertation or capstone. In some countries a whole term or semester or the whole of the fourth year may be given over to undertaking an Honours dissertation.

Experiential learning for all

Indiana University-Purdue University Indianapolis (IUPUI), US

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

Further information

Wilson (2009)

www.iupui.edu/administration/acad_affairs/rise/

www.iupui.edu/administration/acad_affairs/rise/rise_proposal.pdf

Strategy 3: Link undergraduate research and inquiry to institutional policies for employability

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

On campus undergraduate research employment

Northwest Missouri State University, US and the University of York, UK

Undergraduate students being employed in a variety of roles, including academic roles, on campus is an important feature of many US universities. The scheme at Northwest Missouri State University is a strong example of such structured programmes – with

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

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

Institutional research skills certificate
Universities of Warwick and York, UK

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

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

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

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

Undergraduate research programmes to support first-year success, racial and cultural diversity and widening participation

University of Michigan, US

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

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

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

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

Undergraduate research and the scholarship of engagement

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)

6.2 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
McMaster University, Canada

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

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

Strategy 7: Raise students' awareness of research

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

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

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

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

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

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

Advanced Study Courses

Australian National University (ANU)

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

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

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

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

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

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

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

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

The Undergraduate Research Opportunities Program (UROP) supports research partnerships between MIT undergraduates and academic staff. Formed in 1969, it is

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

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

Strategy 10: Have students investigate issues that are of importance to the university or other students

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

Student representatives investigate issues that need addressing in their programmes
University of Exeter, UK
Students from ten subject areas across the University have been engaged as a pilot project (2008-09) in a variety of action-research activities with the purpose of improving learning and teaching within their Schools. This has been a collaborative project involving Education Enhancement and the Guild of Students, with student representatives from Staff-Student Liaison Committees (SSLCs) taking responsibility for promoting evidence-based change. Student-selected topics include assessment and

feedback, the quality of seminar provision, shared learning spaces, peer mentoring for language teaching, inter-campus teaching and employability. Data have been collected via focus groups, informal interviews of staff and students, and questionnaire surveys. Findings will be presented via presentations at a student-led conference. SSLCs and programme managers are expected to take responsibility for embedding recommendations for change into strategic planning and action.

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

Strategy 11: Value the role that student organisations can play in supporting undergraduate research

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

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

To support its commitment for the interaction between research and scholarship with teaching, UEA investigated the reality of University rhetoric about the relationship between research and teaching. The University's Centre for Applied Research in Education worked in co-operation with the UEA Student Union to recruit 12 student researchers to research the student experience of research at UEA. "Members of the Student Union played an active part in the management and execution of the project work" (Zamorski, 2000, 6), as well as in the subsequent policy decisions to ensure students benefited from, and were involved in, the University research environment.

Further information
Zamorski (2000, 2002)

Strategy 12: Celebrate undergraduate research and inquiry

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

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

Further information
www.unh.edu/urc

Strategy 13: Provide support and encouragement to students undertaking undergraduate research and inquiry

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

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

Intergenerational student teams support first-year inquiry courses in Chemistry
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)

6.3 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;
— 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
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
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

University of Gloucestershire, UK

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

Further information
Case study 1.1

6.4 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

Nottingham Trent University (NTU)

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

Further information

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

Strategy 18: Provide support to academic staff with regard to professional development so that they are encouraged to become engaged in undergraduate research and inquiry

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

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

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

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

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

Further information
www.hefce.ac.uk/cetl

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

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

Including the expectation of involvement with undergraduate research in adverts for academic posts is one way of explicitly identifying the activity; encouraging research

staff to engage with undergraduates is another. At the University of Queensland research staff are funded through central institutional funds to undertake teaching for up to a quarter of their time.

Research staff are funded to engage in teaching
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

Case studies 6:
Undergraduate research and inquiry in institutions

6.1 Mainstreaming undergraduate research and inquiry
Miami University, Ohio, US

Miami University, Ohio is moving from a teaching paradigm to a leaning and discovery paradigm. The TOP 25 project calls for 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". The TOP 25 Project involves the largest recruiting courses (actually 31 of them) being rewritten as inquiry-based courses. Each course has been allocated $35,000 to fund curriculum revision. Learning technologists and educationalists support the teams of faculty involved. Seven or eight courses per annum are being redesigned over a four year period. Together the courses account for almost a quarter of total credit hours. All courses with more than 1,000 credit hours are in the programme. Many of the courses are being 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.

Further information
Hodge *et al.* (2007, 2008)
www.units.muohio.edu/led/Top_25_Project/Index.htm

6.2 Final-year project presentation
Alaska Pacific University, US

At Alaska Pacific University, a small private university, all students in all disciplines undertake a senior project and present it to the campus community on designated days at the end of each semester. Thus students experience both undertaking research and communicating their work through spoken presentations. The institution has a strong commitment to active and research-based learning, and they now market themselves as "The University of Active Learning." They have a strong year one orientation to active learning and a range of required courses in all years involving research techniques and projects that lead into the required final-year senior project. This has a strong applied focus. As well as a formal

research paper, students in discipline groups (mainly Environmental Sciences, Human Services and Business) present their research as a professional public presentation. These end-of-semester presentations are advertised for the faculty, staff and students, as well as interested members of the public. Other classes are cancelled so that the student body may attend. Often, members of the site where the investigation takes place also attend. The final assessment is on the 40 to 60 page research paper, the quality of the presentation and handling of questions at the presentation. While numbers of graduating students are small (approximately 70 per year), the idea of a public presentation as part of the final-year project could be adapted by larger departments and institutions.

Further information
distance.alaskapacific.edu/course/info.php?id=387
www.alaskapacific.edu/Pages/default.aspx

6.3 Undergraduate research celebration days in US

Many US institutions have a special day, days or a whole week in which students from across the institution present their research, generally by posters but also by talks, exhibitions or performances. These are often accompanied by talks from leading researchers in that institution or nationally. Audiences for such events are faculty, fellow students; in some cases, e.g. Boston University and Bates College, the dates for such events are carefully selected to ensure parents, potential students, alumni and potential sponsors can attend (Huggins *et al.*, 2007a). The Council on Undergraduate research website provides useful details on many such events.

Further information
Huggins *et al.* (2007a)
www.cur.org/Publications/celebrationdays.asp

6.4 First-year online introduction to research course
   Virginia Tech University, US

The Undergraduate Research Institute at the College of Liberal Arts and Human Sciences at Virginia Tech University piloted in 2008-09 an online course to introduce students to undergraduate research. Virginia Tech University, like many other large research universities faces the dilemma of knowing the importance of exposing undergraduates in

year one to the research culture of the institution, while not having the resources to give each one of them an individualised experience with a faculty member.

Research about undergraduate inquiry was explored in addition to models from other institutions and student development theory pertaining to working with first-year students. 'LAHS 2984: Introduction to Undergraduate Research' spans both semesters. Assignments vary from readings that help students understand the culture of a research university and the importance that research plays in university life, to them attending the Undergraduate Research Institute Kickoff and experiencing the Virginia Tech Undergraduate and Prospective Graduate Student Research Conference. Students are not just exposed to what research means in their major field of study, but gain an interdisciplinary perspective by examining the ways that research and creative work is conducted across disciplines.

In its first year, enrolment is limited to about 30 students – but the intention is to use this 'experiment' to then 'scale up' the course so that it can support many students by crafting assignments that would be thought provoking and informative yet easily evaluated by graduate students and second-year students who have passed the course.

Further information
www.uri.clahs.vt.edu/Student%20Resources.html

6.5 Integrating academic staff and students at different levels through 'subject families'
University of Oxford, UK

As part of overall institutional planning, the University of Oxford is using the idea of 'subject families' to help integrate undergraduates and postgraduate students with research staff and academics in the Colleges. Periodically students and staff in related subjects come together for academic and social activities that showcase and discuss current research by College members. These changes have also opened up opportunities to develop interdisciplinary links and for undergraduates to appreciate better the research done by staff in their College and the prospects for some of them of pursuing research careers. This may be an idea that other institutions could adapt for departmental implementation.

Further information
University of Oxford (2005)
www.st-annes.ox.ac.uk/study/undergraduate/subject-families.html

7.   National policies and strategies

*"In the 1980s, the National Science Foundation initiated
the Research at Undergraduate Institutions program. …
The Howard Hughes Medical Institute began to award
undergraduate science education grants that often supported
UR programs. … The National Conferences on Undergraduate
Research (NCUR) began in 1987 to provide an opportunity for
student researchers to present their work, while disciplinary
professional societies began to include poster sessions for
undergraduate research student presenters as part of their
conference programs."*

— Hunter *et al.* (2010, chapter 1)

*"Science, technology, engineering and mathematics (STEM)
education at all levels continues to benefit from information,
communications and other new technologies, with their
potential for more engaging and inclusive learning and
discovery. Access to interactive data sets, simulations, and up-
to-date research results, as well as the opportunity to interact
with researchers, has increased."*

— National Science Foundation (2006, 2)

*"Research councils should work with universities, research
institutes, charities and industry to develop a national Research
Experiences Programme for undergraduate students."*

— Nigel Thrift, Vice-Chancellor, the University of Warwick, in his
  invited contribution to the Department of Innovation, Universities
  and Skills' Debate on the Future of Higher Education (2008, 15)

National systems can play key roles in supporting institutions in bringing undergraduates
into the worlds of research. In the UK we operate in a system where governments and
nationally funded authorities, such as the Funding Councils, play central roles. In the US

and other systems, the role of government, while still significant, may be less direct, but here other national organisations, including foundations, can play central roles, as do State-level authorities in Australia. National forces and agencies can, however, have a negative impact on undergraduate research and inquiry. In the UK, for example, the Research Assessment Exercise (RAE) has moved many academics out of high level discovery research and, more significantly from a student inquiry perspective, encouraged institutions to focus selected academic staff on international level research and reduce their interaction with undergraduates. This process has also discouraged many academics from writing textbooks and other teaching-focused materials that might support student inquiry (McNay, 1999; Lucas, 2006). The new Research Excellence Framework (REF) scheme is unlikely to change these trends. Nevertheless there are several strategies that national and state systems can develop to encourage undergraduate research and inquiry. A broad typology of such national interventions is shown below:

National strategies for developing undergraduate research and inquiry

1. Fund high quality learning resources to support student research and inquiry.
2. Ensure national quality assurance and enhancement systems support undergraduate research and inquiry.
3. Ensure research funding supports research dissemination and undergraduate research.
4. Target research opportunities to students in particular disciplines.
5. Target research opportunities to students from under-represented groups.
6. Encourage disciplinary and professional associations to support undergraduate research and inquiry.
7. Recognise and value student organisations playing a leading role.

Strategy 1: Fund high quality learning resources to support student research and inquiry

National funding systems and research evaluation systems can support student inquiry and research by positively valuing and explicitly funding high quality learning materials that support student research and inquiry. Here information technology offers the potential to make high level research materials available to many students and to support them in using these materials for research and inquiry. In the UK, the Joint Information Systems Committee (JISC) has funded a number of such projects including some with the US

National Science Foundation. JISC is also playing a central role in researching, advising and funding projects that support the physical redesign of learning spaces to support student inquiry. (www.jisc.ac.uk/uploaded_documents/JISClearningspaces.pdf).

Trialling e-learning in Bioscience discovery laboratories
UK

Funded by JISC at the University of Bristol, "eBioLabs intends to transform the delivery of laboratory-based bioscience courses by developing, deploying and evaluating a personalised electronic learning space. The aim is to transform the delivery of laboratory-based courses and realise their potential to be some of the most active, discovery-led sessions learners encounter in their university careers." After initial research the innovation will be evaluated on approximately 250 first-year Biochemistry undergraduates in the Autumn and Spring terms of 2009-10, and subsequently all materials will be publicly available.

Further information
www.jisc.ac.uk/whatwedo/programmes/elearningcapital/curriculumdelivery/ebiolabs.aspx

Innovative approaches to teaching and learning in Geography
US and UK

DialogPlus was an experimental project funded jointly by the US National Science Foundation (NSF) and the UK JISC. The project combined the efforts of geographers, education specialists and computer scientists at Pennsylvania State University and the University of California, Santa Barbara (US) and the Universities of Southampton and Leeds (UK) to create electronic learning resources that enabled students to work more independently out of class.

Further information
Martin and Treves (2007)
Rees *et al.* (2008)
www.dialogplus.soton.ac.uk

Strategy 2: Ensure national quality assurance and enhancement systems support undergraduate research and inquiry

National quality assurance systems can support undergraduate research and inquiry through a range of procedures from developing national metrics of teaching quality that in part centre on student inquiry, such as that of the US National Survey of Student Engagement (section 8), to funding projects that share good practice, as in the Australian Teaching Research Nexus (www.trnexus.edu.au/). QAA Scotland has a national quality enhancement process that is currently funding institutional and disciplinary networks and projects centred on student graduate attributes developed through research and inquiry (Barrie, 2006; www.enhancementthemes.ac.uk/themes/ResearchTeaching/default.asp).

Council on Undergraduate Research (CUR)

US

CUR, founded in 1978 and based in Washington DC, is a national organisation. Members include nearly 3,000 individuals and 575 colleges and universities. Its focus is on supporting undergraduate research in all types of institutions. Its leadership works with agencies and foundations to enhance research opportunities for faculty and students, and assists administrators and faculty members in improving and evaluating the research environment at their institutions.

Further information

www.cur.org

Strategy 3: Ensure research funding supports research dissemination and undergraduate research

In all national systems research funding is highly selective and in many systems the encouragement of *student* research and inquiry is not supported through research funding. However, in the mid-1990s the US National Science Foundation reviewed its programmes and competitive research grant procedures to ensure that high level research more significantly impacted on the wider society. This review resulted in a major redrafting of its criteria for research awards to include strong criteria to

require research dissemination and undergraduate as well as postgraduate involvement. The NSF has since developed and evaluated a wide range of initiatives to support undergraduate research throughout US higher education (Haggett, 2006; National Science Foundation, 1995, 2006).

Internationally the pressures for high level research selectivity may both limit the numbers of academic staff who have ready access to funding and time for research, and, in effect, reduce the opportunities for undergraduates to be involved in research. The English Research Informed Teaching Fund is an innovative way of supporting undergraduate students benefiting from and participating in a research environment.

NSF Division of Undergraduate Education (DUE) promotes undergraduate research and inquiry in STEM disciplines across the HE system
US

DUE manages a range of grant programmes that constitute a comprehensive approach to improving science, technology, engineering and mathematics (STEM) education at two- and four-year colleges and universities. These programmes support the development of innovative educational material, courses and curricula, pedagogical techniques, and assessment instruments and methods; the acquisition of modern laboratory instrumentation and equipment; professional development for faculty; and scholarships for students.

Further information
www.nsf.gov/ehr/due/about.jsp

The Research Informed Teaching (RIT) fund
UK

In 2006, the Higher Education Funding Council for England (HEFCE) announced a three-year £40 million programme with funds allocated inversely proportional to an institution's research funding. Institutions needed to demonstrate how their funding would support linked objectives, including students experiencing research and developing research skills and embedding research-informed teaching in institutional structures. A smaller additional three-year RIT funding has been agreed, but the money is being distributed as part of widening participation funding.

Further information

www.dfes.gov.uk/hegateway/hereform/heresearchforum/index.cfm; www.hefce.ac.uk/pubs/hefce/2006/06_11/; www.hefce.ac.uk/learning/enhance/quality.htm

Strategy 4: Target research opportunities to students in particular disciplines

In the context of undergraduate research selectivity, in particular with respect to academically able students (section 3), a number of national systems have sought to increase the number of students in particular disciplines who have the capacities and interests to pursue a research career (Jenkins and Healey, 2007b).

Research councils' vacation bursary schemes
UK

These are a way of supporting the recruitment of the best undergraduate students into research degrees, and therefore are ultimately about improving the supply of researchers, particularly in the science (STEM) disciplines.

Further information
Engineering and Physical Sciences Research Council (2008)
Lyne (2007)
www.rcuk.ac.uk/default.htm

Science Foundation for Ireland (SFI) undergraduate research experience and knowledge awards (UREKA)
Ireland

Selected undergraduate students conduct a 10 to 12 week research project within a cutting-edge research group during the Summer. They also attend a variety of events to further develop the skills needed for a career in research. SFI currently funds 11 UREKA sites at academic institutions throughout Ireland.

Further information
www.sfi.ie/content/content.asp?section_id=505&language_id=1

Strategy 5: Target research opportunities to students from under-represented groups

Particularly in the US, financing undergraduate research is seen as a way the national system can support those groups under-represented in higher education or in particular disciplines and professions.

Advancing Hispanics, Chicanos and Native Americans in Science (SACNAS), US

SACNAS is a society of scientists dedicated to fostering the success of Hispanic, Chicano and Native American scientists, from college students to professionals, to attain advanced degrees. SACNAS organises a national conference with some 600 travel grants where undergraduates present their research; presenters receive training and mentoring, and make contacts with graduate schools.

Further information
www.sacnas.org

Strategy 6: Encourage disciplinary and professional associations to support undergraduate research and inquiry

National and international disciplinary societies can ensure that selected undergraduates participate in conferences, publish in sections of mainstream academic journals or in designated disciplinary undergraduate research journals. They may also share good practice in establishing discipline-based undergraduate research programmes. Thus the US Society for the Teaching of Psychology has published a wider-ranging account of discipline-based undergraduate initiatives in Psychology (Miller *et al.*, 2008).

In the UK many of the Higher Education Academy Subject Centres have been active in sharing disciplinary perspectives and resources to bring teaching and research together (www.heacademy.ac.uk/ourwork/research/teaching/disciplines). Now would be an opportunity for them to focus on developing undergraduate research and inquiry.

National undergraduate research journal, UK

Bioscience Horizons is a free online journal from a mainline publisher publishing the best undergraduate Bioscience research from the UK and the Republic of Ireland. All papers are written by students and based on final-year research projects.

Further information
biohorizons.oxfordjournals.org

Strategy 7: Recognise and value student organisations playing a leading role

Student national organisations can play important roles in lobbying for student involvement in national research governance and can contribute to the types of initiatives outlined above. Thus the Scottish student organisation, Student Participation in Quality Scotland (www.sparqs.ac.uk/), has played a key role in ensuring student perspectives are central to the current QAA Scotland focus on student research-mindedness and graduate attributes. The Irish case study below shows that recent graduates can also play a significant role.

Irish Undergraduate Research Journal and Awards, Ireland and UK

Established by two recent graduates from Trinity College Dublin, the Irish Undergraduate Awards were launched in September 2008 and are now supported by all seven Irish universities and the two Northern Ireland universities, as well as by leading corporate organisations and individuals. The aim will be to celebrate undergraduate research across Ireland, and to hold events that bring selected undergraduate students in contact with leaders in commerce, industry and public life to discuss issues of public concern, and encourage a more entrepreneurial culture in a scholarly manner. Central to the scheme will be the Undergraduate Journal of Ireland, which will publish selected papers, projects, essays and dissertations.

Further information
www.iuawards.ie/site
www.trinitynews.ie/index.php/features/features/271-trinity-graduates-spearhead-new-awards-for-academic-excellence

8.   The research evidence

"Findings from several studies point to the positive influence of undergraduate research programs on persistence and degree completion. ... Well-controlled studies indicate that participation in research programs also elevates degree aspirations ... and the likelihood of enrolling in graduate school ..."

— Pascarella and Terenzini (2005, 406)

"While students value being close to research, and to the idea of a university as a research community in which they are included, there are many ways in which they feel excluded."

— Zamorski (2000, 1)

"Comparison of the perspectives of faculty and their students revealed considerable agreement on the nature, range, and extent of students' UR (undergraduate research) gains. Specific student gains relating to the process of 'becoming a scientist' were described and illustrated by both groups. Faculty framed these gains as part of professional socialization into the sciences. In contrast, students emphasized their personal and intellectual development …"

— Hunter *et al.* (2007, 36)

The focus of this publication is on enhancing practice and policy. Our proposals grow in part out of the international research evidence on teaching and discipline-based research and teaching relationships.

Research shows that, while for many academics the distinguishing feature of higher education should be the interconnection between teaching and discipline-based research, this is often not readily revealed in practice and, most significantly here, is not easily identifiable in the student experience of the curriculum (Brew, 2006; Jenkins, 2004). A range of studies have shown that for many students their experience

is of being excluded from research (Brew, 2006). This research has focused on the student experience of staff research, in relation to Figure 1.1, on students as the 'audience' for academic staff research. Thus Jenkins *et al.* (1998) carried out focus-group discussions with undergraduate students in a range of disciplines at Oxford Brookes University. Students who perceived the involvement of academic staff in research as being incorporated into their teaching tended to see their courses as current and as stimulating intellectual excitement. However, many students did not see themselves as stakeholders in staff research. Zamorski (2000, 2002) came to similar conclusions in a study at the University of East Anglia (UEA), where she supervised students who were employed to research their own and their peers' learning experiences in relation to staff research.

Internationally a range of studies using different research methodologies have confirmed these interpretations, in particular the Boyer Commission's (1998) analysis of the US research-elite institutions and a comparison of the awareness, perception and experience of research by students in two English universities and one Canadian (Turner *et al.*, 2008). This research has been important in stimulating efforts to make undergraduate students more aware of research done by academic staff, but also in directing greater attention to make students explicitly *participants* in research and inquiry. We have shown in this publication something of the rich international interventions ranging from individual courses to national initiatives to move undergraduate students from the periphery to near the centre of university research. What, however, does research tell us of the impacts of these interventions?

8.1 Research on selective undergraduate research programmes

When we have met with officials from the National Science Foundation and Howard Hughes Medical Institute and other national undergraduate research funders, a central question for them was in effect: 'Is the money we are investing in undergraduate research having the desired impacts?' One study that impressed them was the work of Baxter Magolda *et al.* (1998) on the impact of a ten-week intensive research experience for some 75 students at Miami University, Ohio. Analysis of student reports and statistical analyses of 'epistemological reflection' revealed that these students became "more confident as learners, more capable of thinking independently, more aware of learning as a life long process … These reports suggested that *more complex*

assumptions about knowledge stemmed from participating in a mentored, independent research experience" (p1, emphasis added). In the UK an evaluative study of a cohort of ten students on a pilot undergraduate scheme at the University of Warwick revealed students who appreciated "having access to the research community in their departments … (and) who learnt much by getting closer to the culture of inquiry in their subject and greatly appreciated playing a role in knowledge production" (Blackmore and Cousin, 2003, 24–25). This research provided key evidence for significantly expanding this scheme through the Reinvention Centre for Undergraduate Research at the University of Warwick and Oxford Brookes University.

Particularly in the US, there are now many such research and evaluative studies using a range of research methodologies showing the positive impacts of such enrichment programmes for selected students. Such studies are now so extensive as to make them suitable for meta-analysis and enabling general conclusions to be drawn from rigorously executed research (Pascarella and Terenzini, 2005). The work of the Ethnography & Evaluation Research team at the University of Colorado at Boulder has been particularly significant (Hunter *et al.*, 2010). Drawing on their comparative research on multi-week, faculty-mentored research in Science departments in four liberal arts universities, but also relating that to research on undergraduate research programmes in research-intensive universities, they conclude that:

> *"The literature converges on a broad set of benefits as arising from engagement in authentic research. Notably congruent are: gains in confidence and in establishing collegial working relationships with faculty and peers, increases in students' intellectual and practical understanding of how science research is done; students' greater ability to work and think independently from faculty; and the role of UR both in helping students to assess the fit of research as a career and to clarify career and graduate school plans. Across the studies, these results underscore UR experience as offering a constellation of gains that collectively reflect students' personal, intellectual and professional growth."*

> — Hunter *et al.*, 2010, chapter 2

Their research is also important in developing a robust and publicly available research methodology, the Undergraduate Research Student Self-Assessment, that others can adapt to analyse their institutional interventions (Hunter *et al.*, 2008; www.salgsite.org/).

This approach has been adapted for use in a study of undergraduate research placements in the UK by the University of Reading. The ongoing work by Joanna John and John Creighton surveyed 366 students from 47 universities and interviewed 30 students and supervisors from five universities, including both science, technology, engineering and mathematics (STEM) and non-STEM disciplines. The results will hopefully build the evidence-base for the impact of these schemes in the UK setting.

A significant, and perhaps distinguishing, feature of undergraduate research schemes in the US, is the role of some of these programmes in addressing issues of social justice, in particular the under-representation of certain ethnic and racial groups from higher education, and especially from STEM disciplines. The case study of the University of Michigan Undergraduate Research Opportunity Program (see section 6) is but one example of such programmes. Recent research on the impact of that well-established programme has demonstrated that "UROP students had higher retention rates than their matched non-UROP counterparts … of note are the differential and positive impacts for African American students and African American male students in particular" (Locks and Gregerman, 2008, 23). The Ethnography & Evaluation Research team at Boulder has recently completed an analysis of the impact of a range of such programmes, focusing on their impact on STEM disciplines. They conclude that:

> *"Collectively, the evidence shows the power of undergraduate research as a tool for engaging minority students in authentic science in order to overcome past societal disadvantages and develop individual talent in communities that have not had these opportunities. Whether such efforts can scale up the point that they cumulatively foster a more diverse scientific workforce is a bigger question, whose answer remains to be seen."*

> — Hunter *et al.*, 2010, chapter 8

We should point to the fact that the Boulder teams' main focus on the impact of undergraduate research emphasises the multi-week, intensive and faculty-mentored

dimensions; but they also acknowledge that the wider definitions of undergraduate research as outlined in section 2 of this publication, in particular strong course work-based research experiences helped students learn "to apply critical thinking skills directly to a particular research problem … [and gain] general critical thinking and problem-solving skills" (Hunter *et al.*, 2010, chapter 4).

8.2 Research on mainstreaming undergraduate research and inquiry

There are extensive research studies on the impact of particular forms of inquiry and research-based learning. Here we focus on two studies that relate most strongly to our concern for mainstreaming research and inquiry for all students. One particularly important and generalisable area of research has been the US work leading to the development of the National Survey of Student Engagement (NSSE) and its subsequent use (Kuh, 2008, 2009). This gives strong research-based evidence as to which curricular interventions are likely to produce high levels of student engagement and achievement in their studies. The central conclusions from that research so far are that:

> *"There is growing evidence that – when done well – some programs and activities appear to engage participants at levels that elevates their performance across multiple engagement and desired outcomes measures such as persistence. … They include first-year seminars, common intellectual experiences, learning communities, service learning, undergraduate research, study abroad and other experiences with diversity, internships, and capstone courses and projects."*

> — Kuh, 2008, 14

Recent research on the relationships between student characteristics, engagement and outcomes adds an additional layer of complexity to our understanding, as many of the effects of college are conditional (Pascarella and Terenzini, 2005), in that some students appear to benefit more than others from the same educational programmes or practices (Kuh *et al.*, 2007). Although:

> *"… the effects of participating in high-impact practices are*

> *positive for all types of students … historically underserved students tend to benefit <u>more</u> from engaging in educational purposeful activities than majority students. … Most institutions can increase student engagement and success by more consistently using what the research shows are promising policies and effective educational activities and practices. Almost every college or university offers some form of every high impact practice described here. But at too many institutions, only small numbers of students are involved. The time has come for colleges and universities to make participating in high impact activities a reality for every student."*

— Kuh, 2008, 17, 22

One institution that has made significant moves to mainstream inquiry for many students is McMaster University, which for over 20 years both developed various forms of inquiry learning in elite programmes and professional schools, and more recently initiated a series of discipline-based first-year inquiry courses. The Social Science first-year course is described in case study 1.2.

Analysis of five years of data (Justice *et al.*, 2007a, 2007b), comparing students who took the Social Science Inquiry course with comparable students who did not, shows that it has had a significant impact on how well students perform during their academic careers. Taking the Inquiry course is associated with statistically significant positive differences in obtaining passing grades, achieving Honours, staying on the Dean's honour list, and remaining in university. Recent research suggests these differences may reflect that the students are 18 months to two years ahead with regard to learning skills (Justice *et al.*, 2009) and are both more likely to be aware of the skills they have developed and to use them in other learning contexts (Justice *et al.*, in press). Related research has shown that involving faculty in such 'special inquiry courses' impacts positively on their general approaches to student-focused teaching (Maurer, 2007; Dale *et al.*, 2007).

However, other research on this initiative also shows that developing and sustaining such interdisciplinary programmes is difficult and requires strong leadership at institutional and department levels, and strong support from mainstream faculty. In the

case of McMaster University, the initiative has faced problems. Despite the impressive research evidence on student performance, the interdisciplinary inquiry courses have struggled to remain viable as they rely on central funding and thus go against the grain of the disciplinary department resourcing model. Relatedly it was not so well perceived by many discipline-based staff, who were not as positive to its student-centred interdisciplinary pedagogy and who thought the institutional reward structure favoured high level faculty research (Justice *et al.* in press; Spronken-Smith, 2009 personal communication). More recent research, comparing the institutionalisation of innovative curriculum change at McMaster University and the University of Gloucestershire, suggests that unless there is dedicated central funding for the innovation, curriculum changes that are integrated in departmental practices appear to be more sustainable. At the University of Gloucestershire, attempts to implement the recent University Teaching Learning and Assessment Strategy are largely being successful due to strong leadership as regards personnel and policy, and a culture valuing excellent teaching coupled with a tradition of innovation, embedding changes within departments, strong quality enhancement systems and a wealth of professional development support for academic staff wishing to undertake curriculum change (Spronken-Smith *et al.*, 2009). This research on departmental and institutional embedding reinforces the importance of the strategies we outline in sections 5 and 6, but also helps direct us towards areas for future research.

8.3 Areas for future research

We think the evidence for the effectiveness of well-structured, selective undergraduate research programmes is strong, although there does need to be greater attention to research on disciplines and professional areas other than science, technology, engineering and medical disciplines. Internationally we need further research on the relative impact of various undergraduate research and inquiry-based learning projects and in which contexts they are effective, and, as Kuh (2008, 2009) suggests, for which students the various forms of 'high impact activities' have the greatest positive impacts. Much more work is needed as to the institutional, departmental and disciplinary contexts and cultures in which various forms of inquiry- and research-based learning are effective. Here we think Trowler and Cooper's (2002) work on 'teaching and learning regimes' – to which we would add 'research regimes' – offers a powerful conceptual lens both to establish research understanding and to shape disciplinary,

departmental, institutional and national initiatives. These regimes refer to the local cultures concerning concepts of curricula and pedagogy, and the power relations that shape the particular ways the work of teachers and students is carried out and understood (Fanghanel, 2008). Drawing in particular on the approach of Kuh (2008, 2009), and recognising the high costs, including staff time, of some of the research and inquiry curricula we have described here, we need context-rich, but also generalisable, research understandings of how institutions can best structure such experiences through a degree programme. Involving our students and national and regional organisations in such research can help us find our ways forward.

9.   Conclusion: building connections

"While students value being close to research, and the idea of the University as a research community in which they are included, there are many ways which in practice they feel excluded. … The complete research process is often invisible to students and the partial picture they have … can be … misread and misunderstood by them."

— Zamorski (2000, 1)

"The premise of undergraduate research, by definition, is that undergraduates can and should be part of the conversation of research scholars, and not merely as spectators but as participants with an active role in research themselves. … Research in its turn figures to gain by being liberalized, which is to say that scholars may have to define their research less narrowly in order to teach it to undergraduates."

— Graff (2004)

"The challenges before us in undergraduate science education are very clear: how can we provide active and engaging modes of learning such as research opportunities, with their inherent pedagogical value, to a larger number of students earlier in their undergraduate careers …? And, how can we successfully broaden utilization of these models beyond the current confines of research universities and the more elite four-year colleges ... ?"

— National Science Foundation (2003, ii)

"There would appear to be a range of effective and innovative practice [regarding research graduate attributes] going on at the university, however there is no apparent systematic approach."

— Land and Gordon (2008, 6) quoting one institutional contact

In conclusion, we return to some of our earlier perspectives, affirm key connections between the sections of this paper and suggest ways forward. As we stated in the first section, for us the key to developing undergraduate research and inquiry is to mainstream it and integrate it into the curriculum for all students. To achieve this aim we argue here that it is important to make connections between different levels of action and different forms of research and inquiry.

This paper builds on the work of institutions and academics in different parts of the world in developing a better understanding of links between teaching and discipline-based research and ways of progressing these links further. In particular, it was inspired by a conference in 2006 organised by the Higher Education Academy and the Research Councils' UK Executive Group (Higher Education Academy, 2006).

With a keynote speaker from the US National Science Foundation (Haggett 2006), the conference investigated US conceptions of undergraduate research and how they might support an effective research culture in the UK undergraduate curriculum and the increasing diversity of students entering postgraduate research programmes.

We are convinced that US-derived conceptions of *undergraduate research* offer ways forward for universities worldwide to hold onto the Humboldtian ideal of the university as an institution where teaching and research are interconnected. The strength of *undergraduate research* is that the spotlight moves from the traditional focus on individual academics, being effective as both researchers and teachers, to a focus on students and realising the Humboldtian ideal through the *undergraduate curriculum*. The task then for national systems, institutions and departments is to reinvent and reshape the overall curriculum and other aspects of university structures to support students engaging in research and inquiry. This perspective not only gives due value to all students, it also potentially values all staff – not only research-focused academic staff, but also teaching-focused academics, librarians, technical support staff, educational developers and so on. For a 'research-active undergraduate curriculum' to be realised all these roles have to be equally respected and effectively connected.

This is an important agenda if higher education is to be effectively higher. Here we reaffirm, in particular, Barnett's (2000a) argument that the central role of the university should be to help all students cope with supercomplexity and Baxter Magolda's (2008) view that university curricula should support students moving to

more complex conceptions of knowledge. Such goals are, we argue, both essential and realisable through mainstreaming research and inquiry throughout the curriculum. This aim, however, poses challenges to current and future practice and policies. This paper, through its wide array of case studies, has revealed an international galaxy of interesting and effective practices from the level of the individual course to national policies. However, for undergraduate research and inquiry to be realised for all or many students, these interventions need to be interconnected. Clearly such interventions may well start in particular courses or within a specialist undergraduate programme, but the task then is to scale up and connect these interventions.

We were struck by how, in particular, some of the American readers who provided us with critical support in reading an earlier draft, commented on what they saw as major difficulties in realising in US institutions, such interconnected interventions at course team, departmental, institutional and national levels. Perhaps they were picking out key strengths of the UK system with its strong institutional and national quality enhancement systems; for example, effective national requirements for institutional teaching strategies, many of which now do in part focus on linking teaching and discipline-based research and supporting undergraduate research. Or perhaps these US observers were seeing the UK through rose-tinted glasses. For we could point to how QAA Scotland's project on 'graduate research attributes' has uncovered much innovative good practice in institutions, departments and disciplines, but has also revealed that such practices and policies are often isolated examples and not yet connected in a coherent way in the curriculum to support student understandings of research (Jenkins, 2009; Land and Gordon, 2008). The RAE and its successor, the Research Excellence Framework, for example, sit outside any overt connection to the undergraduate curriculum.

We hope that part of the reason for such lack of connectedness within institutions lies in the fact that our collective understandings of teaching-research linkages and, in particular, undergraduate research, are relatively recent. Changes often start in particular programmes in particular institutions or through particular institutional-level initiatives. It takes time to make these interventions into structured connections within and across institutions. In 2001 when we visited the US we were struck by the quality of the undergraduate research programmes, but we also observed that at the time they seemed to have made limited impact on the mainstream curriculum. Now we, and more critically US scholars, such as George Kuh (2008), see more structured interventions across some institutions. From a UK perspective we look with admiration at how many

aspects of US national, and therefore also institutional, research policies are structured to support undergraduate research. There are lessons there for us in the UK to consider, and the good news is that some of the UK research councils are moving in that direction as we outlined in section 7.

Perhaps the key idea we have promulgated here is the potential connections between 'undergraduate research' and 'inquiry', and indeed the connections between different forms of research. Thus in section 2 we cited Angela Brew's (2001, 21) view that: "There is no one thing, nor a set of things which research *is*." This perspective has informed much of the publication, including our discussions of the nature of undergraduate research and inquiry in section 2 and the way in section 4 we welcome the varieties of discipline-based undergraduate research and inquiry practices and strategies and the different forms of knowledge such inquiries produce.

However, we also recognise that some readers and some institutions will decide to draw key distinctions between 'discovery research', 'undergraduate research' and 'inquiry', and will implement undergraduate research programmes for selected students. Other departments and institutions will see strengths in the wider, more inclusive, perspectives we have argued for. Nationally and internationally we need to develop further the practices and strategies we have described and analysed here and, as we showed in section 7, ensure that such interventions are researched as to their impacts on students' understanding of knowledge complexity and how that helps them in their lives after graduation.

Our students, and indeed the wider society, face what appears to be a difficult and uncertain future. Immediately they face an uncertain employment market; they look towards an indeterminate future in a world faced with uncertainties over climate change, globalisation, international conflicts and major advances in research continually reshaping our understandings of the world we live in. Helping our students understand and cope with uncertainty, ambiguity, complexity and change is not just valuable to their development at university and after graduation, it may also be central to the future of humanity. To support students in this uncertain world we echo the words of David Hodge (2007, 1), President of Miami University, that, "undergraduate research should … be at the center of the undergraduate experience."

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Punkt 7: Levende Campusser

På seneste Institutrådsmøde drøftede rådet Levende Campusser, herunder studenterforeningen på IKL. Alexander Tage Stubberup fortæller om foreningen og status i kølvandet på den stiftende generalforsamling for foreningen mhp. drøftelse af, hvordan vi kan understøtte som institut.

Punkt 8: Evt.

Referat

Punkt 1: Godkendelse af dagsorden

Deltagere: Keld Thorgaard; Alexander Tage Stubberup; Louise Mønster; Inga Ernst Andersen; Annette Rasmussen; Helene Balslev Clausen; Julie Borup Jensen; Steen Ledet Christiansen; Niels Ulrik Sørensen; Morten Ziethen; Lone Stoustrup; Sissel Kondrup Bach (Ref.)

Afbud: Celina Trier Lykke Nielsen; Dorte Larsen; Helle Birch Andersen; Rikke Ørngreen

Dagsordenens punkt 5 og 6 blev byttet rundt, således drøftelsen af samspillet mellem forskning og uddannelse kunne sættes i spil i drøftelsen af indhold og rammer på institutseminaret.

Desuden blev punkt 7; Levende Campusser behandlet som punkt 1, hvorved Alexander Tage Stubberup havde mulighed for at deltage under punktet.

Dagsorden blev godkendt med ovenstående bemærkninger.

Punkt 2: Orientering v. Keld

Som optakt til de øvrige orienteringspunkter indledte Keld med at adressere dialogen om fremtidens humaniora, der kontinuerligt har været taget op på instituttet. Det humaniora, vi ønsker at skabe, skal være retningsgivende for den måde, vi håndterer tingene på, herunder for den større bevægelse det er at se på instituttets aktiviteter og studier. Desuden var følgende punkter til orientering:

- Diversitet og ligestilling
    - Igangsat indsats på AAU, hvor hvert enkelt institut skal lave indsatser på området – arbejdet foregår i SU-regi
- Kandidatreform
    - Der er nedsat et kandidatudvalg, som bliver afgørende ift. at formulere udmøntningen af reformen. Det er vigtigt at have en opmærksomhed på såvel institut- som SSH-niveau ift. at præge arbejdet. Arbejdet pågår fra nu og frem til oktober
- Strategimål for 2024
    - Der er et forløb i gang på fakultetet, hvor man lægger sig fast på særlige punkter, og herefter arbejdes der med det på institutniveau – der vil senere ske en skriftlig høring IR

Institutrådet spurgte ind til AAU's forskningsindikator, herunder Kanalregistret (den norske liste). Keld orienterede om, at der er igangsat en kollektiv indstillingsproces af de publikationskanaler, instituttets forskere udgiver i, men som ikke er på den norske liste. Desuden vil der blive arbejdet med forskningsindikatoren i en række sammenhænge, og der vil blive igangsat en proces i samarbejde med VBN-teamet. Nærmere information vil blive udsendt.

Punkt 3: Økonomipunkt

Keld orienterede om, at instituttet har iværksat og gennemført en række besparelser i 2023, bl.a. med henblik på at håndtere de udfordringer, der er beskrevet i materialet (jf. vedlagte bilag 'Arbejdet med at sikre en økonomi i balance på SSH'). Instituttet ser ud til

nogenlunde at holde budgettet for 2023, og det har vi gjort det de sidste mange år trods ringe grundvilkår.

Instituttet har brug for stærke forskningsmiljøer, og det er hjælpsomt med bredde i aktiviteter. Følgende highlights blev efter gennemgang af Keld lagt ud til rådets drøftelse:

Optagelsestal og udvikling af grundindtægter og økonomi

- Optagelsestallene var som forventede og stemmer overens med budgettal (Faktisk optag; 196, budgetteret optag; 231). BA optaget er vores store udfordring (35 færre end budgetteret) på KA har vi flere optag end budgetteret (74)
- Der er en særlig udfordring ift. små hold og aktiviteter fremadrettet vedrørende Anvendt Filosofi, Dansk, Organisatorisk Læring og Spansk
- Det er nødvendigt med flere drøftelser med dekanatet om danskkravet på LISE. Det ville betyde meget for optaget også på spansk og for kandidatoptaget fremover
- Muligheden for flere ILOOstuderende i Aalborg afsøges igen
- Der er rekrutteringsinitiativer i gang på Dansk og studierevision på Organisatorisk Læring

Udvikling i økonomien

- I perioden 2019 til nu er STÅindtægter gået ca. 1/3 ned pga. dimensioneringer, lukning af uddannelser m.m. Det har været udfordrende at håndtere denne nedgang, men det er lykkedes på nogenlunde fornuftig vis. Forventningen er et yderligere fald i STÅ-indtægter frem mod 2027. Det rammer basisforskningsmidlerne, at vi går ned i STÅ

Hovedpointerne i drøftelsen af highlights og det vedlagte materiale (bilag vedr.; Arbejdet med at sikre en økonomi i balance på SSH) var følgende:

- Det er ikke en ønskværdig udvikling, men det er godt, at vi ikke skal hente et stort underskud her og nu. Ting har hele tiden fluktueret, og det er vigtigt at se på vilkår og tendenser ift. den bedst mulige måde at komme igennem dem uden at skære uhensigtsmæssigt i fag mv. Det er problematisk, at man på instituttet ikke uddanner i tysk og spansk
- Et opmærksomhedspunkt er, hvilken betydning det har for fx forskningsnorm og frikøb fra projekter, hvis man forøger undervisningsnorm for VIP

Punkt 4: Efter- og videreuddannelsesområdet

KT indledte punktet med at orientere om arbejdsgruppen, der hen over foråret har arbejdet på en centralisering af EVU-studieadministration med henblik på en styrket EVU-organisering. Instituttet har mange aktiviteter på området, hvorfor der vil være en del samarbejde med den nye enhed.

Institutrådet gjorde opmærksom på den enorme betydning, den studienære administration og studiesekretærene har for de studerende.

Der bør være en opmærksomhed på at sikre en studienær administration fremadrettet i regi af en ny EVU-enhed; pointen, som også tidligere er blevet fremsat, tages til efterretning.

Punkt 5: Institutseminar

Det er ambitionen, at såvel VIP som TAP på institutseminaret kommer til at arbejde praktisk med arbejdsopgaver, der har relevans for det daglige arbejde og med 'det moderne humaniora' som overligger. Der vil både være fokus på uddannelses- og forskningsdelen og både studie- og forskningsstrengen inddrages mhp. at sikre lokale aftryk på aktiviteter på seminaret. Hovedpointerne fra drøftelsen i forlængelse af den forudgående drøftelse af samspillet mellem forskning og uddannelse var følgende:

- En forskningsgruppe arbejder med at gøre unge til medforskere; en forskningsambition i højere grad end en uddannelsesambition. Det vil være godt at arbejde videre med, hvad det vil sige at være medforsker.
- Kandidatreformen handler om at skille kandidaterne fra forskningsambitionen. Det skaber nogle spændinger ift., hvordan vi taler om samspillet nu. Det er vigtigt at gentænke vores uddannelser, især mht. ambitioner om at få vores studerende med.

Punkt 6: Samspillet mellem uddannelse og forskning

Keld orienterede indledningsvist om, at der ligeledes i studiestrengen er igangsat en diskussion af samspillet mellem forskning og uddannelse, og at diskussionen desuden vil blive integreret i programmet på institutdagen. Drøftelsens sigte er en diskussion af, hvordan vi på instituttet kan nuancere forståelsen af forskningsbaseret undervisning og involvering af studerende i forskning og publicering. Desuden ønskes etableret en inspirationsbank over gode eksempler på, hvordan dette praktiseres på instituttet. Institutrådet havde følgende input:

- Af sparekataloget fremgår det som et forslag, at man kan have projektfrie semestre. Men netop projektarbejdet er et eksempel på en af de aktiviteter, hvor den studerende kommer nærmest det at være forsker. Bl.a. derfor er det ikke en rigtig vej at gå med projektfrie semestre
- En VIP har i samarbejde med studerende udgivet en BFIgivende antologi
- Ekstracurriculære aktiviteter, fx æstetisk læsekreds
- Der har været stor opbakning fra studerende til 'Digitalisering for humanister'/v. Anders Kalsgaard
- Det giver noget at blive inddraget som kandidatstuderende – at opleve diskussioner i forskningsgrupper mv. Forskningsgrupper kunne nogle gange invitere de studerende ind. Nogle gør det allerede og inviterer desuden studerende til at holde oplæg
- Det kunne være en mulighed for nogle studerende at praksisophold på 9. semester foregår i forskningsgruppe, herunder publicering af det, de skriver på. Nogle grupper har erfaring med dette og oplevede det som en god ressource, fx ifm. dataindsamling
- At give kandidatstuderende mulighed for at deltage i kredse for ph.d.studerende kunne give praktisk drive og inspiration til finansiering af ph.d.-forløb

Punkt 7: Levende Campusser

Alexander Tage Stubberup indledte punktet med at berette, at instituttets studenterforening siden sidst er blevet CVR-registreret med navnet HumUs. Planen er indledningsvist at være til stede på campus i forbindelse med de nye studerendes opstart, herunder at sætte nogle arrangementer i søen med fokus på bl.a. talentudvikling og a-kasse/fagforening.

Punktet genoptages på næste institutrådsmøde, da forbindelsen til Teams ikke er optimal.

Punkt 8: Evt.

Intet yderligere

Overblik: Noter

Overblik: Delte kommentarer