5
Connecting across disciplines and out to the world

1 Introduction

The third dimension of the Connected Curriculum framework, 'Students make connections across subjects and out to the world', highlights the importance of students having opportunities to make conceptual connections between their own subject(s) and other disciplines. They may be able to study with students and faculty members from outside their main subject field and have opportunities to look outwards to the world; that is, they become aware of some of our complex global challenges. In doing this, they can be empowered to consider their own values and future contribution to the world. They can also engage with international perspectives, developing their awareness of knowledge traditions from cultures that differ from their own.

As highlighted in Chapter 2, the disciplinary cultures and structures of our higher education institutions continue to have a strong impact on the ways in which students study and on what they study. In recent years, however, there has been increased interest in interdisciplinary ways of working. Literature suggests that while specialist expertise remains vital, there is a growing need to prepare students for crosscutting forms of enquiry in a world where challenges are so complex and yet so profoundly interconnected (British Academy 2016; Lyall et al. 2016). Where different areas of knowledge have become sharply differentiated within universities, forming themselves into distinctive disciplines with firm boundaries, opportunities may be lost to develop new theoretical framings, new ways of gathering and analysing evidence and new possibilities for society.

How might institutions and departments tackle the challenge of making the most of interdisciplinary possibilities, while sustaining

excellence within disciplinary specialisms? We look here at some practical ways of developing interdisciplinary and cross-disciplinary learning opportunities for students, starting with making modest adjustments to existing programmes and then looking at some more radical approaches. We go on to explore some of the theory behind interdisciplinary approaches, and conclude with some vignettes of practice reflecting this dimension of the Connected Curriculum framework.

2 Enriching current programmes through connecting with other disciplines

Students choosing to study in higher education often, but not always, select a single or at least a main (major) discipline for specialist study before they begin their degree. There are significant variations in the way this plays out across the sector internationally, however. In some national and/or institutional contexts, students typically experience a broad selection of topics for study on arrival at university and only specialise in later years of study. On distance learning programmes, too, there may be wide flexibility in choosing topics to make up a degree award. But on more traditional degree programmes, and in the UK in particular, students typically select a main or even single subject of study – for example English, Mathematics or Physics – before they step across the campus threshold, and their focus may be very much on that subject throughout their studies.

Of course some 'disciplines' are intrinsically multi-disciplinary and perhaps more accurately described as fields. Subjects such as Archaeology and Geography are made up of a number of elements, crossing from the physical sciences through the social sciences to the humanities. And those that are professionally accredited, leading towards a specific professional qualification, have their own characteristics. These subjects – for example, Medicine, Architecture and Education – draw from a range of 'pure' and applied disciplines but are very carefully and holistically designed to ensure that graduates are thoroughly prepared for the given profession. Postgraduate degrees also vary considerably: some are very specifically focused on one specialism, while others pull together a number of subjects and offer significant flexibility.

These variations in context mean that the third dimension of the Connected Curriculum offers a different kind of challenge to each of

these different contexts. For programmes of study that already comprise different disciplinary perspectives, the challenge is one of considering whether these can be enhanced. Do the kinds of connective curriculum features described in Chapter 4 afford new possibilities? Could aspects of the connected 'throughline' of enquiry, such as academic tutorials, a capstone module or a Showcase Portfolio provide new ways of stretching students, challenging them to analyse links and contrasts between different disciplinary perspectives and methods?

Some students are in effect 'visiting' other disciplines, for example by taking on an optional module or project from another. Others may be studying two disciplines in parallel, as is commonplace in 'combined honours' programmes in the UK. One or more of these connective design features may be employed to empower students to make stronger intellectual connections between fields, and to be rewarded for doing so.

For programmes comprising a single discipline, discussion may more usefully focus on whether and where there could be opportunities for students to take a wider view. Can curriculum features described in the last chapter, such as Connections modules, afford new possibilities for students to step beyond their main area of study as they undertake research and enquiry? Even tightly knit disciplines can offer opportunities for students to range beyond the home subject, so that they can come back to it with fresh eyes.

3 Developing new interdisciplinary programmes

A more radical way of enabling students to connect across disciplines is to offer fully integrated, interdisciplinary programmes. These are more common for Masters degrees but also possible at undergraduate level. We look here at two programmes at UCL whose development was underway before the Connected Curriculum initiative was introduced but which illustrate many of its characteristics: the Bachelor of Arts and Sciences (BASc) degree and the Integrated Engineering Programme (IEP).

Bachelors of Arts and Sciences

The first innovative example of an interdisciplinary programme of study is that of the Bachelor of Arts and Sciences (BASc) degree at UCL (UCL

2016k). The director of this degree, Carl Gombrich, has outlined the thinking behind its introduction (British Academy 2016, 71–78). He defines an interdisciplinary degree as one in which:

- students study in more than one academic department;
- students study some courses that are explicitly inter-/cross-/post-disciplinary;
- students are asked explicitly (by means of a dissertation or other work) to synthesize or contrast the knowledge acquired in more than one discipline.

Gombrich notes that, although a number of students in the UK and beyond do study more than one subject as part of their degree, it is less common for them to be asked explicitly to make connections between its different elements. The BASc takes a distinctive stand in doing this, by requiring students both to study across the sciences and the arts, humanities and social sciences *and* to undertake 'some synthesizing of disciplinary perspectives' (Gombrich, in British Academy 2016, 73).

Students on the programme follow one of four disciplinary Pathways:

- Cultures (Humanities and Arts)
- Societies (Social Sciences, Law)
- Health and Environment (Health and Environmental Sciences)
- Sciences and Engineering (Hard Sciences, Maths and Computer Sciences)

Reflecting the idea of a connective core or throughline of enquiry, the BASc requires students to engage with a number of core courses (Table 5.1), alongside a range of options. The core courses include modules in which students explicitly engage with areas of thought and study in ways that cut across typical university subject boundaries.

Topics such as Approaches to Knowledge, Qualitative Thinking and Object-based Learning (Chatterjee and Hannan 2015) shine very specific lights on the contrasts between different ways of undertaking enquiry. They also afford opportunities for making and critiquing connections across disciplines and of linking those connections with 'real world' challenges.

The BASc programme is extremely popular, with high numbers of students applying to it, very good student evaluations and very strong graduate employment. Its connective features may stimulate thinking for leaders of other kinds of programmes.

Table 5.1 Bachelor of Arts and Sciences (BASc) Core Modules (2016/2017)

Phases of study	Core Modules
Year One	• Approaches to Knowledge: Introduction to Interdisciplinarity • Interdisciplinary Research Methods • Quantitative Methods and Mathematical Thinking • Language • End-of-year Lab Conference
Year Two	• Object lessons: Communicating Knowledge through Collections • Quantitative Methods 2: Data Science and Visualisation • Making Value Judgements: Qualitative Thinking • Interdisciplinary Elective • Language
Summer at end of Year Two	• Internship
Year Three (Y001 Only)	• Year Abroad at an approved university • Study Abroad Dissertation
Final Year	• The Knowledge Economy • Dissertation • Language

An interdisciplinary professional programme: the Integrated Engineering Programme

The second example of an interdisciplinary undergraduate degree is the Integrated Engineering Programme (IEP) at UCL. This programme aims to combine innovative teaching methods and an industry-oriented curriculum with discipline-specific, accredited degree programmes. Participating throughout the degree in interdisciplinary activities, students develop their transferable professional skills in the context of real-world engineering projects (UCL 2016m).

Bains et al. (2015) explain that the IEP draws on the Connected Curriculum philosophy by tapping into the institution's research-base:

> It is founded on the premise that although a strong disciplinary engineering foundation is vital, modern engineering problems do not respect these disciplinary boundaries. This means that students have to learn to work in multi-disciplinary teams on interdisciplinary problems.

Although engineering specialisms are maintained, a series of crosscutting activities enables students to collaborate to solve complex problems and challenges (Figure 5.1).

The programme's core modules enable students to develop engineering modelling, design and analysis skills, in addition to professional and transferable skills. Key to its design is enabling students to appreciate the interdisciplinary nature of Engineering as a field; students start to work in interdisciplinary teams in their very first term and continue to work on challenges and scenarios through the programme. They are also able to undertake a major interdisciplinary capstone project. As students progress through the programme, they have opportunities to see and engage with relevant research activities in the department and beyond.

These two programmes illustrate ways of bringing disciplines together through designing a whole new programme and using interdisciplinary connections as an underpinning characteristic. Specialist, single-disciplinary programmes of study are likely to want to make much more modest enhancements to their programme when reflecting on the benefits to students of stepping outside their home subject at some point during their studies. However, this dimension of the Connected Curriculum aims to prompt all programme teams to take a fresh look at the opportunities currently provided and consider whether they can be strengthened meaningfully within the local context.

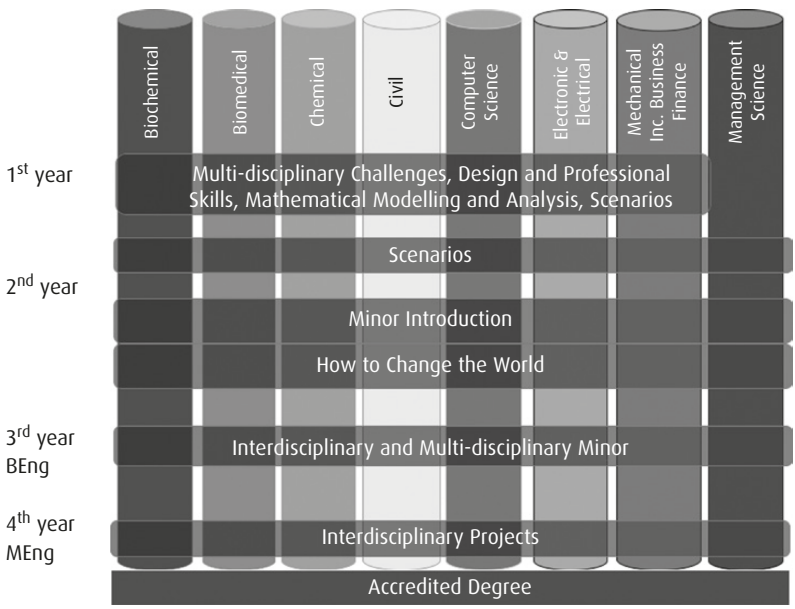

Fig. 5.1 Structure of the UCL Integrated Engineering Programme

4 Why is connecting across disciplines important?

University disciplines and their cultures

The history of academic disciplines is a long and curious one. The writer and physicist C. P. Snow wrote with regret, in the aftermath of World War Two, of the emergence in the twentieth century of 'two cultures': 'literary intellectuals' and 'scientists' (Snow 1959). Snow, for whom this polarisation is 'a sheer loss to us all' (1959, 12), railed against the inability of literary intellectuals (those in the arts, humanities and social sciences) to engage in any serious way with science. They in turn critiqued scientists for not educating themselves in literary culture:

> There seems to be no place where the [disciplinary] cultures meet. I am not going to waste time saying that this is a pity. It is much worse than that.

Snow argued that 'creative chances' should result from the 'clashing point' of disciplines as they meet (1959, 17). He criticised what he saw as the particularly English 'fanatical belief in educational specialisation, which is much more deeply ingrained in us than in any country in the world, west or east'. His solution was curriculum change:

> There is only one way out of all this: it is, of course, by rethinking our education.

The anthropologist Clifford Geertz (1982, 32) later observed the particularities of disciplinary cultures and the diverse ways in which we think in those disciplines. Like Snow, he argued that the modern world needs more interplay between disciplinary ways of thinking and being. Advocating better dialogue between people in different roles in higher education, he recognised that if there is to be genuine interplay between diverse disciplinary and professional positions, we must accept how deeply the differences in perspectives run and come to understand them better. We need also to 'construct some sort of vocabulary in which [these differences] can be publicly formulated', so that specialists in different areas can 'give a credible account of themselves to one another'.

New technologies have contributed to the building of more fluid academic networks; they have the capacity to spread emergent ideas and findings rapidly. The digitally connected, internationalised contexts in which disciplines act and develop are therefore even more fluid and

permeable than they were at the start of this century. Reviewing curriculum in this context is timely: do our degree programmes reflect the shapes of emergent academic networks, ideas and findings?

Developments in interdisciplinary research

Addressing the possibilities afforded by connecting across disciplines in a research-based curriculum is particularly relevant at a time when research itself is moving in new interdisciplinary directions. A recent report by the British Academy (2016) highlights numerous contexts in which interdisciplinary research (IDR) is now taking place in the UK and beyond. It outlines challenges faced by researchers whose work cuts across established disciplines but also the benefits to knowledge production. The British Academy uses a broad working definition of IDR, which includes:

- Individual researchers' learning methods from other areas and applying them to issues that arise in their own discipline.
- Exploratory collaborations between disciplines to find areas of common interest – or to identify new approaches to issues within each respective discipline.
- Challenge- or question-focused research that requires the input of a range of disciplines working together – such as research in public health or sustainability.
- Emerging disciplines that bring together approaches from separate areas, for example biomedical engineering and digital humanities.
- Individuals or groups of researchers working in areas seen as inherently interdisciplinary because of the range of questions addressed or the range of approaches taken – such as Classics or Geography. (British Academy 2016, 8)

The British Academy study finds that the most frequently cited reasons given for interdisciplinary research is 'its essential role in addressing complex problems and research questions posed by global social challenges, as well as the increased rigour it can bring to one's understanding of one's own discipline' (2016, 9). It challenges here the assumption that to range across disciplines necessarily weakens the rigour in the 'home' discipline. A defence of traditional disciplines can always be made; see for example arguments put forward by Jacobs (2013), who defends the inherent richness and openness of established disciplines such as economics and

biology. However, the focus of this dimension is not on dismantling distinctive disciplines but on building appropriate bridges between them in ways that strengthen them in a modern, digital world that increasingly connects across traditional knowledge boundaries.

5 Making a difference in the world

Revisiting our earlier emphasis on the potential of education to make an impact on 'the global common good', we consider the potential of engaging students in interdisciplinary and cross-disciplinary tasks that engage with and make a difference to the world. Situating subject-based learning in the wider context of both the students' overall development and contemporary global issues is not an aim readily accepted by all in academia. When Clifford (2009, 142) undertook research into the different attitudes among academics with respect to interdisciplinarity, for example, she found that some found it difficult to 'move away from a focus on "the science" to a focus on the holistic, personal and academic development of students'. She argues, however, that:

> Students need to grasp the concepts of theoretical science, but they will also be faced with using their science in the world, and they will need some understanding of global issues and [to] have ways of making ethical judgements about their work. Students will also need to be able to work within a multicultural environment wherever they are geographically located.

Connecting across disciplines does not speak only to intellectual connections and discoveries, then, but to global and ethical awareness. Recent work on school curriculum by Boix Mansilla and Chua (2016) at the Harvard Graduate School of Education is relevant here. Their focus on 'signature pedagogies' (see Shulman 2005) in global competence education highlights the value of preparing students, in terms of both skills and attitudes, for a complex and changing global landscape.

Boix Mansilla and Chua (2016, 3) define global competence as 'the capacity and disposition to understand and act on issues of global significance'. They characterise three key areas of focus:

- Firstly, global competence is cast as a capacity to understand – to use disciplinary concepts, theories, ideas, methods or findings in novel situations, to solve problems, produce explanations, create products or interpret phenomena in novel ways.

- Secondly, if 'understanding' speaks of depth and flexibility in subject matter expertise, 'global competence' as a disposition speaks of depth in terms of student ownership and transformation.
- Finally, as global competence focuses on issues of global significance and action to improve conditions, learning must be visibly relevant to students and the world. When significance is considered, global competence curricula becomes a call for authenticity, for carefully looking to the contemporary world for topics that matter most to examine.

These themes echo the orientation and values of the Connected Curriculum approach: building new knowledge and analyses, promoting student ownership and transformation, and making a difference to the world in ways that are relevant to diverse students. If there was ever a time when these are relevant it is now: the political upheavals in the United States and in Europe in 2016 have contributed to an extraordinary period of global change and challenge. Students are entitled to engage with global issues as they study and to develop knowledge and critical insights that can underpin their agency in the world.

This work by Boix Mansilla and Chua prompts us to consider again how we are currently engaging students with global themes and challenges in our curricula. Can curriculum design features such as 'Connections' modules, academic tutorials or a capstone module (Chapter 4) or outwards-facing assessments and/or a Showcase Portfolio (Chapter 7) be catalysts for enhanced student learning in this area? For example, one Connections module might address the idea of global issues directly, challenging students to work in groups on a given theme, while at the same time prompting students to make connections between the themes and topics they have learned elsewhere on the programme. The curated Showcase Portfolio approach could allow students to undertake an independent study on a global issue that is a topic of interest to them personally and include that in the Portfolio, together with a brief analytic commentary on what has been learned and on how the study has shed light on their wider learning.

There is no one 'right' approach for departments and programme teams. The aim here is to consider a range of possibilities for students to make connections across disciplines and link these ideas to global themes that might be enriched and extended.

6 Conclusions

Making connections across disciplines is not a territory whose pathways every academic and every student will walk easily. Von Humboldt argued that:

> there are naturally many who are active (in the university) to whom tendency towards depth and breadth is alien and there will be some to whom it is repugnant. … It need, however, find expression only occasionally, here and there, to have a widespread and enduring impact. (Cited in Morgan 2011, 332)

It remains vital for specialisms to sustain themselves as rich intellectual spaces. However, the wider world beckons for students just as it does for research with its multiple strands of enquiry. Providing gateways in the curriculum from one discipline to another for students has the potential to strengthen and deepen their critical and creative faculties as practised in the home discipline. Where it is possible to open up shared spaces for making enquiries about the world that draw on the content and practices of more than one discipline, students can develop the breadth and adaptability needed for a rapidly changing social, economic and international landscape. They can also see their home discipline(s) through more educated eyes.

Connecting the curriculum along this dimension forges both intellectual links across disciplines and opportunities for students to relate their learning and enquiry to the world around them. In the following chapter we look in more detail at how students can make explicit links between academic and workplace learning.

7 Vignettes of practice

The vignettes of practice here highlight some of the ways in which programmes of study are engaging students in cross-disciplinary and interdisciplinary investigations. The first shows how chemists and physicists at UCL combine their knowledge to tackle a complex scenario. The second describes a cross-disciplinary undergraduate group research project at the London School of Economics and Political Science, and the third introduces a scheme whereby students work in multi-disciplinary teams in the UCL Faculty of Engineering to develop practical solutions to societal and environmental challenges.

1. Cross-disciplinary scenarios in an undergraduate Chemistry degree at UCL

Our research focuses on searching for new types of physical (magnetic) behaviour, often in materials that appear deceptively simple. Looking for the extraordinary and properties that we don't know enough about to even predict, calls on us to be able to recognise inconsistencies and identify what makes an observation remarkable. The research is not one of classification but of taxonomy based on deductive logic and the isolation of behaviours. The skills for this research are far more sophisticated than the skills of a standard undergraduate course – it cannot succeed without strong abilities to precisely translate ideas from simpler situations, to critique and logically to analyse situations, and to recognise when new classifications are needed. Experiments need to be invented and data scrutinised in the effort to reveal these extraordinary characteristics.

Undergraduates are challenged when asked to apply these skills within such an open-ended scenario. In part, this follows from our current degree programmes not allowing both physics and materials chemistry to develop as specialisations. Those that have done more physics typically have a weaker knowledge of chemistry concepts, such as atomic bonding, and less experience in synthesising materials. Those that have studied more materials chemistry will know less of the exotic quantum mechanical rules that underlie magnetic properties, and so are less familiar with the foundation concepts of the theoretical models. Having such clear deficits in their knowledge forces students to return to their foundation material and redevelop it quickly into this research context: ideas are liberated from the confinement of lecture courses. This is because the ideas cannot simply be translated, they have to be adapted and extended in response to a continuing programme of research. They are given depth and reality. In the experimental sciences this creative redefinition of knowledge is called for time and time again by the need to understand the results of experiments, to create logical deductions, to define the next research question and construct a suitable study. Eventually what was once learned becomes unlearned, recreated and assimilated into an understanding of the research field.

By the end of the final year research project the undergraduates have not only gained experience at a frontier of research, they have become scientists that are able to critically reconstruct the earlier lessons of their degree. They question. They no longer see the material

of the course as static. It has become a fluid understanding that is allowed to evolve and grow.

Submitted by Dr Andrew Wills, Reader in the UCL Department of Chemistry, and a UCL Connected Curriculum Fellow.

2. Cross-disciplinary research groups in the social sciences at London School of Economics and Political Science (LSE), UK

LSE GROUPS is an intensive, undergraduate group research project, run by LSE Teaching and Learning Centre. It takes place in the last two weeks of the summer term each academic year. Students from across the School are placed in cross-year, cross-disciplinary groups and undertake an original research project under a broad overarching theme. Recent themes have included 'Social Change in London' and 'Poverty and Inequality in London'.

In the course of two weeks, students come up with a research question, review the relevant literature, choose an appropriate methodology, collect and analyse data, write up a research paper and present it at an academic conference on the final day. Each group is supported by a research supervisor, usually PhD students well advanced in their doctorates, and through resource sessions on different aspects of the research process.

LSE GROUPS is underpinned by an enquiry-based learning philosophy; the students learn about research and knowledge creation by undertaking research themselves. Meanwhile the supervisors are also melded in a community of practice through daily meetings and reflective discussions. For students and research supervisors alike, LSE GROUPS is a transformative educational experience. As one student commented: 'Our ideas became the focus of our investigation in LSE GROUPS, whereas they are only secondary in undergraduate courses. The supervisors guide you but you do the thinking for yourself, rather than being told what to think.'

Vignette of practice submitted by Dr Claire Gordon, Head of LSE Teaching and Learning Centre and Director of LSE GROUPS.

3. 'How to Change the World' in Engineering

UCL's 'How to Change the World' programme is a credit bearing, intensive, two-week programme involving over 700 students from

(*Continued*)

across the Engineering Faculty. Students work in multi-disciplinary teams of five to six developing practical solutions to societal and environmental challenges set by external organisations such as Arup, the Department for Transport and the International Committee of the Red Cross. The challenges resonate across sectors and are international in nature: for example, energy generation in rural African locations; reducing urban congestion; and increasing access to safe drinking water and sanitation.

The programme:

- enables students to see how their own discipline interacts with other disciplines;
- assists students in articulating their strengths;
- reflects business practice in the workplace – the challenges are intentionally loosely defined so that the students refine the brief in consultation with their challenge partner;
- takes groups of students through each stage of the design process from researching and clarifying the client's needs to meeting industry experts to working up a prototype and a design solution;
- provides all students with a client-facing consultancy style project, which they can market to employers;
- focuses on delivering tangible outputs – the students pitch their proposals to the challenge partners and academics at the end of the programme;
- encourages self-reflection: students produce an individual, self-reflective video relating to their experience;
- facilitates the development of the skills employers identify as lacking (e.g. commercial awareness, communication and team-working skills);
- provides opportunities to meet alumni and employers and explore career opportunities;
- reflects the techniques used by employers to assess candidates such as group exercises, presentations and self-reflection on performance.

Student teams are self-managed, with an innovative probation system managed by the students themselves to resolve any team-based issues. The programme leads up to 'Dragons' Den' style presentations with the proposed solutions being judged by industry partners and academics; and a Careers Expo involving employers from across the engineering sector.

The programme has been operating since 2014, with annual refinements based upon student and other partner feedback. Forty challenge partner organisations were involved in the 2016 programme together with UCL research staff and entrepreneurial and legal support (for teams wishing to develop their ideas further). The scale of the programme is such that it provides an opportunity for all second-year students in the Engineering Faculty.

Submitted by Mark De Freitas. In his role as Careers Consultant at UCL, Mark reviewed and promoted this programme, which was developed by Dr Kate Roach and UCL's Department of Science Technology, Engineering and Public Policy.