Chapter 8

Setting the interdisciplinary scene

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Interdisciplinarity, working *across* specialities, is something that has been shaping higher education increasingly since the 1990s. It is a mode of working that cuts across the usual habits of a single discipline, focusing on solving a particular problem or situation by drawing on a range of expertise. There are times when grand claims are made for interdisciplinary work, and times when it is seen as a buzzword that needs to be put somewhere because it sounds good in grant applications.

Interdisciplinary research is difficult partly because it goes against the grain of specialization, and going into details deeply is inevitable when one is doing research. Interdisciplinary *education* is even harder because there is often less consensus about what understanding we are trying to impart: subject specialists are themselves often not sure how to agree on these and have to collaborate to find their way to an appropriate understanding in each new collaboration. In this overview, Davies argues that one consequence of this is to emphasize the open-endedness of collaborative research, and that students can be a part of it – indeed they make a vital contribution to judgements about what kinds of knowledge and collaborations are of value.

Since appearing in the 1940s and accelerating from then (Lynch, 2006), 'interdisciplinarity' has become a buzzword in higher education internationally. Its supporters have stressed that great things are made possible when disciplines work together, things that are not possible through traditional research: by pooling different areas of expertise, we can tackle issues that are urgent and large-scale in the world outside the university. It has also created some complicated challenges when it comes to teaching. This chapter offers a brief overview of what it means to be interdisciplinary (or not) and sets the scene for some distinct types of interdisciplinary

learning and teaching. If it is guilty of oversimplification, it is because of its brevity, but there is more detail and nuance in the references.

What is interdisciplinarity?

In order to think about what interdisciplinarity is, we need to think briefly about what single academic disciplines are.

Subject matter?

Many academic disciplines are named after their subject matter: we are all familiar with 'Physics', 'History', 'Law', and so on. These examples generally appear to most as stable, relatively unchanging subjects, but they are not as fixed as they might appear. Even with its empirical, provable, repeatable findings, Physics has not stood still by any means: even if a time machine was invented to consult the founder of the modern era, Einstein would have a formidable amount of catching up and readjustment to do. That is despite the fact that the actual physics of the universe has not changed: it is our understanding that has moved on. To be more specific, our *methods*, *questions* and *priorities* have altered as understanding, technology and priorities have changed: Physics as a subject was witness to this as the vast majority of departments added 'astronomy' to their names over the twentieth century.

Methods

In other words, we must also note that academic disciplines have distinct methods and approaches *to* their subject material, and different ways of identifying suitable material in the first place. Anthropology, sociology and history all study 'people', for instance, but in very different ways and with different intentions.

Evidence

As a result of these different approaches, what counts as *evidence* changes profoundly from one discipline to another: science, especially medical science, is dismissive of 'anecdotal' evidence (by which they mean evidence that cannot be tested, was not gathered in controlled conditions and might therefore be a red herring, and so on). In contrast, and for example, those studying cultures without writing systems frequently have nothing *but* isolated comments, i.e. *just* 'anecdotal evidence'. They have found other ways of dealing with all the hazards that come with isolated and 'unprovable' pieces of information (for example, see Jenkins, 1995). Anthropological fieldwork, for instance, after over a century of direct experience of unfamiliar cultures, generally warns

its practitioners to be deeply cautious of asking people direct questions and accepting their replies at face value. They are sensitive, for instance, to the fact that people tend to be influenced by what they think their audience wants to hear and that statements are rarely to be taken literally and superficially. Perhaps the statements 'really' mean, 'I wish this tiring person would stop asking strange questions'; or they might give jokey or boastful answers that make the findings 'unreliable' (certainly not literal): it is very hard to tell what to believe – see, for instance, Peoples and Bailey (2011: 123) for an example of the authors *thinking* they were being teased.

Anthropologists therefore tend not to carry notebooks around visibly, instead making their fieldnotes at suitable moments in private, and preferring to observe and ask a very limited number of direct questions: they want to see things as 'naturally' as possible. They might not even fully reveal what they are trying to find out, and go 'undercover', which makes patient and quiet observation far more important than a series of questions. One American anthropologist joined her own university as a first-year undergraduate to find out more about her students' world, and spent a year immersed there, for the most part just watching and listening: that way she could notice things that she would never have thought of asking about (Nathan, 2006).

In stark contrast to this, some areas of the social sciences rely almost completely on semi-structured interviews, which may well be recorded and transcribed, arranged in advance and conducted in a semi-formal setting. This provides comparable material that can be aggregated (e.g. '57 per cent of respondents preferred tutorials to lectures') as well as more qualitative findings and considerations. The concerns of anthropological ethnography are less prevalent in this kind of situation (because the interviewers have a common culture and understanding, to a very large extent) and different kinds of judgements are being made. As a rule of thumb, sciences (including many of the social sciences) tend to favour generalizable findings, while the humanities are more interested in the distinct and the particular. Though this is a gross simplification, it illustrates the kind of broad differences and the implications for gathering evidence and choice of methods across academia.

Good questions

An awareness of the limits of evidence and methods means that there is a knack, which has to be acquired, of identifying what a good *question* is: is it meaningful, and answerable, to the satisfaction of other experts in that field? 'Answerable' can depend on all kinds of external factors.

For instance, Thomas Bayes formulated a theorem, which now underpins Bayesian probability, in the mid-eighteenth century. It was not until the mid-twentieth century that computers could actually begin exploring its implications: the calculations were simply too complex to be practical before then.

Being able to identify a meaningful ('good') question in an academic environment is perhaps the most critical skill one can acquire, and it is a skill that requires a thorough acquaintance with the discipline. A question that cuts to the heart of one discipline's priorities may pass another by completely. For example, Dame Mary Douglas spent much of her career as an anthropologist exploring how particular social structures shape knowledge and influence what is considered important. I do not mean to imply she was alone in this, but her *Missing Persons* (Douglas and Ney, 1998) is a good example of the antipathy many of her discipline have for individualized approaches such as psychology and economics, with a running critique that borders on scathing arising from the assumption that people and ideas exist in a vacuum. I once happened to be at the same seminar as her, presented by a historian, about the ideas of a particular group in the first millennium CE (Common Era). She asked if he knew whether they lived alone or in groups and received the slightly wrong-footed reply, 'I have no idea'. The question was polite, and was asked in full awareness that had the speaker spent years learning anthropology, he would not have mastered the range of ancient languages that enabled him to read the texts in the first place; besides that, she would also have been aware that most of the texts were simply found in the desert with very little accompanying evidence of how their authors had lived. But she had to ask, to try to bring her disciplinary understanding to bear. Each of them had focused on different aspects to the extent that some things were almost never considered (for various reasons), while others had become central: but anthropology and textual history had not explored the same paths, and so different questions were of interest.

Disciplinary practices and culture

Writing

There is more to this 'disciplining' than simply identifying relevant evidence and interrogating it in a relevant way, though. Each has its own ways of *writing* that must be learnt: reports must have a particular style if they are to be understood; essays need to be structured in a particular way; a portfolio is another kind of writing that is harder than it looks, as is a legal brief (on which see Wilcox, 2007; or for biomedical research, Budgell, 2009).

Even the decision to write with or without footnotes fundamentally changes the way one communicates; these are all things that must be learnt by application, practice and review. Habitually writing in a particular way has a surprisingly profound effect on how one thinks and behaves. For instance, the question of whether one should write in the active or passive voice runs deep and in alignment with deeper currents: the passive *is* traditionally used heavily in science and emphasizes that the evidence is what legitimizes the argument; attention is drawn to the process and the findings rather than the scientist to emphasize that facts are established irrespective of the person by whom an experiment is undertaken. By contrast, in the humanities and social sciences we use the active to stress that we are taking responsibility for making a judgement; to use the passive is to shirk this duty.

Presentation and communication

Presentation of information in general is equally diverse across the disciplines: an hour-long talk is very different from a three-minute presentation, textbooks are written in very different styles, and so on. Do we present our findings at the outset confidently, or even *over*-confidently?[2] Or do we suggest them cautiously within a culture of modest understatement? These will be understood by those who know as simply being normal ways of saying 'I'm sure that …'.

Practices that would be embarrassing failures in one field are the norm in another, and for good reasons. It also takes practice to judge how much one can expect an audience to know and how much needs to be explained to get the point across. This can be true even within the same discipline, but becomes exponentially more complicated the more disciplines that are involved.

Risk, resources and environment

Everyday matters, like the use of equipment or resources, also have a subtle but far-reaching effect on creating a particular 'disciplinary way of being': is it, for instance, a risk-averse culture that inculcates habits of careful planning and preparation? This can be considered both in literal terms of the physical environment and in the kind of resources available. Ancient history, for instance, is ever-aware of both the remoteness of the cultures being studied and the sheer weight of *lost* evidence, which leads to a general distrust of speculation and a level of detail in footnotes that other disciplines simply do not feel the need to bother with.[3]

Another 'secondary' aspect that might be relevant is *scale* and impact: chemical engineering (which works in multiples of tonnes) is less forgiving of minor spillages or trivial inaccuracies than chemistry (which tends to

work in grams or smaller units) because at that scale, expense, waste and risks are all similarly magnified.

Each field will have their own versions of what factors matter and it will affect the culture in many ways: for instance, when visiting a colleague in a science laboratory, I was challenged nervously but determinedly in the lift by a member of the research staff to explain who I was and what I was doing there. He explained afterwards that the building contained a large number of extremely dangerous materials. A stranger would not normally be challenged in this way once they had got past security and/or reception, which is standard in many universities now. As well as the 'textbook learning', it is all these behaviours, priorities, things to watch out for, and so on that create a disciplinary culture. To be successful in any academic specialism, one must internalize these values and habits. University education is not just about acquiring (ever more) knowledge. As Oliver and Gourlay outline in Chapter 2, it is about a transformation of one's thinking, so that graduates are able to look at a situation and understand what is possible or desirable in a distinctive way: an architect does not see the same muddy field as an archaeologist; an engineer does not look at a town in the same way as an urban designer; a historian does not look at a group of people in the same way as a geographer. If such differences in perspectives did not result, studying a particular subject would be a waste of time.

Academic tribes

The overall effect, then, is that academics think and operate in distinctive, and very different, ways. 'Knowing how to know' arises from the combination of understanding methods and evidence-handling: not just the answers to questions and knowing what a good question is in the first place, but also judgements about how to respond to unexpected events or discoveries. Is an unexpected crystal formation, produced accidentally in a chemistry lab by an undergraduate, the result of misreading the instructions for the experiment, or a discovery?

A quick glimpse of distinct academic *modi operandi* can be had by considering a joke: a physicist, a biologist and a mathematician are having a coffee opposite a house. Two people go into the house and, a little later, three come out. The physicist says, 'our initial measurement wasn't accurate'; the biologist says, 'they have reproduced' and the mathematician says, 'if exactly one more person goes in, the house will be empty again'.

Sustaining discipline

This disciplinary culture is reinforced and reiterated in a whole range of ways. Depending on the extent to which there are well-trodden paths, staff who 'dabble' in a range of fields may struggle to find employment when interviewed alongside those who have kept their interests strictly focused within the discipline. Some commentators see 'amateurism' and research 'of dubious quality' as characteristic of interdisciplinary work (Jacobs and Frickel, 2009: 51–2; or 'dilettantism' in Frodeman, 2014). They will also find that any research or publications that belong to another field will not generally count in their research quotas: people can be sensitive to the opportunity cost – time spent doing *this* means time not spent doing *that*, and *that* may bring in grant income. Doing *this* therefore translates directly into loss of income for the university. A report commissioned in 2015 by the Higher Education Funding Council for England (HEFCE) and the Medical Research Council (MRC) (Pan and Katrenko, 2015) found that interdisciplinary research had a lower citation impact overall and there are comparable findings from Australia (Woelert and Millar, 2013). Even if someone is successful in keeping up with more than one area (an impressive feat itself), the chances are it will only be limited to specific aspects of those areas.

Research publications by UK academics are assessed by subject specialists within the discipline (after all, who can assess whether something is good maths except another mathematician?) through the Research Excellence Framework, so there is a disincentive to publish unorthodox research because it is 'extremely complex to assess' (Jacobs and Frickel, 2009: 52): you risk a low research rating, and therefore income. Grant applications to obtain funds to undertake research must generally stipulate what they expect to find but, as we shall see, interdisciplinary research can, at times, be an exploratory scouting trip to explore possibilities rather than a predictable process. It may be not so much a case of navigating reasonably well-mapped territory as mapping it in the first place.

One hallmark of good research is originality, but originality is not simply doing something that has never been done before – we might better call it *meaningful* originality, since it cannot be so unusual that no one knows what to make of it. And, while a creative borrowing of methods from other disciplines does appear to promise that, the outcomes are much less certain. Conversely, interesting and valuable work *can* fail to count as original by a particular assessing body: something like the application of a statistical method to historical texts may be highly original in history (if it turns out to work) but bog-standard work for a statistician, who may

receive little or no formal recognition for similar work in *statistics* since they may not have contributed much to understanding in that field.

Because so much income depends on these judgements, it is safer to stay close to the heart of the discipline. The more promising and experimental it is, the more one can risk a project being seen as an indulgence that may be no more than a distracting curiosity: such things can lead to breakthroughs, but is more likely to be a dead end and there is always plenty to be done closer to home. This is why interdisciplinary research is generally less likely to receive funding (Bromham *et al.*, 2016), unless tailored and specific funding is made available as a result of social, policy or legal initiatives or efforts. That can change much more rapidly than 'normal' disciplinary research.

Day-to-day operations will heavily and continuously reinforce disciplinary norms: working in teams; publishing (which involves review by and of one's peers, and includes feedback that will tend to bring everyone back to disciplinary norms); teaching (possibly in teams, and within curricula decided to varying extents by the rest of the department and scrutinized by an external examiner); presenting one's research, or perhaps ways of teaching what is already generally agreed and established knowledge within a discipline; attending conferences and hearing about what others have been working on; attending departmental meetings, which again underline what is 'normal' in the discipline and occasionally draw adverse attention to what is not; and the substantial work of keeping up with one's own area of expertise. All these are an unending repetition of the disciplinary norms that are likely to drown out other perspectives, but constitute the key ways by which institutions, including academic disciplines, continuously create and reinforce disciplinary coherence.

There is generally little sense that extra-curricular areas are important, even if they are not far from the core subject area: physicists and chemists, for instance, are not required or even encouraged to know much of the history of their subject but are almost constantly reminded of the need to research and publish about physics or chemistry. They are certainly not paid to find out about literature, epidemiology or teacher education, however interested they might be in those or any other areas. Such interests are precisely that: 'just' interests that lie outside their main fields.

Metaphors for disciplines

The net result of this has been described in a number of ways: 'silos' is commonly used, as is the idea of liberating ourselves by 'knocking down walls' between disciplines – but it is more complicated than that. Getting

into the next room doesn't necessarily mean you know how to speak the language or share the concerns of its occupants. More fruitful is the metaphor of 'tribes and territories'; the phrase was coined by Tony Becher in 1989 and the description here draws heavily on his study (Becher, 1989) and subsequent revisions.[4] The articulation of 'communities of practice' (Wenger, 1998) also lent weight to this sense of disciplines as identifiable communities that develop distinct interests and, by default, maintain their own ways of thinking and operating.

Teaching a discipline

Put simply, a university teacher's role is to induct students into their 'tribe'. Their mission is to displace previous assumptions and ideas, with the expectation that students will be in an environment and in peer groups that will reinforce the new ideas and behaviours that must be learnt to become a member of the 'tribe'. The curriculum, resources, environment and teaching colleagues will all immerse students in the department's usual practices and environment. Each will make their own way, more or less successfully, through the process of internalizing all these different facets of learning. When it works well it becomes second nature, and virtually automatic – the more instinctive, the better. Though many will leave with an undergraduate degree, those who stay on will incorporate the culture and knowledge to the point where they embody them and become fully part of them, to the point that they can now begin more systematically to impart them to the next generation of students anew.

When running an activity with an interdisciplinary group of probationary lecturers, I asked them to describe the room we were in from the perspective of their discipline. I noticed that a civil engineer sitting near me immediately started drawing the shape of the large and oddly shaped room *without looking up*. Watching his outline take shape, I first thought it was wrong but when I looked at the corner in question, I realized he had noticed more about the room's perimeter than I had, even though I had looked around, obviously knowing what activity was about to begin. A civil engineer, an architect, a planner and experts from other disciplines who are sensitive to space, layout, and so on would have noticed the layout without deliberate effort; those (like me) who were not cued to notice space had to look, in a way for the first time. While I was noting these varied reactions, the engineer informed me, still without looking up, that the fire extinguisher by the emergency exit was not where it was legally required to be.

That activity was intended to show those probationers just how deeply and automatically they thought in their particular disciplines. When

asked what struck them most about the room, biology-related academics talked about the appalling conditions for life to persist (in a subterranean dry space like that, it had no chance), linguistics lecturers talked about an optimum environment for sound (for virtually the same reasons), historians tried to guess how the room had come to exist in its strange form (it had been converted), and so on. Each group described the room from a completely different set of interests. Put differently, this is about *focus*, but the flipside of focusing on one thing is that you must ignore others: as Woelert and Millar (2013: 757) put it, 'certain things and aspects become visible and in this sense "real", while others are rendered invisible.' Disciplinary learning therefore includes a great deal of learning to ignore or discard information that is of little or no use.

… and learning

From the student's perspective, this massive effort to create coherence and consistency may not be visible. In fact, as it is presented to them, it may be deliberately broken down into what appear to be constituent, even unrelated, slices, to make it more manageable. This can, ironically, be too successful as a teaching strategy, and lead to fragmented learning, where students do not realize that what they learnt in one module is relevant to another – a key impetus for the Connected Curriculum strategy. But the more they engage with the curriculum, with the department, the subject and the environment they find themselves in, the more they internalize the material, the methods, the thinking, the practices and the values. Successful graduates do not emerge the same as they went in, whether or not they continue to work in a related field.

Enter the 'real world'

Given this inherent centripetal tendency, it is not surprising that when academics are consulted about 'real-world' issues, sometimes their expertise does not match those problems. A frequent issue is *timescale*: expert knowledge is not always quick, because universities are not satisfied with quick results that might turn out not to be accurate. Or they might simply not match what is wanted – a mechanical engineer once explained the problems of long-term stress-testing of machines to me by saying rhetorically 'if you want a chicken quickly, boil an egg': in other words, if you expose an egg to the same warmth in three minutes that it would receive from the mother hen sitting on it for three weeks, you will not get the same result.

Alternatively, it might give answers that no one wants to hear and whose relevance (but not accuracy) experts are unsure of: Douglas and Ney's

Missing Persons opens by discussing the paradox faced by anthropologists in a world that wishes to address the global issue of poverty, when a significant part of their understanding was that many 'primitive' societies lacking resources and experiencing gruelling work seemed to consider they had a good life, free from want. What were anthropologists to bring to the efforts to reduce hardship in a world that was trying to address 'not just lack but potentially lethal lack'? (Douglas and Ney, 1998: 5). They wrote the book to 'reorganize the terms of the discourse' for the social sciences, to think again about what they were saying, and what they might usefully say.

This kind of conditional answer to pressing issues is what leads to a general perception that disciplines are insular and that walls need knocking down, though we should swiftly note that if any problem *is* solved by a discipline, it will never become visible: if we are graduating medics to become GPs then there is no 'real-world problem' that needs solving (a lack of recruitment or unwillingness to go on to general practice is not the same issue).

But the world keeps coming with its questions: recent decades have seen increasing calls for academia to overcome these limitations as part of a more general push towards greater engagement with the wider world. There is a long tradition of academia embracing social or political issues that cut across distinct fields of study, often forming 'Studies' as its area of interest: roughly chronologically, we might mention 'interdisciplines' such as Marxist Studies (spanning history, economics and much of the social sciences), Women's or Gender Studies (which had a similar reach but more interest in literature and art than Marxist Studies); Environmental Studies as the precursor to climate change-related issues (this is now deeply embedded in, and critical to, many of its relevant areas, such as Oceanography) and, most recently, variously named but related interests in BME (black/minority/ethnic) issues, such as #WhiteCurriculum, outlined by Teresa McConlogue in Chapter 7. But these are academic-heavy movements that intend to have an effect *on* the world on academic terms by their consideration of a single issue or perspective in any and all contexts, rather than situations where the world defines what *it* wants from academia. In that sense, they are at the *opposite* end of the spectrum from interdisciplinarity as being 'about real-world issues'.

Consider, for example, expertise being brought to a high-crime urban area. Criminologists, legal experts, perhaps anthropologists and/or sociologists, a historian of the area, educationalists and others (perhaps even the people who live there …) will quickly find that their expertise does not mix easily. Each will come with a different focus, different solutions

and competing priorities. They will identify different problems as the most urgent and as soon as they begin talking as experts using expert terminology (otherwise known as 'jargon'), the others will not be able to follow them in any detail and the subtleties of their knowledge will be lost.[5] However, none can solve the problem on their own, and all must learn to work together if a useful outcome is going to be produced, whereas interdisciplines that compromise too much are rapidly in danger of dissolving, organized as they are around particular perspectives.

Interdisciplinary modes

It is possible to distinguish different types of interdisciplinary work but, given that there is no single discipline thinking about it to enforce consistent use of terminology, various terms are used, often interchangeably, to refer to different kinds. What is useful is the distinctions of different modes, and for our purposes the three most likely are:

- *multidisciplinarity*, by which I mean a team where each member contributes their expertise separately and within clearly defined limits: think of a team building a house, where the plumber does the plumbing, the electrician the wiring, and so on. They may well become familiar with each other's work, but do not intrude on it.
- *transdisciplinarity*, often defined as the result of collaboration beyond the university or with an entirely unrelated field, or as V.A. Brown puts it, 'academic knowledge extended by other ways of knowing' (Brown, 2015: 210). For instance, a fictional example (as far as I am aware) might be a geographer coming across a way of thinking about infection and the spread of bacteria in an organism, and applying the idea, with suitable modification, to how human populations move and grow.
- (critical) *interdisciplinarity*, when different disciplines work together to explore something and the fundamental workings of their expertise are challenged by doing so. This contrasts with the first two types, which draw heavily on individual disciplines retaining their basic mode of working but encountering unfamiliar ones and drawing on them.

The different focuses and priorities will clash, with no obvious way to make a judgement. Consider our hypothetical high-crime area:

- Are we usually discarding, or focusing on, anecdotal evidence?
- Are we accustomed to 'big data' in the form we have it?
- Do we interview people to find out more, or rely on ethnographic observation?

Then there is the question of what counts as a satisfactory outcome. Is it lower crime in the *short* term? If so, are we even looking at the medium term? What exactly is 'short term' in this context? Or is it improved educational engagement and prospects for likely offenders, or rebuilding a physical environment because the existing one 'encourages' crime? How concerned are we with the social fabric of the area?

When spelled out, these differences are fairly obvious (and I am not claiming the example is fully developed) but it can be surprisingly difficult to make them clear, and harder to find ways to choose between them. Since most experts have, as explained, internalized their process of judgement-making to the point that it is second nature, automatic and 'obvious', they find it difficult to grasp just how different a perspective someone else is bringing. Typically, they expect that simply explaining what they think is the priority will settle the matter, but their colleague from a different discipline will quite possibly do the same thing, underlining the differences: they may find themselves without any way of resolving the difference (Davies, 2011).

The process can be frustrating and disorientating and it frequently requires more time than is initially expected to learn to work together. Perhaps hardest of all can be deciding what gets priority. Often the only way it is likely to work is when an outside agency defines the issue and what would count as a solution. This not only helps choosing between different solutions, but also hopefully provides resources.

In the midst of the difficulty, though, is the possibility of creativity. Expertise tends to perpetuate itself: 'we do it this way' because it works fairly predictably. But being in a situation where the old techniques simply don't apply forces a potentially fruitful rethink as people step back and see how their knowledge and practices work, possibly for the first time in years, ever since they started being second nature. Similarly, learning to explain disciplinary methods and priorities to others can lead to a greater insight into those long-familiar understandings. Others might be able to bring ideas from their fields to the discussion, even bringing solutions to long-standing issues in another discipline. We cannot *guarantee* this happening, but it does happen.

This kind of process is not new, despite frequent claims to that effect: 'traditional' disciplines have always done this. Sider (2005: 48–53), for instance, tells the story of multidisciplinary efforts in the eighteenth century to read severely damaged papyrus rolls found in the Villa del Papiri at Herculaneum, charred – but thereby preserved – when Vesuvius erupted in 79 CE. They tried mercury as a lubricant (it crushed the fragile papyri), rose water, and then a 'vegetable gas' that destroyed the rolls and stank

the palace out. Nowadays, X-rays, infrared and ultraviolet light are more effective at reading these texts, which have lasted two millennia. Disciplines have always adapted as knowledge, technology (possibilities) and needs have emerged. Sometimes, but not always, this leads to the foundation of new disciplines: well-known examples include biochemistry and neuroscience (for example, see Jacobs, 2014).

What *is* new is the systematic promotion of interdisciplinarity on a large (and small) scale: perhaps the most material difference in recent years is the sheer scale of recognition and promotion of, and universities' application to, unprecedented, urgent large-scale issues in the world as a whole (Jacobs and Frickel, 2009; Frodeman, 2014). There has also been a change in terms of institutional support: in the 1968 European student uprisings, it was the students who were calling for interdisciplinary work, but it is now just as likely to be the central management, administration and funding bodies (Castronovo, 2000). This goes beyond the deliberate embedding of interdisciplinary research: it has also embraced the question of bringing new and profoundly interdisciplinary students into academia, such as those on UCL's Arts and Sciences degree, the BASc. These share the 'real-world' and applied focus of interdisciplinary research: for instance, at the time of writing, there is a Wellcome Trust-funded four-year PhD interdisciplinary programme available, based at UCL, Birkbeck and the Francis Crick Institute, which speaks of training in 'all aspects … necessary to address important problems in biomedicine'.[6]

Implications for teaching

Interdisciplinary research is tricky but arguably interdisciplinary education, and particularly interdisciplinary *learning*, are much harder (as recognized by many, e.g. Balsiger, 2015). To think this through, I suggest three main categories.

'Incidental'

First, 'incidental' interdisciplinary work, where a course that is predominantly one discipline borrows items, ideas or findings from another. Though this does have an overall structure (the main discipline), we should not underestimate the difficulties that might arise. Imagine a student intending to become a GP being exposed to ethnographic methods by someone who typically has students doing months of immersive fieldwork, in an attempt to improve their ability to understand the broader picture of their patients' lives and underlying health issues. The default medical training will focus on sifting through what they are told by patients for relevant factors (for instance, diet

and whether they smoke, and so on). Should they become sensitized to the subtleties of ethnographic research, they might start considering that having a surgery is intimidating to some patients and thereby affecting the stories they tell; they start to suspect they should instead make home visits to get to the salient facts. Anthropological fieldwork (ideally) involves immersion in a culture for extended periods, but making each medical consultation into a year-long study seems a little impractical.

But, more seriously, where *would* you stop? These are judgements that must eventually fit into the working of the 'borrowing' discipline. Would you listen for an extra five minutes without intervening, and allow patients to chatter freely? Ten minutes? Ask for relatives to attend to observe the dynamics and perhaps reduce tendencies to exaggerate or understate symptoms? The new medic is ill-equipped to make these judgements themselves: the 'home' discipline has a duty to guide these judgements, which will probably seem arbitrary and rather unambitious to the anthropologist brought in for a guest lecture. Such a guest lecturer will already be worrying about how much background to expect, and what they can realistically ask students to do.

This example began as an imaginary scenario (because my knowledge is inevitably limited) but my efforts to find examples confirmed the basic logic. In discussing 'narrative-based medicine', Kalitzkus and Matthiessen (2009: 84) say that it:

> takes time and effort because 'significant technical and attitudinal change that is necessary does not come quickly.' … At the beginning, [it] can lead through a phase of destabilization and doubt about one's own approach to medical practice … 'The biggest challenge in taking a narrative approach is knowing when to stop.' (Kalitzkus and Matthiessen, 2009: 84, citing Launer, 2002)

I would argue, then, that this is a vivid example of 'small-scale' interdisciplinary interactions; it is not a special case. This highlights another issue: most university teachers able to teach about a particular topic are experts only in that area – the more interdisciplinary the situation, the less likely it will be that our guest lecturer understands other aspects of what the students are studying. Their ability to guide the students on these kinds of questions will be limited and unpredictable. A single lecture within a series may send ripples throughout the course: the difficulties of interdisciplinary teaching and learning are not always easily judged by the proportion of the curriculum they appear to occupy.

A new discipline

My second category pertains mostly to those who have completed one degree and are moving to a different area. Moving from one discipline to one that looks similar may be counterintuitively harder than it looks. Moving from chemistry to chemical engineering, for example, will involve more un-learning than one might expect as, for instance, the scale of operations may become an important factor: a minute error in formulating a chemical reaction will be undetectable when using test-tubes but translate into tonnes when scaled up to the size of an industrial plant. A literature specialist may have to ignore much (but not all) of the subtlety they see in a text if they shift into a more historical area and start interrogating the text for different purposes. But if this changeover is a one-off process, they can at least neglect aspects of their expertise that are no longer relevant, and have a coherent process of changeover, however difficult the transition might be (Land, 2012; Davies, 2016).

Competing and cooperating

Third, we have students learning across a wider set of areas simultaneously. 'Parallel' learning in two or more fields is likely to cause the most turbulence for students. Discerning the undercurrents of a distinctive field typically requires immersion in that field, just as the best way to learn a new language is to move to where it is spoken. This immersion means that there is constant feedback and reiteration of the new ideas and general culture of the discipline, as explained earlier: almost everything reinforces aspects of the discipline.

If students are encountering a range of disciplines, they might well be able to pick up the information they need to master, and start becoming familiar with the underlying methods, ways of handling evidence and methods, and so on, but it will be a challenge to integrate this into anything coherent – before they get a chance, they may well be encountering another one and what they learn will be fragmented beyond their ability to integrate it, or at least to be sure they have integrated it in a way that will be accepted by their peers and assessors.

Students in interdisciplinary scenarios may never get to enjoy settling into the predictable life of one well-established and fairly coherent set of frameworks. As they master their fields, they will need to learn not just to question but when to question, and when to stop, often not because they have reached a 'natural' point of resolution but because they need to integrate answers into an eclectic solution rather than pursue a particular detail.

In many instances this is not critical: they learn what they need to, like medics becoming familiar but not *too* expert in narrative-based

medicine. Fragmentation is certainly one possible response to the challenge of integrating one's learning, and in modularized courses even makes it appear easier to prepare for exams, but it is a version of 'surface learning' where one only mimics understanding but has not grasped the underlying principles of the subject (for example, see Cousin, 2006). The ambition of an interdisciplinary degree is not only to grant access to the creativity that comes from being able to take an expert perspective, but also to refuse to see it only that way. They will need to be ever-conscious of the context they are in and adjust their focus and practices. They will be simultaneously adopting multiple sets of practices that may appear to contradict one another and adjusting to the way staff steeped in one discipline may even appear to dismiss the ideas, evidence, priorities and values of another. It is likely that guest teaching staff, brought in as experts on a particular topic, will be at best *unaware* of the extent to which they are treading on the toes of another discipline, a discipline about which the students may have learnt just the previous week. All the issues highlighted in this chapter will probably come to the fore at some point.

This challenge is shared by the teaching staff and the students: it can be no other way. There are issues staff can be mindful of – they must think particularly hard about assessment and feedback. For instance, students who are mainly learning how to write reports should be supported when they are then asked to write an essay. But given the scarcity of genuinely interdisciplinary staff who are also teaching as well as researching, and the inevitable reality that *no* academic staff member can possibly master a wide range of disciplinary modes, the staff and students are inevitably going to be puzzling things out together.

This might surprise some, who are used to thinking of university staff as experts in their fields, but it is, in many ways, a perfect preparation for the wider world. It is a common saying now that most of our graduates will do jobs that do not yet exist: we are preparing them not just to know, but to *not* know. Keeping one's head when faced with apparently insoluble problems, and then finding a way to proceed, is a skill that requires practice (and aligns perfectly with a focus on research-based education). Interdisciplinary teaching and learning is challenging and requires careful preparation by the teachers, and a commitment and resilience on the part of the students, but in changing and complex times, is something that offers the opportunity for a unique kind of creativity.

It will be obvious that many of the case studies that follow in Part Two, as well as the dimensions of UCL's Connected Curriculum and ChangeMakers, fit well with many of the themes that traditionally sit under

the heading of 'interdisciplinarity'. University research and teaching have changed beyond recognition in recent decades as they consider their role in wider society, both in terms of what is researched (and why) and how this can become a dynamic process that is reflected in the teaching that is on offer.

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Notes

[1] Address for correspondence: j.p.davies@ucl.ac.uk

[2] See Boutron *et al*. (2010) for a study of 'spin' in medical publications.

[3] The 'master' of historical footnotes is probably Jonathan Z. Smith, whose n.24 runs across three pages in Smith, 1990.

[4] There was a second edition with Trowler in 2001, and a rethink in Trowler *et al*., 2012.

[5] The classic article about this happening is Wynne, 1992.

[6] www.ismb.lon.ac.uk/wt_studentships.html

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