Interdisciplinary Higher Education and the Melbourne Model

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Abstract

The so-called 'Melbourne Model' has recently been adopted by the Council of the University of Melbourne, Australia after a long consultation process and widespread media attention. It proposes the design of new subjects which offer what are referred to as 'different ways of knowing' from students' 'core' disciplines, partly through 'the delivery of breadth subjects that are interdisciplinary in character'. This paper explores interdisciplinary higher education in the light of The Melbourne Model'. Definitional issues associated with the term 'academic discipline', as well as the newer terms 'interdisciplinary', 'pluridisciplinary', 'cross-disciplinary', 'transdisciplinary' and 'multidisciplinary' are examined. Some of the pedagogical issues inherent in a move from a traditional form of educational delivery to that underlined by the Melbourne Model are outlined. Some epistemological considerations relevant to multidisciplinarity and interdisciplinarity are discussed.

Introduction

The Melbourne Model has recently been adopted by The University of Melbourne Council after a long and extensive consultation process and widespread media attention (*Growing esteem: Choices for the University of Melbourne*, 2005; Macnamara, 2006a, 2006b, "The Melbourne Model: Report of the curriculum commission", 2006; Rood, 2006, "What is the Melbourne Model?" 2007). The model has been influenced by the Bologna process, as well as local and regional constraints. These constraints include: the rapid expansion of the higher education sector within Australia and the Asia-Pacific region and the limited opportunities for campus expansion; declining government funding, the internationalisation of the student body; the importance of graduate education to maintaining the university's research profile; and the Federal government's desire to promote diversity in the higher education sector. The University of Melbourne, as one of only three internationally ranked Australian universities, hopes to recruit the best graduate students and, eventually, to compete with similar research-intensive institutions overseas. The Melbourne Model is one major means by which the university hopes to achieve this aim. This paper investigates a particular aspect of the Melbourne Model; namely, the teaching and learning ramifications of interdisciplinary higher education.

What is the Melbourne Model?

The Melbourne Model is the first attempt within Australia to take higher education in the broad strategic direction of North American and European higher education systems. While the implementation details of the model are still being determined, it is clear that the model will drive decision-making into the future at the University of Melbourne. Specifically, the Melbourne Model of higher education has the following features:

- A stipulated emphasis on the production of graduates with 'depth' as well as 'breath', so-called 'T' graduates (a proportion of each undergraduate degree must be taken outside the students' core fields of study).
- A planned reduction from ninety-eight undergraduate programs of study and the existence of six 'New Generation' degrees;

- Disciplinary specialisation being available to students at the graduate level with a 'generalist' education emphasised at undergraduate level (a '3 + 2 model'); and
- Increased emphasis on postgraduate study and the formation of a 'graduate school' culture;

as well as an increased emphasis on 'knowledge transfer' (i.e., a two-way exchange of research and knowledge with the community and other non-academic sectors).

This aim to create graduates with depth and breadth is to be achieved in a number of ways according to the Report of the Curriculum Commission, the body assigned to investigate and implement the Melbourne Model (italics added):

- By "underpin[ning] a better understanding of the relevance of discipline studies in a wider context and of the *value of interdisciplinary connections"* (p. 8);
- By the design of new subjects which offer students: 'different ways of knowing' from their 'core' disciplines, and by: "the delivery of *breadth subjects that are interdisciplinary in character"* (p. 12);
- By offering: "greater opportunities for students (and staff) to experience *interdisciplinary teaching and research collaborations* across the university" (p. 4).

("The Melbourne Model: Report of the curriculum commission", 2006)

The University of Melbourne's Curriculum Commission explicitly endorses as a formal recommendation: "*multi-disciplinary approaches to foundations of knowledge*". The difference between the terms 'interdisciplinary' and 'multidisciplinary' is not made clear in the Curriculum Commission report, and the precise ways in which these changes might affect teaching and learning were not discussed in detail. However, since that report was released and the University has begun the process of implementing its recommendations, it is now clear that multidisciplinary and interdisciplinary studies are to be achieved through at least two avenues: the study of subjects outside a student's 'core' discipline; and the study of interdisciplinary subjects, designed specifically as part of the Melbourne Model. These interdisciplinary breadth subjects are now in the process of being developed and approved through the appropriate university processes. They include subjects such as, 'Catastrophes, Cultures and the Angry Earth', and 'Drugs that have Shaped Society'. All these changes raise pedagogical and educational issues of importance for universities as well as their prospective students.

Definitional Issues: What is an Academic Discipline?

There is a growing body of literature on the nature of academic disciplines and interdisciplinarity (Aboelela *et al.*, 2007). In a recent extensive critical review of the literature, Aboelela, *et al.* (2007) have determined there are over 500 published sources related to interdisciplinarity, of which 42 articles are concerned with interdisciplinary research and the remainder concerned with other aspects of interdisciplinarity (e.g., examples of interdisciplinary practice). In this section we attempt to make some distinctions in this field clear and provide a structural typology to understand the various disciplinary options available to a university if it is to go down a path of being 'interdisciplinary' and what this might mean. In order to explore interdisciplinary and other variations, it is first necessary to understand the term 'academic discipline'.

What is an Academic Discipline?

The academic disciplines as we know them today are considered by many to be largely discrete and autonomous, although not homogeneous (Becher, 1981). The traditional view of an academic discipline is an area of study "with its own theories, methods and content … distinctiveness being recognised institutionally by the existence of distinct departments, chairs, courses and so on" (Squires, 1992). An academic discipline

has also been defined as “a branch of learning or scholarly instruction” (OED). However, this definition is circular in that ‘branch of learning’ requires further explanation. Disciplines are generally considered more discrete than ‘fields of study’ (FOS) in that a FOS is generally outlined when undertaking a course of study in a discipline. Thus, FOS has a wider meaning than discipline. Discipline experts or practitioners, and universities in general, provide a framework for students by setting out FOSs for students to follow. A discipline thus defines and delimits a FOS rather than the other way around.

Beyer and Lodahl (1976) have defined ‘disciplines’ in more general terms. They suggest that a discipline provides the ‘structure of knowledge’ that trains and socializes members of a Faculty. This training and socialization includes the ability to carry out the appropriate tasks of teaching, research, and administration that are germane to the discipline. It also includes the production of relevant research, the process of peer-review, and the system of rewards (Beyer & Lodahl, 1976; Reich & Reich, 2006). Becher (1981), too, defines disciplines broadly as ‘cultural phenomena’: “they are embodied in collections of like-minded people, each with their own codes of conduct, sets of values, and distinctive intellectual tasks” (Becher, 1981).

This traditional view of the nature of academic disciplines as discrete and autonomous began with the development of universities in Europe. The earliest universities began with only four disciplines: medicine, philosophy, law and theology. The department of physics at Oxford still retains the name ‘Department of Natural Philosophy’ in recognition of this heritage. The ‘sciences’ as we know them today did not exist in earlier times. Over the centuries, increasing specialisation has resulted in more disciplines being added, and by the 1950s one report noted around 1,100 scientific disciplines (Max-Neef, 2005; Schultz, no date). More recent attempts to do this have resulted in more being added ("Classification of instructional programs", 2000, "List of academic disciplines", 2007). Codification of academic disciplines is a widespread practice in academic institutions but this codification occurs only at the level of the body of knowledge in a discipline, as opposed to the type of scholarly practices and activities and the behavioural features of its practitioners. The ARC RFCD codes are an example of such a codification system.

This evolution of academic disciplines continues. There are calls to create new academic disciplines from a variety of unlikely candidates, for example, business succession planning and genealogy (Ip & Jacobs, 2006; Wagner, 2006). Similarly, there are questions about whether traditional academic disciplines—for example, accounting—deserve to be described as such (Fellingham, 2006). There have been various attempts to undertake anthropological study of academic disciplines, and to describe these unique cultures, all with limited success (Becher, 1981, 1989). While there is general agreement about what an academic discipline is, it is also clear that many have porous borders.

While academic disciplines are, to some degree, porous, there are certain features that can be agreed upon. The following features are among those normally mentioned:

- the presence of a community of scholars;
- a tradition or history of inquiry;
- a mode of inquiry that defines how data is collected and interpreted;
- a definition of the requirements for what constitutes new knowledge;
- the existence of a communications network.

Of course, the differences among the disciplines are as important as the things that bind them. Art historians, geologists and economists all differ markedly in terms of how they substantiate their knowledge and their methodologies (Hofer, 1997, 2000, 2001). Academic disciplines also differ markedly in regard to standards of justification and evidence, degrees of certitude in what constitutes knowledge, and in their understanding of the structure of knowledge itself. Epistemological issues will be discussed further in **Section 4.**

Under the traditional notion of academic disciplines as discrete and autonomous entities, there is a standard educational pathway for students. With few exceptions, students begin their studies in one of the broad faculty divisions (the sciences, arts, commerce, and so on). They survey the landscape of the disciplines and, by the end of their second year, specialises in one of them. This discipline influences students' views about what is known, what is valued, and what is capable of investigation. By the end of their studies, a student of accounting need not know a great deal about finance; a biology student need not know much about physics; a psychology student may not be very familiar with neurology, and so on, though they may have passing familiarity with cognate disciplines.

Over time, disciplines gain their independence, especially once a defined and unique methodology is employed to determine the subject matter of each. For example, cognitive science, once the province of philosophers, is now considered to be on its way to becoming a discipline, if it is not a discipline already.

The view of the disciplines as 'horizontally' structured along a continuum, with 'hard' or empirical sciences at one end, the 'soft' sciences in the middle, and the humanities at the other end is common. In between the extremes (the dotted lines) are various disciplines of a greater or lesser degree of methodological 'hardness' or 'softness'. Figure 1 shows the standard view of the relationship between the disciplines on the 'hard-soft' continuum. This view has been supported and validated by empirical studies (Biglan, 1973, 1977; Creswell & Bean, 1981; Donald, 1986; Sinclair & Muffo, 2002; Smart & Elton, 1978).

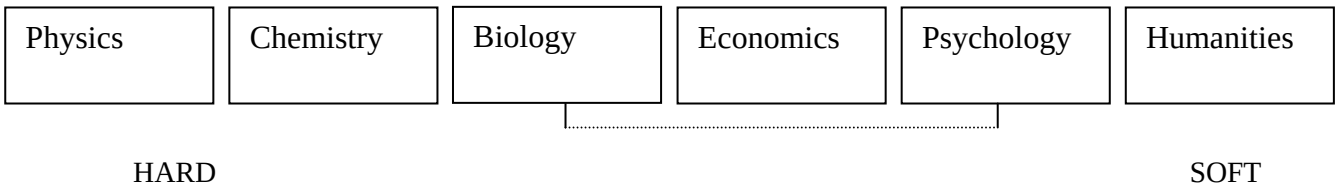

Figure 1: The 'hard'- 'soft' continuum of academic disciplines

However, despite the intuitive appeal of homogeneous disciplines arranged along a continuum, this simple account clearly does not account for all situations. There are many instances of an apparent lack of homogeneity. For example, some parts of economics and psychology are empirical ('hard') in nature and others are not. Physics before WWII was characterised by the quest for immutable laws of nature; after the war it became more focussed on industrial applications (Becher, 1981). It is clear that the simple 'hard-soft' dichotomy lacks subtlety to adequately describe the disciplines.

Disciplinarity

Following from the above discussion, 'disciplinarity' describes the traditional view. It is a term used to describe academic disciplines as autonomous and discrete areas of study which do not normally cooperate or coordinate their academic efforts across disciplinary boundaries. Disciplines can be seen as discrete 'boxes' (albeit with porous boundaries at times). At the undergraduate level students normally specialise in one discipline and this discipline influences students' views about what is known, what is valuable and valued, and what is capable of investigation.

Problems with the traditional notion of 'Academic Disciplines'

As noted by Squires (1992), the problem with the traditional notion of academic discipline is that it fails to acknowledge that disciplines are not historically fixed; that they evolve and change over time. Like everything else, academic disciplines are culturally and historically situated. Disciplines are also not defined by one attribute but by many, and the relative emphasis on these different attributes can differ from

discipline to discipline, and even within disciplines. For example, a discipline such as psychology has undergone great changes from its inception as an introspective discipline with the work of William James, Sigmund Freud, Carl Jung and others, to its current empirically-based concerns, though there remain different 'branches' where, for example, psychoanalytic research is still discussed. There have been attempts to redefine the notion of 'academic discipline' to recognise these points (Becher, 1989; Biglan, 1973; Donald, 1986; Kolb, 1981; Squires, 1992).

Squires (1992) has defined an academic discipline in terms of three 'dimensions': their *object* (what they are concerned with, their current problems and issues); their *stance* (their current epistemic concerns, that is, what they consider to be their framework of knowing and how they do things – their methodology); and their *mode* (that is, how they reflexively consider themselves as a discipline, for example, the extent to which they are 'normal', 'mature', or 'revolutionary' in the Kuhnian sense). Many disciplines go through periods of 'normal' science (that is, business-as-usual using an unchallenged, commonly agreed-upon theoretical framework), to 'revolutionary' periods where these frameworks are questioned, thrown into doubt and/or replaced (for example, Einsteinian physics replacing Newtonian physics) (Kuhn, 1962).

Squires (1992) has a more sophisticated understanding of 'discipline' that recognises these points. He claims that all disciplines are "multidimensional spaces which define, protect and enlarge themselves along any of those dimensions, and in so doing, come into conflict or cooperation with other disciplines" (Squires, 1992) . See Figure 2 below.

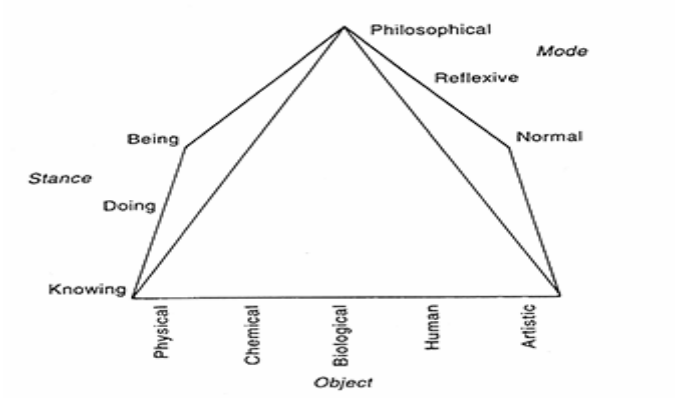

Figure 2, Squires' (1992) account of a discipline

On Squires' account, friction and permeation can occur at the borders of disciplines, and influences can be widespread among them. An example of the latter is the empirical methodology of the hard sciences. This has had a dramatic and lasting effect on other disciplines that are traditionally remote from the concerns of the sciences, for example, linguistics.

Multidisciplinarity

Given the understanding of disciplinarity above, we can now look at an important variation, multidisciplinarity. Multidisciplinarity recognises the fact that there are many discrete and autonomous disciplines. While undergraduate students normally specialise in one discipline, they can study several over the course of a typical degree program. For example, in addition to accounting subjects, an accounting student also studies some subjects in finance, and may also study some economics, and/or, perhaps less commonly, seemingly unrelated disciplines such as history or music.

In terms of research, in some areas of investigation there may be multidisciplinary contributions from several discipline areas to a joint research program. However, in practice, each of the disciplines contributes from its own perspective. In both a practical and intellectual sense, each of the disciplines stands alone.

Multidisciplinarity has been described more simply as the view that: "everyone [does] his or her thing with little or no necessity for any one participant to be aware of any other participant's work" (Petrie, 1976). Multidisciplinarity is the co-existence of a number of disciplines. It is no more intellectually, or academically, illuminating than what typically exists in higher education degrees.

Cross-Disciplinarity

Cross-disciplinarity is another variation of disciplinarity. In cross-disciplinarity (often terminologically confused with 'interdisciplinarity'), a topic *normally outside* a field of study is investigated with no cooperation from others in the area of study concerned. Two examples might be the physics of music and the politics of literature. While sometimes informative and interesting, this type of inquiry involves the use of essentially foreign techniques and tools from those normally used to study the phenomenon under consideration. There is rarely any transfer of methodologies in cross-disciplinary work. Taking one of the examples above, musicians don't necessarily learn any physics and physicists do not necessarily learn much about music.

Interdisciplinarity

A third variation of disciplinarity is interdisciplinarity. While the traditional view regards disciplines as discrete and autonomous, interdisciplinarity recognises the subtleties of the nature of academic disciplines. There are a number of possible forms that interdisciplinarity might take, but there are points of common agreement. These will be outlined below.

Interdisciplinarity has been described as "a remedy to the intellectually deadening effects of excessive specialization" (Field & Lee, 1992, "Interdisciplinarity", 2007). There are a number of variants of interdisciplinarity that can be understood as located on a continuum from benign to radical.

Relational Interdisciplinarity

At the benign end of that continuum, interdisciplinarity is regarded simply as elective subjects taken from a variety of disciplines that in some way relate to [a] general topic – an example might be women's studies (Garkovich, 1982). Here there are "two or more disciplines … contributing their particular disciplinary knowledge on a common subject" (Garkovich, 1982). Related things can be—and frequently are—discussed from different angles. This might be called *Relational Interdisciplinarity* and its similarity to multi-disciplinarity is clear. This kind of interdisciplinarity is not especially interesting. It is what academics do as a matter of course.

Exchange Interdisciplinarity

Moving along this continuum of variants of interdisciplinarity, another view involves "entrench[ing] discipline boundaries" and "leaving open mutually radical dialectic-critique of opponent territories" (Davidson, 2004; Rowland, 2001). This view might merely imply critique and the critical exchange of views while maintaining robust disciplinary integrity. This variant might be called *Exchange Interdisciplinarity.*

Pluridisciplinarity

Moving further yet along the continuum, another variant of interdisciplinarity is sometimes known as *Pluridisciplinarity* (Max-Neef, 2005). It requires two or more disciplines *which combine their expertise* to jointly address an area of common concern. This usually arises in areas of study where the topic under investigation is too complex for a single discipline to address. Examples include the AIDS pandemic, the water crisis in Australia, global warming and climate change. Topics such as these require the efforts of many specialists. An issue such as 'land use', for example, is seen differently from economic, geological and environmental perspectives. In the health sciences, a pressing social concern such as obesity requires the

integrated views of behavioural scientists, molecular biologists, and mathematicians (Aboelela et al., 2007). Many of the university breadth subjects proposed under the Melbourne Model are focused on topics just like these.

Where in Disciplinarity and Multidisciplinarity there is no cooperation at all between disciplines, pluridisciplinarity involves cooperation, without coordination. A recent example of this is the new 'discipline' of Cognitive Science. Here philosophers, linguists, computer scientists, artificial intelligence experts, neurologists and brain scientists cooperate in the production of papers in dedicated conferences and journals, for example, *Journal of Consciousness Studies* and *Behavioral and Brain Sciences*. This cooperation is toward an understanding of topics of common concern, in this case, the scientific study of consciousness.

There is often a transfer of techniques and methodologies in pluridisciplinarity research. For examples, unlike in the past, philosophers of mind now openly discuss empirical methods used by neuroscientists, and vice-versa, neurologists openly discuss philosophical terminology and concerns (Dennett, 1991). However, while there is a strong amount of cooperation and common mutual interests, there is no sense in which computer scientists and philosophers do research that is independent of their respective disciplinary areas. Entire encyclopaedias are now published in the area of Cognitive Science, but they are still partitioned into the relevant discipline areas (Wilson & Keil, 1999). In pluridisciplinary research, the research is discipline-based, and researchers may discuss inform each other about an issue that is of common concern from their different respective academic positions (see Figure 3 below).

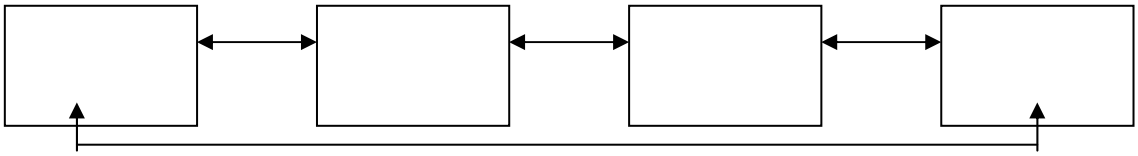

Figure 3: Pluridisciplinarity (cooperation without coordination) (Max-Neef, 2005)

Figure 3 shows the autonomy of discrete disciplines which may cooperate with each other when circumstances demand. This cooperation may involve the sharing of methodologies, techniques or concepts.

This variant of interdisciplinarity is explicitly presupposed under the Melbourne Model. There is a plausible case to be made for pluridisciplinary relationships between the disciplines, which may not be as discrete and autonomous as the traditional view claims. Some issues and topics appropriate for undergraduate university level study are simply too complex to be properly investigated within a single traditional discipline. If interdisciplinary relationships are fostered in the Melbourne Model, then traditional disciplinary structures would be retained, and interdisciplinary relationships formed for the purposes of teaching and learning. These relationships might go some way to promote critical dialogue between the disciplines of complex topics that are beyond the resources of individual disciplines alone.

Petrie (1976) notes that the history of the disciplines teaches us that disciplinary specialists themselves seek interdisciplinary relationships when the demands of their subject warrant it, and not before. Certain conceptual issues demand new perspectives to provide breakthroughs. These insights can certainly come from different disciplines. The history of thought provides many examples where disciplinarians have themselves welcomed interdisciplinary relationships. Biology needed physics at a certain stage of its development. Ecologists use mathematics when it is needed. Philosophers of mind began to seek relationships with neuroscientists and computer scientists when their *a priori* speculations about internal 'representations' led to a need to understand what an internal 'representation' might be. There are numerous cases in which the nature of a problem has necessitated the insights of another discipline (Petrie, 1976). Interdisciplinarity occurs naturally among disciplinary specialists.

Like relational interdisciplinarity, however, pluridisciplinarity is not especially different from what typically occurs in university education. It is something academics do as a matter of course. Interdisciplinary exchanges—such as those presupposed under pluridisciplinary relationships—occur normally and need not be mandated by the institution, although under the Melbourne Model, these exchanges may intensify and become more critical. It seems wise for the University of Melbourne to adopt the cautious form of interdisciplinary education it has outlined in its 'breadth' requirements and simultaneously maintain and preserve a robust disciplinary focus through the 'depth' requirements. Appropriate evaluation and quality assurance processes in place would allow interdisciplinary exchanges to flourish within an appropriate regulatory framework while ensuring that learning in academic disciplines is not compromised.

Modification Interdisciplinarity

Moving further along the continuum, there is yet another variant of interdisciplinarity. Unlike multidisciplinarity—where disciplinarians need not discuss things with each other—this variant requires "more or less *integration and even modification of the disciplinary sub-contributions* while [an] inquiry is proceeding. With this version there is often co-ordination from a higher hierarchical level. Different participants need to take into account the contributions of their colleagues to make their own contribution" (Petrie, 1976). Within this view, the latter point is crucial; for one of the criticisms and concerns of some interdisciplinary work is that it is 'interdisciplinary' in name only. This variation might be called *Modification Interdisciplinarity.* It can be outlined in Figure 4 below. Modification interdisciplinarity involves more than cooperation. It requires that disciplines are *changed* in some way by the association with other disciplines. The arrows below indicate that the hierarchical concerns are influencing in some way the structural integrity of disciplines below. An example of this might be when medicine harnesses the concerns of biology, physics and psychology to serve 'higher' pragmatic purposes, or when disciplines such as agriculture, forestry and commerce serve the needs of politics (Max-Neef, 2005).

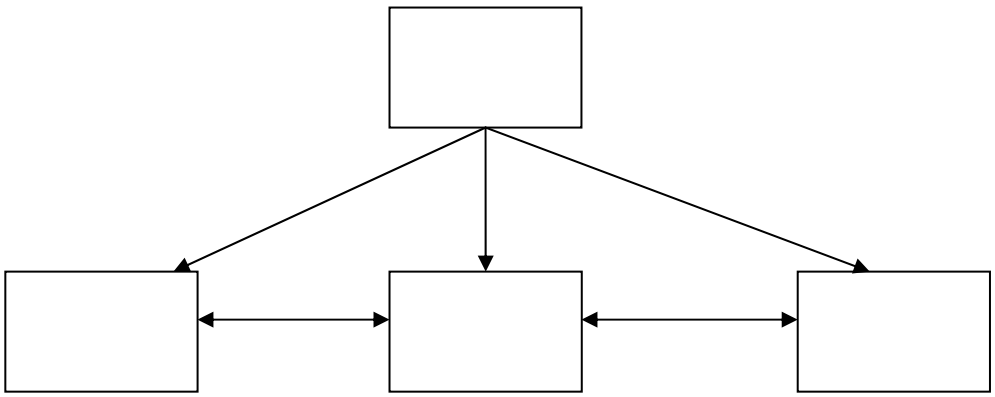

Figure 4: Modification Interdisciplinarity (Coordination from a higher hierarchical level)(Max-Neef, 2005)

Transdisciplinarity

Moving yet further along the continuum of variants of interdisciplinarity, at the extreme end is a view of interdisciplinarity as involving the "collapse of academic borders and the emergence of a new discipline" (Davidson, 2004). This is sometimes known as *Transdisciplinarity* (Max-Neef, 2005).

However, there are considerable problems with this kind of interdisciplinarity. Dissolving academic boundaries would seem to go against the gains won in terms of the basic research productivity of individual disciplines. How, in a practical sense, would disciplines continue work done in dedicated disciplinary areas of concern if boundaries were 'dissolved'? What does this mean exactly? How would disciplinary integrity be maintained? How would traditional academic concerns be maintained in attempts to reorganise the

curriculum to meet more pressing global challenges? If boundaries between disciplines are dissolved it becomes unclear to what extent traditional disciplines would survive. In any case, it has been noted that: "initiatives which in effect collapse disciplinary boundaries … violate the special purpose of the university" (Davidson, 2004; Rowland, 2001) .

The various forms of 'disciplinarity' can be represented as follows (see Figure 5 below):

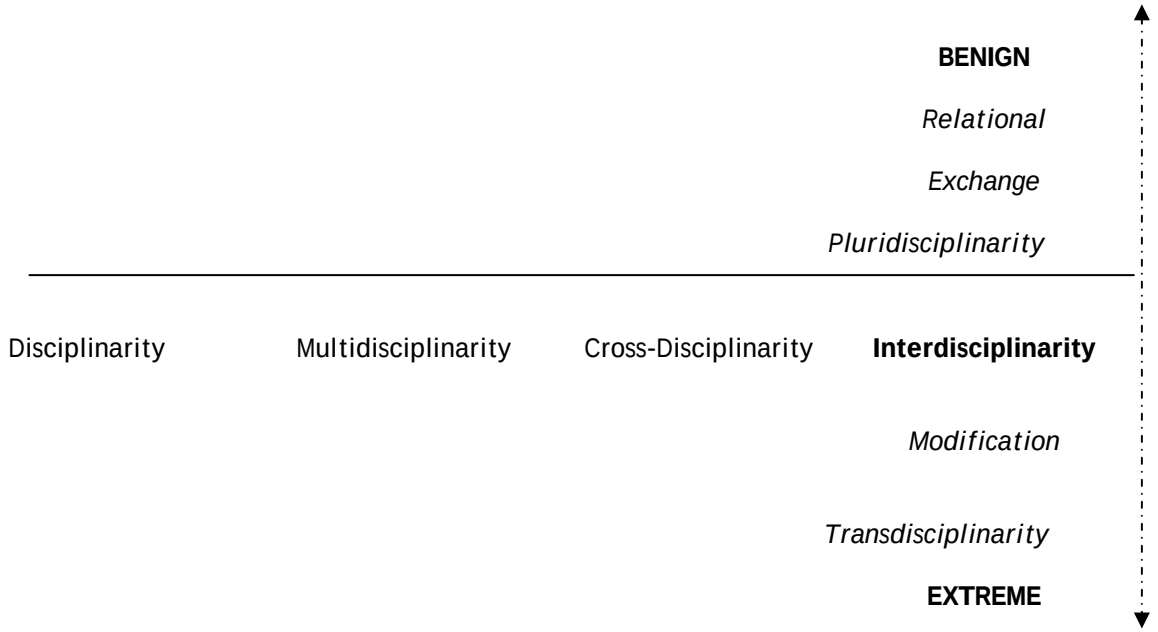

Figure 5: Various forms of 'disciplinarity'

Interdisciplinarity Reconsidered

There is a considerable literature indicating interdisciplinarity in its various forms is widespread in a diverse range of traditionally academic domains: health sciences (Aboelela et al., 2007); engineering (Froyd & Ohland, 2005); sociology (Garkovich, 1982); higher education (Davidson, 2004; Field & Lee, 1992; Kezar, 2005; Newell, 1992; Petrie, 1976; Wolman, 1977); ecology (Golde & Gallagher, 1999), music (Ellis & Fouts, 2001); environmental studies (Steiner & Posch, 2006); community studies (Suarez-Balcazar *et al.*, 2006); management (Tress & Tress, 2005); and science (Wolman, 1977). In addition, there have been sustained discussions on the role of interdisciplinarity in academic research (Feller, 2006; Reich & Reich, 2006; Schommer-Aikins *et al.*, 2003).

However, it is not often clear from this literature just what type of 'interdisciplinarity' is desirable, and under which contexts it might be useful. Further, the term 'interdisciplinary' is often used without much clarity. We conclude from this discussion of interdisciplinarity that, of the five variants presented, the only coherent versions which preserve a discrete sense of the disciplines, and which we might accept without argument for implementation into higher education teaching and learning are *Exchange Interdisciplinarity* and *Pluridisciplinarity.* The former involves "entrench[ing] discipline boundaries" and "leaving open mutually radical dialectic-critique of opponent territories". The latter involves disciplines combining their expertise together in areas which are too complex for single disciplines alone. The other variants either formalise what academics in the disciplines do as a matter of course, or they seem far too radical to be acceptable without further substantive argument.

Pedagogical and Epistemological Considerations

What implications does interdisciplinarity have for teaching and learning? There is a commonsense case for suggesting that the best education that can be provided to students is a sound discipline-based education, with opportunities for interdisciplinary discussion when it is warranted. The mix between the local, disciplinary content and interdisciplinary content is critical. Sufficient local content will ensure that *students themselves* see the need for interdisciplinary understanding when the occasion demands it, just as disciplinarians, as described above, seek interdisciplinary relationships when they see a need to do so. An education that is too broad might not allow for sufficient expertise in the core discipline for an adequate appreciation of when interdisciplinary work is needed and when it is not. But given that some interdisciplinarity will be desirable, the questions of how best to incorporate it into students' learning experiences are key.

The issue of cognitive maps

It is well known that different disciplines have their own way of viewing the world. Sometimes these are known as mental models, cognitive maps or frameworks, or 'paradigms' (Kuhn, 1962). Practitioners understand the world in terms of the cognitive models they possess; they 'see' things differently. Disciplinary-based concepts are necessary for viewing the world in a certain way. In the normal course of events, of course, students learn these cognitive maps when they are inducted into a discipline. This is part of what it means to become 'educated'. Unless one learns music theory, for example, it is difficult to recognise a plagal cadence for what it is; without music theory, one just hears pleasing sounds. Similarly, "the visitor [to the laboratory] must learn some physics before he sees what the physicist sees" (Hanson, 1975). The phenomenon of the 'theory dependence of observation' and the notion of cognitive maps occurs, without exception, in all academic disciplines.[2]

Once a student has learned a discipline-specific cognitive map, it becomes difficult for those inducted to see things any other way. This being the case, what challenges do a focus on interdisciplinarity raise for higher education students and providers?

Interdisciplinarity will, by necessity, result in fewer topics being taught in traditional ways. However, disciplinary depth is important to ensure that students develop the required cognitive maps in both disciplinary and interdisciplinary studies. Undergraduate higher education should provide education that both prepares students for the changing world of employment and that provides a pathway into graduate programs. Such depth is critical for intending graduate students who have to eventually make research contributions (Golde & Gallagher, 1999) as well as for those leaving university after undergraduate studies to take up a profession. The Melbourne Model aims to achieve sufficient depth for success in both pathways.

Under the Melbourne Model there is also an explicit requirement for students to take a minimum of units—75 points or a quarter of the degree requirements—in other subjects to meet the 'breadth requirements'. By necessity, this will mean less traditional instruction in the core discipline. Under these circumstances, and without careful consideration of the pedagogy, it is possible that some students may find it challenging to learn the cognitive maps in both the core and the breadth disciplines.

The issue of disciplinary language

A related point concerns language. It has been recognised that in addition to providing the requisite cognitive maps for students, a discipline must also teach a distinct, discipline-specific vocabulary. This raises a number of pedagogical issues. It is as important to teach the language and technical terms of the disciplines, as it is to teach the methodologies, procedures and concepts (indeed, they cannot be taught *without* the language). But even within disciplines that are naturally grouped together, there are significant differences in

language. For example, the language of Accounting is very different from the language of Management, Finance or Law. In disciplines not usually grouped together, these differences are even more pronounced. The language of accounting, for example, is very different from the language of Chemistry or History.

This raises significant epistemological, as well as practical, challenges for students and, therefore, academic staff teaching these students. Some of the disciplinary 'vocabularies', and the assumptions behind them, are incommensurable with vocabularies from other disciplines. 'Mass' to a Physicist does not mean the same thing as 'mass' to an Engineer or Architect. The notion of a 'fact' and 'evidence' are largely matters of disciplinary definition. If there are differences in the use of single words, it can be expected that differences in the understanding of theoretical concepts will be vast (Feyerabend, 1993).

In the interdisciplinary university, where students are compelled to achieve breadth as well as depth, the language of disparate disciplines may need to be taught. While this is not an inconsistent aim, it is challenging to achieve without possibly losing the strengths of a well-grounded education in the language of single disciplines independently. Mixing the unique languages of Commerce and Engineering, for example, may be possible, but may also result in an inadequate training for both employment and graduate study if not done with care. Graduating students will need to emerge from university with the required discipline-specific vocabulary in each of the disciplines in which they have studied.

Interdisciplinarity and Idea dominance

It has been claimed that a central feature needed for interdisciplinary success in research, but also—albeit to a lesser extent—teaching, is *idea dominance* (Petrie, 1976). Viable projects require a key 'idea' without which, failure or abandonment of the project is almost certain. It has been noted that over 50 percent of interdisciplinary collaborations fail (Doz, 1996; Kezar, 2005). The key idea needs to be mutually agreed upon as being important by all concerned. Different, even inconsistent, ways of viewing the idea are, of course, welcomed in the process of intellectual discussion, but that there are agreed-upon *problems* is not in dispute.

In independent, 'traditional' disciplines, idea dominance is not a critical issue. The ideas that Economists, Engineers or Psychologists regard as being important are filtered out from weaker ideas in routine intellectual discussions and weak ideas are abandoned. The dominant ideas become viable and become the focus of investigation and learning, that is, of research and teaching. Dominant ideas are closely aligned with eventual success and achievement in results that all parties to the project regard as being illuminating, and offering some degree of intellectual progress.

However, interdisciplinarity does not work this way. By necessity, different cognitive maps and vocabularies are involved. In cases such as 'Global Warming' the idea is mutually agreed upon as being important by all participants from various disciplines. However, these cases are rare, and sometimes interdisciplinary research runs the danger of being done, not for any legitimate academic reason, but simply: "for the sake of being interdisciplinary" (Petrie, 1976).

The pedagogical issues that the concept of idea dominance raises are critical for the success of interdisciplinarity. It is critical that students emerge from interdisciplinary undergraduate studies with a clear idea of the dominant ideas of their discipline(s). Graduates must be able to recognise a dominant idea from a weaker idea and to distinguish ideas that belong to certain disciplines from those that are interdisciplinary in nature. They must also be able to raise appropriate questions (that is, 'legitimate' questions from the perspective of their discipline) to critique ideas from both a disciplinary and, if necessary, interdisciplinary perspectives.

The effects of breadth on specialisation

Students usually want to study a discipline in which they believe they have some natural talent. Students who have skills in mathematics gravitate to Mathematics, Physics, Engineering or allied subjects. Students with talents in language-rich subjects tend to study in the Humanities, Law, Social Sciences, and so on. If interdisciplinary study is compulsory, this may disadvantage students who are weaker in terms of broad interests (and perhaps excellent in areas of narrow specialisation). It has been noted that: "interdisciplinary efforts seldom work if the participants are not fully competent in their own fields", and that "… disciplinary competence is sometimes at odds with broad interests and imaginative speculation" (Petrie, 1976). These observations may be more relevant to research efforts than to the teaching and learning arena but they are worth noting.

There is some evidence that individuals who are outstanding in a particular discipline—as opposed to being very good—tend to be very narrowly focussed in their skill area. Petrie (1976) asserts that: "…one tends to see good disciplinarians uninterested in interdisciplinary efforts, and many who are interested seem to have marginal disciplinary competence" (Petrie, 1976). Becoming an excellent disciplinarian demands undivided focus. Expertise is also the result of substantial amounts of training, and the empirical evidence suggests that this training is not transferable (Chi *et al.*, 1988; Johnston, 2003).

Johnston claims that experts perceive "meaningful patterns in their own domains better than non-experts". This is hardly surprising. They also use more higher order principles to solve problems, work faster and with more accuracy, are better at self-monitoring, comprehend the meaning of data more readily, recognise the relative weighting of variables and have better domain-specific short and long term memory (Johnston, 2003). It may be that expertise is a necessary requirement in disciplinary studies in order for excellence to occur. This degree of specialisation, single-mindedness and focus required for expertise to occur brings challenges in a university that has the stated aim of pursuing interdisciplinary education. However, 'expertise' among mature scholars and 'expertise' among undergraduate students are very different (Marginson, 2007, pers. com. 15/6/07).

In a practical sense, the balance between disciplinary focus and interdisciplinary relationships is difficult to navigate and demands careful judgement for both staff and students. Neither a disciplinary focus nor interdisciplinary relationships can predominate for successful interdisciplinary work to occur and be successful:

> If one is not … extremely adventurous and extremely interested in the project, the rewards which accrue simply due to disciplinary competence are likely to pull an [extremely competent] individual away from the interdisciplinary effort. Likewise, the person of extremely broad interests but lesser disciplinary talent may feel the project is going well, when it, in fact, never gets beyond the superficial (Petrie, 1976).

While it is true that cutting edge work goes on in the margins of disciplines, basic and foundational work remains within a discipline. Universities must ensure that ideas are allowed to dominate in each discipline and reach successful outcomes. Graduates need enough exposure to key disciplines to learn these ideas, although they must be able to move outside their discipline to obtain interdisciplinary assistance when necessary or appropriate.

Valuing interdisciplinarity in the institutional setting

Another important pedagogical issue is the institutional setting in which interdisciplinary work goes on (Petrie, 1976). Transplanting interdisciplinary exchanges in an institution not set up for this purpose is likely to create problems. Purposeful and directed interdisciplinary work requires an appropriate system of rewards and institutional support, promotion, seed funding, release time, teaching and innovation grants and

recognition, and so on. These rewards need to be directed to *interdisciplinary* work. At present, the principal rewards for academic staff at most universities are by means of disciplinary channels (publication in top-tier disciplinary journals, evidence of having advanced their discipline, teaching awards for teaching undertaken in a discipline, and so on). There is some evidence that this is beginning to change with, for example, the emergence of a number of interdisciplinary journals.

Staff will naturally put their efforts where rewards are available. Under the typical reward circumstances for staff outlined above, interdisciplinary work may not flourish. Students, too, may recognise that the important work is being done in the disciplines (not inter-disciplines). Interdisciplinary projects, courses and 'breadth' requirements, may be seen as token parts of the educational experience and may not be taken seriously.

Preparing for and Managing Change in Higher Education

There are a number of considerations in preparing for and managing changes in the focus of disciplinarity in universities. One is that if students take subjects outside the broad discipline area in which they have chosen to focus their efforts, attention must be given to the preparation of students for such multidisciplinary and interdisciplinary experiences because students may not be naturally inclined toward, or adequately prepared for, these subjects. Students must therefore be explicitly inducted into the academic discourse of all disciplines in which they study. This is particularly important if students are taking subjects in disciplines that are very different from their core discipline(s).

The requisite vocabularies would need to be taught within each discipline. The preparation and use of 'checklists' or glossaries of key terms designed for each discipline and appropriate to each level of study might be helpful. These would be useful to both students focusing in the disciplines concerned and to students taking interdisciplinary breadth subjects.

But induction into an academic discourse and way of knowing and of seeing the world will take much more than checklists. As a pre-cursor, it may be necessary for academics from Faculty disciplines to devise minimal levels of disciplinary induction in the cognitive maps required for a graduate from each discipline so that a staged process toward building those maps may be possible. The introduction of 'bridging' or intensive preparatory programs that are integrated into the curriculum may need consideration. And clearly, particular attention will need to be paid to the ways in which assessment practices will ensure and uphold standards and help determine student understanding and readiness to advance in level of study.

It may also be necessary to put in place mechanisms to benchmark standards with students and/or graduates studying elsewhere where an interdisciplinary focus is not in place. One way this might be done is to ensure graduates meet benchmarked standards in the conceptual requirements of the discipline by comparing their learning outcomes with those of with 'single discipline' graduates from other comparable institutions.

In order to encourage interdisciplinarity, it might also be beneficial for the university to put in place mechanisms to recognise when interdisciplinary exchanges occur naturally, that is, when discipline problems demand them. These exchanges might be between students, staff and/or staff and students and processes to detect viable exchanges and to foster them would be helpful. In order to create and maintain an environment where such exchanges might occur, processes need to be put in place to allow students to gain enough expertise to recognise the value and need of interdisciplinary study and work. Formal 'fieldwork' programs, on-site experience, mentoring arrangements in real work situations, involvement in undergraduate workshops and conferences, and similar mechanisms will be likely to assist in the creation of such an environment.

In terms of preparing and supporting the on-going development of staff for multidisciplinary and interdisciplinary environments, new academic development programs may be necessary. These might focus

on developing a 'de-centring' of the academic self of the participants and allowing an appreciation of different world views. This would, perhaps, promote critical "conversations between disciplines, whilst retaining the integrity of those disciplines" ("Academic honesty and plagiarism", 2003; Davidson, 2004). One effect of such a program would hopefully be encouraging teaching and learning across the curriculum in a manner that does not violate disciplinary culture and values.

The evaluation of interdisciplinary teaching also needs careful thought. Recommended ways of undertaking this are outlined elsewhere (Field & Lee, 1992). For example, quantitative assessment measures are least valuable where the outcomes cannot be easily specified (as in the case with interdisciplinary studies). Qualitative measures which focus on student maturational development involving portfolio analysis and the College Outcomes Measures Project instrument (have been useful in some contexts in determining the development of appropriate skills. Measures need to be discussed and agreed upon within an institutional context and the systems used must feed into both recognition and reward, and quality assurance programs in the University.

Concluding remarks

The move toward the Melbourne Model and the incorporation of interdisciplinarity will bring many challenges to the University of Melbourne. It is hoped that such a move will also bring many advantages to student learning not typically found in traditional approaches to higher education through disciplinary studies. However, interdisciplinarity also brings unique epistemological and pedagogical issues to the fore. It is hoped that this paper will contribute usefully to discussion on these issues and on the important change in Australian higher education that is represented by the move to the Melbourne Model.

Notes

1. This paper is a longer version of a document produced for the *Academic Resources for Teaching and Learning Series*, Centre for the Study of Higher Education: The University of Melbourne.
2. Polanyi outlines clearly the way in which a medical student comes to "see" in a new way: "Think of a medical student attending a course in the X-ray diagnosis of pulmonary diseases. He watches, in a darkened room, shadowy traces on a fluorescent screen placed against a patient's chest, and hears the radiologists commenting to his assistants, in technical language, on the significant features of these shadows. At first, the student is completely puzzled. For he can see in the X-ray picture of a chest only the shadows of the heart and ribs, with a few spidery blotches between them. The experts seem to be romancing about figments of their imagination; he can see nothing that they are talking about. Then, as he goes on listening for a few weeks, looking at ever-new pictures of different cases, a tentative understanding will dawn upon him; he will gradually forget about the ribs and begin to see the lungs. And eventually, if he perseveres intelligently, a rich panorama of significant details will be revealed to him: of physiological variations and pathological changes, of scars, of chronic infections and signs of acute disease. He has entered a new world. He still sees only a fraction of what the experts can see, but the pictures are definitely making sense now and so do most of the comments made on them" (Polanyi, 1973).

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