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Interdisciplinarity: a literature review

Angelique Chettiparamb

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a literature review

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Tel: 023 8059 4814
Fax: 023 8059 4815

E-mail: llas@soton.ac.uk
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Dr Angelique Chettiparamb is Research Fellow in the School of City and Regional Planning, Cardiff University. Her research interests relate to design, planning and governance (particularly in relation to local government). She has researched local-government/community interfaces, meta-governance, social movements and their interface with globalisation, poverty, planning education and design development in water intensive climates. She has a theoretical interest in complexity theory and its application and is generally interested in planning theory and design theory. In terms of teaching she contributes to modules on planning in the UK and in developing countries.

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Introduction

In recent times, the theme of interdisciplinarity has gained popularity in policy, practice, teaching and research circles. Even as scepticism for the concept exists, it has now gained moral overtones with arguments for why interdisciplinarity is both desirable and inevitable. Within policy circles in UK interdisciplinarity has been largely normatively accepted. Thus in both teaching and research, the drive for interdisciplinarity is encouraged both through the Higher Education Academy and the Research Councils. This report provides an overview of the concept, its teaching (rather than research) implications and its current policy relevance, based purely on extensive literature review. Three types of literature sources were researched. The first of these was printed material, which included journals, research monographs and edited collections. The second was the Internet, focusing on websites of educational institutions, organisations and groups promoting interdisciplinarity. The third source concentrated on policy documents and government publications. The report is divided into five sections. The first clarifies the nature of disciplinarity, the second clarifies the nature of interdisciplinarity, the third moves into the realm of practice, the fourth focuses on interdisciplinary teaching, and the fifth and final section reviews the higher education policy context in UK.

1. Disciplinarity

Given the numerous nomenclatures, ideas and distinctions within the concept of interdisciplinarity, the first step is to present a review that seeks to clarify the meanings, understandings and debates surrounding the term. As the concept of interdisciplinarity cannot be fully understood without an understanding of the concept of disciplinarity (Menand 2001, cited in Bridges 2006, p. 261), the meaning and nature of disciplinarity is first clarified.

1.1. History

The term "discipline" etymologically links to the Latin term *disciplina* which means "the instruction given to a disciple" (http://www.etymonline.com/). The Oxford English Dictionary places the origin of the word in the Middle Ages. However, the historic origin of disciplines as a structuring mode for academic practice is placed differently depending on the geographical location and what feature of disciplines are being highlighted. While Struppa (2002) argues that the term has been around "since the very inception of western thought", Aram (2004, p. 380) and Turner (2006, p. 183) mention that the word has been in use since the Middle Ages, when universities first made their appearance in the western world in Paris and Bologna (Hearn 2003, p. 3). In the context of America, Chandler (2004, p. 358) links "discipline" to the period 1870-1900, which is when most universities in the US were established. Michel Foucault talks about an emergence in the 1970s of what he calls the "specific individual" who speaks from a particular disciplinary location (within the university), distinguished from the "universal individual" who "speaks as the conscience and consciousness of society" (Chandler 2004, p. 357, following Foucault 1980, pp. 126-27). Hearn (2003, p. 6) argues that disciplinary structures in the UK became entrenched in the mid-nineteenth century when the universities were subjected to major reforms that were conditioned by external cultural, economic and political factors. The historic point when disciplines are thought to have originated, the way in which disciplines are thought of, and the particular arguments that are sought to be advanced thus varies by country.

Reasons for what is seen as the main impetus for the emergence of disciplines are also many. For instance, Boisot (1972, p. 89) argues that the formation of disciplines has its origin in two tendencies. The first of these, he argues, arises from man's natural tendency to separate, classify and conceptualise the surroundings. The second arises from the need of science to take full advantage of accumulated knowledge. Aram, (2004, p. 380) following Lattuca (2001), comments that the advancement of disciplinary education in the US followed not only a commitment to science, but was also a result of the belief that citizens had to be educated in specialised fields in order to participate in the economic life of the country. Turner (2000, p. 48) makes the point that not all successful organisations of knowledge actually became a discipline. He puts the formation of disciplines down to challenges in "regularizing an internal market". For Turner, thus, disciplinarisation "is a kind of protectionist device that responds to the alteration of the markets by the action of others" (p. 50). In Cobban's analysis of the history of universities, the emphasis is placed on organisational action:

> The history of medieval universities reinforces that institutional responses must follow quickly upon academic achievement if the intellectual moment is not to be dissipated. The absence of regular organisation may initially

> provide a fillip for free-ranging inquiry, but perpetuation and controlled development can only be gained through an institutional framework. (Cobban 1975, quoted in Clark 1983, p. 4)

Three primary sources – science itself, the outside society and organisational factors – are thus identified, even if these factors do not really operate in isolation independent of each other.

1.2. General characteristics of disciplines

For Aram (2004) disciplines are "thought domains – quasi-stable, partially integrated, semi-autonomous intellectual conveniences – consisting of problems, theories, and methods of investigation" (p. 380). They are quasi-stable because they are continually changing and evolving, partially integrated, because they are internally fragmented and specialised, semi-autonomous, because the boundary of each discipline cannot be clearly defined. Parker (2002) puts forward the notion that a discipline is "a complex structure: to be engaged in a discipline is to shape, and be shaped by, the subject, to be part of a scholarly community, to engage with fellow students – to become 'disciplined"' (p. 374). She makes a distinction between the subject and the discipline in that the former is skill and knowledge based, while the latter is modelled more on the lines of wisdom, which provides the value and rationale for the acquisition of the former.

Turner (2000) provides a further conceptualisation:

> Disciplines are kinds of collectivities that include a large proportion of persons holding degrees with the same differentiating specialisation name, which are organised in part into degree-granting units that in part give degree-granting positions and powers to persons holding these degrees; persons holding degrees of this particular specialised kind are employed in positions that give degree-granting powers to them, such that there is an actual exchange of students between different degree-granting institutions offering degrees in what is understood to be the same specialisation. (p. 47)

Various general characteristics of disciplines are thus emphasised. Even when they overlap, these characteristics can be discerned as belonging to three standpoints that emphasise particular aspects. The first of these standpoints emanates from a scientific-epistemological approach and clarifies analytical features of what might constitute a discipline. The second emphasises and relates the discipline to society, while the third stresses the institutional/organisational aspect of disciplines.

1.3. Distinguishing characteristics of disciplines

The specific forms that disciplines acquire over place and time are varied (Becher 1989; Clark 1983; OECD 1972). However, there are broad understandings of how in general terms disciplines might distinguish themselves from each other. Following the varying approaches to understanding disciplinarity, particular ways in which each discipline is understood to forge its distinctive characteristic can also be discerned. Again, the first emanates from a scientific-epistemological approach and distinguishes between concepts, methods and ways of knowing that are specific to a discipline. The second

discerns ways in which the disciplines come to be socially embedded and practically realised with respect to a larger external society. The third takes a more organisational view, focusing on how knowledge is institutionally organised and structured.

Boisot (1972) provides a definition in scientific terms. He argues that a discipline is a structure with three elements. These are:

- observable and/or formalised objects, both manipulated by means of methods and procedures
- phenomena that are the materialisation of the interaction between these objects
- laws – whose terms and/or formulation depend on a set of axioms. These account for the phenomena and make it possible to predict how they operate. (p. 90)

Squires (1992) identifies three rather more sophisticated dimensions to distinguish between disciplines:

- what they are about (object)
- their stance towards that object, in terms of a concern with knowing, doing or being
- the extent to which they are operating in a normal (in the sense of Kuhn 1962), reflexive or philosophical mode (p. 202).

The first of these is concerned with the content, the topics and problems that are addressed. The second is concerned with the methods, techniques and procedures that a discipline adopts in the furtherance of knowledge. The third relates to "the extent to which the discipline treats its own nature as the subject of reflexive analysis" (p. 202).

Heckhausen (1972) analyses disciplines rather finely and advances seven criteria on which disciplines might distinguish themselves. These are:

- the "material field", which "comprises the set of objects in an understanding on the common sense level" (p. 83) (e.g. zoology with animals)
- the "subject-matter" of the discipline, which is the "the point of view from which a discipline looks upon the material field" (p. 84)
- the "level of theoretical integration", which denotes the "categorical nature of relevant observables" (p. 84) (e.g. one can imagine chemistry being constituted at a lower – purely in terms of the hierarchy proposed by general systems theory – theoretical level of integration than say biology or physics)
- the "methods" of a discipline which it uses "first, to get at the observables of its subject matter; or, second, to transform observables into data which are more specific for the problem under investigation" (p. 85)
- the "analytical tools" of the discipline, which "rest on strategies of logic, on mathematical reasoning and on model construction" (p. 85)
- the "applications of a discipline in fields of practice" (e.g. applied fields are more eclectic) (p. 86)
- the extra disciplinary "historical contingencies" which influence the discipline (p. 86).

Other models of disciplines are described also in Biglan (1973), Kolb (1981) and Donald (1986).

Depending on the level of sophistication and detail one wants and needs to engage in, disciplines have thus been understood in different ways using different sets of criteria. Those reviewed above tend to place an emphasis on the distinguishing features that are largely internal to science. In addition to these, disciplines are also seen as social constructs, and are described in social terms. Price (1970, cited in Becher 1989, p. 20), points out that differences in the substantive content lead to differences in the social practice of the disciplines. Consequently disciplines are likened sometimes to the concept of paradigms advanced by Thomas Kuhn. For Kuhn (1962), disciplines are characterised by three elements: symbolic generalisations, models and exemplars. These, he argues, shape scientific communities and define problems and solutions. Whitley (2000, quoted in Aram 2004, p. 381) defines disciplines as "reputational work organisations" that are engaged in the production of knowledge. The social side of science is highlighted here. Following empirical studies, Shinn (1982, quoted in Becher 1989, p. 20) observes that "the internal structure of the cognitive and social arrangements match" and that "epistemic factors and scientific instrumentation" do not provide a full explanation without "social elements". Apostel (1972) goes so far as to say that "a discipline does not exist. A science does not exist. There are persons and groups practising the same science or the same discipline." (p. 147) In other words a discipline can only be defined by indicating:

1. P: a group of persons
2. A: a set of actions, performed by these persons
3. I: a set of interactions or communications, among these persons and to other persons
4. E: a method of regenerating the set of persons by means of certain communications of an educational nature
5. L: a set of historic learning methods. (p. 146)

Further, according to Huber (1992) "a discipline also functions as a vehicle for the reproduction of social structures while in turn having its social structures reproduced by them" (p. 193). From a more anthropological perspective Becher (1989) identifies "devices" that academics employ for demarcating and defining their academic "territory". These constitute idols, pictures, books, artefacts, traditions, customs, practices, language, terms of appraisal, symbolism adopted, transmitted knowledge, beliefs, morals, values, rules of conduct, shared meanings, specially reconstructed histories, heroes, myths and legends.

Besides factors that are internal to science and social factors, the third way of approaching and distinguishing between disciplines links knowledge production to organisational structures found in universities. Lodahl and Gordon (1972, cited in Becher 1989, p. 20) remark on "the intimate relations between the structure of knowledge in different fields and the vastly different styles with which university departments operate". According to Aram (2004), the organisational embedding of disciplines creates "a heightened sense of autonomy, definitiveness and stability" (p. 381). For Turner (2000), academic departments that represent disciplines can be in essence interchanged with similar departments in other universities. He argues that within disciplines "hiring, tenuring, promoting, advising, granting degrees, placing students and so forth are, in a great many important respects, the same" (p. 46). So the discipline according to Turner has to have distinct elements in order to distinguish itself: a nominal

element that involves a name; "actual facts of employment" that involve people trained in the discipline; and also the beginnings of a market for the employment of those trained in the discipline.

Different ways of distinguishing between disciplines lead one to conclude that knowledge domains can only be understood by taking cognisance of the type of knowledge, methods and practices of a scientific community, the ways in which these practices are socially validated, and the ways in which they constitute definite organisational entities that are specific to different cultures, spaces and times.

1.4. Change in disciplines

An understanding of the nature of disciplines is complemented by an understanding of variations and change within disciplines. Changes in disciplines can be discussed in terms of both space (stressing geographical differences) and time (stressing historic changes). Many cross-national studies have attempted to isolate the differences and similarities between disciplines as practised in different countries over time.

One of the most influential of such studies is that conducted by Burton R. Clark on higher education from a systems viewpoint. Discussing the influences of the inherent nature of knowledge on the academic system, and following Meyer (1977), Clark remarks that:

> we have thus come close to saying that knowledge is an actor, that it determines tasks and groups. But naturally it is not: persons and groups act on its behalf, and the ways in which educational groups are composed and controlled shape the ways in which knowledge is bundled. As educational institutions in general evolve, they develop categories of knowledge and thereby determine that certain types of knowledge exist and are authoritative. (p. 26)

In other words, knowledge is linked to discipline: "[the discipline] specialises by subject, that is, by knowledge domain" (p. 29).

However, Clark notes that "the discipline (or profession) is also comprehensive in that it does not specialise by locality but rather pulls together a craftlike community of interest that reaches across large territories" (p. 29). The disciplinary dimension is important since, according to Clark, "it is the discipline mode of organisation that has rendered higher education, over time and space, basically meta-national and international, much more than elementary or secondary education" (p. 29) and "despite the common tendency to overlook the importance of the discipline, it can readily be seen as the primary mode" (p. 30).

The primacy accorded to disciplines is largely in tension with the earlier proposition made for the primacy of social and institutional factors. The tension is resolved by conceptualising differences in higher education across countries as a result of the interaction of disciplines which cut across local boundaries, and local factors that are crystallised in what he calls enterprises. These are essentially the institutions. Thus: "In the academic world, the disciplines are 'product lines', and the enterprises are

geographically centred. The representatives of the first criss-cross the representatives of the second." (p. 31)

Clark points further to two ways of approaching the study of higher education. Those who research scholarship inevitably focus on disciplines as they explain the primary commitment. Those who research the teaching and service commitments highlight the factors connected to enterprise. Thus: "Disciplines pressure institutions to be scholarly, and sometimes to be interested in research. Institutions pressure disciplines to be student-centred, and sometimes to be cognisant of other fields of study." (p. 32) Jamison (1982, quoted in Becher 1989) points out that "for most of its recent history, natural science has been affected by particular national styles in terms of the direction of scientific research, the form that scientific conceptualisation has taken and the intensity of scientific development" (p. 21). The similar yet different model of variation over space is also highlighted by Ruscio (1987, cited in Becher 1989, p. 21) when he makes the point that even though there might exist substantial variation in the manifestation of disciplines, they nevertheless do share an "endemic culture" that is unique to the discipline. Becher, who also conducted another cross-national empirical study, found that people were able to talk about "typical French papers" (p. 21) that denoted a geographical marker. Thus we may conclude that even when disciplines constitute a force in itself they are geographically mediated in their final manifestation.

Studies in changes in disciplines over time present a consistent picture of disciplinary fragmentation. Clark (1983) argues that traditionally disciplines display a high degree of resistance to external change. Oxford and Cambridge, for example, as institutions resisted change in their disciplinary structures for decades; this was primarily due to the self-sufficiency of their organisation. Disciplines are nonetheless subject to mutation and proliferation from within. This proliferation is more pronounced in some disciplines than others and it spills out from "dynamic centres to the more placid peripheries" (p. 207). The study by Dogan and Pahre (1990) creates a slightly different picture. Their study was based on "innovation" and its relation to the disciplines, especially those within the social sciences. They argue that knowledge accumulation in science creates scientific specialisation because of divisions of ideology, epistemology, methodology or theory. As a result the discipline becomes "unknown and unknowable" since "no theory or conceptual framework can continue to encompass the entire field" (p. 58). This results in fragmentation. As the density of scholars working in the core area of the discipline increases, more scholars move along the fragmented zones. Fragments in a discipline eventually confront other fragments from other disciplines and lose contact with fragments in the parent discipline. When the fragments combine hybridisation occurs. A hybrid zone need not always be institutionalised, though it can be. Once institutionalised, it attracts more and more scholars, which eventually leads it to repeat the process of specialisation and fragmentation. Dogan and Pahre show that innovation is most likely to happen in the hybrid zone; academics working here can easily become "hybrid critics" as they look back with fresh insights at their parent discipline and identify lacunae and gaps.

Disciplines are thus not static wholes that exhibit constant character across time and space. They are variable in space by virtue of enterprise and fragmentation and recombination in time. Nonetheless, disciplines still possess and retain characteristics that make them identifiable as disciplines.

1.5. Normative debate for and against disciplinarity

There are two main strands in the normative argument surrounding disciplinarity. The first of these presents an argument of what disciplines do for the advancement of scientific thought. The second stresses a social perspective. Within the second strand, one line of thought is more internal and emphasises what disciplines do for academics as social entities. The other perspective looks outwards and comments on what disciplines do for society at large.

According to Finkenthal (2001, cited in Aram 2004, p. 380), disciplines are involved in the development of concepts that are far removed from direct sensory experience. The concepts are discipline specific and provide what is commonly recognised as depth of inquiry for the investigation. It is the restriction of a discipline to a particular mode of inquiry that enables this. Thus Dogan and Pahre (1990, p. 116) quote from Sartori (1969, p. 66): "Each discipline throws light on a set of variables precisely because other factors are assumed to be external, distal, and equal." An analytical simplification is recognised as necessary for clarifying and exploring causal relationships and the distinctiveness of each discipline is celebrated. Thus for Geertz (1983) human thought is to be understood not by concentrating on the commonalities between disciplines, but on the differences of disciplinary traditions.

The second argument for disciplinarity advances the view that it is by means of disciplines that "thinking traditions" take shape. Mills (n.d.) argues that disciplines are provide a "theoretical triangulation point" that is necessary if one is to make sense of new perspectives and horizons. He provides reasons why disciplinary affiliations are beneficial, arguing firstly that disciplines have contributed immensely to the production of knowledge. They serve the "vital function of curating, preserving and defending humanistic knowledge" by offering checks and balances together with archival logic through disciplinary journals and books. Michael Oakeshott (1989, p. 134 quoted in Mills, unpublished) argues that:

> Each techne is, or involves, a particular manner of thinking, and the notion that you can think but without thinking in a particular manner, without reference to some definite universe of discourse, is a philosophical illusion. Every true 'techne' profoundly studied, knows something of its own limits, because it has some insight into its own presuppositions.

Third, the value of disciplines is also tied to the idea of rigour. Thus Klein argues: "When tied to the detection of error and the value of an epistemic community for testing new work, 'discipline' has an undeniably positive value." (1986, quoted in Weingart 2000, p. 29) A similar virtue for disciplines is argued in Bridges (2006) when he claims:

> The reason why we might give special attention to research - and urge others to do likewise – lies, on this view, in its claims (i) to be based on sustained enquiry; (ii) to be enquiry characterised by the qualities of care and thoroughness contained in the everyday sense of the systematic; and (iii) in its claims to be systematic in this slightly more technical sense of a rule governed system of enquiry. Such rule government constitutes the discipline of the form of enquiry – and when such discipline is sufficiently well developed and differentiated it enables us to refer to the system as a discipline. (p.264)

Hunt (1991, quoted in Bridges 2006, p. 264) further argues that: "The discipline of a discipline, by which I mean the rules of conduct governing argument within a discipline, does have a worthy function. Such rules make a community of arguers possible."

Fourthly, from an internal social perspective, Henkel (2000) in a multi-national study of identity change in academics concludes that: "Many academic values were embedded in concepts of the discipline and often expressed in a language shared by members of the discipline. Academic concepts of higher education continued to be strongly linked with the value of education within a discipline." (p. 256)

Fifthly, Turner (2000) argues that the main contribution of disciplines is to provide what he calls a market discipline. This is the training of people in "fundamentally the same way" (p. 52) that allows the acquisition of certain skills or knowledge that enables them to meet the demands of the market by "privileged access" (p. 64). Henkel (2000), in her study of academic identities, also agrees:

> Engagement with the main principles, concepts, theories and debates of a discipline made it possible to develop knowledge, skills and values that were needed by individuals and their society as well as by the economy. It could however, also be an excellent preparation for the labour market. Many academics believed that they could best fulfil their responsibility to their students in this way. (p.256)

The corresponding arguments against disciplines are also many. One of the most commonly found arguments is that they are limiting in the quest for truth. Thus Griffith and Miller (1970) observe that "the focusing of the group's attention on a single series of phenomena and the development of a distinctive scientific style results in a considerable restriction of the range of information regarded as relevant" (quoted in Becher 1989, p. 46). Campbell (1969) argues that disciplinarity leaves vacant the "interstitial gaps".

Second, disciplinarity is often seen as the pursuit of "more of the same", in the sense that creativity and innovation is, with the passage of time, seen to occur less within disciplines. Thus Dogan (1996, p. 296) argues that: "The fruitful point of contact is established between sectors and not along disciplinary boundaries."

Third, disciplinary practitioners can very often be so socialised into their disciplines that they lose their reflexivity. As Bridges (2006, pp. 265-266) points out: "The more firmly established a discipline the less explicit is people's awareness of its rules. It is in the formation and development of new patterns of enquiry that people are especially aware of what is distinctive about it."

Fourth, disciplinarity is perceived as not lending itself to addressing problems in the real world. Thus the OECD (1982), in a report on the linkages of universities to communities, named one of its chapters "Communities Have Problems, Universities Have Departments".

Fifth, disciplines have a tendency to lose sight of the amount of knowledge not accessible to it by the very limitation of its boundaries. This can lead to imperialistic

trends. Lichnerowicz (1972) points out that a discipline "is a *privileged viewpoint* over a large fraction of the world and is thereby very *imperialistic* towards other competing disciplines" (p. 122) (original emphasis).

Sixth, disciplines without hybridisation are eventually likely to become "crowded", yielding less and less knowledge (Dogan and Pahre 1990). The Interdisciplinary Studies teaching staff at Wayne State University pose the following question:

> Imagine that you have been a photographer for the past twenty years and then decided to quit. Let's say you never read much literature before, and chose it as your next speciality. Couldn't we say that now, after making this move, you are learning more in one day than you learned before in one month? Couldn't we say that you are now expanding your horizons at a faster rate and having more fun to boot? (www.is.wayne.edu/ISPInfo/WhatIsIS.htm accessed 12 September 2005).

Seven, Becher (1989) points to negative social aspects of disciplinary organisation (true for at least some disciplines):

> when the patriotic feelings within a discipline are high, deviations from the common cultural norms will be penalised and attempts to modify them from the outside will be rejected. Any systematic questioning of the accepted disciplinary ideology will be seen as heresy and may be punished by expulsion: any infiltration of alien values and practices will be appropriately dealt with, either by direct resistance or by incorporation into the prevailing framework of thinking. (p. 37)

Furthermore, Becher shows how disciplines in social terms give rise to hierarchies in academic life resulting in pecking orders, elites and gatekeepers within which new entrants must "find their place".

Eight, Dogan and Pahre (1990, p. 85) problematise the internal social and organisational logic of disciplines with the inherent logic of research. They argue that even when organisational attributes such as hiring, promotion, peer review, teaching and administration are organised and jealously guarded along disciplinary lines, in research terms, the sovereignty of disciplines are threatened. They further argue that at least in the case of the social sciences, many disciplines do not have a very strong core, with sub-disciplines being grouped together mainly because the people working in them have a "residual feeling of common identity" (p. 84).

Becher (1989) sums up the discussion for and against disciplinarity when he says "to see the whole is to see it in breadth, but without access to the particular vision: to see the part is to see it in depth, but in the absence of the general overview" (p. 50).

1.6. Summary

The literature on disciplinarity has been reviewed so far. The period in which the notion of disciplines came to be used in the sense it is used today varies. It is placed by various authors in various times, depending upon the geographical location and the particular aspects of disciplinarity that is being discussed. General characteristics of disciplines were then reviewed, picking up three approaches for attempting to understand disciplines. These are the scientific-epistemological, the social and the organisational approaches. These three ways of looking at disciplines are also mirrored in ways of distinguishing between disciplines. Geographical and temporal variations of disciplines respectively highlight the importance of context and dynamic evolutionary aspects within disciplines. Finally, normative debates surrounding disciplinarity have been reviewed both from a scientific viewpoint and from a social viewpoint, the latter being discussed both with reference to what disciplines do for academics as well as what they do for society.

2. Interdisciplinarity

2.1. History

Roberta Frank (1988, cited in Klein, 1996, p. 8) places the origin of the term interdisciplinarity within the Social Science Research Council, when the term was used as a kind of 'bureaucratic shorthand' for research involving two or more professional societies. However, the first citation in *Webster's Ninth New Collegiate Dictionary* and *A Supplement to the Oxford English Dictionary* refers to a December 1937 issue of the *Journal of Educational Sociology* along with a notice for Post Doctoral Fellowships for the SSRC (Klein 1996, following Frank 1988).

Interdisciplinarity has since been promoted by several movements. One of these is the Unity of Science movement which campaigned in the 1930s and 1940s in the West. The search for "grand and simplifying concepts" such as the second law of thermodynamics, mass-energy equivalence, quantum mechanics and general systems theory have also promoted interdisciplinarity (Klein 2000, p. 5). The concept gained momentum in the US with the student unrests in the late 1960s. One of the demands during this unrest was for disciplinary structures in universities to be removed and replaced by more holistic concepts that were closer to practical life. Later the concept of interdisciplinarity came to denote reform, innovation and progress (Weingart and Stehr, 2000, p. xii). In 1972, following extensive cross-national research, the OECD published the seminal volume *Interdisciplinarity*, which sought to promote interdisciplinarity in teaching and university organisational structures. Several studies and conferences followed. However, when the OECD reviewed interdisciplinarity in *Interdisciplinarity Revisited* a decade and a half later, they found that interdisciplinarity had lost its momentum and that departments and faculties were not only back but were in fact strengthened (Weingart 2000, following Levin and Lind 1985, p. 9).

Klein (1996, pp. 20-21) citing Peterson (1990, p. 223) highlights the argument that there are fewer interdisciplinary programmes now than in the 1970s. But, she notes, if one were to look beyond organisation charts, interdisciplinary activities will be seen to be occupying a larger amount of staff time. She cites Clayton's (1984, 1985) conclusion that even though "overt interdisciplinarity" may not have made much progress, "the concealed reality of interdisciplinarity" is in fact flourishing behind the "subject façades". Bechtel (1986) found that only about 20% of projects in targeted government programmes were interdisciplinary; the rate was nonetheless substantially higher in supposedly disciplinary programmes. Thus interdisciplinarity was not keeping a close fit with organisational structures in universities.

Klein (2000) notes that "for most of the twentieth century, the question of knowledge has been framed by disciplinarity" (p. 3). She argues that: "Over the course of this century, metaphors of knowledge have shifted from the static logic of a foundation and a structure to the dynamic properties of a network, a web, a system, and a field." (p. 21) This has caused some observers to remark that the notion of disciplines is artificial and is now breaking down into a postdisciplinary world (Turner 2006, p. 184, Rosamond 2006).

The interdisciplinary literature nevertheless has a strong North American bias. Klein (1985) notes this with respect to interdisciplinary problem-focused research. More than a decade later, Payne (1999) notes that from 1986 to 1996, the growth of institutions offering interdisciplinary programmes in US was reported as over 36%, while the growth of programmes itself increased almost 75%. He concludes that "the interdisciplinary movement in American higher education appears to be a significant and continuing one" (p. 175).

2.2. Disciplinarity and interdisciplinarity

Arguments for interdisciplinarity generally stem from debates surrounding disciplinarity. Within arguments for interdisciplinarity, two main threads can be found. The first argues for interdisciplinarity normatively, positioning it either in terms of filling the gaps that disciplinarity leaves vacant or in terms of transcendence surpassing what disciplinarity can ever hope to achieve.

Within the normative argument, which argues for the gap filling role of interdisciplinarity, Brewer (1995, quoted in 1999, p. 327) with respect to environmental issues writes:

> much high quality science illuminates environmental problems, but it is often poorly organised or incomplete. It often does not have an interdisciplinary integration and synthesis that permit problems to be seen in a larger context, especially in an ecologically sensitive and sensible one. It is often not geared to the scale needed to shed light on environmental problems of long-term importance to human well-being. In short, much essential knowledge is not capable of guiding the development of policy, heightening public awareness, or even informing and enlightening political debate.

The contrast with disciplinarity continues, when Brewer notes that: "Problems designate theory and methods, not the reverse, in sharp contrast to discipline-based and curiosity-driven inquiry." (p. 328) However, problems however are constructed rather than given; they constitute a representation that might often be limited or biased by human experience and expectation. Since this representation is susceptible to manipulation towards favoured constructions, multiple disciplines, perspectives and methods are necessary: "Specialised views, theories and tools must be tested and applied by bringing them into interaction with views, theories and tools from different fields of inquiry" (1995, quoted in 1999, p. 327), as "any method has blind spots that focus attention on highly selected aspects of a problem while blocking it out for others (1999, pp. 329-330, citing Stern, 1986). Brewer here argues normatively for interdisciplinarity from a problem-focused viewpoint. Integration, synthesis, contextualisation, scale relevance, validation of disciplinary worldviews, theories and methods, and concern for longer temporal horizons are claimed for interdisciplinarity.

A broadly similar argument can be found in Rosamond's (2006) call for interdisciplinarity with regard to studies in globalisation. He notes "academic conversations are, by and large, introverted and self referential affairs" (p. 517), due to which "our extant academic universe is congenitally incapable of dealing with globalisation" (p. 517, following Smith 1998). The argument advances:

> is nothing less than an invitation to think about the pathological constraints that disciplinarity imposes upon the development of knowledge about globalisation and its consequences. Aside from reifying themselves to the extent that their internal criteria for the judgement of rigour and excellence became dynamic contributors to their production regardless of whether or how their objects of study are changing. (p. 518)

In his review of Sorensen's (2004) work, Rosamond mentions the author's consciousness of ways in which theoretical starting points induce particular types of analysis and foreclose the possibility of certain other conclusions. Citing from Sorenson, Rosamond makes the following point:

> If realists want to make a serious contribution (sic) to the debate about what happens to the state, it is necessary to modify some of their core assumptions. If they do not, they will remain painted into a corner where the realist state-centric position is always vindicated, irrespective of what happens in the *real world,* because the unassailable power of the state is built into the realist assumptions about the worlds. This reduces the realist state-centric view to a mere matter of faith and the debate with retreat scholars is turned into a 'religious' shouting competition instead of *an analytical endeavour to find out what is actually happening*. (pp.521-522) (emphasis added by Rosamond)

Rosamond goes on to conclude that: "Disciplinarity has undoubtedly shaped the developing area of globalisation studies in a negative sense, but interdisciplinarity will only make a difference if epistemological radical speaks to epistemological radical across the disciplinary divide." (p. 530)

In addition to the above problem-focused argument for interdisciplinarity, the more theory driven argument calls for transcendence, of disciplines. Thus in an interview with Ruiz published in the e-journal *Interculture*, Leitch states:

> In recent decades, not surprisingly, the autonomy of many academic disciplines has given way, to a greater or lesser extent. It seems an era of interdisciplinarity. "Theory" is born out of this moment. It is an unstable fusion of literary studies, linguistics, psychoanalysis, anthropology, Marxism, philosophy, gender studies, poststructuralism, new historicisms, postcolonial and ethnic studies, an open-ended postmodern assemblage that displaces the modernist formalism dominant from the 1930s to the 1960s in the US. (www.fsu.edu/~proghum/interculture/VB%20Interview.htm accessed 12 September 2005).

Similarly Stember (1991, cited in Payne 1999, p. 176) suggests that in a transdisciplinary inquiry the attempt is to integrate disciplines to the extent that the disciplines themselves disappear and a unitary type of inquiry emerges.

The normative dimension of interdisciplinarity is sometimes stressed. For instance Romm (1998) advances "an argument for seeing interdisciplinary practice as tied to reflexivity" (quoted in Payne 1999, p. 173). She emphasises the potential of interdisciplinarity to enhance both "democratisation of knowledge construction

processes in society" (quoted in Payne, 1999, p. 173), and "discursive accountability" (quoted in Payne 1999, p. 173). Yet another argument on similar lines, depicting the interaction between interdisciplinarity and disciplinarity in terms of postmodern interdisciplinarity can be found in the interview with Leitch cited above. He clarifies as follows:

> Whereas modern interdisciplinarity dreams of the end of disciplines with their awful jargon and fallacious divisions of knowledge, the newer postmodern interdisciplinarity respects difference and heterogeneity, proliferating several dozen new interdisciplines such as black studies, women's studies, media studies, cultural studies, postcolonial studies, science studies, disability studies, body studies, queer studies, etc. Significantly, these fields directly challenge modern humanistic objectivity and the idea of the university as a serene ivory tower, organised and disengaged. They struggle against the hegemonic order, have activist roots; engage in community outreach of a political sort. Yet, still and all, they submit to modern disciplinarity, its requirements, standards, certifications as well as its methods (exercises, exams, rankings, supervision, norms). So it's a mixed phenomenon, postmodern interdisciplinarity.

However, both the normative dimension and the paradigmatic dimensions claimed for interdisciplinarity are challenged by Payne (1999). He argues that interdisciplinarity in practice need not always include "reflexive potentials for knowledge construction" (p. 174). He argues that how diverse insights from various disciplines can be integrated is a key interdisciplinary concern. Towards this, he cites Klein (1990, p. 188), who argues that interdisciplinarity is "neither a subject matter nor a body of content. It is a process for achieving an integrative synthesis, a process that usually begins with a problem, question, topic, or issue" (p. 175). Further he cites Newell's (1997) attempt to disengage interdisciplinarity from critical, postmodern or any such paradigms, no matter how sympathetic to those worldviews one might be. Newell warns "of the risk to future interdisciplinary development of having critics of it ascribe radically political, feminist, or postmodern assumptions to all interdisciplinary studies" (Payne 1999, p. 177).

Besides the normative arguments, the second type of argument for interdisciplinarity is more phenomenological in the sense that it emanates from observations of practice. This view posits that interdisciplinarity already exists within disciplines. The organisation of disciplinarity and interdisciplinarity is intertwined historically, with interdisciplinarity (most often) quietly flourishing within disciplines. Thus Klein (2000, p. 8) argues: "The space of interdisciplinarity is not just *out* there – interdisciplinarity activity these days may be *in* the heart of disciplinary practice." Dogan and Pahre (1990) show how specialisation and hybridisation in disciplines are in fact in the nature of knowledge advance, while Klein (1996) opines:

> The interactions and re-organisations that boundary crossing creates are as central to the production and organisation of knowledge as boundary formation and maintenance and further that [c]lose inspection of boundary crossing reveals that disciplinarity and interdisciplinarity are productive tensions in a dynamic of supplement, complement and critique. (p. 2)

Interdisciplinary knowledge strengthens connections between disciplines and in that process it weakens the division of labour in disciplines, exposes gaps, stimulates cross-fertilisation and creates new field of focus for knowledge inquiry (Klein 2000, p. 18).

Nissani, (1997) lists ten points in an exultation of interdisciplinarity:

1. Creativity often requires interdisciplinary knowledge.
2. Immigrants often make important contributions to their new field.
3. Disciplinarians often commit errors which can be best detected by people familiar with two or more disciplines.
4. Some worthwhile topics of research fall in the interstices between the traditional disciplines.
5. Many intellectual, social and practical problems require interdisciplinary approaches.
6. Interdisciplinary knowledge and research serve to remind us of the unity-of-knowledge ideal.
7. Interdisciplinarians enjoy greater flexibility in their research.
8. More so than narrow disciplinarians, interdisciplinarians often treat themselves to the intellectual equivalent of travelling in new lands.
9. Interdisciplinarians may help breach communication gaps in the modern academy, thereby helping to mobilise its enormous intellectual resources in the cause of greater social rationality and justice.
10. By bridging fragmented disciplines, interdisciplinarians might play a role in defence of academic freedom. (p. 201)

There are naturally counter arguments for interdisciplinarity. One is that interdisciplinarity is parasitical and cannot exist without disciplines. When institutionalised, interdisciplinarity "uses up" disciplines. It is a "sink" which does not contribute to the "source" (Hansson 1999, p. 340). A further argument is that interdisciplinarity is very difficult to achieve in practice. Creative ideas arise in idiosyncratic ways and are not a matter of organisation of knowledge. Thus knowledge cannot be guaranteed and produced on demand. Other factors such as "working together with", "understanding other researchers", "personal chemistry" and "subjective feelings of good will among researchers" have all been purported to contribute more to collective success (Hansson 1999, p. 340).

Witte and Robitscher (1999) point to other pitfalls such as a "bland intellectual ecumenism", which tends to flatten out all disciplines into one collective discourse or set of methods. They note the danger of interdisciplinarity itself becoming a discipline, with its own perpetuating bureaucratic machinery. And they identify the potential for a perceived degree of superficiality in interdisciplinarity, where it can be "an invitation to silliness and untutored speculation" to the extent of even legitimating dilettantism.

There are thus different modes and ways in which interdisciplinarity connects to disciplinarity. It has been argued that both limit themselves to distinct problem domains. When interdisciplinarity emerges, sometimes it is conceived in opposition to disciplinarity, in which case, there is normally an accompanying normative discourse. The normativity within interdisciplinarity has also come up for discussion with standpoints advocating caution. At other times disciplinarity and interdisciplinarity are seen as

intertwined, with one complementing and enabling the other. Cynicism in the discourse of interdisciplinarity has also appeared.

2.3. Discipline - interdiscipline linkages

In this section the actual ways in which discipline-interdiscipline linkages are built/can be built are examined.

Following an extensive study on interdisciplinarity in universities, OECD (1972) reported on some general principles that they discerned in the actual practice of interdisciplinarity. These are summarised below:

1. "*No constant relationship exists between the idea of regrouping disciplines and that of an interaction between the disciplines and regrouping people.*" Essentially this finding reports that very often in pedagogy, teaching exists in a rather ad hoc way with students left to make sense of the whole. There was hardly any team teaching effort.

2. Mostly disciplines are regrouped around a field of study rather than on the basis of a structure of knowledge or of learning algorithms.

3. The number of regrouped disciplines can be extremely variable. Ranging from two to three to as many as more than twenty.

4. Criteria employed for regrouping varied. However a typology was identified as follows:
   - re-grouping one or several theory-oriented disciplines within or several rather practice-oriented disciplines
   - regrouping disciplines which are largely homogeneous (purely practical one, purely theoretical ones).
   - regrouping a set of exact sciences and one or several social sciences
   - regrouping a set of social sciences with one or two exact sciences, whether the latter be considered as a tool of the social sciences or as a part of the rigorous intellectual training required
   - regrouping on the basis of similarity or the amount of shared areas
   - regrouping on the basis of disciplinarity or heterogeneity
   - combined study of a set of methodologies independent of their object
   - ratural regroupings, meaning regroupings that at the same time respect scientific traditions, the interaction of their objects and methodological requirements.

5. It was reported that no systematic conclusion could be drawn for how integration should occur or for how much emphasis each discipline should receive. (pp. 39-42)

Darden and Maull (1977, cited in Klein 2000, p. 6) examine how discipline-interdisciplinary linkages might occur in the interaction of two fields. According to them, a "field" denotes a central problem with a domain of related things, explanatory factors, goals, techniques, methods, concepts, laws and theories. When there is interaction between two fields we then have "interfield theory". Generally in science integration

tends to be local. Bechtel (1986, quoted in Klein 2000, p. 6) identified five patterns of disciplinary relations. These are:

- developing conceptual links using a perspective in one discipline to modify a perspective in another discipline
- recognising a new level of organisation with its own processes in order to solve unsolved problems in existing field
- using research techniques developed in one discipline to elaborate a theoretical model in another
- modifying and extending a theoretical framework from one domain to apply in another
- developing a new theoretical framework that may reconceptualise research in separate domain as it attempts to integrate them.

Almost in parallel to the above, Karlqvist (1999) notes that there are five modes of interdisciplinary research as follows:

- Mode 1 is concerned with unification of knowledge. Here the attempt is to demonstrate that two things are actually the manifestation of the same structure. If this happens new theory forms and new methods develop.
- Mode 2 is concerned with addition or accumulation of knowledge from many fields to address a common goal. There is no challenge to each other's discipline in this instance.
- Mode 3 is when knowledge is compatible but needs additional interpretation to be meaningful. One example in the case of systems science, which is sometimes described as being more of an art or craft than a science.
- Mode 4 is when not only theories but also underlying assumptions and paradigmatic bases for theories are different as in the cases where the natural sciences and social sciences come together.
- Mode 5 is when the repertoires of theories and methods are different and also interpretive and conceptual differences in culture exist.

The above five modes also correspond to the following gaps:

- doing the same thing in different ways
- doing different things that can be combined
- doing different things that cannot be combined absent an additional framework
- doing things differently
- thinking differently.

For Klein (2000):

> An intersection is a system of negotiating contexts. Most intersections involve techniques, specialised skills and instruments. Intersections, though, also occur in interpretive phases, from borrowing vocabulary and ideas to theoretical explanations such as new grounding of 'valence' and 'gene' in other disciplines. (p. 9)

Ways in which interrelations are forged between disciplines might thus vary. At times it might be conceptualisations such as the conceptualisation of genes to be a part of chromosomes, which link disciplines together (for example, genetics and molecular biology). Sometimes disciplines are connected by overlapping foci, principles or theory, such as in the case of physics and chemistry. At other times one discipline might be absorbed into another as astronomy can be absorbed into physics. Also two disciplines can join together to form a more unified discipline, such as geometry and arithmetics merging to form mathematical science (Klein 2000, pp. 18-19).

Interdisciplinarity can thus have different types of relations with disciplinarity, each of which involves different scientific levels with accompanying differences in the types of challenges faced.

2.4. Types of interdisciplinarity

Following from the ways in which interdisciplinarity relates to disciplines, the former has been classified in different ways. These classifications lend conceptual clarity to the notion. They are discussed below.

The most commonly used classification of types of interdisciplinarity is provided by OECD (1972, pp. 25-26). Here four classes of interdisciplinarity are identified. These are:

1. Multidisciplinary […] juxtaposition of various disciplines, sometimes with no apparent connection between them, e.g. music + mathematics + history.
2. Pluridisciplinary […] juxtaposition of various disciplines, assumed to be more or less related, e.g. mathematics + physics, or French + Latin + Greek: "classical humanities" in France.
3. Interdisciplinary […] an adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organising concepts, methodologies, procedures, epistemologies, terminologies, data leading to an organisation of research and education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge (disciplines) with different concepts, terms, methods and data organised by a common effort working on a common problem with continuous intercommunication.
4. Transdisciplinary […] establishing a common system of axioms for a set of disciplines.

Heckhausen (1972, pp. 87-89) identifies six types of interdisciplinarity. They are presented in an ascending order of maturation:

1. Indiscriminate interdisciplinarity: This consists of "encyclopaedic endeavours" that end up in "curriculum mix-ups". Here introductory studies of various fields are thought to counteract disciplinarity. It mainly provides vocational training for pre-university practitioners, but is also found when an "imperialistic" discipline claims other disciplines to be "auxiliary".
2. Pseudo-interdisciplinarity: This happens when disciplines sharing the same analytical tools such as mathematical models or computer models are claimed to be interdisciplinary. Topics such as pattern recognition, game and decision

theory, and models of social action may form the topics whereby and through which integration is claimed.

3. Auxiliary interdisciplinarity: This happens when the method used by one discipline yields data that has an "index-value" for another discipline at its level of theoretical integration. Cross-disciplinary use of methods constitute auxiliary interdisciplinarity. These can be "enduring" or "transitional". If the level of theoretical integration is not achieved, it can lead to criticism and revision causing more sophistication and the development of more advanced interdisciplinarity.
4. Composite interdisciplinarity: This happens when different disciplines are brought together to apply different techniques in an effort at problem solving. This type of interdisciplinarity is engaged in technological instrumentality, wherein a hierarchical sequence of clear-cut goals are pursued which might change a "person-environment" system or even innovate one.
5. Supplementary interdisciplinarity: This happens when disciplines in the same field develop a partial overlapping in certain subject matters. The overlaps come about by a correspondence between theoretical levels of integration. However beyond that particular category there might not be an overlap. The overlap is seen, recognised and established to provide a fuller picture of the subject matter. This type of interdisciplinarity exists in the borderlines of disciplines.
6. Unifying interdisciplinarity: This happens when there is a consistency between two disciplines in subject matter, levels of theoretical integration and methods. For example in areas where biology reaches physics.

Boisot (1972) provides another type of classification. He divides phenomena which he defines as "the materialisation of interaction between objects" into "crude" and "legalised". The former is phenomena that have not yet been explained. The second is phenomena that have been explained. Based on this basic conceptualisation, Boisot divides interdisciplinarity into three. These are:

1. Linear interdisciplinarity: this happens when crude phenomena from one discipline is legalised by laws in another discipline.
2. Structural interdisciplinarity: this happens when "interactions between two or more disciplines lead to the creation of a body of new laws forming the basic structure of an original discipline that cannot be reduced to the formal combination of its generators, yet complies with the definition criteria we have suggested above" [of a discipline] (p. 94).
3. Restrictive interdisciplinarity: this happens when there are no interactions among disciplines. Yet, the disciplines are brought into play by a field of application, wherein "[e]ach restricting discipline imposes technical, economic or human bounds on the others" (p. 95).

As seen above, there are many ways in which the concept of interdisciplinarity has been categorised and classified that has led to a profound understanding of the ways in which it might occur.

2.5. Normalising interdisciplinarity

From the debates and discussions involving disciplinarity and interdisciplinarity, a self-reflexive, normalising discourse of interdisciplinarity that seeks to understand its nature,

limitations, potential and legitimacy has emerged. The contours of this discourse are sketched below.

Reynolds identifies three types of problem situations, which might be best suited for disciplinary/interdisciplinary approaches (Sigma Xi 1988 in Klein 2000, p. 13):

- Problems of the first kind: intellectual problems in a traditional discipline.
- Problems of the second kind: multidisciplinary problems that are basically intellectual not policy-action in nature but cannot be successfully undertaken within boundaries of one discipline.
- Problems of the third kind: distinctly multidisciplinary problems generated increasingly by society and distinguished by relatively short-time courses calling in some cases for a policy-action result and in other cases for a technological quick fix.

For problems of the first kind, disciplinary work is strong; for the second type, boundary crossing occurs; and for the third type generally multidisciplinary centres are formed.

Bechtel (1986, quoted in Klein 2000, p. 21) opines that the level at which bridging or integrating is attempted will have an effect on the kind of problems that arise. Hubenthal (1994, quoted in Klein 2000, pp. 20-21) remarks: "The task of interdisciplinary research is not to be solved with a global interdisciplinary theory that cannot supply concrete directives for subject-overlapping research on a specific topic. It must be pursued within individual sciences in daily usage."

Lowy (1992, cited in Klein 1996, p. 22) suggests the interaction zone can be a loosely structured pidgin zone. A pidgin zone in linguistics is "an interim form of communication based on partial agreement on the meaning of shared terms" (p. 22). Sometimes a creole can emerge. A creole is "a subculture or native language of a group" (p. 22). When this happens the participants acquire a new professional identity with hybrid roles.

Klein (1996, p. 10) proposes a conceptual continuum with instrumentalism advocating interdisciplinarity at one end, and epistemology problematises the concept at the other. The two ends are represented metaphorically by the terms "bridge building" and "restructuring" proposed by Nuffield. She argues, however, that: "All interdisciplinary work is critical in that it exposes the inadequacies of the existing organisation of knowledge to accomplish given tasks." (p. 14) Nevertheless, instrumentalism minimises critical thought. Kroker (1980, quoted in Klein 1996, p. 15) makes a similar point when he advances the notion of "vacant interdisciplinarity", which mechanically normalises existing thought. When interdisciplinarity is located well within critique, it challenges disciplinary power rather than merely repackaging or enhancing it (Klein 1996, p. 14). Klein argues "when intellectuality is premised on rediscovery and rethinking, resocialisation and reintellectualisation, interdisciplinarity becomes not just a way of doing things but a new way of knowing" (p. 15).

Kelly (1996) distinguishes between narrow and wide interdisciplinarity, primarily on grounds of incorporation of categories like value and meaning. For Kelly, narrow interdisciplinarity strictly occurs within limited frameworks of scientific naturalism. It enables one to work on 'factual' structures. However, wide interdisciplinarity brings in the humanities along with additional metaphysical categories which add "notions of

justificatory human action" (p. 111). Thus in the case of slums, for example, while narrow interdisciplinarity would allow one to rebuild the slums, wide interdisciplinarity allows one to be aware of why we ought to rebuild (p. 96).

A useful way of conceptualising interdisciplinarity and its use is discussed in Dalke *et al.* (2003). Following Jakobson (1956), they define two types of associations in language. One topic may lead to another metaphorically by using similarity or it can lead to another metonymically using contiguity. Thus metaphor is understood as categorisation and metonym is understood as spatial or temporal contiguity. Agreeing with Wong (2002), Dalke *et al.* argue that theorists come up with metaphors that say something about the world by pointing out equations or algorithms. Observational scientists on the other hand study metonymies that describe the behaviour of a part of nature. The latter group's work is judged by their representational quality, whether they are accurately reported or adequately represented for example. Reflecting further, Dalke *et al.* argue that metaphors inevitably generate metonymic relations which then provoke a reconsideration of the metaphor itself. They are thus reciprocally productive. Interdisciplinarity is perceived as "exercises in explaining to one another the multiple ways in which we are 'metaphorising' our individual metonymic landscapes […] learning not only how to illuminate different items in these landscapes, and how to take different routes among them, but to extend the metaphor we use so frequently here to consider how we might actually rearrange the territory, to use one another's metaphors to alter our own metonymic landscapes.

Klein (2000, p. 12) notes that concepts and theories are influential sources of interdisciplinarity. They are "robust enough to maintain unity across fields, but plastic enough to be manipulated". They are "weakly structured in common use", yet "strongly structured at individual sites" (p. 12). They are negotiable entities that "delimit and construct" (p. 12). For Hayles (1990, p. 144) interdisciplinarity is an "ecology of idea" that does not demand unity, nor overrides differences. Any description of this zone "presupposes a frame of reference that limits, even as it creates, what is said". Thus what is said is always "a function of what is noticed and considered important" (Klein 2000, p. 13).

Strathern (2005) talks about another understanding of interdisciplinarity. For Strathern there are three aspects. Firstly:

> What interests me […] is a very routine and everyday ability that we use all the time and in every context, to draw analogies which take materials from wherever we find them, to copy other people's methods, and so on. It's making extra training explicit to ourselves that separates a self-conscious interdisciplinarity from the routine and everyday ability to mix knowledges. So my first understanding [of] it is of a *self-consciousness about the ability to mix knowledges.* (pp. 127-128) (original emphasis)

Secondly, she sees this mixing as taking different forms, with the focus being on *problem-solving* that in turn creates its own theoretical impetus. Thirdly, she comments that: "I observe interdisciplinarity now, in 2004, as being taken in a representational way, as *standing for other values*, and as a goal to be striven for – an end, not just a means." (p. 128)

There are thus different means by which proponents of interdisciplinarity have normalised it. Some of these are in relation to the nature of knowledge and science, while some of these are in relation to other wider values.

2.6. Epistemological bridging of disciplines

In this section, theories that support an epistemological bridging of disciplines are reviewed. This is primarily based on systems theories and quotes extensively from Chettiparamb (2005).

One of the most influential models for epistemological bridge building is the General Systems Theory (GST) advanced by Kenneth Boulding (1956) in his often quoted and influential article. According to Boulding, systems theory describes a level of modelling that is somewhere in between highly generalised concerns like mathematics, yet above those of the disciplinary sciences. He describes mathematics as a system with no connection to the real world in the sense that it is so much abstracted from the real world that it loses content. Thus "because mathematics contains all theories it contains none" (p. 197). From this placement of the systems theory, Boulding goes on to sketch a role for GST. Accordingly at a low level of ambition, GST just points out similarities in theoretical constructions of different disciplines where they exist and tries to develop models that can be applied to at least two disciplines. At a high level of ambition however, GST aims to construct a "spectrum of theories – a system of systems" which will serve as a "gestalt". Boulding proceeds to identify two ways in which this might be done.

Firstly, this can be done by development of different aspects of the theory, in itself focusing on cross-disciplinary work; and secondly, this can be done by work within disciplinary sciences, which adopt system theories and examine the added insight that they provide within the discipline (Checkland 1981, p. 94). The former then will be more a question of identification of isomorphisms and an abstraction of theoretical essence from the disciplinary theories, which can have relevance across a broader range of disciplines. Work at this level is likely to be informed by metaphysical stands and/or mathematical formalisms. In the latter case, system theories must be combined with other disciplinary theories. System theories being abstract cannot yield knowledge or testable hypotheses on their own. They can however suggest ways of re-interpreting knowledge and suggest research agendas in combination with disciplinary theories to form testable propositions. The contributions of systems theory in terms of insights will therefore necessarily contain both disciplinary issues and systemic concerns, the one co-existing with the other.

The second approach that Boulding advocates is to conceptually operate through a hierarchical arrangement of complexity. The arrangement he proposes is that of first static structures – a level which he calls the level of frameworks containing knowledge about things like the geography of the earth, the pattern of atoms in a molecule, the anatomy of a gene and so on. This level is an essential level without which no further knowledge can be built. The second level is that of simple dynamic systems with predetermined simple motions. He terms this level the clockworks and it contains knowledge of simple and complicated machines, simple equilibrium systems, stochastic dynamic systems etc. The third level is that of control or cybernetic systems which he nicknames as the thermostat. Here transmission and interpretation of information is

integral and is an essential part of the system. It includes thermostats or any homeostasis model – one which maintains a variable at or near any constant level. However, the level is not however determined solely by the system. The fourth level is that of the open system with a self-maintaining structure even though exposed to a throughput of materials, the level of the cell. The fifth level is what is called the genetic-societal level, typified by the plant. Here a division of labour among cells to form a cell-society takes place. The level though may not be capable of much throughput of information via highly specialised sense organs except in a diffuse manner. The sixth level is that of the animal kingdom and is characterised by mobility, teleological behaviour and self-awareness. There is an increase in the information intake by specialised information-receptors and behaviour is dependent on a knowledge structure or image of the environment. This is not a simple piling up of information but consists more of an active structuring of information. The seventh level is the human level, where each individual can be considered as a system. Self-consciousness characterises this level in the sense of a self-reflexive quality. S/he not only knows but also knows that s/he knows. With this comes the capacity to "produce, absorb and interpret symbols (original emphasis) as opposed to mere signs" (p. 204). The eighth level is that of social organisation in which the components are not individual humans but are rather the role the person plays. Social organisation or social systems are defined as a set of roles tied together with channels of communication whereby "content and meaning of messages, the nature and dimensions of value systems, the transcription of images into a historic record, subtle symbolisations of art, music and poetry and the complex gamut of human emotion" (p. 205) all become important. The ninth and final level is the transcendental level which contain the "ultimates and absolutes and the inescapable unknowables" (p. 205).

According to Boulding, each level in the above hierarchy builds upon knowledge accumulated from the levels below, so that the higher levels contain all the information of all the levels below. Thus explanations of animal behaviour will contain explanations at level one, two, three, four and five. The certainty of the knowledge we possess also diminishes as we move up the hierarchy. Thus though behaviour can be explained to a large extent by means of physico-chemical changes in the brain, it cannot be wholly attributed to it. In other word biology is not just physics or chemistry. Boulding, in his paper written in 1956, comments "most of the theoretical schemas of the social sciences are still at level (ii), just rising now to (iii), although the subject matter clearly involves level (viii)" (p. 207).

Emanating from the overall schema of the purpose of systems science and what it intends to achieve, Bunge (1973) proceeds to create an epistemological hierarchy within which he positions systems sciences. Thus according to him systems theory falls in between two levels. The first is the realm of mathematics, which he characterises as being an exact science, and metaphysics characterised as a philosophical endeavour. Both of these are abstract and thus devoid of content. They may thus be qualified as meta-disciplinary. There is then the level of the disciplinary sciences with theories of relevance to particular disciplines. These are less abstract but richer in substantive content. Systems theory is positioned as being less abstract than mathematics or metaphysics, but more abstract than the theories within disciplines (Boulding 1956). Content wise also they hover between the metaphysical realm and the disciplinary realm. Bunge, in his "epistemological hierarchy", extends this further downwards. His

hierarchy has been re-interpreted and modified by Zwick (2001). This re-interpreted hierarchy has the following structure:

Metaphysics Mathematics;
|
Systems Theories
|
General theories (theories within disciplines – both natural and social)
|
Models (specific theories)
|
Relations, Laws, Hypothesis
|
Observables

According to the above structure, just as models can be derived deductively downwards from general theories or built up inductively from relations or laws, so also systems theories can be built up inductively from theories within disciplines by identifying isomorphisms between different theories or deduced deductively from mathematical formalisms or metaphysical positions by adding interpretations (Zwick 2001). It thus qualifies as a meta-theory and stakes a claim towards being more fundamental than disciplinary theories.

The above discussions provide a meta-theoretical base for the epistemological problems underlying a combination or synthesis of disciplines.

2.7. Summary

In this section the history of interdisciplinarity was briefly discussed, moving on to consider interdisciplinarity in relation to the disciplines. The need for both disciplinarity and interdisciplinarity was highlighted. The nature of the relationship of disciplinarity to interdisciplinarity was then reviewed, followed by a discussion of various types of interdisciplinarity. Debates normalising interdisciplinarity were then discussed. Finally meta theories that throw light on how disciplines might be epistemologically bridged were reviewed from a systems theory viewpoint.

3. Interdisciplinarity in practice

In this section, general features of interdisciplinarity in practice are reviewed. The practice of interdisciplinary research and interdisciplinary teaching is not reviewed in detail, the former because it is out of scope of this project and the latter because it is the content of the following chapter. This review relies mainly on the findings of OECD (1972, pp. 42-45), which followed massive cross-national study. The study is still relevant as it explores historic factors – origins, motivations and goals – in interdisciplinarity.

3.1. Origins of interdisciplinarity

The key point that OECD emphasises is that the origins of interdisciplinarity are found in cultural and intellectual traditions of an academic system:

> Although we found that in the United States the preponderant goal was general education, itself subdivided into the objectives of personal and social development, whereas in Europe most lines of argument in favour of interdisciplinarity stress the aspect of intellectual and scientific development, that does not mean that there is a contradiction between these two conceptions of interdisciplinarity but only that each is striving to demonstrate within the context of its own system, that the answer it is providing to the needs in teaching and research is better able than the previous system to meet the needs that the university has accepted the responsibility for. (p. 43)

OECD thus defines origins as "all the circumstances and social and university requirements which may have led to setting up an interdisciplinary activity" (p. 44). The origins they identified are listed below:

1. Those connected to the development of science. Many patterns within this category were discerned. They found that every specialism within a discipline was essentially interdisciplinary. On occasions the opinion was that the interdisciplinary field actually required experts trained in other fields. At other times interdisciplinarity was seen in terms of crisis, whereby the rigidity of the original discipline could be broken. At times interdisciplinarity came about through the conjunction of a discipline with application; at other times it was a result of disciplines latching on to common elements. In the latter cases they found that interdisciplinarity had a tendency to be replaced by transdisciplinarity. They also found that in these cases the approaches in each discipline were considerably altered by the other.

2. Origins for interdisciplinarity were also seen in student movements (US, Canada, France). At times this need is concrete (in the sense that it is in response to student demands), while at others it is anticipated (in the sense that demand from students is anticipated). In the latter cases they noted that there was also an ethos of anti-science. A sort of complementarity of disciplines was suggested, as the pressure was on getting a real hold on the object of study. Similar expectations of teachers were also perceived as a factor. This was noted as being more common in younger teachers who might pursue it at some risk to their own work, and also a source of

conflict between more senior staff who seemed to be more "snugly established" in their disciplines.

3. The third need arose from the need for professional training. Even if a person is an 'expert' within the university, once outside the university, s/he had to be the person to connect other things. Thus having to engage in the day-to-day affairs of concrete practice created a demand for interdisciplinarity.

4. A fourth factor was the original needs in society. This need arises when some agency outside the university – immediate, city, region, country or even global – suggests an area of study to the university which did not exist before such as environmental studies or urban studies. Two types of responses to these origins were found. In the first instance, interdisciplinarity was a substitute for general education. In the second instance, it was the end result of specialisation. However, while the second was found to be more common, it was also found that this was increasingly giving way to the first due to the difficulties of evolving a dialogue between nondisciplinarians.

5. Interdisciplinarity was also reported to have its origins in problems of functioning and university administration. This was not often found and it rarely went into problems that involved knowledge based issues.

OECD remarks that in applied fields the above listing and categorisation were found to be inadequate and required more subtle breakdowns. However, origins had an impact on the interdisciplinarity practised. For instance:

> If a programme in general education is tied to scientific needs, activities involving instruments will be observed to take the limelight; if tied to student needs, self expression, group communications and interpersonal relationships will get talked of, even far from disciplinary frameworks. (p. 47)

OECD nonetheless stresses the possibility and legitimacy of every approach. The origins of interdisciplinarity also provide insight into the classification of interdisciplinarity practised. The also provide answers to why even with the same goals, organisational structures and methods, different forms of interdisciplinarity were observed. The OECD report concludes with the truism: "For interdisciplinarity is the lowest common denominator of innovation without necessarily being its starting point." (p. 48)

3.2. Motives in interdisciplinarity

Motivations are defined by OECD as "all the intellectual and emotional needs and the concerns which may have impelled people to act" (p. 44). The report draws up a list of motives that were observed empirically, stressing the fact that each case was indeed unique as the motives were often mixed even in terms of values attributed. This list is reproduced below:

1. Motives dealing with student needs
   - practising interdisciplinarity (on the undergraduate level) makes it possible for students to change their major field without losing time

- practising interdisciplinarity makes it possible for students to adjust to inevitable fluctuations in the job market
- practising interdisciplinarity creates possibilities for careers in new fields
- practising interdisciplinarity makes it possible for students to continue to remain interested and curious about their work, and they are more highly motivated as a result of feeling that the subjects they are studying are relevant to reality, and as a result of sensing the newness of the subject and the chance to have more enriching personal contacts
- practising interdisciplinarity educates graduates with a more inventive bent of mind
- practising interdisciplinarity emphasises concepts and methods more than subject content, and thereby makes it possible for students to learn to handle instruments and to become more creative. (p. 49)

2. Motives connected to the needs of teachers and researchers
   - finding a human solution to the issue of growing specialisation, which would lead in fact to increasingly superficial knowledge
   - learning to work towards the attainment of common goals starting with different viewpoints
   - discouraging individuals from undertaking isolated tasks
   - opening up new fields of knowledge and making new discoveries possible
   - motives connected to the requirements of the university system. (p. 49)

Interdisciplinarity in these cases was seen as a way to "blow up from inside the barriers and obstacles to communication in the university and to break down from the outside the sharp dividing line between knowledge and reality between the university and society" (p. 50).

3. Motives connected to scientific interests

They are manifold and can be grouped in pairs:
- broadening by field of knowledge; making it possible to narrow it down by using multiple and convergent approaches
- emphasising the unity among phenomena; showing how varied they are
- becoming able to create a theoretical basis for the discipline being studied; becoming able to apply it concretely
- making specialisation possible; forbidding specialisation etc. (p. 50)

3.3. Goals in interdisciplinarity

In terms of goals involved, OECD classifies its empirical data on three criteria. The first of these involves exploring the "frontiers of disciplines and the intermediary zones between disciplines" (p. 52). The second involves making universities respond to socio-political and economic needs of a country. The third involves having a project outside the university, which brings professional practice onto campus. OECD (1972) however declares that: "Concrete working conditions and events have more impact on what research or teaching programme is set up than *a priori* goals, however well defined beforehand." (p. 43)

Weingart and Stehr (2000, p. xii) opine that in universities where the goal of knowledge is to understand, disciplines are the prevailing mode of organisation. However, when the goal of knowledge is to solve problems disciplines do not command much respect. Turner (2000) provides another view:

> There are good reasons for starting a new cartel, or cartelising an interdisciplinary field – turning it into a discipline – as long as there is a market for the students who are being produced, and as long as there is something to be gained by restricting access to positions. Disciplinarisation assures privileged access to markets. And this provides the answer: as long as there are benefits for cartelisation there will be disciplines. And as long as cartelization incapacitates its beneficiaries in taking up opportunities that are of less value inside these markets than outside, there will be a place for interdisciplinarity. (pp. 64-65)

3.4. People in interdisciplinarity

Writings on interdisciplinarity have also studied the types of people that engage in interdisciplinarity. Anbar (1973, cited in Klein 1985, pp. 131-133), for instance proposes the concept of a "bridge scientist". On a multidisciplinary team, this type of scientist tends to pay attention to problems of language, like translating the perspective of one discipline to the perspective of another. On an interdisciplinary team, this scientist tends to concentrate on paradigmatic conflicts rather than conflicts in terminology. After a study of the Stanford Research Institute, Anbar concluded that there are four types of people who become bridge scientists:

- professionals who are strongly grounded in a particular discipline and, having satisfaction in terms of scientific curiosity and recognition by their peers, have become adventurers
- professionals who are strongly grounded in a particular discipline and might like to stay in it, but who feel *forced* to get involved in other disciplines because their own discipline is becoming obsolete and non-marketable
- people who had some rather superficial training in one or more disciplines, who now find that they can get work and consequent recognition as generalists
- people who have moved into managerial, sales or other essentially bridge positions, but have not been prepared to fulfil a bridge role.

He concludes that the first category professionals will tend to be the most active and creative. Category 2 will be less enthusiastic. Category 3 is best used in organisation or marketing rather than project generation or management. Category 4 tend to become "the most serious obstacles" in interdisciplinary research.

Strathern (2005) speaks of the current hype surrounding interdisciplinarity and the present requirement in research funding of having to write in interdisciplinarity. She calls this "a perversion of something that could be valuable". Academics' interest and energy are "based on hope, based on expectations, on anticipation, and these are all incredibly important human attributes" (p. 134). One of the ways in which innovative research is expected to be possible is by branching out and gathering from elsewhere. So a skill, hope or anticipation that is very valuable is what gets hyped. The hyped version is in consequence almost indistinguishable from the real thing.

3.5. Summary

The results of the OECD cross-national survey highlighting the origins, motives and goals of interdisciplinarity as is practised in universities were reviewed in this section. The views of other commentators on some of these topics were also discussed. Writings on people engaged in interdisciplinary work and their personal motivations were then reviewed.

4. Interdisciplinary teaching and higher education policy

"The step from an appealing idea to an operational method is large indeed" (Karlqvist, 1999, p. 379). In the case of interdisciplinarity, finding the idea appealing is one thing, but transferring the idea into pedagogy and teaching requires much more than an understanding of the concept. The literature on various aspects of interdisciplinary teaching – its definition, associated problems associated, goals, curriculum development and teaching methods – are reviewed. Finally three case studies from the US, where interdisciplinary programmes are widely embedded in institutions, are presented.

4.1. Definition of interdisciplinary teaching

Mills and Huber (2005) suggest that "a disciplinary identity is by definition a pedagogic one" (p. 43). If so, then for each discipline there is a specific type of pedagogy. How can one then approach interdisciplinarity in pedagogic terms?

The Subcommittee on Interdisciplinary Teaching at Emory University (www.emory.edu/TEACHING/Report/AppendixC.html) provides the following definition: "(1) the enrichment of one discipline by use of the language, methods, or canons of one or more other disciplines; or (2) the common inquiry into universal themes, such as health, justice, or violence, using the language, methods, and canons of two or more disciplines."

De Zure (1999) citing Klein (1990, p. 55) makes the point that interdisciplinary teaching can take many forms. Thus:

> interdisciplinary initiatives are often described by the form or structure they take (e.g. team teaching), the motivation behind them (e.g. to serve societal or employment needs), how the disciplines will interrelate (e.g. math will be taught *in the service of* chemistry), or by labelling the level of integration (e.g. from *borrowing to synthesis*). It is sometimes used loosely to refer to cross-functional groups, but the mere presence of individuals from different disciplines does not signify interdisciplinary collaboration. Thus the term *interdisciplinarity* is used variably as a concept, a methodology, a process, a way of knowing, and even a philosophy. (original emphasis)

The report of the task force of the Association for Integrative Studies in defining the guidelines for interdisciplinary studies in general education, define interdisciplinary as "involvement of more than one disciplinary perspective and explicit attention to the question of integration". They note "interdisciplinary general programmes take several forms and occur at several places in the curriculum. They frequently appear as 'core courses', 'integrated studies' or 'interdisciplinary studies'. They also may be sequenced with introductory, mid-career, and concluding activities in general education." They further note:

> Whether as "cornerstone" or first-year seminar, as part of a four-year core, or as capstones or senior seminar, interdisciplinary general education approaches share several common features. They frequently are organised around themes, problems or issues, cluster disciplines in knowledge-

> domain offerings [such as humanities, social sciences, natural or life sciences], and are team designed and team-taught with faculty from several disciplines participating.
> (www.units.muohio.edu/aisorg/pubs/reports/genedaccred.html accessed 27 September 2007).

Interdisciplinary teaching thus is a very amorphous concept, encompassing many facets. The literature review below disentangles this variety and dwells briefly on the different aspects.

4.2. General aims and functions of interdisciplinary pedagogy

Heckhausen argues that the teaching of a discipline must start by clarifying its own disciplinarity. In parallel, then, interdisciplinary education must start by clarifying its own interdisciplinarity. According to Klein (1996):

> Interdisciplinary work gets done by moving across the vertical plane of depth and the horizontal plane of breadth. Breadth connotes a comprehensive approach based in multiple variables and perspectives. Depth connotes competence in pertinent disciplinary, professional, and interdisciplinary approaches. Synthesis connotes creation of an interdisciplinary outcome through a series of integrative actions. Synthesis does not derive from simply mastering a body of knowledge, applying a formula, or moving in linear fashion from point A to point B. […] It requires active triangulation of depth, breadth, and synthesis. (p. 212)

Haynes (2002), commenting on Klein (1996, pp. 213-214), observes: "For her, most significant are the abilities to define the task at hand, to determine how best to use available approaches, to devise a working vocabulary that can be understood by all disciplinary audiences, and to extract the worldview and assumptions embedded in each discipline." (p. xiv) Haynes further argues that:

> Interdisciplinary studies fundamentally entail a movement away from an absolutist conception of truth to a conception of truth that is situated, perspectival, and discursive and that informs and is informed by the investigator's own sense of self-authorship. The interdisciplinary perspective is not one that posits a pure relativism in which all knowledge claims are always equal. Instead it rests on the assumption that disciplines and its practitioners, as well as their activities and concepts, are already socially constituted. The task of the interdisciplinary investigator, then, is to invent a new discourse that critically combines key elements of several disciplinary discourses and that is in keeping with his or her own sense of self. (p. xiv)

From this she concludes:

> Interdisciplinary pedagogy, then, is not synonymous with a single process, set of skills, method, or technique. Instead, it is concerned primarily with fostering in students a sense of self-authorship and a situated, partial and perspectival notion of knowledge that they can use to respond to

> complex questions, issues or problems, While it necessarily entails the cultivation of the many cognitive skills such as differentiating, reconciling, and synthesising […] it also involves much more, including the promotion of student's interpersonal and intrapersonal learning. Because interdisciplinarity is a complicated psychological and cognitive process, it cannot be taught with one approach. (p. xvi)

OECD (1972) discusses the general aims and functions of interdisciplinary education in broad terms. It advocates a lead role for the university which works as "both the driving force and regulation of society, where cultural, political, economic and social models will be elaborated and subjected to review, and where the men [sic] who are going to put them into practice will be trained" (p. 195). Within this context the overall function of the university is seen as being "divided between the two functions of' 'processing' flow of information and 'processing' students" (p. 196). For this the following steps are recommended:

- strengthening of the library with a librarian who understands interdisciplinarity
- a mode of education that enables a student to choose what may be best for him/her without having to go through a process of perhaps 'wasted' education in a narrow discipline
- an integration of teaching and research, by allowing students to discover things for themselves. This includes early awareness of relativity of knowledge, scientific honesty and a knowledge of knowing how to learn. It also involves cutting down the gap between "basic" and "applied" research
- incorporation of a training component through apprenticeships. This vocational training must have "in addition to sound specialisation, a measure of all-round preparation and the ability to adjust to new situations and accept continuous "re-training". (p. 199)

4.3. Curriculum, teaching methods and teacher training

De Zure notes that most instructional approaches associated with interdisciplinarity are based on active learning strategies and promote higher–order critical-thinking skills. These are analysis, synthesis, application and evaluation, and they include methods such as "collaborative/cooperative learning, discovery and problem-based learning, writing and math across the curriculum, and methods of assessment that are multi-dimensional, including qualitative and quantitative measures, normed measures, and self-assessments" (http://teaching.uchicago.edu/pod/dezure.html).

Gabelnick (2002, pp. 288-289) lists some of the types of learning associated with interdisciplinarity:

- self-directed learning: non-prescribed learning – no road maps; inventions, integrated with one's values, skills, life experience, e.g. inquiry-based learning
- creative learning: inventive learning – divergent thinking, exploration, discovery, e.g. performance based teaching
- expressive learning: learning in the here and now – connecting feelings with discovery and expressing it in the external world. E.g. Feminist Pedagogy and multi-cultural learning

- feeling learning: vulnerable learning – making mistakes, trying out, acknowledging limits of competence, e.g. mentoring relationship between student and advisor
- online learning: deinstitutionalised learning – on the job learning
- continual learning: lifelong learning – continuation of learning themes, feeling like a beginner again and again, testing oneself and one's knowledge base
- reflexive learning: learning about learning – paying attention to the learning process; folding back reflections into lifelong learning themes, e.g: some type of writing assignments.

Gabelnick further notes that team teaching, writing across curriculum and communities of learning are "frequently touted as 'silver bullets'" (p. 275) to promote interdisciplinarity. To this can also be added other strategies such as study abroad programmes, thesis /project work, vocational training, field based courses, residential living and learning communities, theme houses and theme studies.

In the systematic cross-national OECD (1972) study, aspects of interdisciplinary teaching are noted:

- Teaching relationship. The teacher-student relationship mostly is seen as hierarchical and one-way with its natural extension being the book and dependent closely on disciplines. In an interdisciplinary approach this is challenged, thus "cultivating sensitivity, the art of listening and seeing and the creative and imaginative faculties should henceforth take a much more important place in teaching" (p. 228). This can be possible only through practical work and associating with aspects such as music, film and art appreciation.

- The first level: guidance and personality development. Guidance is conceived of as having a subjective and objective aspect. In the subjective dimension it means detecting the tastes, aptitudes and potentials of students and helping him/her achieve the same so as to bring out the best in his/her personality. It demands intuition, a permanent personal relationship, and a theoretical as well as practical knowledge of differential psychology and characterology. The objective aspect involves knowing the career opportunities available and having the ability to foresee, as far as possible, developments in a rapidly changing society. In teaching methods terms, this might involve workshop and classroom work with discussion seminars. The workshops will offer opportunities for collective study of a wide variety of practical problems. These workshops can lead to written and oral expressions which can be individual or collective and should result in preparing simulated models. Classroom work must be accompanied by a discussion seminar that will help students locate the problems within an overview of contemporary times. The classrooms provide the conceptual tools for the same. Students are thus encouraged to take an overall view of the problem.

- The second level: specialisation and vocational training. The general training provided earlier is to be followed by specialisation and also vocational training possibly through training attachments.

- The third level: introduction to research. This is the stage where the student learns to do research by actually doing it, and acquires research specific skills such as balancing imagination with exactitude, realising the continuing flow of research, and so on.

- Teacher training. It is argued that future teachers must be part of the teaching activity as teacher training cannot exist without practice training. "Awakening and helping the personality of the pupil or student to develop fully, discerning his abilities, developing his creative faculties, and imparting the appreciation and practice of dialogue are tasks which the teacher has so far been ill or unprepared for and which should be in the future form the basis of his mission." (pp. 134-135) This type of mission cannot come about without true interdisciplinary training.

4.4. Assessment in interdisciplinary teaching

Klein (1996) notes: "Criteria for judgement constitute the least understood aspect of interdisciplinarity, in part because the issue has been least studied and in part because the multiplicity of tasks seems to militate against a single standard." (p. 210) She explains:

> The conventional ideal of excellence, though rests on the assumption of a standard body of knowledge or a fixed body of content. The basis of interdisciplinary work is different. Interdisciplinary work reconfigures disciplinary and professional knowledge and knowledge communities. Because the work is sui generis, standard criteria have limited applicability. (pp. 210-211)

Field and Stowe (2002) identify five challenges in interdisciplinary learning:

1. finding a fit in the typically linear assessment arena for creative, interdisciplinary programmes seeking complex cognitive, developmental and serendipitous outcomes
2. describing expected outcomes in non-utopian language while leaving room for discovery of unanticipated outcomes
3. defining the core interdisciplinary construct of synthesis or integration in a measurable manner
4. identifying both conventional and creative assessment techniques for gathering data on interdisciplinary learning
5. keeping the focus of assessment on improving cognitive, affective, and developmental outcomes, thus improving interdisciplinary curricula and pedagogy. (p. 264)

Acknowledging the above, they then consider an assessment environment as follows:

1. The programme should be grounded in the understanding that assessment is used to improve teaching and learning.
2. The assessment programme should be locally developed and must reflect teaching staff's own understanding of interdisciplinarity which might be an evolving one.
3. Teaching staff must be involved in the assessment.

4. The assessment programme will be constantly in a "state of flux".

Following from the above, Field and Stowe proceed to articulate detailed principles for assessment (pp. 270-271).

4.5. The interdisciplinary challenge

Challenges in introducing interdisciplinary pedagogy is discussed below and draws on two sources: first, the OECD (1972) cross-national survey which identifies a set of problems; and second, a report of the Subcommittee on Interdisciplinary Teaching at Emory University (www.emory.edu/TEACHING/Report/AppendixC.html).

4.5.1. The OECD study

The problems and difficulties in engaging in interdisciplinary teaching, is discussed by OECD under the following headings:

- rigidity of institutional structures
- rigidity of people involved including resistance offered by disciplinary frameworks
- lack of facilities.

1. Institutional problems

The model of universities in most countries were found to be based upon the following:

- splitting and grouping of disciplines which do not correspond to the state of science now
- restricted and limited recruitment as it was largely for the middle–class who received a classical education
- a relatively stable structure in society which in turn demanded well-determined occupations which in turn had to have certain types of well "catalogued" knowledge.

This produced higher education institutions, which though varying greatly on structure and operation, could nevertheless be grouped under the following categorisations:

- Schools that emphasised a liberal arts tradition. This model is however argued to be "practically meaningless" now, due to the specialisation in science and the impossibility of providing "all-encompassing learning", which spreads superficial knowledge too thinly and results in the "worst kind of multidisciplinarity".
- Schools of the previous type that have evolved into teaching specific subjects with Chairs and Institutes that are "unaware of each other's existence", resulting in even more fragmentation.
- Schools that stress vocational training, which are slow to incorporate new knowledge and social needs. Most institutions lack precise objectives and are poorly adjusted to social needs.

2. People problems

These problems come from ways of thinking. Interdisciplinarity remains incomprehensible and is thus resisted not only by teachers, but also students and

society in general. Most teachers have spent years teaching in a particular discipline and they might have been pursuing research that is narrowly specialised. For them then, interdisciplinarity could not be "anything other than a shot in the dark or mere dilettantism" (p. 192). Furthermore not all disciplines are at the same level of formalisation and not all practitioners of these disciplines are aware of the lack of it. There are also limitations that are inherent in the nature of a discipline. Finally there is scepticism regarding how these conversions can, even if in principle possible, be executed in teaching and education?

The issue of teacher training is foregrounded in the study report. This is because "interdisciplinarity is first and foremost a state of mind requiring each person to have an attitude that combines humility with open mindedness and curiosity, a willingness to engage in dialogue and, hence the capacity for assimilation and synthesis. Furthermore, it is a discipline in the ethical sense of the word […]" (p. 192). This may in fact involve a complete overhaul, which might include changing contents, spirit and methods in use. The resistance can be discerned not only in senior staff but also in junior staff "who have fixed habits and prefer the easy alternative of not displeasing the 'boss' and risking their career on what seems to be a mere adventure, and thereby bolt down the system from one generation to the next" (p. 192).

Students are also not generally champions of interdisciplinarity though they might have a 'vague sense' that a restructuring is needed. "The 'silent masses' have settled habits, a lack of information, structural inertia, a secret anxiety about the morrow and a fear of the unknown which have induced them to accept the return to the *status quo ante*." (pp. 192-193) More diligent protestors are convinced that the university cannot change without society changing. They choose to fight elsewhere. Others are convinced that for society to change, the university must change first. However, they do not have information on changes in science, new requirements, and ways of getting through the task.

Those in control of jobs in society at large – for example, business and trade – also do not seem to be really aware of the consequences for vocational training that must follow the changes taking place in society. Thus OECD concludes that introducing interdisciplinarity is fraught with psychological impediments.

4. Facilities problems

The most visible material problem is that of space, resulting from the internal arrangements of universities. Disciplines are very often spread out making it difficult to run an interdisciplinary programme on tight timetables. There might be a dearth of small work offices rather than large lecture halls for an interdisciplinary programme. Also important are pressures of time that do not allow teaching staff to engage in innovation, confining them to the bare requirements of their discipline.

The above challenges though identified in 1972, can still be thought of as largely defining the current situation in UK academia.

4.5.2. The Emory University Report

In contrast to the OECD study, the Report of the Subcommittee in Emory University studied its own interdisciplinary programme. This study revealed a detailed set of issues. The problems it identified were categorised under student problems and staff problems.

1) Student problems:
   - incompatibility of semester, class and teaching block schedules which made cross-registering difficult.
   - lack of information about courses on websites
   - difficulty to fit interdisciplinary courses into majors
   - absence of physical common spaces for interdisciplinary study that required the study to be scattered in facilities of the disciplines
   - lack of advice on course selections outside ones discipline
   - difficulty with administrative staff in dealing with cross registration
   - paucity of interdisciplinary internships and opportunities for theory-practice learning
   - lack of central information officer in the university that could provide guidance on interdisciplinary study
   - other problems include long distances between classrooms, short intervals between classes, uninformed secretaries and other support staff, turf wars between teachers and departments for classroom space, delayed and deficient texts that "fall between cracks of two faculties".

2) Staff problems:
   - The first four problems cited by students were also shared by teaching staff.
   - The reward system in universities makes interdisciplinary teaching risky. Teaching in a different discipline must be done in addition to normal discipline related teaching loads and often there was discouragement from colleagues and chairs.
   - When teaching staff are expected to raise a portion of their salary through research grants, time spent developing interdisciplinary course is perceived as "not profitable".
   - Teaching staff holding joint appointments have to undertake full workload from both departments. They are also overburdened with service commitments.
   - In promotions, the value of only one discipline is considered. Expertise from interdisciplinary experts is not considered.
   - Too little encouragement, too little access to funding and services (www.emory.edu/TEACHING/Report/AppendixC.html).

Most of the above identified problems can be seen to be instantiations of the generic concerns identified and categorised by the OECD study.

4.6. Case studies

As an illustration of some of the ideas expressed above, three summarised case study descriptions are provided below.

4.6.1. Social Science Programme at San Francisco State University

Stanley Bailis (2002) describes the programme at the San Francisco University as one that "serves undergraduate and graduate students who do not want a major done *to* them" (p. 3). The programme has been in operation since the early 1960s and Bailis claims two novelties for it, "first, by continuously facilitating fresh patterns of study for students as individuals; and, second, by generating new degree-granting programmes" (p. 4). These are interrelated and stem from certain design features of the curriculum.

The programme sets itself two problems: 1) how to ensure access to the range of disciplines that constitute the instructional domain and that are needed to deal with some problem, topic or theme; 2) how to make coherently integrated use of the instruction thus received (p. 4). By "access" Bailis means taking instruction in other relevant fields such as history, geography, psychology, sociology, anthropology, political science, and economics, and then moving on further deeply into areas that are determined by student interests for which staff counselling and advice is offered. The student is then admitted to the course in the relevant department in the university. "Coherence" and "integration" mean that ideas and information from several disciplines are brought together to the student's own particular subject area:

> Commonalities of assumption, approach, and subject matter among the disciplines that constitute a domain of knowledge must be delineated. Connections between that domain and other broad categories and types of knowledge must be identified and [...] examples must be provided of both conceptual and empirical works that posit similarities and interactions among factors of behaviour that are treated as different and separable in the disciplines. (p. 5)

This is achieved by continuous advising, four required core courses and nine satellite electives. The core courses deal with social science disciplines with respect to differences, relations and use in interdisciplinary scholarship. The first pair of courses, taken in the junior year, addresses three questions:

> Is there a common subject matter of the social behavioural sciences that justifies grouping them together as an area or domain of knowledge? Is this subject matter pursued in each of the seven basic disciplines? How can the bodies of knowledge produced through the practice of these and related disciplines be rendered coherent and integrated? (p. 5)

The underlying assumption used is that humans have a set of adaptive instruments – brain/mind, culture, social structure, polity, economy – and that the disciplines are grounded in the study of one or the other of these, with history lending time specificity and geography space specificity. In terms of epistemology, the arguments focus on the conflict between positivism and instrumentalism in science and human nature. In ethical terms, the discussion surrounds four questions:

> What kinds of knowledge about humans are needed? Is getting and having such knowledge more dangerous than it is useful? Should the knowledge

> that we acquire about humans be regarded as at all scientific? Who should be empowered to answer these kinds of questions?" (p. 6)

Bailis then examines how this subject matter is expressed in each of the seven disciplines by reviewing key texts in each of the discipline and seeing how the author "conceptualises the phenomena under study, how he or she justifies methods used to gather and interpret data, and how these conceptual and methodological positions generate both objects and events actually examined by practitioners of the discipline and their characteristic empirical claims" (p. 6). Finally, the question of integration is posed: can these bodies of knowledge be integrated? This is examined through the history of interdisciplinarity, forms of integrative work which are philosophically associated with various brands of reductionism and holism and applications taken out of the university's problem –and perspective oriented courses and programmes. Thus through a conceptualisation of human adaptive behaviour students are exposed, through evolution theory, to the natural sciences, through ethical and epistemological issues, they are exposed to humanities and philosophy, through integration per se, to theoretical as well as practical issues in application.

Even while they are doing the core courses in the first semester, students are required, after extensive advice, to take six satellite courses offered elsewhere in the university as electives. These electives will include methods courses in the discipline the student wants to rely on, and at least two courses that illustrate integrative work of "professional interdisciplinarians". This is to make students realise that "we can't know everything before knowing something, and therefore, that most of what is known in any scholarly domain is known through the practice of specialised disciplines" (p. 9).

The remaining courses are taken in the senior year along with three more electives. At first the student chooses a subject that warrants interdisciplinary treatment. They find, read and report on the relevance to the topic of fifteen research papers in two or more disciplinary areas. They must then formulate a question that the interdisciplinary reading of the topic prompts and an approach to answering the question. Finally they work on the project closely with a staff member. They are also given an opportunity to discuss their problems and progress.

The students make average grades that are not significantly different from grades earned in any of the departments. Teaching staff in other departments report students from this course as especially interesting as they raise more profound questions. The project work conducted with an awareness of interdisciplinarity is presented as very challenging. But:

> Eventually the students get it. And, interestingly they get it not by anyone 'teaching' it to them, not even by anyone making examples of it available. Instead they get it by being obliged to pay attention to each other's travails in seminars, in which setting they begin to offer each other suggestions based on what they know about each other's topics. It is a kind of small miracle. (p. 12)

When significant numbers of students start to select similar sets of topics from the same set of departments, it usually denotes felt needs that surface among students, teaching staff in departments and often society at large. This is an expression of curriculum demand, which can be served at least initially by regrouping existing courses, which

prove to be a very challenging task. Many of the university's instructional developments started this way:

> as elective course patterns, later becoming freestanding minors, and, sometimes, growing to degree-granting departments and programmes. Women studies, urban studies, criminal justice, information science, gerontology, employment and labour studies, public administration, religious studies, critical social thought, and world development studies are examples that have developed since the late sixties, almost all of which started as a topical focus in our major. (p. 13)

Though other factors such as visionary deans and teaching staff are important, the author argues:

> But these folks are much more likely to be effective if the front-end costs of learning to cooperate across fields have been paid more or less unselfconsciously by faculty and students while pursuing shared interests. This is what the design facilitates. (p. 13)

4.6.2. Interdisciplinarity in Study Abroad Programmes and Eastern Michigan University's Cultural History Tours

Klein (2002) examines how study abroad programmes might contribute to interdisciplinarity. Citing Johnston and Spalding (1997), he identifies four major categories of international education in the US: language study, study abroad, education of foreign students in US, and the internationalisation of higher education in America. From an analysis of an email discussion list, he concludes that of all the interdisciplinary approaches to international studies, area studies is identified as being the most prominent and popular, though other fields such as programmes in global perspectives, international relations, cultural history, comparative development, women's studies, native studies and Canadian studies also emerged.

Within area studies, study abroad programmes tend to be site specific, with travel limited to a single country or region. In both the US and abroad, the study largely tends to be multidisciplinary rather than interdisciplinary. He cites Lambert's (1991) review and observation that area studies is not inherently interdisciplinary, even though some blurring of boundaries occur. Essentially specialists continue to work within disciplinary and sub-disciplinary frameworks which reflect also in the study abroad curriculum. The discipline that occurs most often in area studies was language. Recent developments in Europe are however said to have created new opportunities that are structured as multidisciplinary or interdisciplinary. The Institute for the International Education of Students European Union programme in Freiburg follows a multi-disciplinary format. By contrast, Antioch College's Europe in Transition: The Challenges of Post-Industrial Society takes more pro-active steps towards integration.

Even though numerous examples of such programmes might be cited the question of how exactly interdisciplinarity might be fostered in a study abroad programme remains. According to Klein and Newell (1998, cited in Klein 2002, p. 208) they can occur by:

- course and Course segments clarifying the concept of interdisciplinarity
- capstone seminars
- capstone theses, essays and projects
- coordinated alignment of parallel disciplinary courses
- clustering of disciplinary courses around a common integrative seminar or discussion groups
- organisational structure based on topic, theme, issue, problem, or question
- specific integrative approaches, theories, or concepts (such as systems theory, feminism, Marxism, textualism)
- course learning portfolios and academic career portfolios
- a specific learning model
- common living arrangements, shared facilities and equipment
- fieldwork, work experience, travel-study.

Even though all of the above can potentially be part of a study abroad programme, interdisciplinarity never occurs unless it is actively practised. In a study abroad programme, the task can also present specific challenges – different teaching staff not even teaching common courses perhaps, foreign location, and so on – that may be daunting. Some study abroad programmes adopt an explicit integrative philosophy, such as the Arava Institute for Environmental Studies in Israel. The Institute is rooted in a holistic approach to regional environmental issues, and the use of experiential learning as an integrative format for areas in which the very place is a "living laboratory", such as art in Florence or Buddism in Nepal. Sometimes several elements may be sequentially combined as is done at Lexia International, which offers programmes in many countries. Internships and institutional partnerships are also powerful in bridging theory and practice. Though these varied types of study abroad programmes exist, highlighting the interdisciplinary element is more explicit in the Eastern Michigan University's Cultural History Tours.

The European Cultural History Tour (ECHT) was created in 1974. It started as a summer programme travelling through Western Europe and Mediterranean focusing on history and art. In 1987 it became a full semester programme and also included literature and political science. The travel in the programme is unprecedented, fifty or more cities in up to eighteen countries in one semester. The course in essence is a survey of the cultural history and current political and cultural environments of countries visited. It is offered as separate subjects, with the dominant model being study abroad. Within the course, students must take at least nine semester hours in three different disciplines. However, the relationships between the subjects are highlighted: "Course content tends to look and be disciplinary, but curriculum delivery is interdisciplinary." (Klein 2002, p. 213) The whole programme requires very careful planning and logistic coordination. A logistical director takes care of travel, meals and lodging, teaching staff double up as on-site academic coordinators. In addition a full–time director and support staff administer the overall programme from the campus. Generally upon arrival at a new location teaching staff start by having an intensive meeting supplemented by daily conferrals. Staff from up to four disciplines travel and live with students for the course duration.

A typical day in this programme will consist of visits to museums, monuments, historic sites and governmental centres. A classroom will be a park, museum steps, train station,

hotel lobby or a historic site. Students are guided by the staff member who has the most experience in that particular site with others contributing their perspectives. Teaching staff though experts are also co-learners in this process and must have the ability to "think on their feet, improvise and explore beyond the limits of their own expertise" (p. 214).

Extensive preparation and collaboration are necessary for running this course and the quality of collaboration is crucial. Staff must also be aware of how their disciplines intersect. Core readings that represent various disciplines are mandatory for the course, regardless of what classes the students are taking. They are chosen jointly to resonate with disciplinary and interdisciplinary interests.

The informality arising from travelling and living together facilitates the flow of ideas and opinions and also reduces the distance between teaching staff and students. Very soon even small talk centres on the curriculum. Teaching staff engaged in the programme are eager to go again, though other commitments may prevent them from doing so. They also show a rededication to teaching and learning processes. Even in conventional contexts they engage students in active learning processes, encourage and respond to collaboration with other teaching staff and team teaching. Students engaged in these programme show a heightened and sustained interest in international affairs and exhibit greater poise, self-confidence and judgement.

Klein concludes that if the interdisciplinary potential of study abroad programmes are to be realised, attention must be given to several aspects. The first is advising, with teaching staff seeing interdisciplinarity as important not just an afterthought or oversight. Second, study abroad must be integrated with the rest of the student's academic career. It must not be structured as separate from the regular curriculum; ample formal opportunities for reflection must be structured in. Third, the theme of interculturalism must be integrated with all forms of international education, instead of being taught separately in disciplinary settings since "multiculturalism works at the intersection of disciplines and cultures to dismantle the boundary between domestic and international diversity" (Cornwall and Stoddard 1999 cited in Klein 2002, pp. 216-217). Thus, Klein argues: "No matter what their content is, study abroad courses fall short if they do not include opportunities to reflect on civic responsibilities in a world in which globalisation has dismantled the boundaries of 'home' and 'abroad'." (p. 217) Fourth, interdisciplinarity needs good practice. Klein suggests the following checklist for study abroad programmes in the US:

- Is the interdisciplinary nature of a programme or course explained in promotional print and internet sources, course syllabi, and other course materials?
- Is interdisciplinarity merely implicit, or is there an explicit, clarified focus on integration in all phases, from orientation to course delivery?
- Does the programme go beyond multidisciplinary combinations of different subjects to offering explicit opportunities for reflecting on differences of disciplinary perspectives and their interconnections around particular topics, issues and problems?
- Is integration a random interest or an ongoing process?
- Are the integrative skills gained from interdisciplinary study clarified?

- Are time and resources invested in staff development, preparing individuals for collaborative teaching and acquainting them with the nature of interdisciplinary education?
- Do faculty [staff] work together in teaching, designing the programme and course, and creating course materials, including assessment activities?
- Are the interdisciplinary dimensions of participating disciplines and pertinent interdisciplinary subfields and fields recognised? (p. 217)

Klein (1999) the opinion of Sonnie Carpenter, expressed in an email sent on 5 May 1999, that: "many of the universities abroad [outside USA] […] are figuring out that they have to allow for crossing disciplines in order to keep the study abroad students enrolling." (p.218) The above account is meant as a preliminary step towards realising that.

4.6.3. Undergraduate Interdisciplinary Education: School of Interdisciplinary Studies, Miami University, Ohio Newell (1992) poses a series of questions, the answers to which he provides by means of an illustration:

- How much disciplinary background do students need before they are ready to take interdisciplinary courses?
- How much background in relevant disciplines do academic staff need to develop and teach an interdisciplinary course?
- How visible should disciplines be and what role should they play in interdisciplinary courses?
- Can students learn intellectual skills often associated with disciplinary education, such as rigorous or critical thinking, through interdisciplinary courses?
- Can interdisciplinary courses adequately prepare students for more advanced work in disciplines or for careers that draw upon a disciplinary base? (p. 212)

Miami University's School of Interdisciplinary Studies programme is a four-year degree granting school. It has 300 students and 14 full-time academic staff. It has a core curriculum of exclusively interdisciplinary courses in humanities, arts, social sciences, natural sciences and technology; a residential programme; a writing-across-the-curriculum programme (with programmes in quantitative reasoning and discovery science emerging); and interdisciplinary contract-based majors finally ending in a year long senior project. In the first year, team-developed individually taught courses explore interdisciplinary topics within three core areas: humanities, social sciences and natural sciences. In the second year, core courses are brought together, such as social and physical sciences in examining the US energy policy. In the third year, seminars, which are developed and taught by staff, focus on specialised topics and interdisciplinary methodology in the core areas. In the fourth year a year long workshop coordinates and facilitates the development of individual senior projects which are within the focus of the student's major. Newell presents the emphasis as being on "challenging students' unexamined assumptions about themselves and their world, on the limitations as well as the strengths of each discipline, and on developing a holistic understanding informed by materials from various disciplines" (p. 212).

Newell then proceeds to answer the questions he raised earlier. With regard to the need for disciplinary education prior to an interdisciplinary education, Newell notes that

more and more colleges and universities in the US were adopting an interdisciplinary general education without disciplinary prerequisites. The approach here is that "these interdisciplinary courses solve the problem by providing their own disciplinary base" (p. 212). Each course teaches students what they want about the disciplines on which it draws. The disciplinary knowledge thus emanates from the substantive content. It also comes from the particular definition of interdisciplinarity that the staff member in charge has. Newell notes that even though the programmes offered are "self-consciously interdisciplinary" (p. 212), there is in fact little consensus among teaching staff as to the nature of interdisciplinarity itself. Thus different operational and pragmatic definitions have evolved from discussions of what topic to cover, what books to read, what issues to raise and what sensibilities to develop. Some take basic concepts, some theories, some facts and some methods. However, the world view of more than one discipline is always presented. Thus the question of, say, the possibility of individual freedom is examined, from the perspective of economics, sociology, and behavioural psychology and so on. Each perspective is contrasted with the other and the distinguishing features are drawn out. At the end of the semester, works of authors who have tried to combine these are introduced. Then students are asked to forge their own synthesis.

Newell argues that the perception of a need for a disciplinary education before an interdisciplinary education stems from a misconception of the intent.

> While interdisciplinary courses indeed make use of concepts, theories, methods and factual knowledge from various disciplines, the interdisciplinary understanding they develop is grounded primarily in the perspectives from which those concepts, theories, methods and facts emerge. It takes many years to learn a discipline; it takes only a few readings to begin to develop a feel for how the discipline characteristically looks at the world, its angle of vision, its perspective. (p. 213)

Newell notes that even if one were to agree to the above, the question of how staff might learn more than one discipline may remain intriguing. The Association for Integrative studies at a national level has been set up to provide staff training in running an interdisciplinary course. He also mentions that Miami University was seeking funds to start an Institute of Integrative Studies to offer the same training to staff.

Integrative courses are normally team-developed by staff from different disciplines. Initial exposure to perspectives from other disciplines comes through committee meetings in which the course is designed, and reading material that other team members propose. Typically, however, the agreement of the reading reflects faith in other staff members and respect for other disciplinary perspectives. Much of the command over other perspectives is developed as the course is taught. There is also a weekly staff seminar, where staff discuss common readings for their individual sections of the same course or separate courses that are designed to meet the same requirement. Depending on which discipline is represented in the week's discussion, different staff members will lead the discussion. Newell thus argues that "interdisciplinary general education requires an informed appreciation of the perspective of other disciplines, not expertise in their full range of concepts, theories and methods" (p. 215). It is willingness and preparedness to learn other perspectives that is most important. "We want staff who have a sophisticated understanding of a discipline at the same time as they chafe under its limitations, so that when they turn to the task of learning about other disciplines, they

will not content themselves with a superficial understanding of the aspects of the discipline they utilise in their courses" (p. 215).

Staff from other disciplines in the university are also drawn upon to either provide lectures for students or help to staff in the School of Interdisciplinary Studies to understand key readings and theories on a topic in their particular field.

Newell however moves on to pursue what in a discipline needs to be taught.

> Is it necessary to present each discipline's concepts, theories and methods pertinent to the topic, or should it suffice to read what representatives of the various disciplines have to say on a topic? In other words, can a responsible interdisciplinary course, focus on the conclusions from disciplinary analyses, or is it important to study how each discipline arrived at those conclusions? (p. 216)

However, he makes an argument for disciplinary analyses:

> If students are to develop a feel for a discipline's perspective, they must learn to think like a practitioner of that discipline. Members of a discipline are not so much characterised by the conclusions they arrive at, but by the way they approach a topic – the questions they ask, the concepts that come to mind and the theories behind them. Without some sense of these, we offer our students dogma rather than empowerment, training rather than education. A discipline's perspective provides the means by which it arrives at an answer; it is not the answer itself. (p. 216)

The level of technicality and suchlike pursued in a course depends upon the disciplines involved. In a natural sciences course, technical concepts and theories are used abundantly. In a course on social sciences, precision and rigour maybe emphasised, while in the humanities, clarity and creativity may be emphasised. Newell proceeds to then present evidence of learning that is not just anecdotal impressions or *a priori* reasoning. This is presented by way of recognition of courses by other disciplines, recognition of staff within the university, student performance in grades, postgraduate admissions, skills traditionally associated with disciplinary education, student behaviour and retrospective evaluation by graduates.

As an explanation of why interdisciplinarity develops rigour and critical thinking in students, Newell cites Paul (1987) and argues that interdisciplinary courses are more likely to promote "strong sense critical thinking", while disciplinary courses are often more likely to promote "weak sense critical thinking" (p. 220). The latter includes a number of valuable informal logic skills such as distinguishing evidence from conclusions, relevant from irrelevant facts, and facts from ideals; assessing the validity of assumptions and arguments; and recognising internal contradictions, implicit value judgements, unstated implications of arguments, and the power and appropriateness of rhetorical devices. Stated most broadly, strong sense critical thinking involves turning that critical eye inward upon oneself, becoming critically self-reflective. By identifying the assumptions and values of competing perspectives, including those they find most appealing, students are encouraged to recognise and formulate a critique of their own irrationally held beliefs and biases. Through the process of deriving insights into a topic from diverse disciplinary perspectives, students learn what Paul terms "multilogical

thinking": "the ability to think accurately and fair-mindedly within opposing points of view and contradictory frames of reference", as well as "the ability to enter sympathetically into and reconstruct the strongest arguments for points of view fundamentally apposed to their own" (p. 220). Newell proceeds to argue for the necessity of both types of skills and thus the need to balance disciplinarily and interdisciplinary within the curriculum.

4.7. Summary

This chapter has looked into the practice of interdisciplinary teaching. It first defined the meaning of interdisciplinary teaching and then proceeded to review goals and aims of such teaching. Curriculum, teaching methods, teacher training issues and assessment were then looked into. The challenges in introducing interdisciplinary education were also reviewed. Finally, three case studies of different types of interdisciplinary programmes were summarised.

5. Interdisciplinary teaching and higher education policy

This chapter reviews the policy context in the UK with reference to interdisciplinary teaching. It starts with a review of the Dearing Report (1997) as it is one of the most influential documents in recent times. (www.leeds.ac.uk/educol/ncihe/nr_001.htm).

5.1. The Dearing Report

The National Committee of Inquiry into Higher Education (1997) was primarily set up to "make recommendations on how the purpose, shape, structure, size and funding of higher education, including support for students, should develop to meet the needs of the United Kingdom". Part of the principles outlined for the terms of reference of the Committee was:

- the effectiveness of teaching and learning should be enhanced;
- learning should be increasingly responsive to employment needs and include the development of general skills, widely valued in employment.

Thus higher education is not an end in itself and a strong link to the world of practice is to be maintained.

The enormous growth in knowledge is acknowledged and consequently there is a recognition that learning is to be thought of more as a lifelong process. The Committee recommends that institutions in higher education "need to recognise more consistently that individuals need to be equipped in their higher education with the knowledge, skills and understanding which they can use as a basis to secure further knowledge and skills". Furthermore, with respect to jobs there is the recognition that: "There may be a shift away from routine processes within narrowly defined functions and towards teamwork which crosses functional boundaries." The Committee thus seeks to move away from a traditional pattern of provision of higher education. Thus "many will still take a concentrated and lengthy programme of study in higher education, immediately or soon after school or further education, in preparation for entry to work, but this will be seen as only the foundation for the first stage of a career". The programmes of study are expected to prepare students for lifelong learning and thus managing their own career.

In the context of the above, within the chapter 'The Nature of Programmes', the Committee reflects on the breadth and depth of programmes. They take into consideration the employer perspective that essentially seeks high level analytical skills and cite from Purcell and Pitcher (1996) that "for many years over 40 per cent of jobs advertised for graduates in the UK have been open to applicants from most, if not all, disciplines". They also note the opinion of the Committee on Higher Education (Robbins Committee 1963, p. 91):

> There are unquestionably young men and women for whom study that involves penetration in depth is naturally appropriate. They are eager to get to the heart of the subject and to develop powers of rigorous analysis and observation within its ambit. For such students the specialist degree courses […] are an admirable education […]. Nevertheless there is another sort of mind that at the first degree stage is likely to be more at home in broader fields studied to more moderate depth.

For future programmes the Dearing Committee thus recommends that:

> We believe that introducing breadth more extensively would assist students to respond to the social, economic and cultural changes they will be facing throughout their lives by assisting them to think divergently and to integrate information and knowledge from a variety of sources.

They go on to suggest a diversity of programmes that give the student a potential to:

- study a single subject degree, where that subject is set in its broader context
- construct a broad foundation of knowledge and understanding in an area where the student may like to specialise later
- study a combined degree including a small number of subject areas
- study a general degree which would cover a wider range of subject areas providing a good advanced general education.

Recommendation 16 of the Committee thus states:

> We recommend that all institutions of higher education should, over the medium term, review the programmes they offer:
> - with a view to securing a better balance between breadth and depth across the programmes than currently exists
> - so that all undergraduate programmes include sufficient breadth to enable specialists to understand their specialism within its context.

With respect to specialisation occurring in higher education, the Committee opines that:

> This pattern of higher education, typical of the traditional, elite, higher education system, has carried across into the more diverse system of today. We believe that it is not serving all students well. It requires applicants to higher education to be clear at a relatively early age what they want out of higher education, and promotes undue specialisation at school aimed at meeting the admission requirements for particular programmes.

5.2. Quality assurance

Quality assurance efforts in UK have by and large followed a philosophy of detachment from the theses that academic disciplinary expertise leads to excellence in teaching. Thus, Henkel (2000) in her review of the higher education policy scenario in UK comments on the language of the Higher Education Funding Council for England (HEFCE) as being "that of educational theory rather than of traditional academic beliefs, such as the inseparability of teaching and research, the preservation of academic standards" (p. 76). What is more, in taking the position that good teaching is not necessarily a function of active research, Henkel argues that HEFCE associates itself with the idea that good teaching is not necessarily a function of active research" (p. 77). Following a call for greater explicitness on the evaluation criteria for teaching, the Council issued a framework encouraging departments to adopt more holistic criteria rather than subject or teacher centred definitions (p. 80). However, through her empirical work on academic identities, Henkel observes that: "Implicitly or explicitly, elite concepts of quality and the conditions required to achieve it remained powerful

influences" and that "almost all [academics] maintained discipline-centred concepts of higher education" (p. 107)

5.3. Subject Centres

The drive towards holistic generic criteria for assessment in teaching and learning has led to the organisation of disciplines around subjects seen in the setting up of Subject Centres for learning and teaching, with substantial public funding. Parker (2002) argues that "although we do have support for and research into teaching, it comes within a newly imposed framework of the nature, purposes and ends of teaching in HE, and within a new configuration of subject areas divorced from discipline communities" (p. 374). Parker identifies a clear difference between subjects and disciplines. A subject is "reassuringly concrete – a subject can be defined, has a knowledge base which can be easily constructed into a programme acquisition", while the notion of discipline "brings with it tricky questions about access and boundaries" (p. 374). In the present orientation of higher education policy, Parker sees the use of subjects in the place of disciplines as a move towards removing unwelcome associations of elitism and exclusivity: "it is somehow easier to ask what use a 'subject' is in the real world than it is to ask the use of a 'discipline', 'profession' or 'calling' – words which, however unworldly provide, by implication, the answer" (p. 374).

5.4. Summary

From the above review of the policy situation in UK, it is clear that there is an external compulsion towards interdisciplinarity, which is grounded in the concept of usefulness. In order to understand and make sense of this trend, Kant's work on the Conflict of Faculties might be useful. He writes, "a faculty is considered higher only if its teachings […] interest the government itself, while the faculty whose function is only to look after the interests of science is called lower because it may use its own judgement about what it teaches (1972, quoted in Hearn 2003, p. 4). Furthermore:

> It is absolutely essential that the learned community at the university also contain a faculty that is independent of the government's command with regard to its teachings, one that, having no commands to give, is free to evaluate everything and concerns itself with the interests of […] truth; one in which reason is authorised to speak out publicly. For without a faculty of this kind the truth would not come to light (and this would be to the government's own detriment). (Kant 1972, quoted in Hearn 2003, p. 5)

Building on from the above conceptualisation, Hearn argues that the emergence of the "useful disciplinary university" was a result of economic, political and cultural factors during the time of industrialisation, and that they arose to ensure social and political conformity (pp. 6-7).

The same argument can however now be advanced for interdisciplinarity. Thus Hearn says "predictably, just as discourse about critical interdisciplinarity developed within the academy, external social and political demands (most notably the Second World War) called for the development of problem-focused, instrumental interdisciplinary research" (p. 8). This has created a crisis for the universities of today:

> Debates around the impact of external corporate interests and funding on academic freedom; debates about the role of 'new learning' technologies,

> debates about the impoverishment's of public education, debates concerning the disciplinary "rigour" of the humanities in the face of the 'cultural turn' of the 1990s, better known as the "culture wars" and, of course, debates about the legitimacy and content of interdisciplinary research – all betray a determination to define, once and for all, the university's nature and mission. These debates drive to resolution and usually articulate, in some form or other, one side or another of the paradox outlines above: utility vs. uselessness; pragmatic, skill-based education vs. the pursuit of learning for learning's sake. So where does interdisciplinarity sit inside the conflicted site of the university? Is interdisciplinarity exemplary of the university's animating paradox? Or, is it, in effect, working to nullify or cripple it? What can current incarnations of interdisciplinarity tell us about the relative health of the university's tradition of contestation and conflict? (p. 8)

Hearn proceeds to warn us of the risk of interdisciplinarity becoming a "Trojan horse". She argues that:

> problem-focused, or instrumental interdisciplinary research is particularly vulnerable to the external logic of corporate interests as it can leave unexamined the assumptions behind the delineation of "problems" to be studied, the sources of its funding, and the social, political, and economic implications of the 'solutions' it offers. Here, we can see how the rubric of "interdisciplinarity" functions as a Trojan horse, smuggling external political and economic interests inside the wall of the academy. And so "interdisciplinarity" becomes a sign or a code word. Cloaked in the rhetoric of academic freedom and innovation, "interdisciplinarity" can serve as a rationale and as a source of legitimation for private interests and corporate-style institutional arrangements inside the academy. […] With this term, [academic administrators] are able to signal one meaning – free academic innovation in knowledge formation – and execute another – an uncritical capitulation to agendas and problems determined by government and corporate interests. (p. 10)

Poovey (2000 quoted in Hearn 2003, p. 11) writes: "The only way we can evaluate the effects of market penetration into the university in terms other than the market's own is to assert some basis for evaluation that repudiates market logic and refuses market language". For Hearn (2003, p. 12) this means: "Interdisciplinarity" must be both an intellectual and an overtly political endeavour involving a rigorous process of self-reflexive analysis beyond issues of representation and into the terrain of the political economy of knowledge production." Ways in which this might be achieved will necessarily vary with particular situations and institutions. Hearn herself suggests linking of intellectual work on interdisciplinarity with what she calls "new forms of community both inside and outside the university" (p. 12). However not losing sight of essences within the politics of nomenclatures, policies and programmes, be they internally or externally imposed, remains an overall necessity.

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Tel: 023 8059 4814
Fax: 023 8059 4815
E-mail: llas@soton.ac.uk
www.heacademy.ac.uk/ourwork/networks/itlg

Series Editor: John Canning

Dr Angelique Chettiparamb is Research Fellow in the School of City and Regional Planning, Cardiff University. Her research interests relate to design, planning and governance (particularly in relation to local government). She has researched local-government /community interfaces, meta-governance, social movements and their interface with globalisation, poverty, planning education and design development in water intensive climates. She has a theoretical interest in complexity theory and its application and is generally interested in planning theory and design theory. In terms of teaching she contributes to modules on planning in the UK and in developing countries.

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