

Postgraduate students' experiences in interdisciplinary research studies

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Abstract

Many postgraduate interdisciplinary research (IDR) candidates in the applied disciplines work across two or more traditional areas of study. Such candidates often spend considerable time on knowledge-building activities outside their home (or undergraduate) disciplines; IDR candidates venture into new fields and are exposed to the cultures and values of different disciplines. In this study, IDR candidates, from different applied disciplines, were selected as case studies. The study was delimited to a range of interdisciplinary permutations across the 'hard' and 'soft' applied disciplines (e.g., engineering management, health informatics). The focus of this article is postgraduate students' experiences in doing an IDR study for a Master's thesis. In the article we explore the challenges faced by candidates, with a view to minimising these, given the contribution that IDR can make to a developing society.

INTRODUCTION

We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline (Popper 1963, 88).

The practicalities and logistics of interdisciplinary research (IDR) are generally not compatible with traditional structures of scientific enquiry, nor with the organisational arrangements that tend to dominate university practices, even though there has been much focus in recent years on developing an IDR environment in higher education. The structures of the research establishment: supervisor training, funding, administration of grants, peer review, publishing and professional recognition, etc. have been slow to include IDR, despite the prominence given to IDR in South African policy documents and in calls for research funding proposals (e.g., South African National Research Foundation 2008).

The focus of this article is, however, candidates' experiences in doing IDR Master's studies in both the 'soft' and 'hard' applied disciplines (including various permutations of these). The difficulties and advantages that candidates experienced were analysed, with a view to understanding the ways in which IDR practices are enabled or constrained. Our larger purpose in this study is the enhancement of candidates' experiences, and the strengthening of IDR supervision.

THEORETICAL FRAMEWORK: STRUCTURE, CULTURE AND AGENCY

The theoretical framework for this research is developed from social realism, which provides a language of description for understanding disciplinarity and interdisciplinarity as knowledge and knowledge-building concerns, within departmental and interpersonal contexts. Personalities, individual levels of understanding and motivation, as well as departmental arrangements, including traditional and new research supervision practices, impact considerably on IDR. The literature suggests that it is the academic disciplines or knowledge fields, more than the concerns of research supervision relationships, and departmental structures, that tend to inform the practices of academics (Neumann, Parry and Becher 2002). Academics from different disciplines tend to operate in isolation from one another (even if they are in the same department or faculty) because epistemologies, methodologies, and a variety of other practices tend to be different across disciplines. Research practices involving interdisciplinary collaboration, for example, are unlikely to come about through a process of personal development or commitment alone. IDR requires researchers to understand the nature of the 'home' disciplines, as well as the knowledge base of the emerging or established 'interdiscipline'. IDR is also unlikely to become established when supportive structures are absent in higher education institutions (Fullan 2001). Isolation works against IDR; it is only through structured interaction that the separate life-worlds of the disciplines can be bridged.

Disciplinarity

A number of scholars have examined the ways in which disciplines differ (e.g., Bernstein 2000; Biglan 1973; Kolb 1981; Whitely 1984; Becher and Trowler 2001; Neumann, Parry and Becher 2002; Max-Neef 2005). Many of these scholars have attempted to categorise disciplines based on what they believe to be the most salient differences between them. Biglan (1973), for example, separates disciplines along two dimensions, concluding that there are 'hard pure' (e.g., physics), 'soft pure' (e.g., sociology), 'hard applied' (e.g., engineering), and 'soft applied' (e.g., education) types. Biglan's typologies and taxonomies invoke Habermas's (1971) classification of knowledge systems into three main categories: 1) the humanities (hermeneutic) tradition; 2) the 'empirical-analytic sciences', based on the 'deduction of law-like hypotheses' establishing predictive correlations among phenomena; and 3) the 'sciences of social action', which include economics, sociology and political science. Thomas Kuhn (1970) conceptualises the cognitive framework of a discipline

as consisting of three elements: 1) its underlying theory (or generalisations); 2) its idealised models and analogies (fabricated examples that are abstracted from real cases to ideally describe phenomena); and 3) exemplars (which are specific instances of generalisations and models). Bernstein (2000) distinguishes disciplines according to their knowledge structures; he distinguishes between 'hierarchical' and 'horizontal' knowledge structures. In the 'hard' disciplines, knowledge is predominantly hierarchically organised and each knowledge area is 'coherent, explicit, and systematically principled' (Bernstein 2000). In the 'soft' disciplines, knowledge is horizontally or segmentally organised. The applied disciplines have developed out of practice and in contrast to the pure disciplines they tend to be more 'context dependent, tacit, multi-layered, [and] often contradictory across contexts' (Bernstein 2000). Whitely defines the important difference between disciplines as the degree of 'technical task uncertainty' (how much variability there is in the problems being examined) and 'strategic uncertainty' (how much instability there is in the way the research is conducted) present in the field (1984, 126–129). Max-Neef clusters disciplines according to whether they describe 'what exists' (the first, empirical level), what we are 'capable of doing' (the second, productive level), what we 'want to do' (the third, planning level), and what 'we should do' (the fourth, ethical level) (2005, 8–9).

The hard applied disciplines share with the hard pure disciplines a need for progressive mastery of techniques in a linear sequence, often based on concepts developed in the pure disciplines of physics and mathematics (Whitely 1984); hard applied disciplines emphasise the knowledge and procedures associated with pure hard disciplines (e.g., experimentation, accuracy) for legitimating their own knowledge claims (Maton 2007). The soft applied disciplines similarly draw on both the practices (e.g., ethnography, qualitative enquiry) and the knowledge claims of the pure, soft disciplines (Christie and Machen-Horarik 2007). Kolb (1981) characterises disciplines according to the ways in which they demand that students learn; he places these disciplines along two continua which he calls 'active-reflective' and 'abstract-concrete'; while Neumann, Parry and Becher (2002) analyse different disciplinary orientations to teaching. Breslow (2005) describes disciplinary difference in terms of epistemological, methodological, communicative, professional, and educational variables. Muller (2008) extends these variables to characterise professional and vocational curricula in particular.

From the taxonomies and typologies briefly outlined above, we can develop a schematic model of the disciplines involved in this study.

Table 1: Disciplinary variables in soft and hard applied fields

Disciplinary variables	‘Soft’ applied disciplines e.g., Education, Marketing, Management, Design (in some aspects)	‘Hard’ applied disciplines e.g., Engineering, Information Technology, Health Sciences, Design (in some aspects)
Ontology	Derived from philosophical questions about the nature of existence/being.	Derived from scientific questions about the nature of existence/being.
Epistemology	Derived from sociology, psychology.	Derived from mathematics, physics, chemistry.
Typical research methodologies	Exploratory, problem-posing, ethnographic, action research, qualitative.	Experimental, problem-solving, R&D cycles, quantitative.
Profession regulation	Usually non-formal professional associations.	Often have strong, regulating professional councils (except in new fields, e.g., ICTs).
Teaching style	Student-centred, reflective practice, lecture-workshop.	Subject-centred, lecture-demonstration, laboratory-based tutorials.
Learning styles	Discovery-learning, constructivist, group discussion, personal development, process-oriented.	Pragmatic, team-based learning, problem-based learning, project-based learning, laboratory practical, experiential learning, product-oriented.
Values	Theorisation, argumentation, creativity, insight, consistency, fluency of expression, logical textual development, independent thinking, critique.	Measurability/measurable criteria, accuracy, originality, standardisation, efficiency of systems and processes, cutting-edge techniques and technologies, professionalism.
Academic culture	Participatory, low publication rate.	Entrepreneurial (e.g., contract work), role-oriented, patents, high publication rate.
Communication practices	Personal (e.g., use of first person in academic texts), ‘slow’ texts.	Impersonal (e.g., use of passive constructions, avoidance of first person in academic texts), diagrammatic (graphs and charts), calculation-based, ‘fast’ texts.

Interdisciplinarity

The increasing importance of ‘Mode 2’ knowledge (Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow 1994) produced through IDR, means that the number of interdisciplinary postgraduate studies is likely to increase. Manathunga and colleagues (2006) write that ‘if universities are to produce future research leaders capable of solving the complex problems of the twenty-first century ... then they will need to design doctoral programs that develop students’ interdisciplinary knowledge, skills and attitudes’ (Manathunga, Lant and Mellick 2006, 376). As a mode for education and discovery IDR has been shown to address issues of health, environmental sustainability and more prosperous lives, and has the potential to continue to address complex problems (Beckman and Beckman 2005).

As interdisciplinary practices emerge, there are attempts to define interdisciplinary scholarship (e.g., Klein 1996; Lattuca 2001; Marts 2002; Max-Neef 2005). Lattuca (2001) describes a continuum of interdisciplinary practices. 'Informed disciplinarity' occurs when a course based in a particular discipline (e.g., Engineering) is informed by areas of other disciplines (e.g., Management). 'Synthetic disciplinarity' occurs when there is closer integration between courses in different disciplines, such as when a supervisor (e.g., from Engineering) and a co-supervision (e.g., from Management) are appointed to supervise a thesis on Engineering Management. 'Transdisciplinarity' occurs when a course includes concepts that are outside of its traditional disciplinary area (such as a design candidates involved in a wellness project). Transdisciplinary research is understood as 'the development of a common conceptual framework that bridges the relevant disciplines and that can serve as the basis for generating new research questions directly related to the defined problems' (Marts 2002, 503). Stokols and colleagues (2005) identify the term 'transdisciplinary' as a process that involves shared concepts, as well as the integration and extension of discipline-specific theories, to address common research issues. Stokols et al. (2005) have contrasted this with multidisciplinary research, in which independent or sequential research is said to be focused on a common problem, and interdisciplinary research, in which greater sharing occurs among participants anchored in their respective disciplinary perspectives but which, in the view of Stokols' group, '... stops short of achieving novel and integrative conceptual models' (Stokols, Harvey and Gress 2005, 204). For Max-Neef, interdisciplinarity involves the integration of two vertical levels, such as the empirical level (e.g., sociology) with the productive level (e.g., engineering); while transdisciplinarity involves the integration of all four levels (the empirical, the productive, the planning and the ethical). In this way, Max-Neef (2005) extends our appreciation of the complexity of transdisciplinarity, in particular the multiple 'levels of reality' and 'simultaneous modes of reasoning' (2005, 14) that are involved. Transdisciplinarity is more generally understood as attempts by higher education to be relevant to the contexts in which knowledge will be used or impacted upon, and is associated with the work of Gibbons and colleagues (Gibbons, Limoges, Nowotny, Schwartzman, Scott and Trow 1994; Nowotny, Scott and Gibbons 2001).

Lattuca's (2001) fourth category, 'Conceptual interdisciplinarity', occurs when a new discipline or field of practice is established, such as 'Environmental Management', 'Ergonomics' or 'Health Informatics'. Marts (2002) describes interdisciplinary research as 'a cooperative effort by a team of investigators, each expert in the use of different methods and concepts, who have joined in an organized program to attack a challenging problem' (Marts 2002, 502). Such conceptual interdisciplinarity is linked to what is known as 'translational research' in the medical field, defined as '... the application of basic scientific discoveries into clinically germane findings, and simultaneously, the generation of scientific questions based on clinical observations' (Rustgi 1999). IDR can thus be broadly defined as a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of

specialised knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (National Academy of Science 2004).

Studies of how individuals become competent members of interdisciplinary groups and what role disciplinarity plays in this process has begun to influence teaching and learning, including research supervision (e.g., Collins, Evans, Ribeiro and Hall 2006). Collins and colleagues (2006) coin the term 'interactional expertise', which they use to describe practices developed by, for example, design candidates studying the practices of sports trainers. Interactional expertise is developed through long term interaction with a discipline that is different from the home discipline, without full immersion in its knowledge and practices. Interdisciplinary study is, in this regard, a special case of academic socialisation since it has to do with how candidates integrate (or do not integrate) across different disciplinary practices in identity formation.

IDR studies, such as in those analysed in this article, are enhanced when there is common ground, or the potential of negotiation around what Star and Griesemer (1989) call a 'boundary object'. Boundary objects are able to cross the boundaries between disciplines, they can 'adapt to local needs and constraints of the several parties employing them, yet [are] robust enough to maintain a common identity across sites'. Boundary objects allow collaboration without complete consensus as they enable different understandings to be reframed in the context of a wider collective activity or project. Theorists in the field of interdisciplinary study use different metaphors to name catalysts or enabling mechanisms for collaboration. Galison (1997) refers to a 'trading zone' in which the different understandings of different disciplines can be negotiated, while Nowotny et al. (2001) describe 'transaction spaces' in which the processes of interdisciplinary engagement are facilitated. While differing disciplinary perspectives have the potential to close down collaboration, boundary objects, mediating artefacts, trading zones and transaction spaces have the potential to enable productive collaboration, including the sharing of knowledge, meanings and practice.

RESEARCH DESIGN AND METHODS

For this study, postgraduate IDR candidates, from different home disciplines, were selected as case studies. The study was delimited to a range of interdisciplinary permutations across the 'hard' and 'soft' applied disciplines (e.g., Engineering Management, Health Informatics). The researchers developed a semi-structured interview based on the outcome of an initial pilot study for this project. Candidates who were engaged in, or who had recently completed, IDR studies were selected for interview. The interviews enabled the candidates to critically reflect on the process and progress of their research studies. All interviews were recorded and field notes were taken. Although the interviews were not formally transcribed, they were listened to several times by the researchers in order to digest the information

provided by the candidates. Some transcription was done and transcripts used for the direct quotations in this article. The interview data were captured in spreadsheets for the purpose of analysis and comparison. The data generated by the graduates and candidates identified the difficulties and benefits that they experienced.

Table 2 provides an overview of the IDR candidates, their undergraduate areas of study and their areas of postgraduate specialisation.

Table 2: Research participants

Candidate	Undergraduate field	Postgraduate field	Co-supervisor	Current status	Years (expected) to complete
Candidate C1	Nature conservation	Environmental education	No	Data analysis	3–4
Candidate C2	Electrical engineering	Engineering management	Yes	Graduated	2
Candidate S	Information and communication technology (ICT)	ICT education	No	Literature review	4
Candidate K	Human Resource Management (HRM)	HRM in advertising	Yes	Graduated	5
Candidate M	Information and communication technology (ICT)	Health informatics	Yes	Graduated	2
Candidate V1	Design	Design education	No	Graduated	3
Candidate V2	Design	Design management	No	Graduated	5
Candidate V3	Design	Ergonomics	Yes	Graduated	2

FINDINGS

There were a number of themes that emerged from an analysis of the candidate interviews: 1) the need for a 'metadisciplinary' understanding when conducting IDR; 2) the additional time needed for IDR studies, 3) the need for suitably qualified and experienced supervisors and examiners for IDR, 4) the role of communication in IDR contexts and 5) developing and sustaining an IDR culture. While many of these issues (and particularly difficulties associated with these issues) are common to most postgraduate researchers' experience, they tend to be exacerbated in contexts of IDR.

Metadisciplinarity

It is not surprising that although all candidates knew that they were doing IDR, they were unclear on what that term meant: they could not explain to what extent their research was interdisciplinary (e.g., whether one discipline was more dominant

than another), what kind of interdisciplinarity was involved, or what the different epistemologies or methodologies associated with the two (or more) disciplines were. Candidate K, for example, knew from the beginning that his project was interdisciplinary. It included Human Resource (HR) Management and Advertising. The research was however done in the HR department, where the supervisor had significant knowledge and experience. A co-supervisor from the Marketing department was duly appointed, also with expertise in his occupational field. But the specific area of HR management/Advertising was, however, a new one for both departments (and also new to the HR/Advertising industry). This meant that the candidate had to be proactive and keep in touch with these changes. But it should also have required the specialist supervisors to become familiar with each other's domains and their associated epistemologies and practices. The literature suggests that without a metadisciplinary understanding, interdisciplinarity is unlikely to be successful (Lattuca 2001).

Candidate S, doing discipline-based educational studies did not consider education to be a discipline (and neither did his supervisor) and claimed that there was no need 'to supplement the [Information Systems] supervision with education co-supervision'. In answer to the question why she did not have an educational specialist as a co-supervisor, a candidate doing discipline-based educational research claimed that a 'co-supervisor was not necessary as she already had a qualification in education' (Candidate V1). It is unlikely that a basic education qualification would be sufficient for the advanced levels of disciplinary understanding (in particular educational research practices and theoretical frameworks). It is interesting to note that among the three candidates doing discipline-based educational IDR, none had requested a co-supervisor from Education. The same is true for the two candidates doing discipline-based management IDR. It would seem that in these cases, at least, that there was disciplinary dominance, and that a project that might appear to be interdisciplinary is only nominally so.

A greater awareness of, and respect for, the different disciplines and what they can offer, would be an important first step for successful IDR. Developing 'metadisciplinary' awareness, for example, by defining the nature of the IDR that one is undertaking, and the level of the interdisciplinarity involved (Max-Neef 2005) is an important first step in understanding how IDR might (or might not) be synergistic with traditional practices within the academic context. The literature offers several terms that are often used interchangeably: interdisciplinary, multidisciplinary, inter-professional, cross-disciplinary and transdisciplinary. Candidates were, unsurprisingly, confused by these terms and how they related to their own practices. Metadisciplinary awareness would enable a better understanding of the inherent complexity of IDR (under its different names and in different forms) (Max-Neef 2005).

IDR takes time

As can be seen from Table 2, the completion of an interdisciplinary Master's thesis takes longer than a 'monodisciplinary' thesis. Candidate C1 took 'over a year just to write up the proposal'. In the case of Candidate K, the field was extremely new, and delays were caused as he waited for:

many changes in legislation ... the code of practice only came out two years after my research started ... had to wait for the code of conduct ... act to be gazetted ... added to which there was hardly any related literature (Candidate K).

For this Candidate the duration from proposal to data collection was four years. This candidate was also held up by the literature review – mainly due to changes in the industry, as there had been neither an act nor a code of conduct in the interdisciplinary area. Candidate K indicated that he was happy with the progress of the thesis (after the data collection delays), given the circumstances. These, according to the candidate, mainly included the dynamics in the industry as there were constant changes. It took three months to conduct the qualitative research, due to the fact that the candidate had to wait for appointments as industry practitioners were quite busy, however the data collection was complete by the third month.

According to the Candidate S, whose research topic is of interest to him and had not yet been thoroughly researched in South Africa, the focus of his research only became clear after three months of interactions with different research groups and with fellow students, and it was not fully clear to him that it was IDR. It took him five months to draft the proposal. Candidate S showed a high level of pro-activeness and interest in his study and was prepared to go out of his way to address administrative hitches and hence did not rate these as significant challenges. The fact that the candidate was an employee at the institution of study meant he was able to seek information on the procedures and other administrative information required to ease arising difficulties.

Despite these (and other) delays, when the candidates/graduates were asked whether, in retrospect, they would have changed the topics to more 'monodisciplinary' ones, none of them claimed that they would have tackled a more straightforward topic. Delays, re-routings and other contextual factors are inevitable in IDR – inevitably a long-term project involving the development of expertise in complex areas (Collins, Evans, Ribeiro and Hall 2006); while this causes difficulties, candidates who embark on IDR do, nevertheless, experience a sense of purpose, that is typical of such research (Max-Neef 2005).

Good IDR supervision (and examination) is hard to find

The importance of suitably qualified and experienced supervisors for the IDR area cannot be overstated. This is obviously important for all postgraduate research, but in 'monodisciplinary' research, there is usually a pool of supervisors whose skills and expertise can be drawn on. Typically, in IDR, there are fewer supervisors and fewer

appropriate examiners who have expertise in the particular IDR area. It is obvious that experienced IDR researchers are needed, and that such experienced supervisors will also model research practices such as publishing and attending conferences, thereby inducting the IDR candidate into a research culture.

IDR supervision

Some of the candidates' supervisors were well versed in general research methodology, but many were not experts in the specific research area. Candidate V3 stated that finding appropriately qualified supervisors was a major difficulty, but once they were identified, her supervisors became a successful supervision team. They were experienced in their individual disciplines, and they appeared to respect each other's expertise, and could then apply their knowledge in different ways. Candidate V3 goes as far as to say that 'they complemented each other'. Candidate V3's experience is typical of 'synthetic disciplinarity' (Lattuca 2001), that is, the natural affinity that particular disciplines have – in this case 'design' and 'ergonomics'. Candidate V1's supervisor was experienced in IDR and had published widely (although not in the discipline-based educational field in which he was supervising). Candidate V2 did not have experienced supervisors, and while the level of their expertise in their disciplines might be excellent, their lack of research experience in the interdisciplinary field of design management hindered the process of working in an interdisciplinary way. In the case of Candidate K, the main supervisor was the candidate's Head of Department, and was chosen because he had supervised other candidates and was an efficient research administrator. The co-supervisor came on board much later (three years later) and was chosen for his strength in the marketing and advertising fields, as well as for his skills in statistical analysis. Some candidates felt that there was a lack of direction, or lack of interest in their work. Other candidates interviewed felt confident that they were receiving good supervision. Candidate C2 felt that he had good supervision, but that perception changed after he received the examiners' reports.

IDR examination

Candidates who were about to submit for examination, as well as the graduates interviewed, commented on the importance of selecting appropriate examiners. IDR often creates a new area of knowledge, and finding appropriate examiners can be challenging. Candidate V3 was involved with the identification of international examiners, as there were no local researchers who were suitably qualified to examine her thesis. Candidate V1 felt that while there was no one person who was perfect to examine, the examiners all had a particular area of expertise that was relevant, in other words that someone from 'Design' and someone from 'Education' should examine the thesis. This is often where IDR unravels, as examiners without IDR expertise will tend to come to the thesis with a 'monodisciplinary' lens, and the candidate may be landed with lengthy corrections. This happened to Candidate C2, whose thesis was

examined by engineers (who did not value the management component of his work) and by a management specialist, who found fault with the management component (which had not been supervised by a management specialist) and who required considerable changes. As Candidate C2 put it 'I had to go away and practically write another thesis'. Candidate V2 was not convinced that all the examiners had a broad enough view of her field to examine her work as they had been qualified in specific disciplines and had not done IDR. While candidates obviously should not select their examiners, and (officially at any rate) do not know who will/has examined their work, it is nevertheless important that the candidate feels that there is the expertise to assess his/her work in the areas being researched – particularly when they are new areas or when they are not in traditionally researched fields.

Communication in IDR

All of the interviewees pointed out the importance of communication between supervisors and student, and between supervisors (or main and co-supervisor) for the success of IDR.

Supervisor(s)/candidate communication

The main form of communication between supervisor and candidate is in the form of feedback on work done – either in written form (e.g., using 'track changes' on MS Word documents) or in a face-to-face meeting. Regular feedback and/or meetings between candidate and supervisors can help to shorten the lengthy process of IDR. Candidate V1's supervisor, for example, set up a weekly meeting schedule, and this opened the way for excellent communication. Candidate V1 explained:

... even if we meet for only 5 minutes ... it is an excellent habit ... it keeps the channels of communication open ... and provides ample opportunity to ask questions ... and the supervisor to remain well informed on the progress of the student ... as well as suggest readings or a course of action (Candidate V1).

Candidate V1's supervisor used a selection of 'mottos' to explain how he would supervise:

Socrates said you cannot teach anyone anything, but you can ask provocative questions.

Research supervision is the facilitation of learning on a higher level of understanding, with the only "end product" being the enhanced thinking ability of the research student.

The reason for all education is the person who learns, and not the content of what is being learned.

The act of supervision [of postgraduate students] is a [mutual] voyage of discovery, a relationship between the supervisor and the student, the designer and the user, the educator and the learner.

Research supervision cannot follow a method, even though ground rules exist; otherwise it is no better than undergraduate rote learning (Candidate V1, quoting her supervisor).

Candidate V2 rated her supervisor's feedback as 'poor' (mainly because there was so little of it). Candidate V3 had to be very proactive with both supervisors and seek meetings. The feedback was extremely slow, in one case, it took more than 3 months to receive any comment on work submitted. Feedback was very important for Candidate V3, although it took different forms. One supervisor would give feedback in meetings, the other (on a different campus) mostly by email.

Supervisor/supervisor communication

Candidates felt that it was important for the two (or more) supervisors to not only respect each other's expertise, but also to meet with each other (either with or without the student) in order to resolve any difficulties, as suggested by Manathunga et al. (2006). It seems that it is more common practice, however, for the co-supervisors not to communicate. Candidate K could not recall a single meeting with both supervisors, and in fact wasn't sure how they felt about each other. Candidate V3, on the other hand, while getting separate feedback, had joint meetings with both supervisors, in order to prevent conflicting advice, and for all to 'be on the same page'. Such meetings are likely resolve any issues that arise from very different research approaches between supervisors, and clarify the way forward for the student. Candidate M felt that the two supervisors worked well as a team and respected each other's skills. The main supervisor invited the co-supervisor to all meetings with the candidate. She also felt that they worked well together to resolve the few administrative difficulties encountered.

Candidate V3 suggested that in addressing the issue of communication between supervisors, a code of conduct or a contract could be signed between all parties. Developing a set of guidelines for the supervision of interdisciplinary projects may be appropriate, and could include guidance on issues such as meetings with all supervisors and students.

IDR cultures: from 'individual forays' to established research centres

Manathunga and colleagues (2006) point out that 'individual forays into interdisciplinary research can be fraught with conflicting supervisors' perspectives and difficulties in attempting to bridge disciplinary intellectual and administrative silos' (Manathunga et al. 2006, 368). The participants' responses confirm the

difficulties of 'individual forays' and suggest instead that supportive structures and multiple, on-going projects are the mainstay of an IDR culture.

Disciplinary cultures

The first indication of a viable IDR culture is the prior existence of a 'monodisciplinary' research culture in which colleagues embark on research projects, publish their findings and supervise postgraduate students. If there was not such prior culture, it becomes difficult to build an IDR culture. For example, the Design candidates pointed out that although there were many interdisciplinary projects in the area of design, and that 'all design is actually interdisciplinary' (Candidate V3), the design disciplines themselves do not have a long and established culture of research (even though this might have occurred informally in the form of undocumented artefact production). The Design candidates V1, V2 and V3 commented on feeling 'isolated', V2 being the only M student at the time, and V3 having only one other M student to meet with. The complexity of collaborative research activity requires a high degree of disciplinary knowledge and practice on the part of supervisors; nevertheless, our findings also suggest that integration, the formation of a new area, is part of the key to success in this type of work. By its very essence, IDR requires the 'deconstruction of knowledge and identity, which is then reconfigured into new forms of knowledge and action' (Lattuca 2001). Researchers working in interdisciplinary realms require the ability to move between interdisciplinary and disciplinary scholarship. This ensures that they do not lose sight of the disciplinary strengths they bring to their interdisciplinary work – this point links to our earlier point on the importance of 'metadisciplinary' awareness.

Boundary objects/mediating artefacts: shared interests

The first step in introducing an IDR culture is to find researchers (or supervisors) who have 'shared interests'. In order to establish an interdisciplinary project, a 'boundary object' or 'mediating artefact' can be helpful in creating an area of common interest amongst supervisors and other disciplinary specialists. Candidate C2 explains that:

Although not all academic engineers acknowledge engineering management as a legitimate area of research ... there are enough academics who are interested in consultancy or engineering entrepreneurship to be interested in this area ... although most only want to supervise [in the discipline] (Candidate C2).

Candidate C2 thus found a cohort of academic engineers who shared an interest in engineering management, a 'developing field' (Temple and Allan 2000) in order to find 'adequate' supervision. Candidates involved in discipline-based educational research have similar experiences. Candidate V1, for example, felt that the overarching interest in student development 'tied the examiners together, despite coming from different disciplines'. Shared interests, as Candidate C2's experience bears out, is usually not sufficient for successful IDT.

Trading zones/transaction spaces: building expertise in the IDR area

Developing supportive structures such as an IDR group that meets several times a year to discuss projects can develop initial 'shared interests' into a 'trading zone' or 'transaction space' in which expertise can be developed. An IDR group provides a platform for discussion, as well as events that students considering interdisciplinary projects could attend. IDR groups contribute to building a culture of research. It should be pointed out that an emerging IDR group, such as a collaboration between an IT and a Health faculty can have advantages, in terms of growing expertise and funding opportunities for research candidates. A disadvantage, if there is a single IDR group or project, particularly in areas that do not have a traditional research culture, is that candidates might be forced into areas that do not particularly interest them. Candidate M claimed that a difficulty for her, despite expert and enthusiastic supervision, was 'getting through literature on health where my personal interest is not high' (Candidate M). The way to address this is to develop several IDR projects and collaborations, these can learn from one another, and provide choices for research candidates.

Established IDR cultures

Candidate C2 explains that 'there isn't an Engineering Management group' and felt that his studies might have been more successful had there been such a group. He claims that if he had chosen 'Engineering Education' instead of Engineering Management he would have been able to 'get much more support from the group' (Candidate C2). This suggests that once there is a 'critical mass' of researchers in a particular area, the quality and efficiency of postgraduate IDR is likely to improve. The growth of a research culture provides a greater choice of qualified supervisors, but also a more supportive learning environment for students. Candidate V2 observed that the situation in Design, since she did her Masters:

... has greatly improved ... there are increasing numbers of post graduate design students ... and post graduate students appear to meet regularly (Candidate V2).

Candidate M describes an ongoing IDR collaboration between an IT department, a design department and Health faculty in the area of 'Health Informatics' in which 'IT candidates design platforms, design students undertake design for health ... wellness or rehabilitation ... and all contribute to collaborative concepts' (Candidate M). The advantage of this ongoing research collaboration is that postgraduate candidates can work alongside more experienced supervisors, learning from work that has already been accomplished. (In the early phase of this collaboration, choices for postgraduate IDR were more limited, as was Candidate M's experience).

One of the candidates felt that the ongoing interdisciplinary projects in the Design Faculty

contributed “to the growth of Design” in that other disciplines which have a more established culture of research could be accessed through co-supervising interdisciplinary projects (Candidate V3).

In established projects, as several interviewees point out, the research culture influences and informs work in honours-level research projects that are then developed into Master's IDR projects. The growth of the field itself may result in an increase in the number of qualified supervisors. With the growth of interdisciplinary projects, the pool of suitable examiners will also grow.

Figure 1, shows the development from single to multiple IDR collaborations; the implications for the growth of IDR research expertise and for the enhancement of postgraduate IDR is clear.

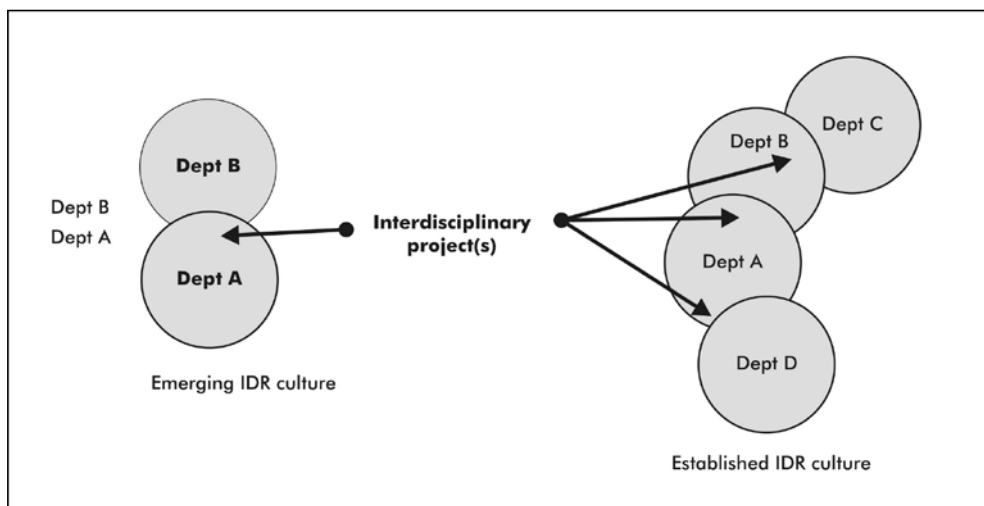


Figure 1: Emerging and Mature IDR cultures

CONCLUSION

The research findings suggest that ways to improve the IDR experience for the students include 1) developing ‘meta-disciplinary’ awareness (for both supervisors and candidates) in order to clarify their particular interdisciplinary positions, and the ways in which disciplinarity influences interdisciplinarity, at the start of the study; 2) either warning candidates about the additional time taken usually taken in IDR studies, or finding ways to shorten the project (one Candidate felt that most IDR projects were too complex for the Master's level); 3) finding and appointing suitably qualified and experienced supervisors and examiners for IDR; 4) establishing communication protocols, such as a requirement that the supervisor should always cc the co-supervisor when giving feedback, regular meetings that both supervisors

should attend, etc.; and 5) developing support for IDR groups amongst staff across faculties and departments – both to ensure that there is a ‘critical mass’ of expertise, and to provide candidates with reasonable choices for their IDR projects.

IDR candidates require supportive environments that enable them to work across multiple disciplines and departments, and to be fairly assessed for their interdisciplinary work. This article highlights the importance of providing IDR-friendly environments, and identifies some of the steps that candidates, their supervisors and their institutions can take to facilitate and evaluate IDR projects more effectively. Advances in the applied disciplines increasingly require the collaboration of scholars from various fields. This shift is driven by the need of research studies to address complex problems that cut across traditional disciplines, as well as the capacity of new technologies to both transform existing disciplines and generate new ones. IDR is often impeded by institutional policies and practices that favour traditional disciplines and their administrative structures. It seems clear that IDR will grow in the future, and steps should be taken to ensure that the students have rich and productive learning experiences.

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