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Bruce, Christine, Stoodley, Ian, and Pham, Binh (2009) ***Doctoral student's experience of information technology research.*** **Studies in Higher Education, 34 (2) pp. 203-222.**

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https://doi.org/10.1080/03075070802556131

DOCTORAL STUDENTS' EXPERIENCE OF INFORMATION TECHNOLOGY RESEARCH

Abstract

As part of their journey of learning to research, doctoral candidates need to become members of their research community. In part, this involves coming to be aware of their field in ways that are shared amongst longer term members of the research community. One aspect of candidates' experience we need to understand, therefore, involves how they 'see' or 'constitute' the fields of research in which they are engaged. The study reported here investigated IT research students' differing ways of experiencing their object(s) of study and their research field or territory. A phenomenographic approach was adopted, using techniques developed from an earlier study of experienced IT researchers in order to make the results comparable. The results extend an existing collective model of the character of information technology (IT) research; and suggest directions for doctoral education and associated research across the sector.

Introduction

As doctoral education and research performance becomes increasingly important in the higher education agenda, the research community has gradually been turning attention towards understanding aspects of the research experience, from the perspective of senior researchers as well as doctoral candidates (Åkerlind, 2008).

As part of their journey of learning to research, doctoral candidates need to develop shared understandings of their field with longer-term members of the research community, for example supervisors, industry partners and other research leaders. Understanding researchers' varying ways of seeing their research objects is an important element of moving towards a shared understanding of the collective endeavour**.** Experienced researchers also need insights into the *commonalities* and *complementarities* of their enterprise, both for their own work and to help them induct new researchers into the community of practice. These commonalities and complementarities form the basis of researchers' collective competence and create the distinctive culture of discipline-based research (Bowden and Marton, 1998; XXXXXXXXXX).

How can we help doctoral students make sense of their research domains? Newcomers may be assisted, and collaboration at all levels enhanced, through having access to each others' understandings of what it means to do research in that domain. Doctoral students, as part of their induction into the research culture, need to understand the shape of their field as it may appear to different contributors, including their peers and more experienced researchers.

Part of candidates' experience that we need to understand, therefore, involves how they see the research domain in which they are engaged. In this paper we present the example of information technology (IT) doctoral students' views of IT research, its objects and territories. The emergent picture of their views expands existing understandings of IT researchers' collective awareness, and allows us to compare students' views with those of experienced researchers. The differences between the two groups provide useful insights for higher degree supervisors inducting new researchers into the IT research community.

These potential benefits suggest that there may be value in similar work being undertaken in other discipline areas. As doctoral candidates enter into a research culture, we would want them

to become familiar with, as well as contribute to, shared understandings of their field. Despite the resurgence of interest in doctoral education in recent years, the study we report here is the first to investigate students' views of a field with the intention of comparing those views with the perspectives of experienced researchers.

Background

Our study into IT doctoral students' ways of experiencing their research objects and territories is situated in a line of research that has an extensive history of uncovering variation in ways of 'seeing' phenomena in the world around us (Marton and Booth, 1997; Bowden and Marton, 1998). Most of these investigations have attended to student learning in undergraduate coursework and schools. In the last ten years, this line of research has begun to direct attention towards investigating ways of seeing research (Brew, 2001; Kiley and Mullins, 2005; Wood, 2006), and to the 'collective awareness' of researchers in different disciplines.

Studies into ways of seeing research have shown us that *research* and *learning to research* is understood in several different ways across disciplines. Recent investigations have focussed on supervisors' conceptions of research (Bills, 2004), ways of understanding success in research activities (Bowden et al, 2005), and ways of experiencing being a researcher (Akerlind, 2005). A detailed review of the work is provided by Åkerlind (2008).

Investigating the 'collective awareness' of a research group involves exploring researchers' shared understandings of their research object or territory (Bowden and Marton, 1998, p.196). This approach has been taken in the areas of material science (Baillie, Emanuelsson and Marton, 2001), physics (Ingerman, 2002; Ingerman and Booth, 2003), and information literacy (Bruce, 2000). Mostly, the views of supervisors or experienced researchers have been sought. We have also completed two studies exploring the collective awareness of IT researchers. These investigated ways of seeing the significance and value of IT research (xxxxxxx, 2004) and different ways of seeing IT research objects and territories (xxxxx, 2005).

xxxxxx (2005) presents the different ways in which IT researchers see the domain of IT research, its research objects and territories. In that paper we describe a picture of the ways in which IT research is understood within the academic research community, making visible the changes and

developments in ways of constituting the research object that have been an essential part of the emergence of IT research. The research outcomes brought differences and complementarities in researchers' views into the open, thus enriching the collective awareness of IT research.

The pattern of views that emerged was offered as a platform for use by experienced researchers in establishing research collaborations; and as a framework through which higher degree research students and their supervisors may be encouraged to explore and understand the complexities of their discipline (xxxxx, 2005). In this paper, we compare outcomes from the 2005 investigation with the students' views presented here, revealing both similarities and differences. The picture of research students' views we present here extends our existing framework, supplementing the earlier depiction of the academic community view with the views of doctoral candidates.

The outcomes of this study therefore have both theoretical and developmental significance, contributing to an emerging pedagogy of supervision for research candidates in the IT discipline. The contribution of this study resides in its ability to:

1. provide a point of comparison with outcomes from other investigations of IT researchers' collective awareness;
2. contribute to a systematic framework for research development strategies for doctoral candidates and their supervisors;
3. provide an impetus for the consideration of development strategies for novice as well as experienced researchers.
4. suggest the important of similar work being undertaken in other disciplines; both to further our understanding of the learning to research agenda and to inform supervisory practice in other fields.

Students' ways of seeing suggest that they should be helped to learn from, as well as contribute to, our emerging understanding of the research community's view.

Aim

The aim of our project was to investigate aspects of the collective awareness of information technology (IT) research amongst doctoral candidates in that field. We explored significant

variation in IT research students' ways of seeing:

1. IT research; What does it mean to do IT research? What is it that makes a project identifiably IT research?
2. their research object(s). How do IT research students see the 'things' underpinning their research? How do they collectively constitute or 'shape' the objects of IT research? What kinds of shared understandings do they have of their research object? How do their understandings differ?; and
3. their research field, or territory. What are the features of the field? What are its boundaries as students see them?

Research Method

In order to explore significant variation in ways of seeing we have adopted a phenomenographic approach (Marton and Booth, 1997). This approach has been used successfully in earlier studies into learning about information technology concepts and phenomena. Investigations have been conducted, for example, into the learning of information systems (Cope, 2006), programming (Booth, 1992; Bruce, et al, 2004; Stoodley, Christie and Bruce, 2006), and network protocols (Berglund, 2002). Phenomenography has also been used successfully in earlier investigations focussed on researchers' 'collective awareness' of their research object (see for example Baillie, Emanuellson and Marton (2001); xxxxxx (2005); xxxxxx (2004); Ingerman and Booth (2003)), as well as on their broader experience of research (see for example, Brew, 2001; Bills, 2004; Åkerlind, 2005, 2008).

The phenomenon under investigation in this study is IT doctoral students' views of IT research, its objects and territories. We have interpreted the character of IT research, as constituted in the relations between research students and their research domain. This means that, following Marton and Booth (1997), we have sought an understanding of how IT research is looked at and how it appears, to the beginning researcher. The results of the research are described as categories, which highlight variations in research focus, sometimes also called the 'theme' or 'internal horizon', and variations in perceptual boundary, sometimes also called the 'margin' or 'external horizon'. These are key elements of the 'awareness structure' of each category, indicating the reason for the earlier use of the term 'collective awareness' to describe the ways of

seeing or understanding that are both represented and recognised amongst groups of researchers. The interrelationships between the categories is described as an ‘outcome space’.

In phenomenographic research, the term 'experience' is used to refer to the constitution of a phenomenon in the interaction between 'perceiving subjects' and an 'appearing object'. Following Bowden and Marton (1998) we have sometimes used the phrase 'ways of seeing' instead of 'experiencing' or 'constituting'. The term 'seeing' also reflects the importance of 'awareness' to phenomenographic research.

Participants

Participants in our project were candidates in doctoral degrees studying in a faculty of information technology. All the students belonged to the same research centre and were therefore part of the same broad research community, which indeed was the same broad community in which the earlier studies were conducted. Of the students invited to participate in this project, eighteen responded and were interviewed. Half the group were male and half female. Most participants were under 40 years of age.

Reflecting the diversity of the IT field, students represented a range of sub-disciplines (see Table 1 below), including computer science (CS), Information Systems (IS), Data Communications (DC) and Information Management (IM). Their research experience varied from ‘novice’ to ‘advanced’, indicating that students from different stages of candidature and with different backgrounds in research were included. Most of them were full-time students. While students’ cultural backgrounds were not recorded, the research student cohort at the university where this work was conducted represented many countries, languages and cultures.

[insert Table 1 here]

Talking with research students to discern their ways of seeing IT research

Participants conversed with an interviewer about their views of IT research and its territories in semi-structured interviews of approximately 30 minutes’ duration. Four core questions formed the basis for these conversations, further clarification being sought through probing questions to help the interviewer understand the interviewee’s point of view (Ashworth and Lucas, 2000). The core questions were:

1 Describe your area of research. Is this IT research? Explain what makes this IT research?

2 [In relation to five abstracts of published papers from different sub disciplines] How do you decide whether these studies represent IT research or not?

3 What is it about them that would help you decide?

4 How do you in general decide if someone is doing IT research – or not?

These questions, and abstracts, were the same as those used in our earlier study (xxxxx, 2005) to enable comparison of the outcomes with those of more experienced researchers. Our pilot study did not indicate the need to modify the interview protocol. Interviews transcripts were sent to the interviewees for information and comment, and were then used by the interviewer and other members of the research team for further analysis.

Working with the interview transcripts to discern significant variation in ways of constituting IT research

Describing students' different ways of constituting IT research required us to gain a thorough familiarity with the data in order to identify both the range of meanings associated with IT research, its objects and territories; and the relationships between these various meanings.

Out of this familiarity with the data and critical interpretation of it, patterns arose. We identified meanings attributed to IT research that seemed to be significantly different from each other and used these as the basis of an initial set of categories of description. These categories developed through an ongoing iterative process of analysis, as described in Marton and Booth (1997).

The categories of description which form an important part of the key outcomes from this investigation are analytical constructs that represent the different ways of constituting IT research as established through the interrelation between researchers and data. They include descriptions of both meaning and structural aspects. The structural aspects include attention to the relationship between critical elements attended to by the participants. In this study, certain elements are described as in focus, these are at the centre of attention. The perceptual boundary represents the margin beyond which participants do not see. Each category is distinguished from the others according to their focus. A change of focus, therefore, signals a change of category.

The interrelationship between these categories is understood through the consideration of their perceptual boundaries, or the limits of view of participants when seeing IT research from each category's perspective. Any two categories will certainly have different foci but may share the same perceptual boundary.

While the approach is similar to that used in earlier studies and described in those reports (xxxxx, 2004; xxxxxx, 2005), we deliberately did not refer to the outcomes of the earlier studies while engaged in interpreting research students' views. All evidence for research students' views came from their contributions. As a result it is possible to identify similarities with, and differences from, the views of experienced researchers, even where categories appear to share common meanings.

Key outcomes from the analysis

Summary results. Seven different ways of constituting IT research amongst doctoral candidates were identified: 1) software development 2) information practice, 3) human-technology interaction, 4) application to other disciplines, 5) impact, 6) sanctioned and 7) constructed.

Each category is described below, and includes an explanation of the meaning of IT research as it is construed by members of the group. The structure of awareness associated with each meaning is also described: firstly, in terms of the focus, or research object toward which students' attention is directed; secondly, in terms of the perceptual boundaries of their view which are indicators of the limits of the IT research territory as seen by the students. The different ways in which IT itself is seen is proposed as a dimension which appears in all the categories, and which also varies in its appearance across the categories. A summary of the critical features of each category is presented in Table 2.

[Insert Table 2 here.]

Depicting the objects and territories of IT research An important goal of our study has been to describe the participants' ways of constituting the object and territory of IT research. Taken together, the seven categories comprise the territory of IT research as it is experienced by the research students we interviewed. In each case the focus describes the research object, and the perceptual boundary delineates the research territory. Each category is related to the next through expanding perceptual boundaries which are listed in Table 2. These expanding perceptual

boundaries represent increasing connectedness with, and interest in, the world influenced by information technology.

The complete set of categories may be divided into two logical subgroups, the enhancement categories and the agency categories.

The first set of categories (numbers one to five in Table 2), which we have described as the Enhancement group, tells us *what* meaning is constituted. Within these five categories, there is a conceptual shift in the object of focus from distinct elements (software, information) in category one and two, through stakeholders (humans) in categories three and four, to effects (applications and impact) in categories four and five. When using the enhancement group of categories, research students are focussed on their contribution to the improvement of constituent parts of IT research.

Categories six and seven, the Agency group, are different in character from those belonging to the Enhancement group. These tell us more about *how* meaning is constituted. In the sanctioned view (category six), students are not reflecting on the territory and their own influence, or that of the group and other leaders in the field; students are aware of these elements in category seven. These categories reveal a focus on the possibility of individual contribution to the constitution of the research territory and determination of its objects. In these categories the locus of control rests either with the establishment or with the individual researcher.

The enhancement categories are also interrelated in terms of the expanding perceptual boundaries associated with each, ranging from software in the first category (see Table 2) to including, people, other disciplines or the world, in later categories. There is no suggestion in the data, however, that certain ways of approaching the constitution of meaning (categories six and seven) are associated with particular meanings constituted (categories one to five). Whilst this is surprising it is also consistent with the findings of our earlier study.

Category 1: Software development

In this category, IT research is experienced as research that is directed towards enhancing software. Central concepts associated with this category are quadratic programming, algorithms,

set logic, coding, paradigm, programming language and software engineering.

> *I thought this is an … IT article, because it is talking about software. (4)*

> *If it involves things like hardware and software, technologies, computing, computational language, computational programs, then I would say yes that is IT research … (9)*

Hardware-related concepts such as networking, IT artefact, processor and chip also indicate IT research, however predominantly with reference to the software that enables these to run. In this view, students differentiated between the engineering and physics required for hardware development and their own contribution via software development.

> *For me engineering has a very heavy physical component. … when you start getting into the … IT side of things most of it's … software,*
> *I: So, if you were going to make a new, more efficient CD burner, would that be engineering or … ?*
> *R: Yeah, that's a grey area … if what makes it more efficient is a more clever algorithm that you'll eventually burn onto a ROM chip … that's probably IT. Especially if you're dealing with say algorithmic complexity … If the efficiency is … how the motor spins, … that's more engineering…For me if the heart of what you're trying to do boils down to being … instructions to the … physical components, that for me is more IT flavoured … (1)*

> *Everything has a mix … because it's engineering in the sense that you think of the chip, the circuit layout and the most efficient way to get it and the material to use; in terms of IT, you got to think of … the algorithm (4)*

Structure of awareness The focus of research students using this category is software, which both constitutes the research object and defines information technology as a research territory. Core IT is seen as algorithm design, which provides efficient instructions to hardware. Software development is the central element of this view, with hardware development being relegated to engineering. Their perceptual boundary is the virtual tools that control the virtual world, which is perceived to delimit the margins of IT. In this view, information technology is seen as software written to make computers work.

How this differs from other views This category contrasts with the next category in its focus on software development without reference to information being processed and in its exclusive orientation towards the virtual world. This view does not see beyond virtual tools; anything lying outside the virtual world is not part of IT.

Category 2: Information practice

In this category, IT research is experienced as research directed towards enhancing the relationship between technology and information practice. Key concepts included in this category are information storage, retrieval, transfer, processing, access and use. Computer systems, both hardware and software, are seen as mediums for the manipulation of information; both information and technology are seen as essential parts of IT, technology being the enabler of information practice.

> *It's pushing … enhancing and improving the way a person can store, record, retrieve, access, use information. That's what information technology's about, isn't it? (7)*

> *IT … with a name 'IT' … it's about dealing with information…information as data that has been input into or is generated by a computer and somehow processed … And then somehow communicated … (13)*

Structure of awareness The focus of research students using this category is information practice, which both constitutes the research object and defines information technology as a research territory. Core IT is seen to be information manipulation. The perceptual boundary, the margin beyond which research students do not see, is technology, both hardware and software. In this view, information technology is seen as a system which enables the manipulation of information.

How this differs from other views This category contrasts with the previous category in the importance placed on information processing through technology and in its acceptance of physical artefacts as valid objects of IT research. IT now embraces hardware as well as software. It contrasts with the following category in its relative disinterest in human interaction with the technology. This view does not see beyond the information being processed by the technology.

Category 3: Human-technology interaction

In this category IT research is experienced as research directed towards enhancing the relationship between information technologies and human beings. It includes how humans interact with IT artefacts, the skills they need and the way they use them. Humans, information and technology are seen as being part of a unified, integrated communication system.

> *My research … is IT research because it's looking at the way people engage with an information technology, the internet in particular, and how they deal with it. (7)*

You need to take into consideration … how people use those systems, are people using those systems? You can't just create a system without considering the user and how that's going on. (7)

IT … it's about dealing with information … as data that has been input into or is generated by a computer and somehow processed within that computer. And then somehow communicated to … humans … (13)

One participant thought this aspect of IT research made sense of the rest.

There are a lot of … ideas being put forward for solving certain problems but very few of them actually go ahead and say, "Well, what would matter to the end human? … will it work with … what we know about how people interact with the computers?" … without the human being and what … it does to them, and how it changes them, how they change the machine as a result, I don't see any point to it … (1)

Structure of awareness The focus of research students in this category is human beings, which both constitute the research object and define IT as a research territory. Core IT is seen to be about the interrelationship between people and computers. IT and people are integrally bound together. The perceptual boundary, the margins beyond which students do not see, is the technology with which people are interacting. In this view, IT is seen as a computer system in relationship with human beings.

How this differs from other views This category contrasts with the previous category in the central interest in people's interaction with technology as they use it. It contrasts with the following category in its unconcern about where the technology is being applied. This view does not see beyond the technology that the end users are interacting with.

Category 4: Applications to other disciplines

In this category, IT research is experienced as research directed towards enhancing the interaction between IT and other disciplines, which includes both application or contribution to, and collaboration with other disciplines. This includes the application of IT to other disciplines, which is part of the IT development lifecycle. It also includes solving problems in other discipline areas using IT artefacts. IT is seen by some as a tool which may be used to benefit other disciplines.

It's … research that impacts on the application of IT, so that's why I think it does fall within IT. (2)

Applying or using IT or computer power … to solve problems which aren't necessarily IT problems … (2)

As an IT researcher, you're always influenced by other fields but it doesn't necessarily mean that you're in one of those other fields, because you're influenced by them because we want to take our learning from them (5)

We can put some sort of border around what we consider to be IT research … but it doesn't mean that it's not going to take a lot of collaboration with…other fields, like science and engineering and maths and business … to make a better system. … it is not an area of research that I think is ever likely to be well defined because there are these blendings of the various fields involved in dealing with a homogeneous system. (16)

Students discussed the nature of the relationship between IT and other disciplines. They used various images to illustrate their points of view - IT is glue that sticks other disciplines together, a blend of other disciplines, an eco-system, and situated within a context. These typically portray IT as spanning disciplines and therefore pervasive.

IT is like glue. IT is just like a … virtual component … which glues up maybe mathematics and engineering together ... but … it is certainly something, it is not as if it's nothing because it's glue, you see. …its main job is to pull things together and create a better … system or product. (4)

I think of information technology research as being like an Eco-system. … My little component of research is looking very much at a specific area of the psychology of a human engaging with the internet. … other people's research is just another little part of that Eco-system ... (7)

Structure of awareness The focus of research in this category is on applications, which both constitute the research object and define IT as a research territory. The perceptual boundary, the margin beyond which research students do not see, is other disciplines. Thus, the perception represented in this category is of IT as essentially having to do with applications and anything lying outside the world of other disciplines is not part of IT. In this view, information technology is seen as computer systems applied to other disciplines. These systems are distinct from their environment though contributing to it, integrated with it and depending on it for existence.

How this differs from other views This view contrasts with the preceding view in the application of technology to the wider environment. It contrasts with the following view in its unconcern about the influence technology has on human society.

Category 5: Impact

In this category, IT research is experienced as impacting human beings, with an implication that it should enhance life for humans. This impact may be felt in the work environment or in the wider community. It may affect an individual or society at large. IT may influence people directly (through their use of it) or indirectly (through its influence on society). This aspect looks beyond the Information-Technology world - it introduces the element of reflection/self-examination and calls for an orientation towards the future as well as the present.

> *How things change … that's the fascinating thing for me … the culture of the organisation changes overnight with the installation of software …To witness it is quite a shock at times … (1)*

> *So what kind of social implications (are there) for the future?… if we continue to utilise IT to transform organisations … what would we do? how would it happen?, What exactly happens in corporations when it happens. This is information technology still. (3)*

> *I think it's also IT research because of that component that says, "Okay, let's look at the impact information technology's having on humans …" (7)*

> *the word 'application' of computer technology would point me more towards the fact that it was IT, rather than the scientific aspect of it. More the everyday application of the technology to improve the way we do things. (16)*

Structure of awareness The focus of this category is impact, which is perceived to be the core of IT. The perceptual boundary is the outside environment, which is perceived to be the outer limit of IT. In this view, information technology is seen as having moral force.

How this differs from other views This category contrasts with the previous category in its concern for rights and wrongs. This view embraces the wider philosophical world and sees itself as accountable to it.

> *The social impact of some of the social explorations … is out of sync with how it impacts on society. And so it's important to be reflective about, not so much whether it can be done, but should it be done? (17)*

Category 6: Sanctioned

In this category, IT research is experienced as being defined by others, usually the university faculty or school. The students' current context is referred to as having a dominant influence over their perspective. In this category, the established view may not be questioned or

institutional processes may be considered to be a more reliable guide than their own limited knowledge. Some participants were guided by the question of where expertise could be found within existing structures to tackle the problem at hand. Some participants included industry as an influencer of what the academy teaches and others included conferences where research projects were presented as an indicator of what is accepted as IT research.

> *Are they working within the Faculty of IT? This is usually a good indicator… (5)*
>
> *It is IT, yeah. I've seen many of these in IS/IT conferences … (12)*
>
> *I think that it is IT research because I come from a creative industry background … if I wanted to do this kind of research I could not find a suitable supervisor …so I have come to the IT side. I think this is more like my home. (18)*

Structure of awareness The focus of this category is others' opinions of IT, which is perceived to be the defining element of IT. The perceptual boundary, the margin beyond which research students do not see, is the institution, for example, a research department which is seen to establish the limits of IT. In this view, IT is seen as institutionalised and delimited by others; anything lying beyond this is not seen as part of IT.

How this differs from other views This view contrasts with the following view in that the student here is seen as having no personal control over what constitutes IT research.

Category 7: Constructed

In this category, IT research is experienced as being constructed by the researcher. A lack of clear definition of IT research is seen as positive, because it avoids the exclusion of something which may prove to be important.

> *This fluid line is really … fluid because we want it to be fluid. We don't want to … get to a point where we say, "Well, actually, that's outside our scope." Because it actually might be quite important to what we're trying to do. (5)*
>
> *I would like to look at the issues that I am looking at, more social and organisational, some others might be looking at something else. For me to confine this research for somebody else … I don't think that would be fair (10)*

Personal interest and intention are important elements in this way of seeing:

If the person says, "I am now doing art", then they are… similarly with computing (17)

Structure of awareness The focus of this category is the researcher's intention in conducting their research, which is perceived to be the defining element of IT. The perceptual boundary appears boundless, and cannot be defined except by the researcher themselves. Thus, the perception represented in this category is of IT as having to do with the researcher's opinion and nothing may lie outside this and therefore be excluded from IT.

How this differs from other views This view contrasts with the preceding view in that the student here is seen as controlling how they constitute IT research.

What do the outcomes mean for doctoral education in Information Technology and other disciplines?

Earlier in this paper four key areas to which this study has contributed were identified. Each of these is discussed below.

The outcomes provide a point of comparison with outcomes from previous investigations of IT researchers' collective awareness

It is likely that in other disciplines also, the views of research students will differ from those of more experienced members of the research community, as well as share some aspects in common. The character of such differences may vary between disciplines.

How do research students' views compare with the views of more experienced IT researchers? Table 3 compares student and experienced researchers' ways of constituting IT research in terms of meanings attributed and elements towards which their attention is directed. The interest value of these similarities and differences is increased when we take into account that the two investigations were conducted in the same community of practice, with research students being interviewed two years after their academic counterparts.

[Insert Table 3 about here]

Immediately visible from the table is the division of categories for both communities into two groups, the first being focussed on the research object, and the second being focussed on how those meanings are arrived at. Also notable is the greater differentiation constituted in the community of experienced researchers, with eight categories coming from that group and seven

identified amongst doctoral students. Amongst these categories only one, the first agency category, ‘a territory defined by others’ is similar between the two groups. There is no clear correspondence between any of the other categories.

In the first set of categories the doctoral students are largely concerned with the enhancement of their research object, whereas the qualified researchers reveal ways of constituting IT research that are more attuned with the historical development of the field. From this point of departure significant observations may be made about differences in the research objects of interest to the two groups:

1 In at least one category doctoral students are solely focussed on virtual worlds and software enhancement. In this first category, students relegate hardware to the discipline of engineering; it is only admitted to the province of IT research in the second category when the objects of interest are widened to incorporate information. For the academics, or qualified researchers, however, it does not appear that hardware and software are considered separable. Both hardware and software are critical elements of IT research in the ‘technology’ category, and wider technologies such as printing may be considered IT.

2 Some experienced IT researchers identify information as their object of interest, whereas doctoral students direct their attention towards the relation between information and technology as their focus. No category emerged for students where information itself was the object of research.

3 Doctoral students see the human experience of technology, and the impact of IT on people, as a legitimate research object; this aspect is not fore-grounded in the views of experienced researchers. While communication and applications appear as important to the experienced IT researchers, this community is more focussed on information exchange and the application of technology, than on the user experience. This increased awareness of the human experience of technology and the impact of IT, and its inclusion as legitimate IT research, seems to represent a logical progression in the evolution of thinking about IT. The development of computer ethics indicates such a progression, with interest in computer ethics only surfacing in Australia in the 1990s (Bynum, 2004). The increased awareness of impact may also reflect a greater social consciousness on the part of the new generation of researchers, with more IT researchers now asking not only

'What can be done?' but also 'What should be done?'

4 In the agency categories, doctoral students, unlike the academics, are less aware of the territory being constituted by IT researchers as a group. The students are more concerned about the individuals' determination of what does or does not constitute IT research. Furthermore, the doctoral students did not indicate any awareness of the possibility of individual researchers and gatekeepers constituting the field through a dialogic process.

In addition to differences in ways of seeing the research objects, there are also differences in ways of seeing the territory.

1 The IT research territory appears more bounded for research students than for experienced researchers. None of the students saw IT as ubiquitous. Research students interviewed did not easily see the application of technologies to new areas as legitimate research. Development of the product is seen as IT research but not its application to industry or other fields. This is evidenced by the absence of an 'applications' category for students and comments such as:

If you're talking about research I would think that once something has been developed and implemented, from that point it's no longer research. It's then applying the end product …. (2)

…if the result is a new technique for … IT, then I would classify it as IT research. If the result is taking knowledge from IT and applying it elsewhere I don't necessarily consider that to be IT research…(13)

2 Students also seem to be looking to differentiate IT from other disciplines whereas academics seem more aware of collaborative opportunities.

The outcomes contribute to a systematic framework for research development strategies for doctoral candidates and their supervisors.

A key outcome from this study is a framework comprising a set of categories, each of which represents significant differences in IT research students' ways of constituting their research objects and territories. These categories represent different ways of experiencing IT research from a broad perspective, without directly associating them with specific disciplines or sub-disciplines, and which are comparable with the views of more experienced researchers. There is clearly the potential in all disciplines for such frameworks to be created, laying an important foundation for supervisory practice. The intention of such frameworks would not be to classify

specific research students or groups of students, but rather to identify different ways of seeing or experiencing that may change with the context in which they work. This would allow researchers from relevant sub-disciplines to interact freely with the framework.

The outcomes provide an impetus for the consideration of development strategies for novice as well as experienced researchers.

Doctoral education that takes account of influencing candidates' views of their research domain is needed to influence the directions of future research. This is certainly the case in the information technology discipline and may be the case in other disciplines also. The framework described above, together with more experienced researchers' views, provides an enhanced platform for use with doctoral candidates and other higher degree students being inducted into the IT research culture. The framework encourages conversation about differences in the community and makes explicit those commonalities and complementarities which IT researchers experience in all facets of their research work.

A range of questions arise which need to be tackled as the research community progresses in its conversation. Asking questions such as these is likely to be important in many disciplines as cross – disciplinary research becomes increasingly common:

- To what extent do we wish research students to adopt the views of their academic counterparts?
- In what areas are research students more conservative than experienced researchers?
- In what areas are research students pushing the boundaries of the existing research territory?
- How is the cross-disciplinarity of much contemporary research, for example biotechnology, e-research and health informatics, reflected in these views?
- What important perspectives within the research community are not yet reflected in the empirical models?

Information technology research is a relatively new field that has been subject to rapid expansion, diversification and fragmentation. Since the establishment of IT research, Information Systems (IS) and Computer Science (CS) researchers, for example, have come to focus on very

different territories (Gable, 2007; Lenox and Woratschek, 2007; Finkelstein and Hafner, 2002). They investigate areas as diverse as data mining, cryptography, database architecture, multi-media, e-commerce, information management and information science. New opportunities for multidisciplinary research continue to emerge, addressing issues which may be seen as belonging to, for example, life-science, education, management and art.

Investigating the problems and issues of these new frontiers, in business, science, engineering, government and other spaces, requires collaboration between groups of researchers; collaboration which may be enhanced by understandings each others' ways of seeing the research domain. Essentially, IT researchers' understandings of their research domain continue to transform (Orlikowski and Iacono, 2001), and to fragment, in order to account for users' diverse needs. New technologies have stimulated a surge of new approaches for development in industries such as electronic publishing and remote sensing for mining and agriculture. New industries, markets and employment patterns have emerged. Political and economic pressures are requiring IT researchers to adopt outward-looking attitudes, which encourages closer interaction and collaboration with industry and community.

Ideally, the purpose of development strategies would be to further enhance the collective awareness of the IT research community by developing awareness of the different ways of thinking within that community, especially amongst doctoral candidates and supervisors. In the long term, IT researchers' views of their research objects and territories will define the scope of their research and their impact on wider research communities.

The outcomes suggest the importance of similar work in other disciplines to further our understanding of the learning to research agenda

As research becomes increasingly cross-disciplinary, and participation in doctoral education broadens, it seems likely that variation in the experience of research objects and territories amongst students and supervisors could usefully become a point of focus in many disciplines. What is the role of doctoral education in exploring and progressing these conversations? Is it appropriate for such matters to become an integral part of supervisory practice? Doctoral education is certainly an appropriate context within which students and supervisors can consider and discuss the range of thinking within their field and the implications of adopting particular views.

The importance of the emerging implications suggests that similar work in other disciplines could assist in developing an important aspect of the pedagogy of doctoral supervision. At present emphases in doctoral education are placed largely on:

1 the development of high level discipline expertise for the project at hand,
2 enculturation into the practices of a research community such as publication, presentation and grant application,
3 developing expertise around research processes such as proposal writing and analysis,
4 developing so-called transferable skills such as leadership, project management, entrepreneurship and others, and
5 orientation to the process of doctoral study itself, for example communication with supervisors, thesis writing and understanding the examination process.

While ways of seeing *research* and *learning to research* have attracted the attention of researchers focussed on doctoral education and the research culture, consideration of candidates' experiences of their research objects and territories presently have little or no place in the agenda. There is certainly considerable scope for further exploration of candidates' views of their research territories in different disciplines as well as the integration of resulting understandings into supervisory pedagogy.

Conclusions

The learning to research agenda can be significantly enhanced by attending to the experience of discipline based research amongst both doctoral students and more experienced academic researchers. In particular, attending to ways of constituting the field and its research objects in one field, reveals variation of sufficient interest to indicate the potential value of similar work being undertaken in other disciplines. For example, in our investigation students separated out aspects of the field which experienced researchers have been shown to regard as inseparable. Further students demonstrated a stronger social conscience. At the same time they do not appear to see the possibility of individual researchers and gatekeepers constituting the field together

through dialogue.

Looking at doctoral candidates' views of IT research has provided insights into how their views compare with those of more experienced researchers; revealing significant differences across all categories except one and suggesting the need for ongoing conversations about the meaning of these differences. Comparison of the categories found in this study, with the views of experienced researchers, reveals several differences which need be considered in the doctoral supervision process. The questions arising from these differences are also likely to be important in other disciplinary contexts:

- To what extent do we wish research students to adopt the views of their academic counterparts?
- In what areas are research students more conservative than experienced researchers?
- In what areas are research students pushing the boundaries of the existing research territory?
- How is the cross-disciplinarity of much contemporary research, for example biotechnology, e-research and health informatics, reflected in these views?
- What important perspectives within the research community are not yet reflected in the empirical models?

We propose that such questions are of value to many disciplines, and that ongoing attention to the experience of research within discipline contexts will make a significant contribution to taking forward both the higher degree supervision and experience of research agendas.

Acknowledgements and ethical clearance

We are grateful for support from a xxxxxx ATN small grant and from the Centre for Information Technology Innovation in xxxxxx which made this research project possible. Interviews of research students were conducted during 2004 and 2005. Ethical clearance was obtained from the xxxxxx Ethics Committee for the whole project. All the students signed a consent form indicating their willingness to contribute to the research before participating in interviews.

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Table 1. Participants

Gender		Age				Sub-discipline					Research experience (yrs)				Mode	
M	**F**	**<30**	**31-40**	**41-50**	**51+**	**CS**	**IS**	**DC**	**IM**	**Other**	**0-1**	**1-2**	**2-3**	**3-5**	**FT**	**PT**
9	9	6	8	2	2	6	9	1	2	2	1	8	3	6	14	4

Table 2. Key features of the seven ways of seeing IT research

No	Experienced Meaning	Focus or research object	Perceptual boundary, or territorial limits	IT is seen as
ENHANCEMENT CATEGORIES				
1	Enhancing software	Software	Virtual world	The software that makes computers work
2	Enhancing information practices using technology	Information practices	Technology – hardware and software	Systems that enable data manipulation
3	Enhancing the relationship between IT and human beings	IT-human interaction	Technology	A computer system in relationship with people

4	Enhancing the interaction between IT and other disciplines	IT applications	Other disciplines	A computer system applied to other disciplines
5	Influencing and enhancing peoples' lives	Impact	World at large	A moral phenomenon influencing the world
AGENCY CATEGORIES				
6	IT research is that which is sanctioned by others as IT research	Object defined by other's view of what is IT	The institution	Something defined by others
7	IT research is defined by the researcher	Object defined by researcher's intention to be conducting IT research	No limits	Something defined by the researcher

Table 3. Comparing student and academic researcher views of IT research

RESEARCH STUDENTS **In the enhancement categories IT research is experienced as directed towards:**	**ACADEMIC RESEARCHERS** (from Pham, Bruce and Stoodley, 2005) **In the historical development categories IT research is experienced as directed towards:**
Enhancing software development	Technology (hardware and software)
Enhancing the relation between technology and information practice	Information
Enhancing human technology interaction	Information and technology
Enhancing other disciplines	Communication
Enhancing human existence	Application of technology to all human endeavour (ubiquitous IT)

In the agency categories IT research is experienced as:	**In the agency categories IT research is experienced as:**
A territory defined by "others" (institutional gatekeepers)	A territory defined by "others" (institutional gatekeepers)
A territory constructed by the individual researcher	A territory constructed by IT researchers as a group
	A territory constructed in dialogue between individual researchers and gatekeepers.