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LONGITUDINAL STUDIES OF COGNITIVE CHANGE AMONG STUDENTS AND THEIR SUPERVISORS IN THE COURSE OF RESEARCH SUPERVISION LEADING TO A PHD

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Abstract. This project uses concept mapping and interview techniques to track changes in knowledge and understanding among students and their supervisors in the course of full-time research towards a PhD. The on-going work measures *both* cognitive change in the specific subjects that are the topic for research *and* in the understanding of the process of PhD level research and supervision. The data makes a unique contribution to our knowledge of research processes and an understanding of the ways in which knowledge is created by research. It also helps to provide documentary evidence of the ways in which supervisors can act to facilitate learning and discovery. In order to ensure that the results are applicable as widely as possible, the study group includes students and supervisors from among the natural and applied sciences, the arts and humanities and clinical practice. The approach is essentially ethnographic and comprises detailed case study analysis rather than any broad inferential comparison.

1 Background and Context

The PhD is a key step in the emergence of academic status. Not only is it a 'gateway qualification' for an academic career, it is also evidence of an ability to make original and innovative contributions to a body of knowledge or technology. It is of considerable economic significance too, both to the individual who invests time and money in the research and to the wider society. Research-led discovery during or after study for a PhD often leads to publication, patent registration and other activities with potential social, economic or technological benefit.

The full economic costs of a PhD are difficult to establish. The costs to institutions are usually estimated at £87,317 for clinical studies, £71,446 in the natural and applied sciences and £52,383 for the arts and humanities (HEFCE, 2005a). These figures are based on the conventional three year completion rates that are expected by the majority of Research Councils. Recent data from HEFCE (2005b), suggests that in reality only 36% of full-time research council students complete on time, and that among those who are part-time and/or self funding, completion rates can be much lower. It is therefore surprising that there is so little published research documenting the pedagogy of the PhD supervision process. Despite considerable policy review in England, Wales and Scotland since 2000 (e.g. HEFCE 2005b, 2001; HEC 2002; HEFCW 2000a,b), Baron and Zeegers (2002) remain largely justified in the observation that most researchers understand research processes through 'osmosis' rather than any comprehensive or research-based understanding of what it means to do research or to supervise research studies. Lovitts (2007) remarks, "through the simple act of having faculty make explicit their implicit standards and expectations…everyone is provided with information they need to move up a notch or two more on the road toward excellence" (p. 50). However, we have very little data on students' understanding of the rules of engagement. In particular, there is a complete absence of data tracking the simultaneous processes of cognitive change among students and supervisors in the course of research leading to a PhD. This is a key omission in the literature on academic supervision and it is indicative of the general neglect for the support and development of research skills (see for example, the Roberts Report, HM Treasury, 2002). Furthermore, even where implementation of the Treasury recommendations has had significant impact on PhD student funding and training entitlement, support for researcher supervisors has improved little (Taylor, 2004).

This project addresses many of these issues and importantly, it attempts to lay the foundations for the subsequent development of a research-led pedagogy for dissertation supervision. To date, only Hetrick and Trafford (1995) and Salmon (1992) provide detailed analysis of the processes involved in PhD supervision. However both neglect to document the process through time and report instead, individual expectations of the supervisory role. The results indicate the importance of supervision as a process, but do more to highlight the need for future research than to explain exactly what this 'process' might entail. One supervisor in the study of Hetrick and Trafford (1995), for example, is quoted as follows:

"…supervision should involve a journey of discovery for both tutor and student."

[supervisor M quoted in Hetrick and Trafford, 1995]

Nevertheless no extant literature provides empirical data for such a journey through time and no studies to date have attempted to do this simultaneously among supervisor and student. As a result any attempt to formulate pedagogy for dissertation supervision lacks an underpinning research base. This is despite Salmon's

(1992) consistent emphasis on the importance of change and the support for change in the course of research. Documenting change in knowledge and understanding among PhD students and their supervisors is key to understanding what the joint processes of research and of supervision entail (Brew, 2003), and it is surprising that this has not yet been done. Perhaps the relative intractability of the learning process is the most compelling explanation for this lack of empirical data. However, recent theoretical and methodological developments in the fields of concept mapping and of higher education pedagogy mean that these issues can be addressed. This is explained below.

2 Theoretical and Methodological Frameworks

For nearly a decade, Kinchin and Hay have been working to develop the concept mapping method for the enhancement of pedagogy in higher education. Their work has utility for both theory generation and subsequent testing; here the methods are explained and then used to create simple models of research and supervision outcomes that are tested in the study.

2.1 Concept Mapping: A Tool for Identifying Knowledge and Understanding

Concept mapping (*sensu* Novak, 1998) is a method of graphic organisation. Its considerable utility stems from its origins within the human constructivist epistemology and it is now widely reported in the literature for use in the sharing of individual knowledge and understanding. The concept mapping work of Novak and others has been used in studies of learning (Kinchin, 2001b); measurement of learning quality (Hay, 2007); assessment (Edmondson, 2000); cognitive typology (Hay & Kinchin, 2006; Kinchin *et al*, 2000); learning style (Hay *et al*, 2005; Kinchin, 2004); and expert identification (Kinchin, 2001a; Novak & Gowin, 1984).

In 2000, Kinchin *et al* published an important modification to the concept mapping method that encouraged a radically different approach to analysis. In particular, this work proposed a qualitative approach to concept map analysis based on gross structural morphology and it proposed a classification of map structures in three categories: spokes, chains and networks (Kinchin *et al*, 2000). These three typologies are shown in Figure 1. Since the publication of this work, this broad classification of map types has proven remarkably robust, and has now been documented among school children and adult learners, health-care professionals, and academic teachers (see Kinchin *et al*, 2000; Hay and Kinchin, 2006; Kinchin & Hay, 2005; Kinchin *et al*, 2005 and Kinchin & Hay, 2007 respectively). Furthermore, it is indicative of varying roles within the learning process at university (Kinchin, Lygo-Baker & Hay, 2008). Concept mapping can therefore be seen as an integrated mixed methodology.

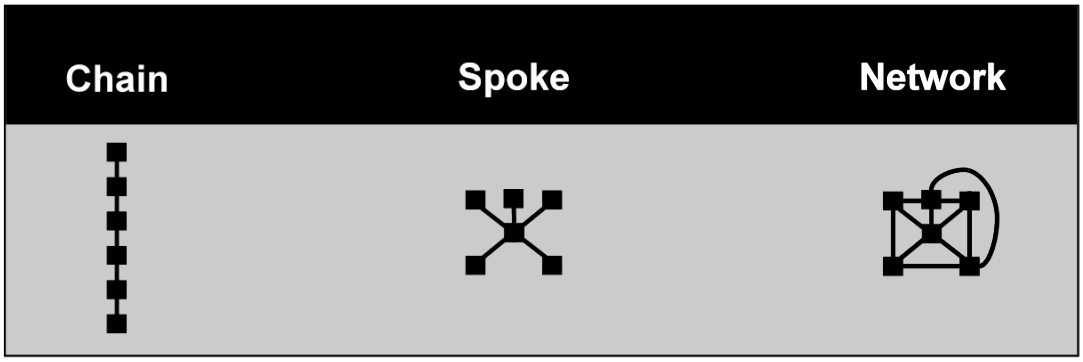

Figure 1. Concept maps comprise three basic structures (after Kinchin *et al*, 2000).

Subsequently, the work of Kinchin *et al* (2000) has had considerable impact on our understanding of 'novice' and 'expert' status (Kinchin, Cabot & Hay, 2008). This is because the three basic knowledge structures (chain, spoke and network) have been shown to be synonymous with rote learning, the emergence of 'learning readiness[1]' and expertise respectively (e.g. Hay & Kinchin, 2006). Furthermore, the spoke, chain and network structures provide a theoretical framework for the measurement of emerging student expertise and the assessment of teaching and learning.

[1] The term 'learning readiness' was used by Hay & Kinchin (2006) to describe individuals who used their tentative and emerging understanding to produce spoke like concept maps that were indicative of their first steps towards individual meaning making (rather than the repetition of the knowledge given from other sources).

2.2. Using Concept Mapping in the Development of Teaching Practice

Recent models of teaching and learning for higher education have emphasised the emergence of 'expert status' as the authentic goal of university teaching (Biggs, 2003; Kinchin, Cabot & Hay, 2008; Kinchin & Hay, 2007; Prosser & Trigwell, 1999). In particular, the work of Kinchin and Hay (2007) suggests how rote and meaningful learning outcomes are alternative and competing endpoints in conventional university level teaching.

In this approach, the two alternative outcomes of learning (meaning-making and rote learning) are characterised by alternative conceptual structures that can be discriminated through concept mapping. Rote learning outcomes will be represented as simple linear chains identical (or very similar) to the linear narratives used by the teacher to describe the topic. Meaningful learning, however, will be characterised by the radical restructure and organisation of concepts, first to form simple spokes structures ('learning readiness'), and later to make 'expert networks'. In the model of Kinchin and Hay (2007), the term 'transformative learning cycle' is used to describe the process of interaction by which students and teachers share and interrogate each others knowledge structures so that new meaning can emerge. Using this approach, Kinchin and Hay (2007) argue that the teacher – student distinction becomes blurred in ways that are legitimate and indeed increasingly appropriate as the student progresses through higher education.

2.3. Measuring the Quality of Cognitive Change through Concept Mapping

One of the most useful applications of the concept mapping method is for the measurement of quality in student learning outcomes. Hay (2007), for example, has developed the technique to be able to differentiate deep, surface and non-learning outcomes in ways that are reducible to empirical measurement. Briefly, Hay (2007) used definitions of learning *versus* non learning (Jarvis, 1992, 1998), deep *versus* surface learning (Entwistle *et al*, 1991, 2001; Entwistle and Tait, 1994; Marton & Säljö, 1976, 1984) and meaningful *versus* rote learning (Novak, 1998), to systematically differentiate conceptual change before and after learning. The work provided the first empirical demonstration that these terms for learning style are more than loosely coined terms and are, in fact, measurable outcomes. This then provides a framework for tracking learning through time (see below) and is an important methodology if subsequent research is to measure the now tangible processes of cognitive change through learning and discovery.

2.4. Using Concept Mapping to Track Cognitive Change in Time

The work of Hay (2007) illustrates the power that concept mapping has to reveal the changes in individual knowledge and understanding that might occur through time. Despite this, however, reports of long term studies to reveal cognitive change are conspicuous, only by their absence. There is now a well developed literature on change in the course of learning. The arguments of Meyer and Land for example, are now widely cited in the literature on higher education teaching and learning (e.g. Meyer and Land, 2003). This work suggests that learning proceeds through a series of 'watersheds' in which failure to grasp 'troublesome concepts' arrests further change, but that once attained, these 'thresholds' represent new vistas for knowledge and understanding. However, such a theory, intuitive though it is, should be subject to empirical measurement before it is widely accepted. Concept mapping, in the way it is described here, affords just such an opportunity. Furthermore, to obtain such data in the course of PhD level research and supervision is the most parsimonious environment in which to carry out such testing. Nowhere in higher education teaching and learning is the importance of 'threshold concepts' likely to rival that encountered in the course of research-based learning. Here, meaningful contributions to the body of knowledge can be made only when new thresholds are broached in order to provide new insights and new ways of understanding existing knowledge. How this can happen at an individual level and in the course of supervision is essential to understanding how research is done and how it can be developed and sustained among emerging researchers by supervision.

It is important for this research that the data illustrate particular cases of cognitive change and show patterns of incremental change as distinct from threshold concept acquisition. Furthermore, the simultaneous assessment of students and supervisors is important for understanding how the cognitive changes of one might affect the other and *visa versa*. What for example are the consequences of new discovery by the student researcher on the extant knowledge structures of the researcher? Do these constitute new thoughts and new ways of seeing things for both parties? Furthermore, will the active demonstration of change (or the lack of it) through concept mapping impede or enhance the rate of cognitive alignment towards new understandings of the field of research and possible of the research/supervision process itself? These are important issues that are able to be addressed through the teaching of conceptual change using concept mapping in the course of research.

2.5. Using Concept Mapping to Describe Processes of Supervision and Learning

There are four valid distinctions between student – supervisor knowledge structures before and after research (see Figure 2). For two, comprising a shared start state, the end point may also be common to both the student and the supervisor (A: concurrent change), or the research may be interpreted differently by either party (B: divergent change). Alternatively, and from different start states, the outcome of research may be consensus (convergent change) or a persistent difference in knowledge and understanding (D: contrastive change).

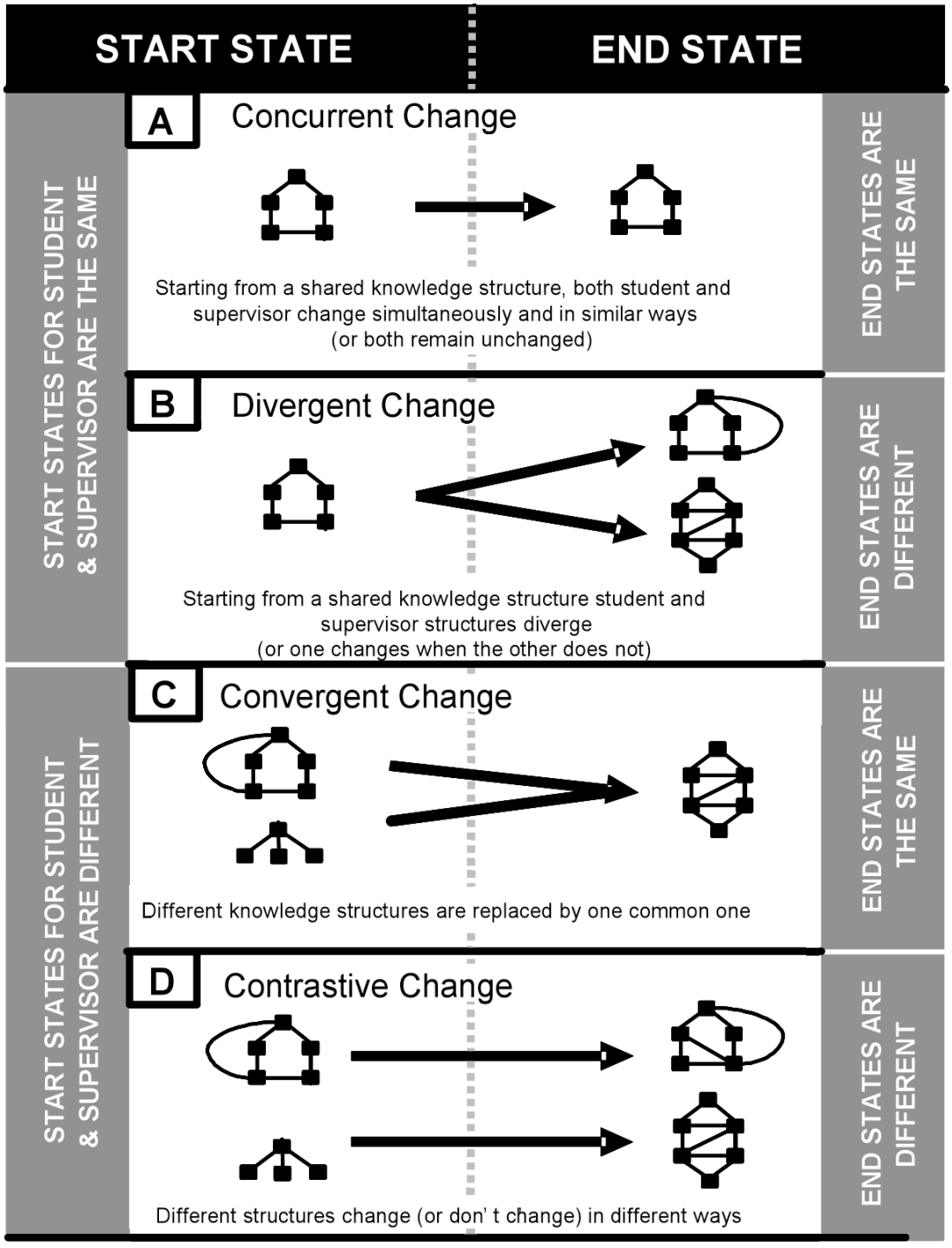

Figure 2. A theoretical framework for assessing conceptual change among student and their supervisors in the course of research

3 Methods

This differs from other investigations of PhD supervision which have focused on 'satisfaction ratings'; 'power issues'; 'completion rates' or 'closeness of supervisor-student relationships', rather we are looking at possible trajectories of mutual conceptual development within the supervisory process, exhibited by students and supervisors up to the production of the thesis. This reflects Wright and Lodwick's (1989) view that for the great majority of students, 'the academic aspects of supervision would take precedence'. In addition, this work follows students through the entire course of study in contrast to most studies that have taken a snap-shot at one point in the supervision process (e.g. Wright and Lodwick, 1989).

An in-depth picture of the patterns that are evident in the ways PhD students and their supervisors work together over time increases our current understanding of PhD supervision and so helps in the design of materials to help novice supervisors to prepare for the process. Cullen *et al.,* (1994) concluded that "programs for staff and students to improve practice can and should be designed to contextualise the generic processes of supervision with attention to disciplinary and usual human variation" (p. 109).

The identification of possible trajectories of mutual conceptual development requires a research design that enables the lived experience of the supervisory process to be explored over time. The method chosen also needs to be congruent with our epistemological position, which relates to the legitimacy of generating data about how PhD students and their supervisors work together by talking interactively with them. The approach most suited to this position is qualitative, utilising what Charmaz (2001) calls "multiple sequential interviews" (p. 682); this type of interviewing "charts a person's path through a process" and creates the opportunity for a "nuanced understanding of that process".

Interviews are conducted with students and supervisors separately so that the research does not interfere with supervision. In-depth, semi-structured interviews are done with the students at four-monthly intervals utilising a grounded theory approach. Interview transcripts are translated into concept map summaries that provide structure for the data: facilitating analysis within cases and across cases. This also helps to identify a route through the developing narrative. Data collection and analysis occur at each stage, and enable each interview to draw upon the experiences of the participants to inform theory generation relating to changes in content and processes over time. Key to the design is the first interview, as the snapshots generated from it are used to inform the subsequent data collection. The interview guide for the first interview explores two complementary lines of enquiry (themes):

1. Topic – looking at the academic area under investigation within the PhD.
2. Process – looking at the conceptions held of the research process and of the PhD as an entity.

Questioning during student and supervisor interviews takes the form of three interconnected phases for each of the two themes. These three phases reflect the three phases of questioning identified by Pedrosa de Jesus *et al*. (2006) as 1) acquisition, 2) specialization and 3) integration. These in turn facilitate the co-construction of concept maps (by interviewee supported by interviewer) by building upon spokes, elaborating chains and finally integrating these as networks. This was guided by careful use of relational language (*sensu* Loewenstein and Gentner, 2005), during the interview to encourage the interviewee to make links explicit.

4 Results

Limited data is available at this point. However, the initial rounds of interviews show promise for this project. Below are concept maps created by a student and supervisor pair in response to the question, "What is a PhD?" The left side of the supervisor map (see Figure 3) indicates a group of skills and the right side details a linear path to becoming an independent scientist. In contrast, the student map (see Figure 4) breaks the PhD into work and study and focuses on learning as a route to publishing. The bottom of the student map indicates a variety of characteristics necessary for publishing. Overall the supervisor map concentrates on acts of doing and being, whereas the student map focuses on learning and acquiring traits and characteristics.

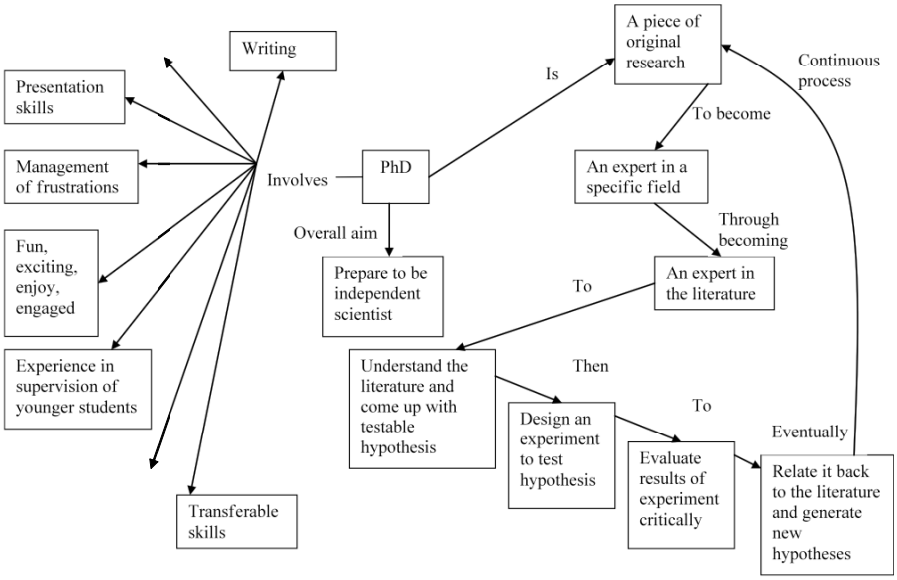

Figure 3. Supervisor map of what a PhD is.

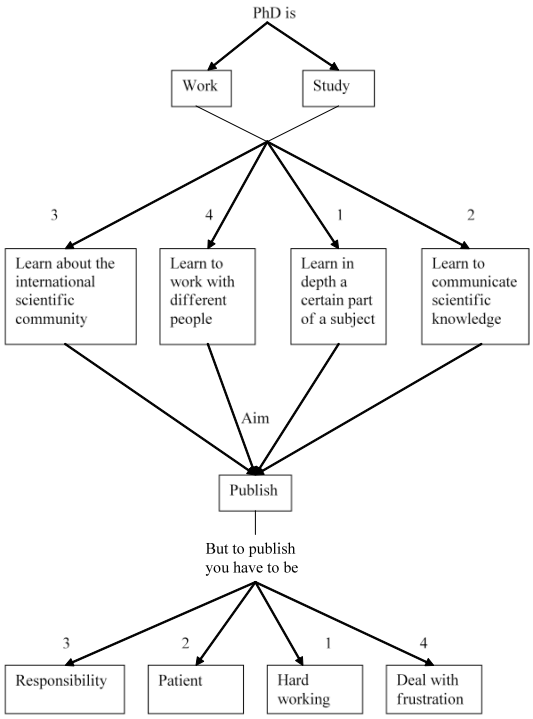

Figure 4. Student map of what a PhD is.

The maps also diverge in the emphasis of the output of the PhD. The supervisor's map details the scientific process of discovery (through hypothesis testing). The student's map centres on publishing, the eventual outcome, but does not indicate the exact path to get there. It will be interesting to see how the two maps shift and change over time. One possibility is the student may move to a more active view of the PhD that matches the supervisor, and the supervisor may move towards a learning-centred model, which would be an example of convergent change noted in Figure 2.

5 Summary

This on-going research project uses concept mapping to explore cognitive change in the PhD supervision process over time. The final results of this study will allow for tracking changes of the understanding of the content and process of the PhD from both the student and supervisor's perspectives. Concept mapping allows for visually tracking these changes over time, and may also be a tool for supervisors and students to use as a

way to monitor and track the PhD process. Furthermore, this unique approach to assessing PhD supervision may allow for analysis of the role of 'expert' and 'novice' status in cognitive change. This research has potential benefits for PhD supervision broadly, as well as the continued development and use of concept mapping in education research.

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