E-learning adoption in a campus university as a complex adaptive system: mapping lecturer strategies

by

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Abstract

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Beyond Distance Research Alliance

The adoption of e-learning technologies in campus universities has not realised its potential for meeting the learning needs and expectations of 21st century students. By modelling university learning and teaching as a complex adaptive system, this thesis develops a new way of understanding and managing the adoption of new learning technologies in campus universities.

The literature on learning and teaching in higher education indicates that lecturers' ability to innovate in their teaching is constrained by tacit and discipline-specific educational knowledge. Introducing new methods and technologies into mainstream university teaching requires explicit review of educational knowledge, and requires support from departmental and institutional organizational systems. Research on organizational change in other contexts, such as manufacturing industry, has used complex adaptive systems modelling to understand the systemic interdependence of individual strategies, organizations and technologies. These models suggest that the integration of new e-learning technologies into mainstream campus university teaching will involve corresponding change processes. Part of this change requires the linking up of diverse disciplinary perspectives on learning and teaching.

The thesis develops a conceptual framework for researching university learning and teaching as a complex adaptive system that includes learning technologies, people, and their organization within a university. Complex adaptive systems theory suggests that the capacity of a campus university to adapt to new e-learning technologies will be reflected in patterns in the strategies of those lecturers who are early adopters of those technologies.

A context-specific study in the University of New South Wales used cognitive mapping to represent and analyse the strategies of a group of 19 early adopters of e-learning technology. These early adopters were participants in a cross-discipline Fellowship programme intended to develop their ability to act as change agents within the university. Analysis of the maps gathered before and after the Fellowship, triangulated with data on the Fellows' participation in organizational change, leads to a new way of modelling how university learning and teaching systems, including their technologies, adapt within a complex and changing higher education context.

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Additional material provided on CD-ROM

All of the following are provided as pdf files with hyperlinks

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Glossary

Ordered alphabetically. Cross-refs to other entries are italicized.

Academic. A university staff member employed on academic terms and conditions, including lecturers and researchers

Action research. A research methodology that allows for cycles of action, data collection and analysis, reflection and planning. In educational research these cycles can be matched with the successive academic sessions or terms in which a course is run, with student feedback driving continuous improvement. Salmon (Eden & Huxham, 1996; Gill & Johnson, 1997; White, 1990) advocates context-specific action research as a way of building new theory through reflective practice. Action research is also advocated for context-specific studies of organizational change management (Kemmis & McTaggart, 2005)..

Adaptation. In biology, "organic modification by which an organism or species becomes adapted to its environment" (OED online, accessed 6 February 2006). In this thesis adaptation is applied the response of human organizations as complex systems interacting with a changing external environment. See also *homeostasis*.

Adaptability. the continuing ability of a *system* to change its internal function and structure in response to continuing changes in the system's environment.

Analogy. Exploration of the functioning of new concepts or systems by reference to things that are already understood. Analogy implies a stronger correspondence with some aspect of reality than a *metaphor*, but a less rigorous one than a *model.*

Apprenticeship. The acquisition of professional skills through practice under the guidance of an expert practitioner

Asynchronous e-learning media. Online learning involving a time delay between each message and response; for example online discussion forums, voicemail and email, online learning tools such as assignment submission and marking.

Blended learning. Amix of e-learning options and media alongside classroom learning activities. Blended learning strategies at the institutional level can, for example, include offering a course in *fully online*, *mixed* and *web-dependent* study modes to suit different cohorts of students. Within a course, blended learning design involves study in which classroom and online activities complement each other.

Causal map. Graphical representation of perceived causal or influence relationships (OUBS, 1999, p21). Such maps can represent a complex network of multiple interrelated causes. *Cognitive maps* are a particular form of causal map, usually representing individual perceptions and strategies.

Clipart. Standard graphics and symbols available from an online library, useful for representing widely recognised objects or ideas. In this thesis, clipart is used occasionally to provide a visual representation of accepted norms, such as the role of the lecturer in relation to an audience.

Codified knowledge. Knowledge that is expressed formally in texts, theories or explicitly reflected in physical systems and artefacts; as distinct from *tacit knowledge*.

Cognition. Originally, the conscious knowledge of an individual *(OED online, accessed 27/04/07)*. This thesis draws upon ideas that extend the concept of *learning* and cognition to include knowledge that is not located within one human mind, but also *distributed cognition* in human organizations and social systems.

Cognitive map (1) Each individual's internal representation of causes, effects and influences, which forms the basis for decisions and actions. (2) The graphical representation of this internal representation as a network of phrases representing concepts linked by arrows representing the perception of how the concepts influence each other. This thesis uses the term cognitive map in both these senses.

Community of Practice (CoP). Informal and voluntary networking among group of like-minded professionals with others in their role or profession, to create, share and manage knowledge across organizational boundaries (Wenger, 2005).

Complementarities. Systemic interdependencies, which can be modelled mathematically, in which "doing *more* of one thing *increases* the returns of doing *more* of another" (Milgrom & Roberts, 1995a, italics in original). Any complex organization will have complementarities.

Complex adaptive system. A *system* with self-organizing properties, which allow it to adapt actively to changes in an environment – originally referring to living biological systems.

Deliberative learning. Where a learner consciously reviews experiences and plans future actions (Eraut, 2000b) See also *reactive learning*.

Distributed cognition. The extension of the idea of individual knowledge and cognition to cover knowledge that is embodied in patterns of teamwork, organizational processes or systems, and in the technologies that support shared activity, rather than being in the mind of one person.

Dualities. A characteristic of complex systems in which different, often apparently contradictory, processes operate within the same system, for example centralization and decentralization of control, or formal and informal ways of organizing (Sanchez-Runde & Pettigrew, 2004).

Early adopters. People who are prepared to use a new tool or practice before the majority, typically 13.5% of those who might eventually use it (Rogers, 2003)

Educational developer. A professional who supports the development of educational media and activities, usually in relation to e-learning. Alternative terms, also used to describe educational e-learning support specialists are educational designer and *instructional designer*. In Australia there are widely varying interpretations of the role.

E-moderating. Facilitation of online learning interactions (Salmon, 2000).

E-learning: Use of digital media and communication technologies, and in particular the online environment, to support learning activities. E-learning is distinct from, but is often integrated with, student administration (enrolments and student records) and library (information repository) systems. E-learning may be into four types:

I. *Web-supplemented*

II. *Web-dependent*

III. *Mixed-mode*

IV. *Fully online*

Experiential learning cycle. A learning process described by Kolb (1984), in which reflection upon experience leads to the formation of theory, which in turn informs actions that shape subsequent experiences.

Espoused theory. Theory that people say they are applying, but with which their actions may be inconsistent. See also *theory-in use.*

Feedback. In technical control systems, where output signal from a process is picked up and becomes part of the input to that same process, either moderating the process (*negative feedback)* or reinforcing the process (*positive feedback*). In this thesis, positive and negative feedback, even when used in soft systems, will be used to refer to such systemic feedback loops. There is a looser definition, not used in this thesis, which refers to feedback as approving or disapproving responses from other people and which forms only part of a systemic feedback loop.

Flowchart. A diagram showing an ordered sequence of information flows, decisions and actions, used to document and communicate data collection and analysis.

Fully online e-learning. Where learning activities and interactions are entirely online. Some fully online learning involves individual self-paced study. In other types of fully online e-learning students interact with tutors and with each other entirely in the online environment.

Hard systems thinking. The assumption that the perceived world contains systems which can be the subject of a systematic process of enquiry, and that ultimately such systems, once understood, can be engineered.

Homeostasis. In biological systems, multiple interdependent adjustments made to maintain an overall state in response to change in the external environment. Examples are the processes through which humans process food and fluids to maintain body temperature and mass. By *analogy* the same term has been applied to organizations as open complex systems that interact with an environment. See also *adaptation*.

Human social system. In this thesis, any pattern of interaction among people, interpersonal, organizational, formal or informal.

Implicit learning. The learning of professional or other skills imitating behaviour, and trial and error, rather than by explicit discussion of options.

Innovation. In relation to university learning and teaching, the introduction of new types of learning activity for students, in which the types of, and media for, interaction among teachers and learners, differs significantly from those traditionally used in the discipline. In relation to organizations, innovation can be defined as the introduction of radically different combinations of organizational activities and organizational structures (Fenton & Pettigrew, 2000b, pp.2-3)

Innovators. The small proportion of people, typically 2.5% who are prepared to try using an unknown tool or practice for the first time (Rogers, 2003)

Intuitive practice. the practiced and unconscious use of skills and knowledge, which may have been learnt tacitly or explicitly, described by Atkinson and Claxton (2000) in the context of classroom teaching in schools.

Learning, The process of acquiring knowledge, also originally refers to individuals. This thesis applies the concept of learning and *cognition* to include knowledge that is distributed across human organizations and social systems.

Learning Management System (LMS). Software to structure and manage access to learning resources for teachers and students. Such systems contain *virtual learning environments (VLE)* and may be integrated with institutional administration systems for automated student enrolment and with university online library systems.

Learning organization. An environment in which individual and organizational transformations take place together (Senge, Kleiner, Roberts, Ross & Smith, 1994)

Lecturer. Members of a university's *academic* staff who have some formal responsibility for teaching students in their discipline, traditionally by lecturing to them**.**

Metacognition. In this thesis, an awareness and understanding among academics of how personal or discipline-specific experience has shaped their own thought processes, and that their own worldviews may therefore differ from the worldviews of academics from other backgrounds

Metaphor. A description of superficial resemblance between one object or action and another. Metaphors can play a part in the process of developing knowledge; creating new meaning by cutting across different contexts (Bateson, 1973).

Microdiversity. The capacity for a wider range of responses among individuals in an organizational system than is required for the current environment. The concept is equivalent to role of genetic diversity in evolutionary biology. It implies some redundancy of capabilities and the capacity for self-organization to increase the range of potential responses (Andriani, 2001).

Mindmaps or spray diagrams. Diagrams that represent ideas as branches from a central concept, in a hierarchical structure (Buzan & Buzan, 2000; OUBS, 1999).

Mixed-mode e-learning. The use of *e-learning* for some essential learning activities, such as online tutorial discussions or groupwork and online assessment, and where there is also some face-to-face teaching. In distance study, for example, mixed mode study might consist of online learning activities combined with a requirement to attend a residential school and sit a written examination. See also *blended learning.*

Model. A simplified representation of structure or process, which can be the basis for a theoretical or empirical understanding or for calculations and predictions. A model is much more than a *metaphor***,** which is a description of superficial resemblance between one object or action and another. A model of a university learning and teaching system is an accurate representation of some significant aspects of the university's organizational processes, which can be used as a research tool to gain understanding of those processes. In the context of developing and engineering a new physical product, a model is a prototype and is explicit (Nonaka, 1994).

However, in other disciplines, the word 'model' refers to conceptual models or mental maps, which can be implicit or explicit. This thesis uses the latter definition, but also develops some arguments to show how physical technologies can embody mental models or theories.

Negative feedback. In technical control systems, where an output signal from a process is compared with a reference signal and acts to limit the process output, for example as in a simple thermostat. In this thesis, negative feedback is also used to refers to similar situation in social and organizational processes.

Network diagram. A graphical representation of multiple interactions and mutual adjustment between system components

Online learning. Any use of networked computer media for learning, whether on a university intranet, for example from a campus computer laboratory, or on the *web-based* internet.

Organizational adaptation. In this thesis, systemic change spanning individuals, communities and formal organization, including changes in tools, technologies and infrastructure.

Organizational adaptability. In this thesis, the capacity for continued *organizational adaptation* and technological innovation.

Organizational learning. In this thesis, the process by which organizations adapt to changes in their environment, involving changes in individual behaviour, in the way informal communities organize and in the formal organizational structures and processes.

Participatory action research (PAR). Research in which action is not observed separately, but instead converges with the research process through communication with the participants who are the subject of the research. PAR allows for the role of researcher as facilitator (Griffin, Shaw & Stacey, 1999).

Positive feedback. In technical control systems, where an output signal from a process reinforces the process causing the output signal. Unchecked, a single positive feedback loop produces a runaway process. In biological and evolutionary systems, positive feedback is associated with growth in organisms and populations, and is balanced by *negative feedback* processes.

Reactive learning. Learning from what has happened, however accidentally, in which there are brief episodes of review after each experience (Eraut, 2000b)

Reflective practice. The acquisition of professional skills through reflection on practice rather than formal learning of theory, as defined by Schön (1983)

Reflexivity. In research methodology, the recognition of mutual interdependence of observer or knower with what is seen or known (Oxford English Dictionary Online, accessed 21 January 2008). Reflexivity is a particular type of reflective research practice, which acknowledges the complex relations between the process of knowledge production, the context of this process and the researcher . Reflexive research methodology therefore suggests research in phases, including reflection on multiple levels and/or themes (Alvesson & Sköldberg, 2000)

Rich pictures. Hand-drawn images used to express and work with imaginative and intuitive ideas, using metaphor.

Scholarship of teaching. One of several types of scholarship defined by Boyer (1990), in which an academic creates and shares knowledge of teaching in the discipline, as well knowledge of disciplinary research practice.

Situated learning theory. A theory suggesting that he best way to learn is in a real-work context (Solomon, Boud, Leontios & Staron, 2001) and which underlies the *community of practice.*

Soft Systems Methodology (SSM). The application of aspects of both hard and soft methodologies to the study of human interaction. Later descriptions, in 2006, summarize SSM as a structured process of enquiry using purposeful activity models that are based upon declared worldviews (Checkland & Poulter, 2006a).

Subsystem. A component of a *system* which also has the properties of a system.

Synchronous e-learning media. E-learning media in which the interaction between participants is instantaneous and happens in real time; for example videoconferencing, teleconferencing, online chatrooms.

System. In this thesis, an organized collection of human activities and their outcomes (which can include material resources and objects). A system has interacting parts, and has systemic properties that are more than the sum of the properties of the parts (Checkland, 1993).

System map. A simplified representation of the scope of a system of interest, showing a system boundary and the main component within that boundary.

Systemic patterns or archetypes. A pattern of *feedback loops* in an organizational system.

Tacit knowledge. Knowledge that is used in practice, but which is not articulated or made explicit, in contrast with *codified knowledge*

Teaching and learning regime (TLR). A discipline-specific *worldview* on teaching and learning, that is, an interlinked system of values, relationships, practices and assumptions about what counts as valid academic knowledge and how it is acquired (Trowler & Cooper, 2002).

Theory-in-use. Theory represented in observed actions, which the person acting may be unaware of and which are often learned implicitly through social interaction rather than explicitly as a theory. See also *espoused theory* and *implicit learning.*

Threshold concepts. Ideas that lead to a qualitative and irreversible change in understanding, and which, once appreciated, shape subsequent learning and behaviour (Meyer & Land, 2006)

Two-dimensional graph. A diagram that can be used to plot the variation of two interdependent quantitative measurements. Such graphs can also be used to illustrate qualitative characteristics of a system's activities that may vary in two different ways along a spectrum.

University teacher. In this thesis, anyone who is employed to contribute directly to student learning, including some who are not employed as academic staff; for example librarians, educational developers, tutors and laboratory demonstrators would be considered as teachers.

Virtual learning environments (VLE). A web-based facility where students can access digital resources and communicate with each other and with their teachers, containing organized web-based learning tools, usually supporting communication and assessment; for example online discussion, chat, quizzes, highly interlinked online learning pathways that can be customized for individuals and groups.

Web-based. Making use of the public internet systems, as distinct from university intranet. Most university *learning management systems* and *virtual learning environments* are effectively web-based, because they are accessible through the worldwide web, and not just from campus computers.

Web-supplemented e-learning. E-learning in which the main learning interaction takes place in the classroom, and only additional or administrative resources, such as course outlines and lecture notes are provided online

Web-dependent e-learning. E-learning in which students are required to go online to complete key elements of their study, for example assessed online discussions, or collaborative work, but where there is no significant reduction in classroom time.

Chapter1. Researching use of learning technologies in universities

Abstract of Chapter 1

This chapter outlines the scope and focus of the research upon which the thesis is based. The research takes place in a context in which, at the start of the 21st century, there has been rapid growth in the range of technologies available to support learning in universities. There has also been substantial change in other aspects of the higher education environment: for example in the needs and expectations of students, in the requirements of employers and government funding bodies, and in internationalization of higher education. All of these changes influence each other, and also influence the decisions taken by individual academics about introducing new learning technologies into their learning and teaching practices.

Systems thinking provides models for understanding how campus university learning and teaching systems are adapting to the introduction of new technologies for learning. In particular, systems models are able to combine consideration of hard technical systems with human social systems. In this context, the term **human social system** refers to any pattern of interaction among people, interpersonal, organizational, formal or informal. The research for the thesis involves a contextual study of a cross-discipline group of campus university staff who have come together to develop their strategies for use of learning technologies. The differences in disciplinary perspectives represented among these university staff are central to the research topic. The three research questions concern individual lecturers' motivations, the role of cross-discipline communities and systemic interdependencies at the institutional level. A cross-discipline research process is also required, to take into account the interaction between technical systems and human social systems.

Complex adaptive systems theories have been used in research into organizational change in contexts other than higher education, and have enabled material and technological development to be modelled together with individual and organizational development, rather than treated as separate systems. The same theoretical frameworks help to explain the systemic interactions found in the study reported in this thesis, involving individual lecturers, the technologies they use for teaching, and the organizational contexts of their disciplines and their university.

The philosophical approach and the cross-discipline nature of the research require that assumptions and use of language and diagrams are made explicit. This Chapter includes some general definitions that will be used in later Chapters.

1.1 The context for the thesis

The research for this thesis is motivated by a desire to understand how learning and teaching practices in campus universities are changing in a rapidly developing technological environment. New digital environments, media and tools are increasingly being used to enhance, or sometimes to replace, the traditional library and classroom learning experiences. Unlike large distance universities, campus universities offer students access to an academic community located in a particular physical place, where they attend lectures, tutorials and in some disciplines practical classes. Many of the learning activities that take place in these traditional university environments have been used by generations of students and teachers. In the UK and in Australia, academic staff who teach students are still usually given the job title **lecturer**, reflecting the traditional role of an individual who imparts knowledge to students by lecturing to them.

At the start of the 21st century the higher education environment is becoming increasingly complex in a number of ways. Universities are no longer able to maintain their traditional role as a place where knowledge resides. Instead, the boundaries between universities and the wider world are becoming more permeable as a result of information technologies; and it is more appropriate to think of the university as engaged in developing knowledge processes and exploiting knowledge possibilities (Barnett, 2000a, pp 65-66). These changes in the higher education environment include a changing role for academics as teachers; because of the changing needs of students and also because of the new technologies that are available for supporting student learning.

In practice, many people contribute directly to student learning in campus universities, including some who are not employed as academic staff. Librarians provide information literacy support. **Educational developers** help academic staff design courses and learning activities. Casual teaching staff run tutorials and act as laboratory demonstrators. In this thesis, these roles and others involved in creating student learning experiences are collectively referred to as **university teachers**. However, the title of the thesis refers to the academic teaching staff as **lecturers**, to indicate that the traditional lecturer role, and the way that it is conceived in campus universities, lies at the centre of the enquiry. Lecturers are members of academic communities in which both teaching and research are carried out. So the term **academic** in this context includes those whose main role may involve teaching, research or both. Academics in different disciplinary communities define their knowledge differently (Becher & Trowler, 2001) and therefore also understand and practice their learning and teaching differently (Robertson & Bond, 2005). Disciplinary diversity, along with a diversity of teaching roles, adds to the complexity of the changes taking place in higher education.

Two international studies published in a report from the Organization for Economic Cooperation & Development (OECD, 2005a, combining reports from OBHE and ACU), gathered data between 2002 and 2004: they suggest that innovative technology-supported learning activities were not being fully integrated into mainstream campus teaching practice. Other studies confirm an international pattern in which campus universities are using digital learning technologies mainly for delivery of course materials such as lecture notes to supplement traditional face-to-face teaching and not to provide students with new types of learning experience.

In Australia, a government survey in 2002 found that, although **online learning** facilities were widely available in universities, they were mostly being used to supplement face-to-face teaching (Bell, Bush, Nicholson, O'Brien & Tran, 2002). A later benchmarking study in New Zealand showed a similar pattern, and notes a "need to consider better ways of sharing and promulgating solid solutions to standard problems as well as innovative and effective teaching practice" (Marshall, 2005).

A review of UK literature and practice since 2000 also reports that the most common use of online learning technology is for delivery of supplementary materials (Sharpe, Benfield, Roberts & Francis, 2006). The observation in 2003 that the adoption, diffusion and exploitation of learning technologies has been slower than anticipated (Martin, Massy & Clarke, 2003) is still relevant for campus universities in 2007. While digital learning technologies are becoming more integrated with UK university teaching practices, and there are many examples of effective innovation that benefits student learning, there are continuing concerns about how the uptake of new learning technologies can be spread to the majority of academics (Adamson & Plenderleith, 2007; HEA, 2007).

One strategy for making sense of complex change in universities is to divide it up into separate studies within established disciplinary areas of expertise. Technology experts focus on developing and understanding new technologies that might be used in learning. Educational experts research what these new technologies afford for student learning, based upon existing knowledge of learning in traditional contexts. Organizational specialists deal with the practicalities of providing university academics and students with access to support services and facilities, both physical and digital. However, identifying the potential of new learning technologies does not automatically lead to their widespread use in university teaching practice. Furthermore, when students learning needs are changing, knowledge of how students have learnt in the past may no longer be sufficient to inform lecturers' decisions about how best to use new learning technologies. Under these circumstances, it becomes doubly difficult to plan institutional support for changing learning and teaching practices. To understand the changes taking place in traditional campus

university teaching practices, it is therefore necessary to study the systemic links between learning technologies, teaching practices and the organizational contexts in which learning and teaching takes place. These systemic interactions take place between people with different perspectives, representing different disciplinary priorities.

The strategies of those who are actively involved in introducing technology-related change in learning and teaching will reflect the systemic interactions they each experience in their own teaching activities. The thesis therefore analyses strategies from a cross-discipline group as they develop their strategies for adopting e-learning innovations in a campus university, during a period of complex change. The analysis uses data from the University of New South Wales (UNSW) in Australia, between 2002 and 2004, when many new learning technologies were becoming available and when there were also changes in the national and international higher education environment. Student expectations and needs have been changing (Krause, Hartley, James & McInnis, 2005; McInnis, 1999; , 2004; McInnis & Hartley, 2002). New government policies for the management and funding of higher education were also being introduced (DEST, 2002a; b; c; d; , 2003). So the work of individual lecturers, departments and senior management in UNSW was taking place in a context of multidimensional change in which learning technology is one of the dimensions.

In order to include multiple interactions between technology, teaching practices and university organization, the UNSW study views university learning and teaching as a system. In systems thinking, human organization is viewed as a cluster of linked activities which together make up a purposeful whole that is more than the sum of its parts (Checkland & Poulter, 2006a). Since 1990, some researchers have been using systems thinking in combination with mathematical modelling to build detailed models of human organizations as complex adaptive systems made up of individuals. The mathematical models have been informed by empirical studies of changes in organizational structures and related technologies (Milgrom & Roberts, 1995a; Pettigrew & Fenton, 2000; Pettigrew, Whittington, Melin, Sanchez-Runde, van den Bosch, Ruigrok & Nugami, 2003). Similar types of systems modelling may provide a way of understanding the complex interactions through which new technologies become incorporated in university learning and teaching.

Systems thinking has shaped the whole thesis, including the literature review, the development of the research questions and the conceptual framework for the research. In a cross-discipline interpretation of research methodologies, Bateson (1973, pp23-35) argues that all research is based upon some initial assumptions and prior thinking, and that no data are truly raw because they have been selected, or selectively perceived, by the researcher according to a particular

worldview. In systems modelling, this worldview is made explicit as the starting point for the research, so that it may be questioned as part of the research process. The underlying philosophy for the research is therefore outlined here in this introductory chapter.

1.2 A university learning and teaching system – hard, soft and complex

In seeking to understand how learning and teaching practices in campus universities are changing in a rapidly developing technological environment, the thesis frames university learning and teaching as a complex multi-faceted activity system. In a campus university, this system involves individual teachers and learners interacting with each other within disciplinary and departmental settings, using and developing different bodies of knowledge, and using the support services and technologies afforded by the institutional environment. First, some further clarification is needed of what is meant by the word 'system' in the context of this thesis.

1.2.1 Systems thinking

Systems as systematic organization

Systems modelling developed initially as a way of using ideas from cybernetics, hard technical information and control systems, to model the information flows between people in organizations. The cybernetic model assumes that any organization will have clearly identifiable goals. In a university, the formal committees and staff reporting structures, the budgets and planning systems, can be understood in this way, as a set of information flows and measurable outcomes. Budgets and performance management systems, for example, involve information feedback loops, usually designed to match measured outcomes (grant income, money spent, numbers of students graduated) with predefined planning targets which are reviewed and adjusted in a regular cycle, often annually.

The use of tangible measured outcomes can be justified using the concept of bounded rationality, in which complex human decision making involves structuring and selection of information based on its utility for achieving a purpose (Simon, 2001). The formal organization of a university can be seen as a system for managing interactions within and between subsystems. A disciplinary department, for example, is a grouping of people among whom there is a higher level of interaction than the same individuals have with people in other departments. The department can therefore be treated as a discrete subsystem with measurable characteristics and behaviours, inputs and outputs, which are the focus of formal management responsibilities, and for which individual department heads may be held accountable.

Formal management systems represent only one perspective on how people interact in an organization such as a university. Other perspectives are needed to take account of the negotiated and qualitative aspects of university life, which are less amenable to being reduced to hard facts or modelled as feedback processes which match measured outcomes with planned goals.

Systems as structured sense-making processes

Universities are also described as a complex mix of diverse disciplinary cultures, each with different views of knowledge and different ways of organizing academic work (Becher & Trowler, 2001; Knight & Trowler, 2000; Trowler & Cooper, 2002; Trowler & Knight, 1999; Trowler & Knight, 2000). In such a context, the organizational goals are open to challenge, are contested (Barnett, 2000a, p 65), and are therefore not easy to define.

Soft systems thinking introduced a methodology for dealing with ill-defined problems, in which the boundaries and objectives of the system are not clear, or are contested. Checkland (1990) and Checkland and Scholes (1990) summarize the difference between hard and soft systems thinking:

- **Hard systems** thinking assumes that the perceived world contains systems which can be the subject of a systematic process of enquiry. Ultimately such systems, once understood, can be engineered.

- **Soft systems** thinking takes the stand that the process of enquiry is itself a system. In other words, the process of making sense of the world is a learning system.

Soft systems thinking as described above, on its own, would result in a purely internal mental process (Checkland & Scholes, 1990, pp 283-285). Scholarly enquiry requires that a framework of ideas is made explicit, and is supported by evidence that can be shared with other researchers. In practice, therefore, **Soft Systems Methodology (SSM)** applies aspects of both hard and soft methodologies to the study of human interaction. Later descriptions, in 2006, summarize SSM as a structured process of enquiry using purposeful activity models that are based upon declared worldviews (Checkland & Poulter, 2006a). This combined hard and soft approach to SSM allows for negotiation between different perceptions of a problem situation, in order to develop an explicit model. The explicit model arising from the SSM enquiry can then be used as the basis of action to change the problem situation. SSM research is in the tradition of action research (Checkland, 1990, p A39), in which social organization is studied not by detached observation, as if in a laboratory, but by taking part in a purposeful change process involving cycles of action and reflective analysis.

SSM therefore provides a basis for research into change in campus university learning and teaching, in which different disciplines have different worldviews (Trowler & Cooper, 2002), and where some negotiation is needed between these worldviews to develop models that can inform action at the level of the university. In this thesis, the investigation into how learning and teaching practices in campus universities are changing in a rapidly developing technological environment includes the interaction of people and technologies within the models developed, meeting the following definition of SSM:

> SSM is an action-oriented process of inquiry into problematic situations in the everyday world; users learn their way from finding out about the situation to defining/taking action to improve it. The learning emerges via an organized process in which the real situation is explored, using as intellectual devices – which serve to provide structure to the discussion – models of purposeful activity to encapsulate pure, stated worldviews.
> (Checkland & Poulter, 2006a, p 22)

As an approach to research, SSM is best practised when the researcher internalizes the underlying philosophy, and does not attempt to treat it as a series of programmed and conscious steps and methods (Checkland & Scholes, 1990, p 298). SSM is therefore described here as a general approach to the research, rather than being included in the main body of the thesis as a detailed rationale for selecting research methodology and methods. However, SSM does require the researcher to state a worldview, in terms of an explicit definition of the system that is to be studied.

1.2.2 A systems model of university learning and teaching

Because the perspectives of different academic disciplines are central to university learning and teaching, the system of interest in this enquiry centres on the individual academics and their disciplinary and institutional contexts. The purposefully organized activities in this system involve its responses to the new technologies becoming available to support university learning and teaching. Like any model, this is a simplification that encapsulates a worldview, and in which some aspects of the system are given more detailed attention than others. Figure 1.1 provides an initial definition of the system of interest, and the scope and focus of the research required.

Disciplinary departments and cultures are subsystems, and lecturers are part of these subsystems. The system model therefore allows for the different worldviews represented by disciplinary subsystems. Factors outside the system boundary are treated as environmental influences. Since this thesis is seeking to understand how learning and teaching practices in campus universities are changing in a rapidly developing technological environment, technology is identified as an environmental factor, along with changing student needs and changes in government policies. Note that the representation of these factors as outside the system boundary does not mean that

they are insignificant, but that the enquiry is focusing on how they interact as a whole with the various system components identified. An enquiry with a different focus would start with a different system map.

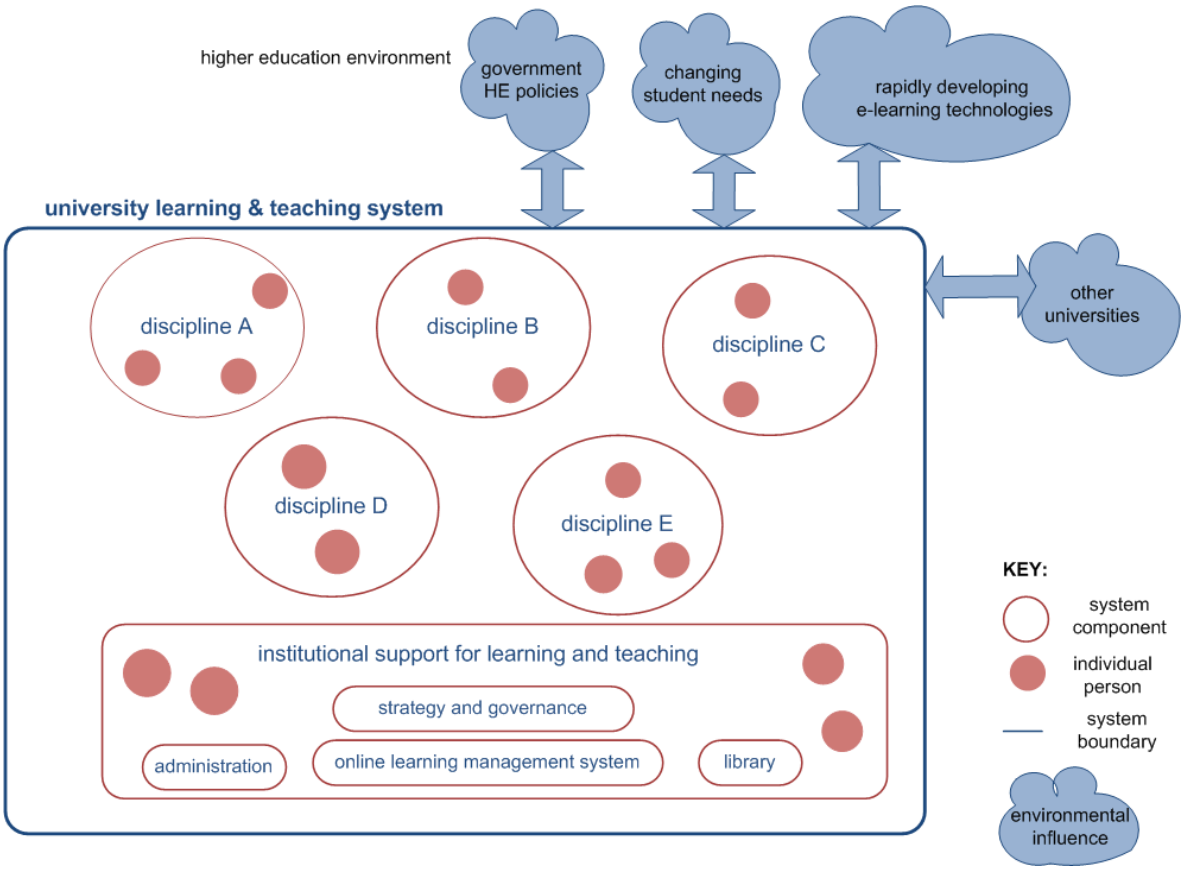


Figure 1.1 A system map of the scope of this thesis

In universities, technological change influences teaching in many ways. For example, information technology for libraries and administration also has a significant role in supporting learning and teaching. However, this enquiry does not focus on the institutional information technology systems through which students and staff gain access to online digital resources and environment, but on use of these facilities by those who directly design and deliver disciplinary curricula, courses and learning activities for students. In campus universities, online digital media offer an addition, or an alternative, to face-to-face interaction in the campus classroom. This enquiry encompasses all digital environments and media that university lecturers can use to provide and structure learning resources and activities for their students.

E-learning as part of the university learning and teaching system

Many digital learning technologies are now provided through institutional online **learning management systems (LMS)**. Such systems contain **virtual learning environments (VLE)** where students can access digital resources and communicate with each other and with their teachers. VLEs contain multiple communication and assessment tools, such as online discussion forums,

chatrooms, quizzes, and highly interlinked online learning pathways that can be customized for individuals and groups. However the availability of these tools says nothing about how they are being used. Most LMSs have built-in reporting functions to provide data on usage. Institutional LMS services are therefore included in learning and teaching support because they can provide structured information and services for the disciplinary learning and teaching practices that use these systems. For the purposes of this enquiry it is therefore necessary to include institutional support systems as system components along with individual academic practices and disciplines.

During the period of the study at UNSW, the term **e-learning** was widely used to refer to all digital learning technologies, although most commonly referring to those provided through online learning management systems and VLEs. There are now concerns about whether this term is adequate to describe the wide and continually expanding range of digital technologies that can be used for learning (Adamson & Plenderleith, 2007). In this thesis, the term e-learning will be used in this broader sense, also including technologies such as CD-ROM, computer use in classrooms, digital recording of lectures, SMS and the use of public **web-based** social environments. All of these technologies can be used in activities that integrate virtual with face-to-face environments.

E-learning technology has changed during the course of the research for this thesis. For example multimedia podcasting and increasingly sophisticated mobile devices offer alternatives to CD-ROMs and fixed computers. In 2007 many universities are establishing an institutional presence in the web-based social environment Second Life. Use of these newer technologies has spread rapidly since the beginning of the study in UNSW. The research questions addressed in this thesis therefore do not focus on particular technologies, but on how university academic staff, their disciplinary departments and their universities adapt to the use of new learning technologies.

1.2.3 The research questions

As noted above (Section 1.1), a number of large-scale surveys indicate that mainstream campus university learning and teaching has been lagging behind best practice in use of e-learning technologies to promote student learning. In order to understand why, despite their potential to improve student learning, e-learning technologies have not been readily adopted in campus universities, this enquiry focuses on analysing individual lecturers' learning and teaching strategies and examining how these strategies contribute to change in the campus university learning and teaching system.

Individual lecturers in discipline contexts

The literature on higher education practice, reviewed in Chapter 2, includes studies of how discipline differences influence learning and teaching. Trowler and Cooper (2002) describe how

discipline differences constrain the development of new educational knowledge in university teaching practice. Educational research findings cannot be instantly implemented across different disciplines because each discipline has its own understanding of knowledge and learning. This enquiry seeks to understand how e-learning innovations in particular may become more widely used in campus university teaching. If individual academics are primarily interacting among people within their own departments, as implied in the model shown in Figure 1.1, then cross-discipline interactions may be the key to spreading innovative uses of e-learning more widely into mainstream teaching practice.

The first research question therefore asks why university teachers, and lecturers in particular, would bother to seek out innovative ways of using e-learning, or to share experiences of innovation with lecturers in other disciplines, so that e-learning innovations may spread more rapidly and benefit more students.

Research Question 1

What can motivate individual teachers in a traditional campus university to put time and effort into:

(i) developing innovative teaching practices using e-learning?

(ii) building shared cross-disciplinary knowledge of e-learning in universities?

Universities as organizations

The university learning and teaching system, as defined above, includes formal organizational structures and accountabilities as well as individual academics. Informal communities of practice are advocated as a way of creating, sharing and managing knowledge across organizational or discipline boundaries (Wenger, McDermott & Snyder, 2002). Research Question 1 deals with how this cross-discipline sharing might come about through voluntary association among individuals who are seeking to develop e-learning innovations. But sharing of knowledge informally does not necessarily imply a change in formal organizational systems and departmental boundaries.

The principles of systems thinking have been used to develop practical links between individual learning and change in formal organizational systems, in particular the concept of **the learning organization** as an environment in which individual and organizational transformations take place together (Senge, Kleiner, Roberts, Ross & Smith, 1994). The management literature includes different views on the concept of **organizational learning** (Argyris, 1999), with some arguing that learning should not be associated with organizations but only with individuals (Stacey, 2003). Although these ideas have been applied to the management of change in universities, there are questions about how effective this has been in practice (Cullen, 1999; Hodgkinson, 2000). The

need for formal accountability can lead to reliance on formal bureaucratic systems, some of which may be constraining organizational transformation rather than encouraging it.

The second research question therefore asks how informal cross-discipline sharing among innovative university teachers can lead to integration of e-learning innovations into the formal university learning and teaching support systems, and into the practices of the majority.

Research Question 2

How can individual teachers, even if they are able to organize in a cross-discipline community to develop e-learning, bring about the changes required in a university's formal organizational systems to enable and support widespread integration of e-learning into teaching practice?

University learning and teaching as a complex adaptive system

The first research question focuses on individuals, and the second on organizational change. The literature on higher education reviewed in Chapters 2 and in the first part of Chapter 3 indicates that knowledge of university learning and teaching systems is distributed across separate areas of academic expertise, and that the connections between these areas of knowledge are sparse. So a cross-discipline approach is needed to understand the systemic interactions between individual lecturers' strategies for teaching, new technologies and teaching methods and the organizational system that support learning and teaching in a campus university.

Complex adaptive systems models of individual and organizational behaviour draw upon mathematical models developed to explain complex biological development. The use of these same concepts to explain complexity in human organizations realises some of the ideas put forward in work by writers such as Bateson (1973) and later Capra (1996), who have argued in principle for a systemic cross-discipline approach to research, combining qualitative and quantitative methods.

The second part of Chapter 3 reviews management research that develops complex adaptive systems models of how organizations evolve as a whole, and how individual and departmental behaviours relate to technological and organizational change. Some of this research applies mathematical modelling to establish how mutual adjustments are needed in different aspects of an organization's activities in order to incorporate the advantages of new technologies. Systemic interdependencies can be modelled mathematically as **complementarities** in which "doing *more* of one thing *increases* the returns of doing *more* of another" (Milgrom & Roberts, 1995a, italics in original). Complementarities are shown to be a universal pattern in any complex organization. In a complex adaptive system model of university learning and teaching, material technologies,

human processes and social organization can be represented as co-dependent. Changing one aspect of the university learning and teaching system, such as the use of learning technologies, requires complementary changes in other parts of the system. It is therefore necessary to identify where these systemic interdependencies lie (Massini & Pettigrew, 2004).

Another characteristic of complex systems is the existence of different, often apparently contradictory, processes within the same system. These are called **dualities** (Sanchez-Runde & Pettigrew, 2004), for example when centralization and decentralization of control, or formal and informal ways of organizing, operate together. Applying the idea of dualities to the introduction of e-learning technologies in a campus university learning and teaching system would imply that a diversity of change processes may be needed – formal and informal, incorporating interplay between different disciplinary perspectives and priorities.

Complex adaptive systems modelling therefore has the potential to explain how new learning technologies may become integrated in university learning and teaching systems, and perhaps also to explain why this integration has been slower than expected in campus universities. From considering campus university learning and teaching as a complement adaptive system, a third research question emerges.

Research Question 3

How do the strategies of individual university teachers co-create the systemic organizational response of a university to e-learning technologies? In particular:

(a) what systemic complementarities are important for the successful integration of e-learning in the teaching systems of traditional campus universities?

(b) how can management of disciplinary diversity and the various dualities inherent in university organization contribute to successful integration of e-learning

Teaching and learning activities are more often analysed as soft systems (i.e. those that deal with individual and interpersonal human processes), separately from hard systems such as e-learning technologies. Management research based upon complex adaptive systems theories provides the starting point for development of a conceptual framework in which the responses of individual lecturers to e-learning technology are seen as part of a systemic whole. The resulting research process combines hard and soft systems approaches and involves different research methods.

1.3 The research process

In taking an integrated systemic approach to university organization it is necessary to accommodate multiple worldviews. This enquiry therefore spans a number of disciplinary traditions. Research that follows a single research tradition can be placed in relation to a particular body of prior work and then described for readers who are already familiar with the language and conventions of that tradition. In this thesis, the interdisciplinary nature of the research and the systems thinking underlying it require that assumptions are made explicit. These assumptions are reflected in the language and in the visual and graphical representations used throughout the thesis.

1.3.1 Writing style and use of language

Personal pronouns

It is customary in formal academic writing to avoid the use of the 1st person singular – to indicate that the writer is presenting objective evidence to support reasoned argument rather than personal opinion, conjecture or anecdote. However, in adopting a systems approach to research it is important to acknowledge the role of the researcher as an influence within the system that is being studied. This research involves a systematic process of enquiry into how mental models, including my own as the researcher, may lead to action that changes the problem situation with which I am concerned. Therefore, rather than assume a false objectivity, I will adopt the following usage:

> **I/me:** indicates where I am synthesising the ideas of others into something new, for example in building the conceptual framework for the research, and where I am describing what I actually did in the course of the research, as in the account of research methodology and methods.
>
> **We/our:** will be used where I am describing work or events in which I took part with others, and not to refer to people in general, nor to refer collectively to the reader and the writer.
>
> **He/she/they:** will be used for all references to other work and literature, where the person or people concerned have already been defined.

Typography and terminology

Parentheses ( ) are used for references, cross-references and clarifications. Square brackets [ ] denote comments from my own perspective as the researcher.

As noted above (Section 1.2.2), some of the vocabulary associated with learning technologies, or e-learning, is changing as the technology develops. Interpretations and usage also vary between the US, UK, Australia and New Zealand. Throughout the thesis, where specialist vocabulary is introduced, it is printed in **bold type** followed by an explanation of its use in the context of this thesis. All such terms are also listed and defined in the Glossary.

1.3.2 Models, metaphors and analogies

A central concept underlying the thesis is that humans use mental models, or maps of reality in order to make sense of the world. In particular I develop the use of the **cognitive map** – each individual's internal representation of causes, effects and influences, which forms the basis for decisions and actions. I also explore how these maps are socially constructed, and how, in an organization such as a university, multiple individual maps constitute systemic knowledge which is not available to any one individual, and which shapes the organization's response to changes in the external environment. In a university, the different academic disciplines account for a wide diversity in how teachers perceive learning and teaching, including potential uses of e-learning.

The study in UNSW uses cognitive mapping to make explicit the ways that 19 university staff members in a common institutional context each perceive e-learning technology, from different individual and disciplinary perspectives. Patterns found from analysing these cognitive maps can be related to theoretical models described in the academic literature on higher education and management research. The value in this study is in providing evidence for a broader model of the relationship between individual lecturers' strategies for adoption of e-learning and the institutional context – a model which is useful in understanding the adoption of e-learning in other university contexts.

A **model** in this context is a simplified representation of structure or process, which can be the basis for a theoretical or empirical understanding or for calculations and predictions. A model is much more than a **metaphor,** which is a description of superficial resemblance between one object or action and another. A model of a university learning and teaching system is an accurate representation of some significant aspects of the university's organizational processes, which can be used as a research tool to gain understanding of those processes.

Nonaka (1994) outlines how metaphors, analogies and models play a part in the process of developing knowledge. Metaphor creates new meaning by cutting across different contexts (Bateson, 1973). **Analogy** allows for exploration of the functioning of new concepts or systems by reference to things that are already understood. In the context of developing and engineering a new physical product, a model is a prototype and is explicit (Nonaka, 1994). However, in other

disciplines, the word 'model' refers to conceptual models or mental maps, which can be implicit or explicit. This study uses the latter definition, but also develops some arguments to show how physical technologies can embody mental models or theories.

1.3.3 Visual and graphical representations

In keeping with its cross-discipline approach, systems thinking uses multiple representations of ideas, visual as well as verbal. Text can represent a narrative, a sequence of events. But diagrams and pictures are able to represent nonlinear aspects of a system, such as feedback loops, information flows, networks and mutual adjustment between different system components. In this thesis, different types of diagram are used to represent different types of thinking, ranging from rigorous model to loose metaphor.

A **System map** consists of a boundary, system components and elements of the environment that influence the system, as in Figure 1.1. The system boundary defines the scope of the system of interest. Different people, with different priorities or knowledge, will draw different systems maps of the same reality. Whereas Figure 1.1 focuses on a university's internal support for learning and teaching, another system map might focus on university internal support for research, or on all Australian universities' research activities at the national level. Several different maps of the university learning and teaching system are developed in the course of developing the ideas in this thesis.

Hand-drawn diagrams are widely used in soft systems methodology literature, to emphasise the human and organic rather than mechanical nature of the ideas, and to convey that they are working diagrams (Checkland & Poulter, 2006a, p 198). However, I have used drawing software to develop and record most of my diagrammatic ideas. So, although I have adopted some of the informal style of soft systems diagrams where appropriate, I have used freehand drawings only for representations that I developed entirely on paper (see below).

Flowcharts can be used for action planning, in the tradition of hard systems approaches to information gathering and analysis (OUBS, 1999). They represent ordered sequences of information flows, decisions and actions and are used in the study to document and communicate the data analysis processes used. Figure 7.2 is an example representing a sequence of events.

Network diagrams are useful for showing multiple interactions and mutual adjustment between system components (OUBS, 1999). One simplified network model with a limited number of components is used to analyse the interactions among disciplinary knowledge, departmental organization, individual teachers and educational technology - the KDIET model, for example in

Figure 6.1. The outcomes of the research are also represented as a similar interaction among four types of component, the ProForMaC framework.

Causal and cognitive maps. Causal maps are way of representing perceived causal or influence relationships (OUBS, 1999, p21). Such maps can represent a complex network of multiple interrelated causes. Cognitive maps are a particular form of causal map, usually representing individual perceptions and strategies. The research for this thesis uses data on individual teacher strategies which were collected and analysed as cognitive maps, using software designed for this purpose. The software and the process used is described in Chapter 5, and Figure 5.9 shows an example. The chapter on research methodology and methods explains how the cognitive mapping process enables analysis and comparison of multiple interacting influences upon individual strategies. (Eden & Ackermann, 1998)

Systemic patterns or archetypes show how **feedback** loops operate in organizational systems. Particular types of action result in a response elsewhere in the system, which may reinforce or balance (**positive or negative feedback**) the initial action. Examples are the 'limits to growth' and 'tragedy of the commons' archetypes. The archetypes are used to interpret and understand how more complex causal feedback loops in a real system contribute to systemic behaviour. (Senge et al., 1994, pp 121-190). Systems archetypes are used to summarise and explain the research findings in terms of general recommendations at the end of the thesis, for example in Figure 8.1 and Figure 8.2.

Two-dimensional graphs. Graph-type diagrams are occasionally used, not to plot quantitative measurements, but qualitatively to illustrate characteristics of a system's activities that may vary in two different ways along a spectrum. An example is the placing of disciplinary knowledge on the 'hard–soft' and the 'pure–applied' axes (Becher & Trowler, 2001), as illustrated in the first part of the literature review (Figure 2.5).

Freehand drawing and rich pictures. I have included a couple of cartoon-type stick-figure sketches to illustrate metaphorical thinking (OUBS, 1999, p40). Such rough drawings can allow the reader to add their own interpretation, and they are left in this form to indicate their imaginative and intuitive rather than rigorous nature. Figure 4.7 is an example.

Mindmaps or spray diagrams represent ideas as branches from a central concept (Buzan & Buzan, 2000; OUBS, 1999). The structure is hierarchical. The main value of this technique is in putting a large amount of related information into one visual image. It is then possible to see how different branches of the map may be related to each other. Mindmaps rely on shorthand representations of ideas developed as the drawings are made. I used them extensively during my

reading of the literature, normally using mindmapping software, but occasionally also on paper. But I have not used them in the thesis itself, as they would require too much additional explanation to be useful for communication.

Finally, it is worth mentioning the use of **clipart**, which can represent widely accepted symbols, norms or clichés (e.g. Figure 9.3).

1.3.4 Organizational learning and cognition

Cognition originally refers to the conscious knowledge of an individual (OED, accessed online 24/04/2007). **Learning**, the process of acquiring knowledge, also originally refers to individuals.

This thesis draws upon ideas that extend the concept of learning and cognition to include knowledge that is not located within one human mind, but distributed across human organizations and social systems. This usage has been challenged as a misuse of the original concept (Stacey, 2003). However, I have chosen to use the words 'cognition' and 'learning' to describe organizational processes with reason. In the development of the theoretical framework for the thesis, I argue that common organizational principles underlie the building of knowledge in an individual human mind and the adaptation of complex human organizations. In a university in particular, individual learning and the social organization of that learning among groups of people is interdependent (Becher & Trowler, 2001).

Universities are in the business of conscious knowledge that is **codified** (i.e. expressed formally in texts, theories or embodied in physical systems and artefacts). A continuing difficulty in the adoption of e-learning innovations is the codification and sharing of knowledge about the innovations. The relationships between conscious and unconscious learning and knowledge (Eraut, 2000b) in individuals are discussed in the literature review and also in the development of the theoretical framework. So also are the corresponding relationships between what is explicit, or codified, in organizational knowledge and what is simply embodied in tacit practices, working relationships and technological infrastructures (Nonaka, 1994)

1.3.5 A note on the cross-discipline perspective

The thesis, and the literature reviewed within it, spans several aspects of university learning and teaching. The treatment of each topic may, in the view of a specialist in that topic, seem superficial or partial. However, my aim is that this thesis will develop a new understanding not from exploring one topic in great depth, but from linking and synthesising selective ideas from different fields of knowledge. I therefore ask that the validity of my arguments is judged in that light rather than from the perspective of one discipline.

1.4 Chapter summaries

The remaining chapters of the thesis are summarized below.

Chapter 2 reviews higher education literature, from which the first research question arises. Discipline differences are identified as central to the integration of e-learning in mainstream campus university teaching practices, and it is therefore particularly appropriate to apply an interdisciplinary approach to research in this area, despite the limitations and difficulties.

Chapter 3 reviews literature relevant to organizational change in universities. Consideration of the relationship between informal communities and formal organization, and the role both of these processes play in organizational learning, leads to the second research question. The literature on organizational learning in universities leads to further consideration of evolutionary and complex adaptive systems models of organizations; giving rise to the third research question.

Chapter 4 uses complex adaptive systems models to develop a conceptual framework for combining the perspectives or worldviews of different academic disciplines. This provides a way of showing how disciplines can complement each other as part of a cross-discipline study, rather than being seen as separate and alternative perspectives and ways of researching.

Chapter 5 describes how the conceptual framework has been used to structure the gathering of information about the problem situation. Individual teacher strategies for adopting e-learning technologies are gathered from one university context (UNSW) in the form of cognitive maps. The maps represent teacher strategies before and after a substantial experience of working with a cross-discipline group of teachers, and therefore enable an analysis of how the cross-discipline experience influences teacher strategies.

In Chapter 6, the cognitive maps representing individual strategies for use of e-learning technologies are analysed in relation to discipline and organizational contexts. Some patterns emerge, which can be related to themes identified in the higher education literature.

Chapter 7 presents evidence of organizational changes in UNSW, to triangulate with the findings from the cognitive map analysis. The results show a relationship between organizational events and the strategies of individual teachers, which can be interpreted in terms of complex adaptive systems theories of change in human organizations.

Chapter 8 combines the results from the cognitive map analysis with the organizational data from UNSW to address the research questions, both for UNSW's context and in terms of implications for learning and teaching in other campus universities. The implications of the research findings for other universities are summarized in systems models of university learning and teaching.

Chapter 9 reflects on the experience of the research process, and summarizes what it has been able to add to previous research. There are also suggestions on how the limitations of this particular piece of cross-discipline research might be addressed in future researchers.

Chapter 2. E-learning and educational literature

Abstract of Chapter 2

This chapter reviews the research literature relevant to the adoption of e-learning in universities, and from this develops the first research question.

International literature on the adoption of e-learning in higher education indicates that, since 2000, traditional campus universities have been slower than distance universities in taking advantage of new technologies for student learning. The contexts of Australian and UK campus universities are similar, and represent part of this international pattern.

Although there is a substantial and growing body of research into the potential benefits of e-learning, relatively little of this knowledge was being applied widely in campus universities when the study for this thesis began, in 2003. Effective use of new technologies requires lecturers to make explicit and review what has been tacit in their face-to-face teaching. However, an analysis of the literature on learning theory and teaching practice in higher education indicates that university lecturers rely heavily upon tacit and discipline-specific knowledge to inform their teaching practices, despite the efforts of educational researchers and academic staff developers.

Cross-discipline sharing of knowledge about use of e-learning technologies enables the surfacing and review of tacit and discipline-specific teaching knowledge. Yet it can be hard work for academics to engage with learning and teaching practices from disciplines other than their own. The first research question therefore asks what can motivate teachers in a traditional campus university to develop and share explicit knowledge of e-learning across disciplines.

2.1 Adoption of e-learning in universities

2.1.1. International context

Barnett (2000a, pp 65-66) has suggested that, with new information technologies available, the boundaries around each university are becoming more permeable; the future role of universities is in developing knowledge processes and exploiting knowledge possibilities rather than in being places where knowledge is created by academics and transmitted to students. A European study of higher education collaborative projects found that there has been a rhetoric of using e-learning to support a knowledge-based economy, by offering wider and different types of access for different types of student learning (Hodgson, 2002). However, this study found that in practice, different e-learning projects had made different assumptions about the nature of knowledge and learning and that these assumptions were rarely made explicit.

International research across 13 OECD countries in 2004 (OECD, 2005a) suggests that the uptake of e-learning is growing generally, and that distance universities have the highest levels of **fully online e-learning**, where learning activities and interactions are entirely online. Distance universities also make significantly greater use of **mixed-mode e-learning**, where a course combines e-learning with face-to-face learning activities. A review of the changes in distance education over the three decades to 2001 describes how earlier distance learning technologies (print, broadcast and fixed media) reinforce transmission models of teaching and learning; whereas newer e-learning technologies enable more socially interactive models of learning (Rumble, 2001). Distance universities' greater use of new learning technologies than campus university teaching practices may be related to their reliance on technology-based learning media rather than face-to-face teaching.

Compared with its adoption in distance universities, e-learning has had little impact on mainstream face-to-face teaching in universities. Studies in Australia, New Zealand and the UK indicate that the **web-supplemented e-learning** has remained dominant e-learning mode in undergraduate teaching (Bell *et al.*, 2002; Marshall, 2005; Sharpe *et al.*, 2006). In web-supplemented e-learning, the focus is on face-to-face teaching, and only peripheral resources such as course outlines and lecture notes are provided online. International studies therefore indicate that there are barriers to the development of e-learning in traditional campus-based universities (OECD, 2005a).

The uptake of e-learning has been faster in some disciplines than in others. In many universities, there is significant use of e-learning in Management and Information Technology courses, and in some cases this is now beginning to spread to other disciplines within the university. Most

universities, however, lack a coordinated e-learning strategy and there is a pattern of initially relying upon emergent faculty-led initiatives and only later adopting a more integrated institution-wide approach. (OECD, 2005a)

Universities are beginning to think through the future role of e-learning in their institutional futures. A survey of leaders of US higher education institutions in 2003 found that most saw online learning as a critical long-term strategy, although they perceived teachers as lagging in their acceptance of it (Allen & Seaman, 2003). For most, meeting student demand is a significant driver, but the barriers include an absence of widely agreed knowledge of what is good online pedagogy, and resistance to change amongst academic staff (Fernandez, 2005; Keaster, 2005).

In contrast, students are more than ready to embrace new technologies as part of their learning environment. By 2002, before the study for this thesis began, 64% of 15 year old school students in OECD countries, had daily access to a computer at home, although only 27% had daily access at school (Debande & Ottersten, 2004). US studies have also shown that many younger students take computers for granted as part of their lives, rather than thinking about computers as separate technology. The new generation of students is connected, used to multitasking and collaboration, and prefers experiential learning. There is often an imbalance between students' expectations and the learning environments they find in universities (Oblinger, 2003). A survey of US undergraduate students in 2006 found that 97% own a PC, 38% own both a desktop and laptop and 20% own a PDA or smartphone. On average the students spend 23 hours a week using technologies. Nearly all use email, 80% SMS, most daily and they report using IT extensively for coursework. However, students are still citing the need for better training of teachers in use of technology. (Katz, 2006)

Despite some national differences, there is a “dramatically changed context for both ‘traditional’ school to university students and electronically connected and mobile mature-age workers”, which crosses international borders (McInnis, 2004). In the market for international university students, the US has the largest share by far. Australia and the UK share a similar position, as the other two major English-language providers, and both countries have higher education interests in the Asia-Pacific region (OECD, 2005b). These commonalities in the higher education environment in Australia and the UK mean that the context for e-learning in both countries will be similar. Across all OECD countries, there is a broad pattern in which e-learning use in campus universities, although expanding, is lagging behind the expectations of students.

2.1.2 E-learning in UK higher education

Since 2000, the UK Government has placed some emphasis on the role of technology in transforming learning and teaching in Higher Education. Government investment in online learning has been substantial, but not always successful. The UK e-University spent £50 million of public money, but attracted only 900 students and was wound up in 2003. A UK Government enquiry found that the e-University had taken a very narrow view of e-learning and had allowed the technology to lead, rather than the pedagogy (House of Commons, 2004).

In 2005, the Higher Education Funding Council for England (HEFCE) strategy for e-learning called for institutions to adopt more context-specific approaches to e-learning (HEFCE, HEA and JISC, 2005). This strategy includes support for universities to develop and embed e-learning over the following 10 years and suggests a review of capacity-building needs in terms of staffing and professional development for university teachers.

In particular, the 2005 HEFCE e-learning strategy emphasises **blended learning**, in which e-learning technologies are integrated with face-to-face teaching, rather than used separately for distance study. The strategy document notes that "institutions are still struggling to normalise e-learning as part of higher education processes", and that "significant investment will be needed for universities and colleges to exploit the benefits of innovation and technologies fully" (HEFCE, HEA and JISC, 2005) – articulating specific objectives for embedding of e-learning. This support for the use of technology to enhance mainstream university learning and teaching is also part of the 2006 HEFCE strategic plan for higher education (HEFCE, 2006).

The earlier e-University focus on developing new technological tools, rather than on disseminating to new users the use of existing e-learning tools (House of Commons, 2004) could reflect an inherent tendency for university staff give a research focus to anything they do (Slater, 2005). The traditional HE ethos and promotion routes, coupled with selective research funding, mean that the main driver for many academic staff is to publish research (Jenkins, 2004). A technological innovation could be easier to represent as the outcome of research than dissemination of its use, especially in those disciplines that focus on technology rather than educational practice. Although the HEFCE (2006) strategy for higher education calls for stronger links between research and teaching, linking e-learning research and teaching practice may not be simple to achieve in practice.

In Scotland, there has been concern that a cottage industry approach to e-learning innovation, based on lone practitioners, raises organizational and cultural challenges for universities, which need a critical mass to justify strategic change (Harvey & Beards, 2004). The Scottish Funding

Council's policy documents also call for investment in technology to enhance the quality of university learning, and in particular to shift the focus from teaching to learning, with blended learning as the dominant model (SFC, 2006).

As noted above, the main uptake of e-learning internationally has been in part-time distance education. In the UK, the Open University, as the major distance provider, has over 160,000 students online (HEFCE, 2006). However, in England, some academics are concerned about the need to provide adequate support for nominally full-time undergraduate students who are in paid employment while studying (Curtis, 2005; Humphries, 2006). Similar concerns are reported across Europe (McInnis, 2004). Blended learning appears to offer a way for universities to provide a more flexible approach to timetabling and attendance, to meet these concerns. Yet in campus-based UK universities, as in other OECD countries, the benefits of the blended learning approach are yet to be fully realised.

2.1.3 E-learning in Australian higher education

There are some differences between UK and Australia government policies for higher education. Nevertheless, as in the UK, the Australian government sees e-learning as having an important role in higher education. In 2002, several Australian Department of Education, Science and Training (DEST) reports highlighted the role of e-learning in relation to teaching quality, and to a need for organizational change in universities (DEST, 2002a; b; c; d), for example:

> "Previously integrated activities of course design, materials preparation, lecturing and tutoring, assignment marking, assessment are being 'unbundled'. New specializations of labour are being established. New opportunities are emerging for courseware sharing and the buying in of student support. ... E-learning was initially seen as a cheaper way of delivering education to students, but substantial costs are involved in designing and delivering a good quality course. Teachers need to commit considerable time to course and materials development, and, especially, to interaction with and feedback to students."
> (DEST, 2002a).

A survey carried out in December 2001 noted that all universities in Australia were involved in online learning to some extent. More than half offered some fully online courses, and others offered web-supplemented or web-dependent learning. However, quality, cost-effectiveness and pedagogy were major concerns. As in other OECD countries, uptake varied widely across disciplines (Bell et al., 2002).

By 2004, online learning had become established as a significant part of campus-based study for first year undergraduate students (Krause et al., 2005). Australian HE institutions reported having 35% of their programmes with significant online components, i.e. greater than web-supplemented as defined by the OECD. This figure is similar to that for other Asia-Pacific region institutions, and compares with 24% in the UK (OECD, 2005a).

In 2001, full-time undergraduate students in Australia were in paid employment for an average of 15 hours per week, and reported a need for more flexibility in the timing of their study activities (McInnis & Hartley, 2002). A similar study in New Zealand found that over 80% of undergraduate students had at least one paid job, for 14 hours per week (Manthei & Gilmore, 2005). Although perhaps not recent and comprehensive, these studies indicate that Australasia has a similar trend to that in the UK, in which many undergraduates enrolled in full-time course are in effect studying part-time.

By 2004, students entering Australian universities were spending less time in class than they did five and ten years earlier, and at the same time they are making more use of campus facilities to access online resources and email (Siragusa, 2005). One survey found that around 95% of students have web access at home and 87% consider themselves to be knowledgeable or expert in using computers (Krause *et al.*, 2005; McInnis & Hartley, 2002).

There is therefore clear evidence that Australian students expect to use online technologies as a central part of their campus learning, and have a need to do so. Nevertheless, the main trend is for campus universities to use the online environment for administrative support and email contact, rather than to support core learning activities (Krause et al., 2005). Most students are experiencing websites used for course notes and information about face-to-face teaching activities and only half say their get adequate feedback from their teachers (Siragusa, 2005). Although e-learning offers a way of meeting student needs, many teachers see an increase in flexibility as giving them more work (McInnis & Hartley, 2002).

In summary, there is evidence to support Australian Government claims that the introduction of e-learning technology is a way to achieve systemic change in the quality of university learning and teaching, in terms of its ability to meet the changing needs of students. Although the distinction between part-time and full-time study in Australia has become blurred, there has been limited progress in realising the full potential of e-learning for meeting student needs in campus-based universities.

2.1.4 The emerging pattern

The pattern internationally, including Australia and the UK, is one in which traditional campus-based universities are struggling to bring e-learning into the mainstream of their learning and teaching systems.

The web is changing the nature of learning and has the potential to make it a more social experience (Brown, 2000). Computers are part of the backdrop of normal life, and offer benefits for university students through customization of learning resources and opportunities for

collaboration (Brown & Petitto, 2003). Unfortunately many campus universities worldwide are not meeting student expectations that e-learning technologies form an integral part of their campus-based study (Oblinger, 2003; Oblinger, 2005; OECD, 2005a). Australia is part of this pattern.

Students bring their laptop computers onto university campuses, and use campus computers wherever available. They carry mobile phones that take digital photographs and send emails as well as text messages. They walk around campus listening to digital music and podcasts downloaded from the internet. Yet a significant proportion of their teachers are reluctant to change from traditional chalk and talk teaching methods. The surveys cited above indicate that, where e-learning is used, it is most often for minor supplements to lectures, such as notes and course outlines.

University leaders are being asked to improve learning and teaching, and to deliver measurable outcomes in both teaching and research. Although e-learning is advocated as a way of meeting student needs more effectively and efficiently, there seems to be little understanding of how to achieve this in campus universities. Distance universities have succeeded in moving to online technologies, so the knowledge of how to use e-learning in higher education is available. There is therefore a need to find out what it is about traditional campus universities that is making it hard for their teachers to integrate e-learning into their teaching.

Although there are shared international patterns across OECD countries, it is also necessary to take into account the differences between countries in the way that higher education is organized and funded, and in the scale of universities' international activities.

The fact that Australia shares with the UK its language, its educational traditions and its position in the international market for higher education is reflected in government higher education (HE) policy. The Australian HE quality frameworks draw upon the UK experience (DEST, 2002d). In 2006 the Julie Bishop, the Minister for Education asked that Australian universities respond to the European Bologna initiative to standardize university degrees (DEST, 2006). Research on the uptake of e-learning in an Australian context could therefore have some relevance in the UK and perhaps also in US universities.

Barnett (2000a) discusses the complex and continually changing HE environment. The age of supercomplexity, he says, calls for a new sense of the academic community, and also a transformation of pedagogies. Barnett maintains that there is a focus on measurable outcomes at the expense of attention to process, notes a need to abandon the transmission mode of education, and predicts the demise of the formal lecture, which is primarily associated with traditional campus-based study modes.

The Group of Eight (Go8) Australian research-intensive universities represents the longer-established campus-based institutions, and expresses a different view from that of Barnett. A formal response from Go8 to an Australian Government Dept. of Education, Science and Training (DEST) discussion paper on the operation of a new Learning and Teaching Performance fund call for rewards based on measurable outcomes and not processes. This paper maintains that there is no need to accommodate all the complexities in the indicators, and instead asks for simplicity, intelligibility and transparency of criteria and methodology in the assessment of learning and teaching quality (Walsh, 2006).

The contrast between Barnett's desire to acknowledge complexity and the Go8's call for simple indicators and measurable outcomes in learning and teaching quality represents a tension between two different, possibly complementary, views of the nature of knowledge and learning: a focus on process and a focus on measurable outcomes. The Australian government view (DEST, 2002a) associates e-learning with changed processes of learning and teaching, in which there may be a significant delay before there are measurable quality outcomes from the investment of academic resources required to bring about the changes.

2.2 Educational research and theories in use

The large-scale national and international studies of e-learning adoption referred to in Section 2.1 indicate that there are differences between distance and campus universities, and also between disciplines, in the use of e-learning. The literature on learning and teaching in higher education provides some insights into what is influencing these differences. This Section reviews some of that literature, selected for its potential to explain why campus universities have been slow to adopt e-learning, and to explain the significance of disciplinary differences for e-learning adoption in universities.

2.2.1 Distance e-learning and face-to-face teaching

The e-learning literature deals with:

- the cognitive processes (individual and social) through which students and teachers can use e-learning technologies in building knowledge
- the forms or structures of learning interaction (synchronous and asynchronous) that can be mediated e-learning technologies
- the affordances of the technologies themselves to transform both learning interactions and knowledge building processes.

Theories of learning and e-learning research

As the use of e-learning technologies has grown, there has been a growing body of research on e-learning. Some of this work reviews educational theory and builds upon it, using empirical research to develop new models for new learning media. My intention here is not to review and analyse the e-learning literature in full, but to indicate through some typical examples the range of knowledge that is available to inform campus university lecturers' use of e-learning technologies, and to show what learning theories have informed these examples.

In the 1990s, some writers on e-learning have discussed how individual university students can use it to build advanced knowledge. Jonassen, Mayes and McAleese (1993) for example, apply cognitive constructivist theories of individual learning to the design of technological learning environments, with little reference to the physical location of the learner or the nature of social interaction among students and teachers. Computer technology provides cognitive tools that the learner can use individually or in groups to construct their own representation of knowledge, for example by doing calculations that help them transcend the limits of memory or problem solving (Jonassen & Reeves, 1996). Other writers have discussed the role of social interaction in individual learning, and extended the idea of individual knowledge and cognition to the idea of **distributed cognition** in which knowledge is a "quality that jointly emerges from social interaction and partnerships with intelligent technology" (Salomon, 1998; Salomon & Almog, 1998).

Empirical research on e-learning often builds upon existing theories of learning. Some of this research has been in distance education, where the technology supports core learning activities (Scanlon, Morris and Cooper, 2002). Laurillard (2002) draws on Pask's conversational learning model to develop a model for learning conversations that can be mediated by technology. Salmon (2000) develops a 5-stage model of the facilitation and support required for learning through online discussion. Similarly the principle of scaffolding, or learner support has been applied to the design of effective e-learning (McLoughlin, 2002; Winnips & McLoughlin, 2001). In distance education, unlike face-to-face learning, the social interaction cannot be assumed to arise spontaneously as a result of physical presence. Distance learning, and e-learning wherever it is used, need planning and design, based upon social learning theories of learning that are made explicit.

Empirical research by Schrire (2004) provides some specific evidence that social theories of learning are needed to understand e-learning, and account for its contribution to the collaborative development of knowledge. Asynchronous discussion provides a convenient way of tracking in detail the collaborative development of ideas, in that the totality of the interaction is through recorded text. In an analysis of asynchronous collaborative online learning among

postgraduate students, three different measures were used to define higher order thinking. Two of these measures are based upon models of developmental stages in individual cognition. The third measure was specifically developed for collaborative enquiry, and accounts for synergistic interaction patterns within each online forum as part of a cognitive process that is distributed across a group. It was this third method that was best able to explain the correspondence between the online discussion and the development of higher-order thinking. The study did not determine the direction of causality between social interaction and individual cognition. Rather, the findings suggest that social interaction and cognition work together to form the learning process.

Overall, e-learning research has added to individual theories of learning by combining them with social theories of learning, and has made explicit the social aspects of learning that have been tacit in traditional campus university teaching practices.

Synchronous and asynchronous interactions

The use of social theories of learning in distance education research, along with the empirical evidence that e-learning is better integrated in distance universities, suggests a further examination of the differences between campus and distance university learning processes.

A review and analysis of international empirical literature comparing distance with campus-based higher education finds that the evidence from asynchronous distance education methods is more thoroughly documented than that available both for the synchronous distance education methods and for the classroom methods with which distance education is compared. Distance education that is effective, in terms of student achievement and satisfaction, is associated with systematic “instructional design” combined with use of computer-mediated discussions and one-way instructional media such as video and web resources. (Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset and Huang, 2004). [The term **instructional design** is used in the US and also in Australia to refer to the systematic processes used to create learning media. One such process uses the ADDIE model – analyse, design, develop, implement, evaluate.]

This analysis defines distance education as that involving a separation of learner and instructor, planning and preparation of learning support, and the use of media to facilitate two-way communication. Distance education methods are divided into **synchronous e-learning media** where the interaction between participants is instantaneous and happens in real time; for example videoconferencing, teleconferencing, online chatrooms and **asynchronous e-learning media**, where there is a time delay between each message and response; for example online

discussion forums, voicemail and email, online learning tools such as assignment submission and marking.

One suggested explanation for the more thorough documentation of asynchronous methods is that they afford a more explicitly reflective environment than the classroom, both for teachers and for students. A follow-up to the study by Bernard et al. (Lou, Bernard and Abrami, 2006) used similar meta-analysis methods and found that undergraduate distance students using instructor-directed synchronous distance methods learn as well as, but no better than, in the traditional classroom. Distance students using asynchronous methods did better than in the traditional classroom, especially when there was collaborative discussion, structured learning activity and systematically designed interactive multimedia.

These comparisons of international literature on distance education with that on classroom teaching suggest that it is the synchronicity of classroom teaching that is significant for learning effectiveness, rather than either the physical location of the students or the media. However, the analyses are done from a US perspective. The characterization of distance education and the emphasis on synchronous media may therefore not be applicable in countries where distance education relies primarily on asynchronous media. Another review of technology-mediated distance education covering only the US also has a strong focus on synchronous media; concludes that there is a need to track the dynamics of synchronous student–student and student–teacher interactions, to move beyond lock-step learning designs and make more effective use of new interactive technologies (Saba, 2005).

In addition to offering learners more flexibility in how and when they learn, asynchronous media enable teachers to record and analyse learning interactions. Online student–teacher interactions provide a ready source of data both for evaluation and for research that develops new teaching models (for example, Salmon, 2000; , 2001). It is possible to use technology to support evaluation of synchronous classroom methods, by using videorecording or other capturing of the student–teacher interactions (Olivero, John and Sutherland, 2004), but these methods require deliberate effort. Monitoring and recording are not inherent in the traditional classroom environment. However, the distinctions between synchronous and asynchronous media, and between physical and virtual learning experiences, are becoming blurred by newer technologies. For example automatic digital recording of lectures as podcasts, and online social spaces that mix synchronous and asynchronous media, are already available to universities in the US, the UK and Australia. So in 2007, technology can enable lecturers to record and reflect consciously upon synchronous learning interactions with students.

The potential of e-learning technologies

The merging of online and classroom learning environments, and of synchronous and asynchronous interactions has the potential to change the nature of knowledge and learning in universities. Students can use technology to mix face-to-face and virtual group learning (Brown, 2000). Kim and Baylor (2006) use social learning theories to discuss how animated digital characters, which simulate human interaction with a learner, can support learning. Multi-User Virtual Environments (MUVEs), such as Second Life offer the possibility of immersive online social learning, using technologies that many young people are already familiar with from online chatrooms and games (Corbit, 2005; Oblinger, 2004). Interactive web-based seminars allow new ways of sharing and recording knowledge (Fritz, 2006).

Some commentators, however, have been disappointed with progress in using even the established online learning systems. In 2002, Oliver outlined the potential of technology as an agent for change in higher education. In 2004 he noted a need to move beyond "instructional comfort zones" in online learning, and in 2005 he commented on the slow progress in uptake of educational technologies during the previous decade, despite a vast improvement in online learning management systems and other tools (Oliver, 2002; , 2004; , 2005). Similarly, Hannafin and Kim (2003) review research on web-based learning and note a lack of pedagogical innovation. In this context, **innovation** is not just the introduction of new learning technologies, but their use to provide students with new types of learning experience. Hannafin and Kim observe that many of the published empirical studies make discipline-specific assumptions and ignore prior research on educational technologies.

In summary, there is a wide range of knowledge about effective e-learning, grounded in empirical research. This knowledge is continuing to develop and is adding to theoretical and practical understanding of how new technologies afford a different range of student learning experience than that available in traditional campus teaching methods. However, the e-learning literature does not explain why many teachers in traditional campus universities, in Australia and elsewhere, have been slow to act upon this knowledge and are largely failing to use even well established e-learning technologies effectively. The reported lack of widespread pedagogical innovation raises questions about how the introduction and spread of knowledge about new learning and teaching methods and technologies takes place.

2.2.2 How campus university lecturers learn to teach

The literature on how university lecturers learn to teach offers insights into the relationship between classroom teaching practice and e-learning.

Theory, practice and scholarship

One strand of research on university teaching focuses on documenting and making explicit the experience of face-to-face teaching. This pragmatic and experiential approach has a long history in the US, beginning with John Dewey in the early 20th century (Null, 2000) and continues to be reflected in some of the literature on university teaching published between 2000 and 2007.

Kugel (1993) puts forward a staged model of how university teaching abilities develop with experience, following the pattern of similar models for development of individual student learning, such as Bloom's taxonomy (described in Krathwohl, 2002), Perry's 9-stage model (Perry, 1988) and Biggs' SOLO taxonomy (Biggs, 1999a). An underlying assumption in the experiential models of university teaching is that they imply that the lecturer learns to teach through individual experience of teaching rather than by applying theories developed by specialist higher education researchers.

Part of the experiential tradition is a questioning of the separation of subject knowledge and knowledge of pedagogical principles (Wilson, Schulman and Richart, 1987). Boyer (1990) maintains that “The work of the professor becomes consequential only as it is understood by others” and advocates **scholarship of teaching** as an integral part of academic activity, rather than viewing teaching as a routine extra function which almost anyone can do.

The nature of the evidence cited in publications from practising teachers is usually in the form of individual case studies, or informal observations, since individual lecturers normally only have access to evaluate their own teaching (Huber, 2004). Kolb's (1984) **experiential learning cycle**, which is based upon empirical research on student learning in US universities, provides a conceptual model that can be applied to the scholarship of teaching. It describes an explicit development of theory that relates directly to practice, as illustrated in Figure 2.1. The learner applies theories in action, thus creating further experience upon which they then reflect. The cycle repeats continuously throughout all stages of knowledge building, and the skilled learner is able to move easily through the phases of the cycle.

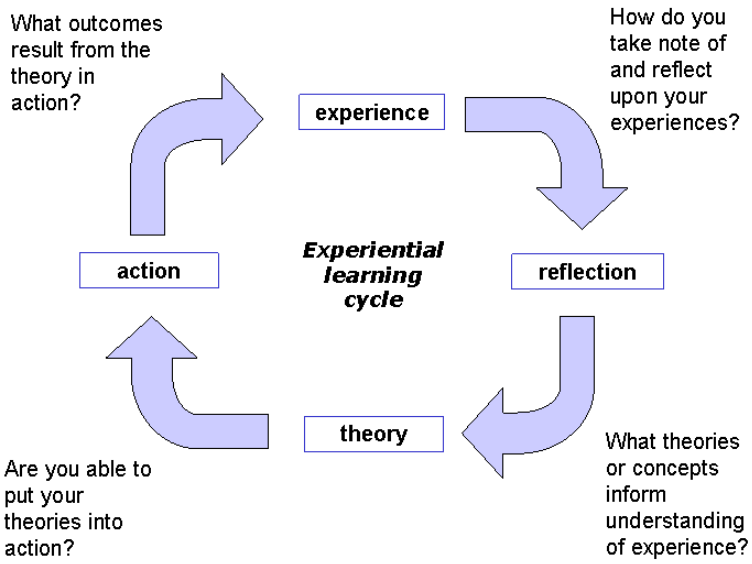


Figure 2.1. Kolb's experiential learning cycle (based on Kolb, 1984)

This tradition of experiential learning is still evident in the movement to promote the scholarship of university teaching. The Carnegie Foundation for the Advancement of Teaching in the US (Carnegie, 2007), the Teaching Quality Enhancement Fund (TQEF) in England and Wales (HEFCE, 2007) and since 2005 the Carrick Institute for Learning and Teaching in Australia (Carrick, 2007) all aim to encourage university teachers to apply the same scholarly standards to their teaching as they would to research in their disciplines. A major part of the strategy for promoting scholarly teaching is to acknowledge and reward individual lecturers who evaluate, reflect upon and publish papers about their teaching. However, schemes to promote the scholarship of teaching have mainly benefited a minority of highly motivated and tenacious individuals, rather than the broad majority of university teachers (Gosling, 2004; Huber, 2001; Huber, 2004). In the UK, a summative evaluation of the TQEF notes that individual teaching awards had limited impact on mainstream teaching quality and questions their value for money (HEFCE, 2005). A reliance on individual experiential learning among university lecturers does not appear to lead to widespread pedagogical innovation and improvement.

Tacit and explicit knowledge in teaching practice

Experiential learning, as modelled by the Kolb cycle, focuses on individual learning experiences, which includes the building of theories that are conscious and which are articulated and shared in a scholarly context. However, there can be a disjunction between the theories university teachers say they are following and what they are doing in practice. For example, Argyris (1999, p.81) describes how, in any organization, **espoused theory** often differs from **theory-in-use**. Theories-in-use are typically learned through socialization, of which the individual may be unaware, and which are accompanied by behavioural strategies that minimize further enquiry. Applying these

concepts to university teaching, a critical review of research on teaching beliefs and practices of university academics (Kane, Sandretto and Heath, 2002) concluded that there is need for more explicit links between espoused theories and teaching practice. Like the experiential tradition and related ideas on the scholarship of teaching (Boyer, 1990; Huber, 2001; Huber, 2004; Kugel, 1993; Trigwell & Shale, 2004), the Kane et al. review assumes that an individual lecturer does the teaching in a classroom, and therefore concludes that research into teaching requires direct observation of the student learning process.

Direct observation by researchers is difficult to achieve in the traditional campus university context, so there is reliance upon self-reported evidence from individual practising teachers and there are few opportunities for independent recording or observation. Constant self-observation is incompatible with the reliance on tacit practical teaching knowledge, which teachers draw upon "in the heat of the classroom" (Olivero et al., 2004). If this tacit knowledge includes the theories-in-use, which Argyris suggests will often have been learned through socialization rather than explicitly, then reliance on tacit knowledge could be a barrier to scholarly enquiry in face-to-face teaching.

The educational literature reports on research that recognises the role of tacit knowledge in professional practice in the classroom. In the absence of formal education in teaching, as has been common in universities, academics have relied upon on knowledge from their own past learning experiences as students (Toohey, 1999, p. 67) and from trial and error in their own teaching (Kugel, 1993). Atkinson and Claxton (2000) explore how tacit experiential knowledge combines with explicit formally learned teaching knowledge in school classroom teaching, and they suggest that there is a role for **intuitive practice**, referred to as "not always knowing what your are doing".

There is understanding of the nature of tacit learning, which explains the apparent discontinuity between theory and practice, and which may also explain why e-learning research is failing to connect with classroom practice. The following theories explain the combination of tacit and explicit knowledge in professional practice:

- Schön (1983) developed the concept of **reflective practice** to explain how professional learning is acquired implicitly as well as explicitly. **Implicit learning** relies on a stance of reflective imitation, and temporary suspension of disbelief, rather than deliberate learning of concepts (Schön, 1983; , 1987). Schön's view contrasts with an understanding of scholarship that is based on conscious reflection, analysis and explicit communication of learning to others (Benjamin, 2000).

- Schön (1987) also describes how **apprenticeship**, which relies on imitation and suspension of disbelief, is essential to acquiring complex professional understanding. Professions and academic disciplines that require a complex mix of physical and conceptual skills – such as music performance, design, architecture and medicine – often include apprenticeship elements in their learning and teaching methods. Although the traditional apprenticeship model is not appropriate for all types of university learning, different disciplines each have their own ways of encouraging the student to follow discipline norms (Lattuca, 2002). Science students, for example, are expected to develop both procedural and conceptual understanding through laboratory activities in which they experience things that challenge their previous commonsense assumptions (Scanlon et al., 2002).

- Eraut (2000b) combines the ideas of Kolb, Schön and others to develop a typology of professional education and workplace learning; as implicit, reactive or deliberative. In implicit learning, unconsciously selected memories of past experience influence behaviour. In **deliberative learning** (whether formal or non-formal) there is conscious review of past events, and planned action. **Reactive learning** involves brief episodes of review and reflection and being prepared for emergent learning, as in reflective practice.

- Gourlay (2004) describes various interpretations and contradictory definitions of **tacit knowledge**. He outlines three broad models:
  (i) the motor skills model (riding a bicycle)
  (ii) the rules-regress model (behavioural and decision-making routines)
  (iii) the 'form of life' approach (the social basis of one's beliefs).
  The first two can become explicit, or codified as public knowledge. **Codified knowledge** can be take the form of written texts or other media, and can be incorporated in computers. According to Gourlay some argue that the third type of tacit knowledge is beyond codification because the sources of beliefs are hidden. Tacit knowledge that cannot be made explicit must be inferred from observed behaviour.

Schön (1987) criticizes the inability of academic research and learning in universities to deal with tacit professional knowledge. Both Gourlay and Eraut, however, maintain that effectively all that has been classified as tacit knowledge can be described or codified. Similarly, deliberative learning can become routinized as tacit knowledge. If tacit knowledge can become codified, and vice versa, there are implications for research into learning and teaching. Intuition can be recognised as the use of tacit knowledge, which can become explicit as part of scholarly enquiry into teaching.

The criticism of academic discourse in universities as unable to deal with tacit professional knowledge, together with the idea that it is possible to make this tacit knowledge explicit,

provides an explanation of the difference between synchronous and asynchronous learning methods found in the empirical literature (Bernard *et al.*, 2004; Lou *et al.*, 2006). The social interactions that take place in e-learning environments, and the emotional aspects of these social interactions, have been made explicit (Salmon, 2000; Salmon, 2005). If university lecturers cannot reliably codify their tacit knowledge of face-to-face teaching contexts (Kane et al., 2002), then this knowledge cannot be transferred into new e-learning environments. Nor can teaching knowledge be shared between disciplines if, as suggested by Wilson et al. (1987), pedagogical principles cannot be considered separately from subject knowledge. Intuitive practice, as described by Atkinson and Claxton (2000), includes a role for tacit knowledge combined with explicit knowledge and reflective practice in teaching.

Feelings as part of learning

Consideration of the role of intuitive practice and tacit knowledge in learning includes acknowledgement of feelings, not only in the sense of intuition, but also in the sense of emotion and physical sensation. Physical sensations are how people interact with and understand their environment (Bateson, 1973). Lattuca (2002) refers to a need to "repair the mind-body duality" in academia; to recognise that learning and cognition have physical, emotional and social components as well as explicitly assessed academic knowledge. Eraut (2000a) similarly, comments that teaching based solely on explicit knowledge could "turn classrooms into cognitive and interpersonal deserts", and suggests periodic review which combines intuition, episodic memory and evidence of student process.

The linking of tacit knowledge with the physical and emotional has been written about throughout the 20th century. The temporary suspension of questioning described by Schön (1987) echoes the principles underlying the Alexander technique for changing physical habits and posture, in which the Alexander teacher leads a client learner through a process for changing unconscious physical responses, without making explicit what exactly those changes are (Alexander, 1932). Commenting on Alexander's work, Dewey noted that: "The technique ... bears the same relation to education that education itself bears to all other human activities." (Dewey in the preface to 1939 edition of Alexander, 1932).

Some theories and models that acknowledge the value of emotions and unconscious actions are widely used by professionals such as trainers, counsellors and therapists, who specialize in face-to-face interpersonal communication. One example is a model widely used in training, which explains how learning that is acquired consciously eventually becomes tacit, as it becomes internalized and automated with repeated use:

Unconscious incompetence: unaware that there is something to learn

Conscious incompetence: aware of the need to learn how to do something

Conscious competence: knows how to do something, but has to think about it

Unconscious competence: does it competently without thinking, as a habit.

This model is detailed in the context of creative interpersonal communication by Howell (1986) who puts it forward as four levels of competence. However, its original source is uncertain (see, for example BusinessBalls-website, 2007).

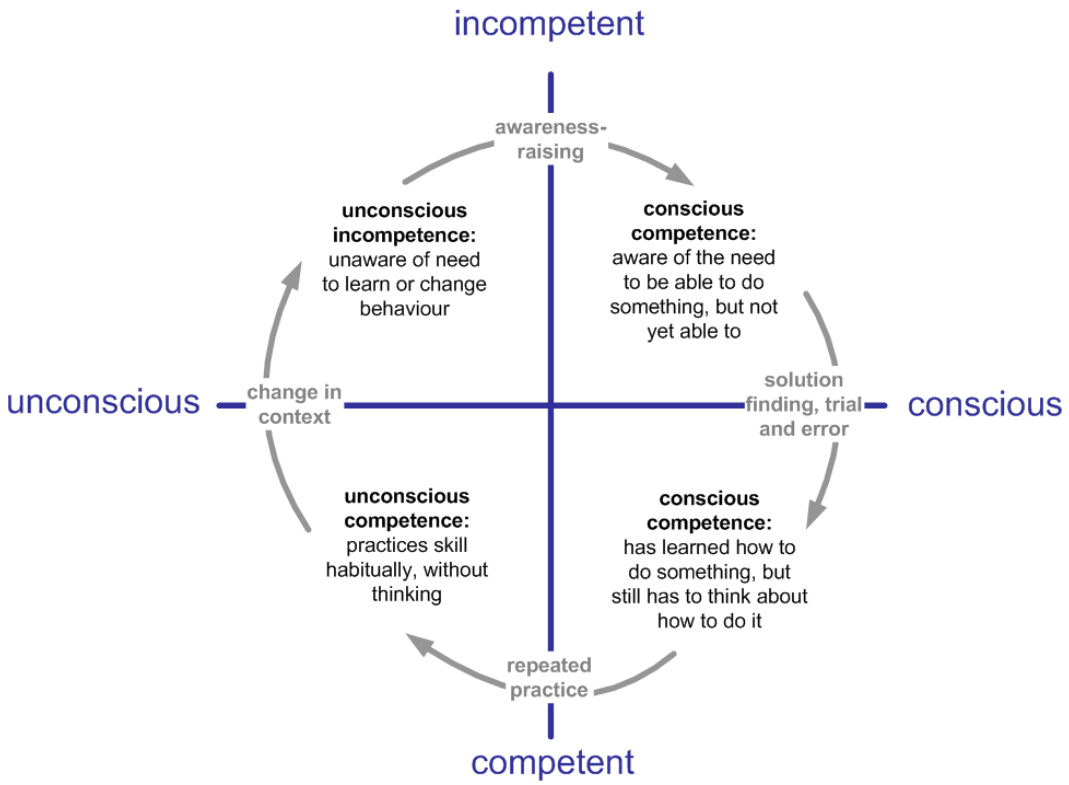


Figure 2.2 The conscious competence model of learning

The conscious competence model is consistent with Eraut's definitions of implicit and reactive learning and with Schön's ideas on how knowledge can be shared by imitation, as described above. The student is guided by many short experiences of imitation, trial and error; only temporarily aware of each specific incompetence until the required skill is in place, after which it becomes automatic. The teacher's feedback may be fleeting – an approving or disapproving glance, a small corrective touch, a word of suggestion on the work in progress. Repeated cycles build layers of knowledge, which neither the teacher nor the student may be fully aware of. If the learning process is successful, there is no reason to spend time analysing it and making each detail explicit. This interpretation of the student-teacher interaction may explain a reluctance to pull apart complex face-to-face learning systems that have been built experientially and tacitly within academic disciplines, especially where a lecturer is unaware of any need to change.

Howell (1986) also suggests a fifth level of “unconscious supercompetence” which he refers to as “flow”, in which "the total resources of the human being achieve harmonious integration”, including the emotional as well as the physical. More recently, similar ideas arise in a theory of deep systemic learning that leads to profound change in people, organizations and societies, called “presence” (Senge, Scharmer, Jaworski & Flowers, 2005). Presence involves comprehensive sensing of the whole environment, deep reflection that engages the unconscious as well as the conscious mind, followed by swift intuitive action. Presence is contrasted with superficial “downloading” of mental models and re-enacting of habits, and it therefore frames intuition as an integral part of learning and enquiry.

Csikszentmihalyi (1992) defines "flow" more narrowly than Howell, as an optimal emotional state which promotes continued learning in the individual; a region between anxiety (where there is too much challenge for the learner’s skills) and boredom (where there is too little challenge).

Other approaches that encompass the physical and emotional aspects of learning, conscious and unconscious, include techniques for the conscious management of unconscious learning processes, incorporated in neurolinguistic programming (NLP) (Dilts & Bonissone, 1993; O’Connor & McDermott, 1997; O’Connor & Seymour, 1990) and the concept of "emotional intelligence" (Goleman, 1999).

What all of these approaches to the role of feelings in learning have in common is that there is a strong focus on the human process of learning, independently of any discipline-specific or context-specific measurable outcomes. This focus on learning process contrasts with academic discourse within disciplines, in which the process is often tacit. The focus of academic assessment is on measurable knowledge and learning outcomes. Can the student use Newton’s laws to predict the path of a moving object? Can the student apply particular literary criticism frameworks to deconstruct the meanings in an English novel, and express this clearly in an essay?

The literature that explores the relationship between tacit and explicit knowledge in teaching confirms the limitations of the university classroom as an environment for recording and analysing the detail of teaching practice. In the university classroom, or in any other synchronous learning environment, teachers rely upon tacit knowledge and unconscious skills. The individual university teacher responds intuitively, in the moment, with unconscious competence, and if inspired, with unconscious supercompetence.

Figure 2.3 illustrates my interpretation of how intuitive practice (Atkinson & Claxton, 2000) relates to Kolb's experiential learning model, Schön's ideas on reflective practice and Eraut’s periodic review. The planning and review required in a scholarly approach to teaching can be part

of a learning cycle involving tacit knowledge and intuition. Figure 2.3 differs from Kolb's learning cycle in that action and experience are simultaneous, and mostly unrecorded. Only longer-term outcomes from many face-to-face interactions are available, for example in the form of results from student assessment.

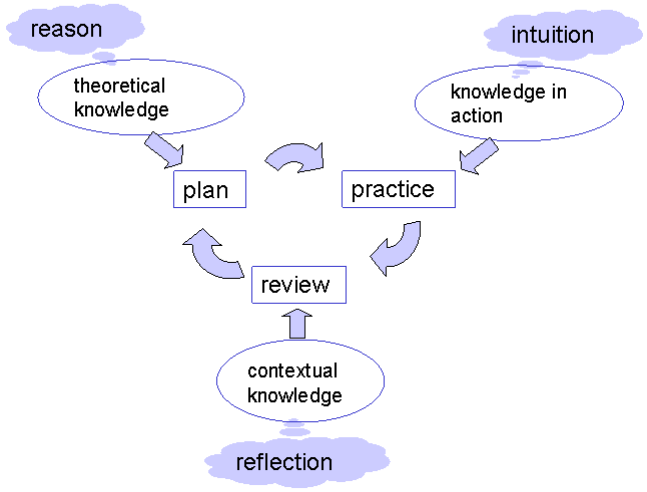


Figure 2.3 Intuitive practice with experiential learning and reflection

E-learning media and platforms provide different forms of synchronous and asynchronous interaction, each requiring different contextual knowledge and new theoretical knowledge. Literature and theories grounded in individual teachers' experiences of classroom practice will therefore not be sufficient to inform teaching practices for e-learning.

In examining the role of intuition in learning to teach, Eraut (2000a) suggests that intuitively derived ideas need to be checked out or tested in a disciplined, rational manner, and that learner self-knowledge is important for lifelong learning. These ideas exemplify the systems thinking described by Bateson, Checkland and others (Bateson, 1973; Checkland, 1990; Checkland & Poulter, 2006a; Checkland & Scholes, 1990). Therefore, if teaching practices are to adapt to make effective use of e-learning environments, then tacit and explicit knowledge, conscious and unconscious learning processes, along with physical, the emotional and the intuitive, all have to be recognised and included.

Codified knowledge, technology and teamwork

Codified knowledge, in the form of research papers and conferences, policies and guidelines, can be transferred between individuals in other contexts and between different teams, whereas tacit knowledge is shared only when people work together (Edmondson, Bohmer & Pisano, 2003b). Codified knowledge also allows teachers to predict and plan

Specialist research into higher education has access to learning across numerous disciplines, and provides codified knowledge to inform university teaching; applying theories from educational psychology, rather than relying on reported teacher experience. The educational theorists are usually professional researchers who are in a position to observe student learning without having to engage in the immediacy of classroom teaching practice, and are able to dedicate time to linking their observations with educational theory.

Advice to university teachers from published authorities aims to promote more effective student learning (Biggs, 1999a; Buehl & Alexander, 2001). Student-centred learning theories such as constructive alignment (Biggs, 1999a; Biggs, 1999b) provide basis for design in any learning medium. E-learning literature provides more examples. Yet some educational researchers say that this knowledge is failing to connect with classroom teaching in universities (Trigwell, Martin, Benjamin & Prosser, 2000; Trigwell & Shale, 2004), and it appears that practitioners are relying on tacit knowledge that does not meet the scholarly standards of the educational theorists.

One common factor evident in the literature reporting on teaching experience and that reporting on student learning research is an underlying assumption that the responsibility for student learning is normally with the individual teacher. If the surfacing and questioning of tacit teaching knowledge and beliefs is necessary for effective integration of e-learning, then a team involving people with different skills and professions (perhaps including an educational theorist) could provide an environment where this can happen. Such teamwork has more often been found in distance education (Laurillard, 2002, ch 12).

Compared to the extensive literature on individual teaching in campus universities, there has been less written on team teaching. Referring to campus university teaching, Benjamin (2000) notes that literature on the scholarship of teaching focuses on individual teachers, and examines how scholarship might apply to team teaching; concluding that team teaching in itself does not necessarily promote a scholarly or reflective approach, if the intention is mainly to share workload and there is no formal reflection on student learning.

Letterman and Dugan (2004) also review the literature on team teaching and cite evidence that team teaching can enhance the quality of the student learning experience. They note, however, that the educational literature offers little in the way of practical guidance on team teaching. Team teaching in campus universities, compared with individual teaching, is more time-consuming for teachers, interferes more with research, involves loss of individual autonomy, and therefore requires institutional support. Teamwork on e-learning projects in campus universities also runs into problems with discipline differences, particularly in relation to pedagogy (Breslin, Nicol Grierson & Wodehouse, 2006).

Laurillard (2002, p. 227) maintains that collaborative development is crucial for e-learning because of the range of skills needed. She also observes that staff time and resources need planning at institutional and departmental level, but that academic staff time is rarely costed in relation to specific areas of their work. Academics in traditional universities spend a significant proportion of their time presenting through lectures and marking and spend hardly any time designing. For many academic staff, the introduction of new technology has been "a nightmare of overwork and lack of support" (Laurillard, 2002, p. 229). Research by Torrisi and Davis (2000), based upon interviews with 10 academic staff at Griffiths University in Australia, supports the link between e-learning and teamwork; concluding that online learning does have potential to reshape teaching practice in a campus university, but that it requires the fostering of a collaborative team approach to course development.

Related to this discussion of the teamwork required for developing courses incorporating e-learning is the idea that knowledge can exist beyond the individual, in the relationships within a team or organization. The concept of **distributed cognition** implies that tacit knowledge can exist not only in individuals, but also at the level of the team, as its members implicitly develop working relationships while they learn together to use a new technology (Salomon, 1998). The role of tacit and codified knowledge in teams adopting new medical technologies has been a subject of management research in Harvard Business School (Edmondson, Winslow, Bohmer & Pisano, 2003b). When technologies are new, **innovators** and **early adopters**, the minority (typically 15%) who generate new methods and make an effort to try them out (Rogers, 2003) may not always make the effort to codify their knowledge for the benefit of others. Where a community is not sensitive to tacit knowledge, as Schön (1987) and Edmondson et al. suggest is often the case for academics and for surgeons respectively, and if codified knowledge is weak, as in campus university teaching where there is a heavy reliance on tacit knowledge, then the new technology will fail to spread and realise its potential.

Visual techniques for sharing of ideas have proved useful for making explicit and codifying knowledge within a university course development team. A study of e-learning in an English campus university reports on use of concept mapping as a way of making explicit difference pedagogical approaches within a course development team (Hughes & Hay, 2001). Inglis (2003) describes similar use of concept mapping in an Australian campus university, in which the team approach to course design was informed by early experience of course teams in the UK Open University. To this, Inglis adds visual mapping of the course design as a way of facilitating the interaction between educational specialists (instructional designers) and subject matter experts. [Note that the term 'concept map' is often used synonymously with cognitive map, in the sense of the diagram rather than the internal mental representation; but it may be used more loosely to

refer to any visual representation of the relationship between concepts.] The Carpe Diem approach to team-based course development also uses visual representation of the learning pathways and activities (Whitehead, Salmon & Armellini, 2007), in this case storyboarding, a technique originally used in film animation. Structured visual techniques can help to make explicit what were previously tacit pedagogical assumptions and differences, but only if campus university systems can support academic staff in taking time out to use these techniques in teams.

In summary then, the integration of e-learning into teaching practice within campus universities requires teamwork across different disciplines and professions to be effective. Tacit and discipline-specific pedagogical assumptions need to be made explicit and shared in order to design and develop new types of learning activity in e-learning environments. Compared with distance universities, campus universities have had less support for team teaching and team development of courses, either from educational theorists or institutionally.

2.2.3 Discipline differences in learning, teaching and knowledge

Tacit and discipline-specific beliefs about learning, teaching and knowledge will remain unquestioned where there is no cross-discipline teamwork, or other opportunities for explicit and interdisciplinary discussion of teaching (Kezar, 2001, p.103). So it is important to understand how disciplinary teaching practices differ and what this implies for campus university academics' use of e-learning.

Beliefs about learning, teaching and knowledge

There is wide variety in teachers' beliefs about learning and teaching, which go beyond those related to developmental stages in teachers' experiential learning, as described by Kugel (1993). A review of educational literature for explicit discussion of epistemological beliefs found that some studies focused on the global construct of knowledge, some on academic knowledge and some on domain-specific knowledge (Buehl & Alexander, 2001). Students majoring in different disciplines hold different beliefs about their knowledge, and little is known about how these beliefs develop. Students may be acquiring their beliefs about learning implicitly, from the learning environments created by their teachers, who are themselves informed by their own tacit knowledge of learning in the discipline. Toohey (1999) describes how disciplinary philosophies shape approaches to the design of university courses. Brown and Roberts (2000) suggest that the capacity to enter into university teaching as an intentional objective research activity is limited by the social contexts within which lecturers experience teaching, and the discourses through which they articulate that experience.

With e-learning, there is an additional difficulty, in that few teachers will themselves have experienced learning through tools now available for use with online learning management systems (such as online discussion, chat, podcasting and blogs); while most of their students have grown up with the internet, mobile phones and instant messaging (Oblinger, 2003; Oblinger, 2005). Explicit advice from educational experts will not be enough to overcome this because: "When push comes to shove, teachers will teach the way they have been taught in the past [...] Thus if we want teachers to change, they will have to experience as students themselves the novel learning environment." (Salomon, 1998, p.7)

In a review and analysis of research and theory related to e-learning, Hannafin and Land (1997) note that, although technology-enhanced student-centred approaches may not be the best choice for all types of learning, simply renaming the traditional process without altering the beliefs about the processes themselves and the supporting methods will not significantly alter the quality of the learning environment. Kane et al. (2002) say that there is a difference between espoused beliefs and those practiced, and the lecturers may therefore implicitly pass on some very mixed messages to their students about the nature of learning.

Disciplinary differences in beliefs about the purpose of education and the design of courses may not be resolvable. If teachers are able to have open cross-discipline discussions with colleagues this will enable them to be explicit about their beliefs and communicate these clearly to students (Toohey, 1999). Thus, effective use of e-learning requires that university teachers practice an aspect of systems thinking, by acknowledging and making explicit their disciplinary worldviews in relation to learning, teaching and knowledge. However, the reported lack of support for cross-discipline teamwork in campus universities (Breslin *et al.*, 2006; Letterman & Dugan, 2004) suggests that there are barriers to cross-discipline work on e-learning.

Barriers to cross-discipline discussions on e-learning

University educational development programmes expose teachers to educational theories and most involve opportunities for discussion of teaching practices across different disciplines. However, as noted above, educational theory is not sufficiently connected with university teaching practice. The following are two examples of how teachers from disciplines other than education may reject the educational theories on offer.

1. Since the 1990s, literature on online learning has drawn upon the cognitive constructivist approach to individual learning (Jonassen et al., 1993). Some commentators say that technology will promote constructivist approaches in educational practice (Elkind, 2004). Educational developers therefore often advocate student-centred constructivist approaches

to improve student engagement with learning. For example, student engagement is a common challenge in science education. Yet some science educators characterize student-centred constructivism as unguided discovery learning and maintain that direct instruction is needed to give students the grounding needed for higher level engagement with the discipline (Carson, 2005; Matthews, 2002)

2. Educational specialists also advocate clear definition of learning outcomes, and constructive alignment of learning activities and assessment (Biggs, 1999a). In disciplines such as design, where teachers model complex problem-solving processes without articulating them, the teacher may find this difficult, if not counter-productive, as the articulated outcome will be an over-simplification of a complex process (Schön, 1987). The concern expressed by Barnett (2000a), follows a similar logic, in criticizing simplistic demands upon universities to deliver measurable outcomes, to the detriment of process.

Perkins (1999) suggests that these difficulties require a pragmatic approach to constructivism which acknowledges that different methods are needed for different kinds of knowledge, and identifies four types of troublesome knowledge:

- inert knowledge (e.g. vocabulary that is understood but not used actively)
- ritual knowledge (e.g. routines in arithmetic)
- conceptually difficult knowledge (e.g. Newton's laws of motion, which can seem counterintuitive)
- foreign knowledge (e.g. value systems of different ethnic groups)

and in later writing discusses how discipline-specific tacit knowledge is also troublesome, in that, as learners "we often get the hang of enquiry in a discipline without having a clear reflective idea of what we are doing " (Perkins, 2006, p40).

Meyer and Land (2002; 2005) build on Perkins' work to develop the idea of **threshold concepts** within disciplines – ideas that lead to a qualitative and irreversible change in understanding, which then shapes subsequent learning and behaviour. Examples are heat transfer in physics (mathematically) and in cooking (empirically); limits in mathematics; opportunity cost in economics; signification and deconstruction in literary and cultural studies. Threshold concepts integrate and transform previous knowledge and may sometimes even lead to a transformation in the learner's worldviews and sense of identity. They are also troublesome to learn, because the learner can initially find them alien and counter-intuitive, or simply incoherent because of their complexity. When threshold concepts become part of tacit knowledge – unexamined

understandings shared within an academic community – they can be particularly difficult to share between different academic disciplines. And yet one way of identifying threshold concepts is to compare how academics from different disciplines analyse a particular set of phenomena (Davies, 2006).

Cross-disciplinary discussion in the detail required in designing use of e-learning in a particular university course therefore means that lecturers will encounter troublesome knowledge and will have to work through threshold concepts from other disciplines. Staff development programmes in university learning and teaching ask teachers to adopt new ideas and practices that in some cases will challenge their disciplinary learning cultures and their sense of professional identity (Fanghanel, 2004).

Trowler and Cooper (2002) offer a framework for understanding the difficulties in introducing a constructivist approach in university educational development programmes – the concept of **teaching and learning regimes (TLRs)** in academic disciplines. Each TLR has its own worldview - an interlinked system of values, relationships, practices and assumptions that may clash with those of the educational developers running the programme. This includes:

- concepts of the teacher's and learner's identity, and the power relations between them – which influences whether the teachers are able to reposition themselves as learners in a new context
- value systems and meanings – for example the status of the 'pure' knowledge of theorists compared with the vocational knowledge of practitioners
- tacit assumptions – for example that it is not an academic's job to teach basic literacy skills, because students are expected to come into university with those skills
- rules of appropriateness – for example, the curriculum development process, classroom practices and types of assessment that are considered acceptable
- recurrent practices – the sets of skills and tacit knowledge that are often embodied in the infrastructure and organizational systems, for example how Physics labs are organized
- discursive repertoires – for example, ideas such as project management and measured learning outcomes are common in management and engineering, but may be rejected as alien in the humanities; conversely learning portfolios and examination of discourse are acceptable in the arts and humanities, but to an engineer seem woolly and imprecise

- implicit theories of learning and teaching – which may be anywhere on the spectrum from transmissive/authoritarian to constructivist/democratic ... or may simply be pragmatic, based on whatever works.

Simply expecting academics to adapt to the educational developers' TLR is not enough. To build a common discourse about learning and teaching among academics from different disciplines requires that participants, educational specialists included, should be encouraged to become aware of their preconceptions, the social roots in their disciplines, and any incongruities between espoused theory and theory-in-action. Yet Trowler and Cooper conclude with questions rather than answers, and do not offer specific guidance on how to implement their ideas in the design of educational development programmes in universities. (Trowler & Cooper, 2002)

The need for cross-discipline metacognition

In summary, the literature dealing with discipline differences confirms that, although educational specialists are likely to espouse cognitive constructivism, teachers in some disciplines may have a different view, and will be more influenced by their established and proven disciplinary teaching practices than by specialists in educational theory. Yet, if the educational specialists apply constructivist principles to staff development in university teaching, they may be obliged to engage with TLRs that go against their own professional values. This conundrum could explain why many university teachers are failing to apply educational theory. The various educational perspectives are not inherently incompatible with each other, but the disciplinary lenses through which they are viewed, and the effort required to communicate across discipline boundaries, can make them seem so.

To build a commonly understood discourse about university learning and teaching, requires first that both the teachers and the educational developers are aware of where their knowledge sits in relation to other disciplines. In other words university teachers need **metacognition** of disciplinary diversity; an awareness of how their discipline experience has shaped their own thought processes. In traditional campus universities there are many disincentives to developing this cross-discipline metacognition, among which are the following:

- Disciplines differ in their values, beliefs, their teaching methods and their conception of what constitutes knowledge.

- Considerable effort, both intellectual and emotional, is required to engage with learning and teaching ideas from another discipline.

- Engaging with codified knowledge about learning and teaching, as offered by educational theorists, is engaging with a new discipline.

Scholarly and reflective university teaching that goes beyond the confines of discipline-specific experience is therefore a major undertaking, both for individual lecturers and for educational staff developers.

2.2.4 Disciplines and communities

Becher and Trowler (2001) provide a framework to aid cross-discipline metacognition, by characterizing different academic knowledge territories and their associated organizational cultures. For example, they characterize disciplines where there is little overlap between specialist knowledge areas as rural disciplines, which typically have loose organization and infrequent communication. On the other hand, in urban disciplines many researchers work on the same problem are typically more competitive, with faster and more highly organized communication. Becher and Trowler also characterize different approaches to teamwork ranging from tightly knit teams where specialisms complement each other, called convergent**,** to loosely knit individualistic ways of working, called divergent**.** For example, biotechnology researchers working on large international multidisciplinary projects would be both urban and convergent (Becher & Trowler, 2001). Figure 2.4 summarizes this model of academic tribal organization.

Figure 2.4. Characterization of academic tribal organization (Becher & Trowler, 2001)

Becher and Trowler also characterize knowledge territories using two dimensions: **hard–soft** and **pure–applied**. Physics and pure mathematics for example, would normally be considered hard

pure disciplines. Philosophy and sociology would be characterized as soft pure disciplines. Similarly education could be classed as soft applied and engineering as hard applied. See Figure 2.5, but note that these examples are intended only as broad illustrations of the model. Particular university departments might classify their knowledge domains differently, depending on their specialist strengths in relation to other departments.

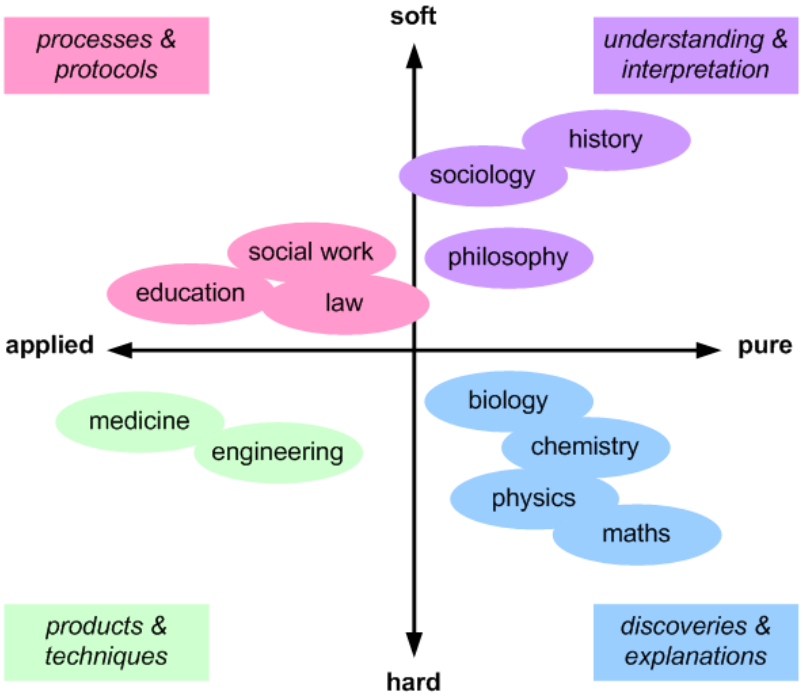


Figure 2.5. An characterization of academic knowledge territories (Becher & Trowler, 2001)

The models depicted in Figures 2.4 and 2.5 show disciplinary knowledge and disciplinary organization separately, but there is a relationship between forms of knowledge and forms of academic organization (Becher & Trowler, 2001). The characterization of disciplinary tribes and territories and the idea of disciplinary TLRs (Trowler & Cooper, 2002), like the concept of distributed cognition (Salomon, 1998), suggest that knowledge about teaching can reside in the way people organize in academic departments and communities, as well as in the minds of individuals. These models may therefore be useful in analysing and understanding disciplinary differences in the adoption of new technologies for learning and teaching – for example which knowledge is codified and which is tacit; and to what extent there is an organized culture of collaboration and teamwork. The international data on adoption of e-learning provides empirical evidence that there are such discipline differences.

Tacit learning and teaching beliefs, and the organizational practices that maintain them, are part of this academic social knowledge-building systems. New technologies provide new social tools. But the introduction of new technologies will be disruptive for academic communities, and may be seen as a threat (Bower & Christensen, 1995; Hilton, 2005; Rogers, 2003, Ch 10). If so,

disciplinary tribal communities in campus universities may also implicitly discourage teachers from integrating e-learning media effectively into their teaching practices. Bateson describes such discouragement of change as a general property of any social learning system:

> "[Tribe members'] ideas about nature, however fantastic, are supported by their social system; conversely the social system is supported by their ideas of nature. It thus becomes very difficult for the people, so doubly guided, to change their view either of nature or of the social system. For the benefits of stability, they pay the price of rigidity, living, as all human beings must, in an enormously complex network of mutually supporting presuppositions. The converse of this statement is that change will require various sorts of relaxation or contradiction within the system of presuppositions." (Bateson, 1979, p. 134)

This description of systemic social resistance to change can also be applied to the social systems of academic disciplines, in explain their response to the introduction of new pedagogy associated with e-learning.

2.2.5 Scholarship and innovation in teaching

Theories developed from e-learning experience have a strong focus on learning as a social as well as individual activity. The development of knowledge about effective e-learning methods has come mainly from research and practice using asynchronous learning media, which facilitate the study and development of new forms of social learning interaction. The literature on how university teachers learn to teach shows how the synchronicity of face-to-face teaching and the absence of cross-discipline teamwork among campus university teachers can hinder innovation. In particular:

- The scholarship of teaching, if confined to the individual lecturer's face-to-face teaching experience, has inherent limitations because the university classroom offers few opportunities for observation of, and reflection upon, the social context of the learning interactions.

- University campus teaching relies heavily on tacit and discipline-specific knowledge. The teachers themselves may be unaware of the beliefs they have acquired from their own learning experiences and are implicitly communicating to their students.

- Educational theorists who focus on student learning rather than reported teaching experience find that their advice is failing to connect with teaching practice, and is not leading teachers to review the tacit aspects of their teaching knowledge.

- Teamwork, especially if involving different disciplines or professions, can offer opportunities for surfacing and questioning tacit knowledge about teaching. But in traditional campus

universities, teaching is more often done individually than in teams, and there is little support for teamwork, either from the educational theorists or institutionally.

The differences in disciplinary knowledge and beliefs have an influence on the way that academic communities organize around their research and their teaching. The relationship between the forms of knowledge and forms of organization will also affect use of technology. Most academics are primarily motivated by research in their discipline, even if teaching is something they enjoy (Metcalf, Rolfe, Stevens & Weale, 2005). Most academics therefore have little reason to make the effort required to engage with foreign ideas and social practices in order to innovate their teaching.

Discipline differences are profound and systemic, and education is itself a distinct discipline. Innovation in teaching methods therefore requires more than an injection of theory from educational specialists. It needs interdisciplinary sharing and codifying of tacit teaching knowledge arising from widely diverse worldviews, which takes considerable effort.

In summary, teachers in traditional campus universities lack the opportunities and the organizational support required to surface and question tacit discipline-specific knowledge in a way that would enable them to develop effective educational design for new learning media. In order to achieve the outcomes sought by higher education policymakers, and to meet the needs of students in the 21st century, individual teachers will have to be motivated to adopt e-learning. The rewards of scholarly teaching may help the careers of a few early adopters. But in general, early adopters of e-learning have little incentive to codify and share their innovations across disciplines, in ways that would encourage the majority to follow suit.

In terms of Rogers' (2003, Ch 7). empirically based model of innovation diffusion, only a venturesome 2.5% of teachers are likely to be **innovators** who will risk an unorthodox approach to academic career development. For an innovation to take hold it will involve the 13.5% who are **early adopters** and are sufficiently respected and integrated within their disciplinary social systems to influence others. A **critical mass** of such teachers is needed for innovative uses of e-learning to become self-sustaining. The higher education literature indicates that this point has not yet been reached, in that e-learning has largely to move beyond web supplements to traditional classroom teaching. There is a need to know what motivates the earlier adopters of an innovation in order to understand how to achieve a critical mass (Rogers, 2003).

Research Question 1

What can motivate individual academics in a campus university to put time and effort into:

(i) developing innovative teaching practices using e-learning?

(ii) building shared cross-disciplinary knowledge of e-learning in universities?

This Chapter has identified several themes in the literature on university teaching that are relevant to this research question.

Discipline differences – in teaching and learning regimes, which include beliefs about the nature of knowledge and learning, teaching practices and ways of organizing.

Teamwork – which is required for effective use of e-learning technologies, but is not well supported in campus university learning and teaching systems.

Empowerment – the ability of individuals to make changes in their teaching practice in a context where university and learning and teaching systems and disciplinary regimes impose some constraints upon the options available.

Beliefs and values – which vary between disciplinary cultures, and include tacit discipline-specific knowledge.

Metacognition – which enables the development of a common discourse about university learning and teaching, based on understanding that discipline-specific experiences and knowledge are part of a larger cross-discipline university learning and teaching system.

Chapter 3. Literature on change management in universities

Abstract of Chapter 3

Literature on the management of organizational change in universities discusses the role of communities in supporting the sharing of individual learning across formal organizational boundaries. Communities contribute to organizational learning, which encompasses not only individual learning, but also the related changes in formal organization and in technologies. This Chapter draws out some common ideas from the literature that are applicable to the adoption of e-learning in universities, and which link with themes in the educational literature. In considering how these ideas might be used to understand the introduction of e-learning in universities, a second research question emerges, on how cross-discipline community sharing of e-learning knowledge can bring about change in the formal organizational systems of a university. Formal university systems can either hinder or enable widespread integration of e-learning into mainstream teaching practices.

The literature on change in higher education suggests a need for change models that incorporate interaction between formal and informal organizational processes, and which also take into account disciplinary and individual diversity. Complex adaptive systems theories of organization are used in researching organizational change in contexts other than universities. These theories provide an explanation of how individuals interact with each other and with technologies as part of an organizational system. Applying the same principles to the introduction of e-learning in a university gives rise to the third research question; on how individual teachers' strategies combine to create the systemic response of the university to introduction of e-learning technologies.

3.1 Communities and organizational change in universities

By reviewing the literature on teaching in higher education, the previous Chapter has established some characteristics of campus university learning and teaching systems that are significant for use of e-learning. The effective use of new educational methods, media and tools requires explicit review of teaching practices and assumptions about how student learn. Yet attempts to educate university academics in the scholarly teaching practices recommended by educational researchers have largely been unsuccessful (Elton, 2003; Trigwell *et al.*, 2000; Trigwell & Shale, 2004). Instead campus university academics have been relying on tacit and discipline-specific knowledge of learning and teaching. Academic disciplinary knowledge and culture is too diverse and complex to allow for a simple model of educational best practice to be implemented across disciplines. This diversity and complexity can hinder the integration of e-learning technologies into mainstream teaching practices, so that potential benefits for students are not being fully realised. For many campus university academics, the kind of cross-discipline engagement and teamwork required for effective use of e-learning is hard work, and has not been widely supported by formal university systems.

Trowler and Knight (2000) argue that, for university academic staff, the formal organizational systems are less significant than informal activity systems, cultures and communities. Yet they also comment that "literature on university culture tends to follow, but lag considerably behind, that in the areas of management and of organization studies" (Trowler & Knight, 2000, pp28-29). Becher and Trowler (2001) suggest that the four forms of scholarship advocated by Boyer (1990) – integration, discovery, application and teaching – now need to be supplemented by scholarships of leadership, management, administration and entrepreneurship.

The first half of this Chapter therefore reviews literature on the organizational contexts, both informal and formal, of academic work. The role of disciplinary and cross-discipline communities is considered, and then theories of how change may be managed at the institutional level.

3.1.1 Learning communities and social theories of learning

Communities of Practice

Communities of practice are advocated as a way to bring about sharing of knowledge in industries where the environment is changing fast, and fast efficient knowledge management is essential (Wenger, McDermott & Snyder, 2002). People network informally with others in their role or profession, to create, share and manage knowledge across organizational boundaries. There are examples where this is a conscious strategy of senior management, in the private sector (Wenger et al., 2002). Communities of practice are open and voluntary associations. They have a

core membership and people who come and go, depending on the value each individual seeks from the association. Communities can be nurtured and supported. But communities of practice cannot be engineered, because a compulsory community would have no need to deliver value to its members. A mature learning community has multiple forms and roles of leadership; which can include connecting people, brokering across boundaries, note-taking and summarising, introducing new knowledge (Wenger, 2005).

Communities of practice are significant for e-learning because they offer a way of developing new knowledge across discipline boundaries in campus universities where the formal systems prioritize support for individual face-to-face teaching. As a result, many writers on e-learning see communities of practice as particularly relevant to the introduction of online technologies for teaching and learning (Allan & Banks, 2003; Bell, 2003; Hung, 2002; Hunter, 2003; Moore, 2002; Oliver, 2003; Turner, 2003). However, although communities have a role within formal organizations, communities are not to be confused with the organization itself (Terjesen, 2003; Wenger, 1998; Wenger *et al.*, 2002).

The idea of communities of practice builds upon **situated learning theory** (Wenger, 1991) which deals with how people learn at work. However, as discussed in Chapter 2, the idea of academics taking time out to learn, formally or informally, about their teaching work may lack legitimacy within a disciplinary community. Australian studies of workplace learning find that even experienced researchers and adult educators can have difficulty legitimizing a focus on their own workplace learning (Solomon, Boud, Leontios & Staron, 2001). Being identified as a learner is sometimes associated with being inadequate as a fully functioning employee (Boud & Solomon, 2003). Contu and Wilmott (2003), in a theoretical analysis of situated learning, call for an understanding that learning practices are enabled and constrained by relations of power, and specifically by the institutionalization of power within organizations. Institutionalization of power will be expressed by, for example, formal reporting, performance indicators, promotion criteria and control of departmental budgets. All of these factors can constrain the operation of cross-discipline learning communities, because, in a university, the formal organizational structures and management processes also align with disciplinary boundaries.

Eraut (2002) refers to the constraints and influences in real work situations, within teams and organizations, and argues that the idea of communities of practice is problematic because such communities are very rare. Eraut also argues that three key qualities in communities of practice – mutual engagement, joint enterprise and shared repertoire – can provide a model of inter-professional learning without the need to define a community of practice. These three qualities can be provided through relevant off-the-job training combined with experience of working in

teams that cross discipline or professional boundaries. The cross-discipline teams required for e-learning can be of this type, formally constituted rather than arising from a self-organizing community. But such teams require formal support from line management, which in a university may be limited by the formal discipline-based structures. So even Eraut's model of inter-professional learning could be hard to achieve in university learning and teaching; not only because of differences in knowledge territories, but also because of systemic organizational constraints upon university teachers as professional learners.

Learning systems – formal and informal

Before the advent of 21st century online social networking tools, Nardi (1996) argued that theories focusing on how individuals interact with learning contexts are inadequate for analysing the social role of technologies; proposing instead that activity theory and distributed cognition theory are more suitable. Activity theory focuses on how a person or a group carries out actions which can become operational routines, sometimes mediated by artefacts, in pursuit of an objective or purpose (Daniels, 2004). Activity theory takes account of tacit knowledge that is built socially through team activities, but does not distinguish between internal (individual) and external (social) forms of knowledge. Distributed cognition theory focuses on the properties of the whole system of people and the artefacts they use, rather than on the details of the interactions between them (Giere, 2002; Giere & Moffatt, 2003). There are objectives, but these are system goals and not those of the individuals.

Duguid (2005) claims that communities of practice go beyond individual learning; in that communities have emergent properties that are the outcome of individual actions, but are more than the sum of these individual actions. The idea of communities of practice, according to Duguid, recognises unseen boundaries and focuses on communities and networks within which practice is coordinated or shared. This description is consistent with distributed cognition theory, in that it also focuses on a learning system and not on individual learning and cognition.

Duguid also contrasts communities of practice with economic approaches to knowledge, which focus on knowledge that is explicit and codified, so that it can be exchanged to facilitate action. Where knowledge has been tacit, this is reflected in high costs associated with codification. Social capital theories, for example, highlight the economic value embedded in social relations, pointing to the value of unseen links between people. Economic theories of knowledge therefore align with activity theory, as described by Daniels (2004), and imply that the value of knowledge is realised through activity.

However Duguid comments that it is "impossible to specify and codify *all* the knowledge involved in even the most elementary practice. [...] Uncodified knowledge provides background context." Referring specifically to university teaching he writes "For all their disciplinary wisdom, teachers are usually unaware of quite what, from their students perspective is on display and of the 'stolen knowledge' that their students carry away." (Duguid, 2005, p.112).

The educational literature reviewed in Chapter 2 indicates a need to accommodate interplay between tacit and codified knowledge as part of individual learning. This interplay is mirrored in, and has a relationship with, the systemic interactions within groups, communities and organizations – in the ways informal community organization and formal organization both complement and constrain each other.

Government legislation and funding requirements mean that universities also have to be formally accountable, to make explicit the value of knowledge and the nature of working relationships. A university can also support student and staff communities and can encourage networking across formal organizational boundaries. But formal organizations and formal education do not operate as communities (Wenger, 2005; Wenger *et al.*, 2002). University work and study are not entirely voluntary and self-organizing. Individuals are accountable within departments for performing the work they are employed to do. Departments and institutions are accountable to professional accreditation bodies and government funding bodies for achieving outcomes that benefit a wider system.

Change in university learning and teaching systems and technologies must therefore involve both the communities and the formal organization of the university. Knowledge of learning and teaching, tacit and codified, exists in distributed form within disciplinary communities and within institutional support systems, as well as in the minds of individual lecturers and higher education researchers.

3.1.2 University change management models

The management literature on organizational change includes a wide variety of models. Kezar (2001, pp 25-57 and 79-112), in an overview of organizational change models applied in higher education, categorizes them and describes how each type relates to change in universities. These are:

Social cognition models, show how participants in an organization interpret external change through the organization's internal mechanisms. For example, the idea of the learning organization accommodates the ambiguities of the higher education environment, by emphasizing discussion and understanding of the change process among participants. However,

there is a difficulty in making university staff aware of mental models that need to be surfaced, examined and altered to bring about change. This difficulty is also evident from the analysis of higher educational literature in Chapter 2. Kezar notes that there has been little empirical research applying social cognition models of change in higher education.

- Evolutionary models acknowledge the need to respond to the university's external environment. One mechanism of response to external change is **homeostasis**, where internal processes and values mediate an adjustment to maintain the overall organizational equilibrium. The data on e-learning adoption cited in Chapter 2 suggests traditional campus universities are displaying some characteristics of homeostasis in their responses to e-learning technologies.
- Teleological models, such as mission statements, strategic planning, total quality management (TQM) and re-engineering have had limited success in universities, especially in relation to learning and teaching. TQM, for example, has failed because it cannot take into account academic value systems. Where strategic planning has succeeded, it has been coupled with cultural change approaches. However, much of the literature focuses on advocating ideal models, rather than studying how change actually occurs.
- Dialectical models are able to explain how change occurs in higher education: through interest groups and power, influencing strategies, informal processes and deal-making, the efficacy of persistence and the role of mediation. Within this, however, political processes can also prevent change, and it is not clear from Kezar's description how dialectical models can guide change management in universities.
- Life cycle models focus on developmental stages in organizations. Kezar notes a lack of such studies in higher education, and that this is also a potential area for future research.

These model categories help in re-interpreting, at the organizational level, the analysis of higher education literature in Chapter 2. For the system of interest in this thesis (Figure 1.1) the higher education literature shows that disciplinary differences and the absence of cross-discipline teamwork have been constraining the adoption of e-learning in campus universities. A teleological approach to integrating e-learning would result in a top-down process, in which a preferred view of learning and teaching is promoted. Such an approach fails to take account of disciplinary diversity. Dialectical models may account for the mix of formal and informal power relationships that influence teaching practices, but would not account for the role of technological change or cross-discipline teamwork. Life cycle models imply that the whole university can be

treated as a single process going through stages of change, and would not distinguish disciplinary differences and technology as system components.

Social cognition and evolutionary models together offer most promise as a basis for research into the response of campus universities to the introduction of e-learning technologies. Social cognition models can take account of disciplinary differences, and address the need for surfacing of tacit knowledge of learning and teaching. Evolutionary models can take account of a university's overall systemic response to new learning technologies.

Social cognition and evolutionary models of organizational change correspond to the systemic perspectives of activity theory and distributed cognition, focusing respectively on the individual in a social and technological context, and the social/technological system as a whole. These perspectives may be combined. Garud and Rappa (1996) put forward a socio-cognitive model of evolution of technologies; linking beliefs of researchers, the artefacts they create and the routines they use for evaluating how their artefacts meet expectations. They describe two cyclic processes linking the individual and social levels of cognition. Although this model is developed with reference to innovation across organizations in general, it can be applied to early adopters of e-learning in different disciplinary departments within a university, as follows:

- In one process, evaluation routines reinforce beliefs. Once the routines become the basis for constructing individual reality, technological claims are perceived as relevant only to those who employ the same routines, and are treated as noise by others. In a university, each disciplinary TLR might therefore adopt only the e-learning tools that match its current shared perceptions of the learning process, filtering the range of options considered. This feedback process also explains why the web-supplemented face-to-face mode of e-learning predominates in campus universities. In the plan-practice-review cycle illustrated in Figure 2.3, the contextual knowledge that shapes the review and evaluation of e-learning tools is based on a limited set of discipline-specific face-to-face teaching experiences.

- The other process is institutionalization through shared cognition, in the form of a common set of evaluation routines, which then shapes the direction of future technological change across the organization. Researchers have to create and believe in their own realities in order to make progress and convince others. Yet they also must be prepared to disbelieve their realities and to embrace an emerging shared reality. Early adopters of e-learning methods in campus universities are in the same position, in that they have to step outside the accepted realities of face-to-face teaching practice in their disciplines. This is where cross-discipline linking, whether through formally constituted teams or through informal voluntary

communities, supports wider adoption and adaptation of the institutional learning and teaching system.

Figure 3.1 illustrates the application of these social cognition and evolutionary process models to the integration of e-learning into the mainstream university learning and teaching, in relation to the individual learning model shown in Figure 2.3. Discipline-based review and planning for teaching practice can be reshaped by exposure to questioning and review from other disciplinary perspectives. Through such review and reshaping, the disciplinary teaching and learning regimes (TLRs) adapt and evolve new shared beliefs and evaluation routines to support new e-learning methods.

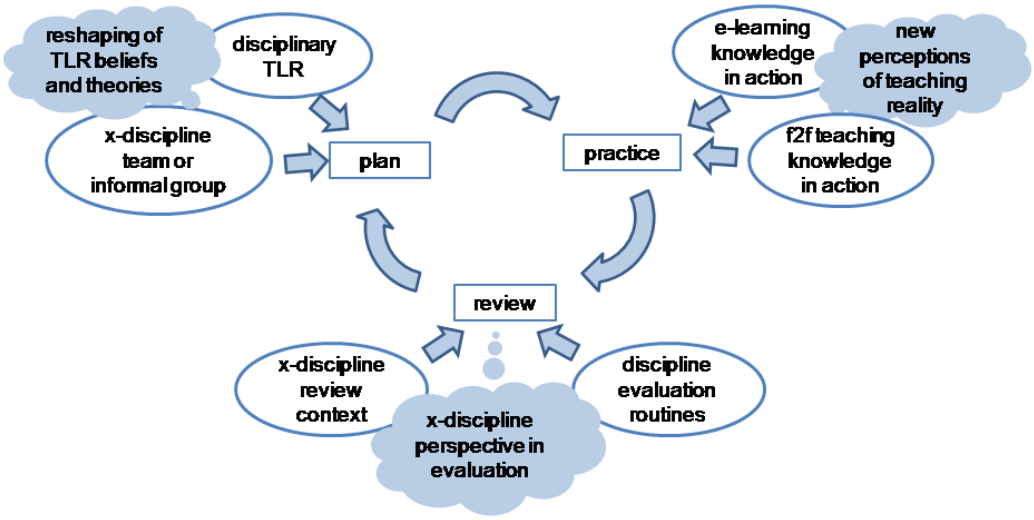


Figure 3.1 Social cognition and evolution process applied to university e-learning

Research Question 1 asks what would motivate individual academics to participate in this process as early adopters. However, individual motivation is only part of the change process. Individuals, teams and communities all work within the constraints of the formal university organizational systems. Social cognition and evolutionary models as described here do not explain in any detail how a shared set of evaluation routines can become part of these formal organizational systems. The widespread adoption of e-learning innovations may be driven by diffusion among a network of peers or near peers, which reaches a critical mass (Rogers, 2003). But Rogers (2003, Ch 10) also identifies a stage where an innovation eventually becomes incorporated into formal organizational routines.

3.1.3 Organizational learning in universities

Social cognition models include idea of organizational learning, which can refer both to the learning of individuals within an organization and to changes in the formal organization itself. Throughout this thesis, I use the term **organizational learning** to mean change that goes beyond individual learning, and brings about an irreversible systemic adaptation of the whole organization to environmental change, in both formal and informal systems. One reason for this choice of definition is that practical application of social cognition models in universities has often been limited to staff development initiatives (Kezar, 2001; Kezar & Eckel, 2002). Staff development on its own has had limited impact on transforming learning and teaching in the UK (HEFCE, 2005). Staff development for individuals is not only shaped by informal social systems. It can also be facilitated or constrained by formal organization.

Stacey maintains that learning can only be understood in terms of interdependent people self-organizing: individuals cannot learn in isolation and organizations can never learn. This interpretation of organizational learning does not recognise deliberate planned changes to formal management systems or to technologies as learning (Griffin, Shaw & Stacey, 1999; Stacey, 2003). The exclusion of formal management systems from the concept of organizational learning is unhelpful for this thesis because informal networks of individual learners do not account for the whole of the change process. In universities, there are people who take on the role of deliberately bringing about change at the institutional level, as managers or as informal change agents who champion particular innovations. Chapter 2 discusses the role of cross-discipline metacognition. Anyone who sets out to change a university learning and teaching system must have some awareness of how that system works at the institutional level.

The work of Senge, Argyris and Schön on organizational learning deals in some detail with the individual learning processes of managers and change agents. Texts by these writers offer guidance and strategies for achieving organizational learning. Senge defines the **learning organization** as involving systemic thinking to identify positive and negative organizational feedback loops, combined with individual and team learning to change **mental models**, which are defined as "the images, assumptions and stories which we carry in our minds of ourselves, other people, institutions and every aspect of the world" (Senge, Roberts, Ross, Roth, Smith & Kleiner, 1999; Senge *et al.*, 1994). Argyris and Schön describe the need for double-loop organizational learning, which controls the long-range systemic response of the organization, as distinct from immediate negative feedback that maintains equilibrium, and they also stress the importance of understanding the consequences of limited learning in individuals (Argyris, 1999; Argyris & Schön, 1996).

There is research evidence that few universities are learning organizations in the sense of systemic adaptation to change (Kezar, 2001). Common barriers to becoming a learning organization include blame culture, a lack of a teamwork and sharing ethos, imposition rather than emergence, and no roll-out of knowledge gained through individual learning (Hodgkinson, 2000). Within campus universities, disciplinary diversity maintains and exacerbates these barriers, as does the tacit and individual nature of much of the knowledge about disciplinary teaching.

Specifically addressing universities in Australia and New Zealand, Cullen applies Vygotsky's social constructivist perspective to the idea of the university as a learning organization – describing a collective zone of proximal development, which involves negotiation of meaning, emergent group cognition and shared expertise in group learning tasks. She comments, however, that universities are "taking on much of the language and philosophy of bureaucratic organizational models that are incompatible with the criteria of a community of learners" (Cullen, 1999).

Ramsden, a key influence in developing the national Course Experience Questionnaire (CEQ) system for Australian universities, focuses on institutional reward systems and the role of the manager in motivating and inspiring staff (Ramsden, 1998). If used as the sole strategy, a focus on management and rewards based upon performance indicators such as the CEQ could promote the bureaucratic organizational models that Cullen criticizes, and which Barnett also argues against (Barnett, 2000a; b). However, perhaps some bureaucracy is a necessary part of teaching quality, for example in ensuring fair and consistent student assessment practices and accountability for use of public funds (Evenbeck, 2001; James, 2003).

Organizational learning then, although widely espoused, has not been generally accepted in practice in Australian universities. There may be good reasons for this. The higher education environment is changing, for example nationally as a result of new government policies and internationally through adoption of online learning technologies. But there is also a great deal of organizational knowledge embodied in the bureaucratic systems and processes of universities. University managers and administrators are likely to resist the idea that their ways of working can be replaced by loosely-knit communities of learners – just as a mathematician might resist the idea that students can develop an understanding of advanced calculus through discovery learning. In bringing about organizational change, the communities of practice have to work with the established systems and processes and the constraints they impose.

If sharing of knowledge within a community requires the surfacing and comparing of individuals' different sets of tacit knowledge, beliefs and value systems, then it is reasonable to suggest that an analogous process is required for organizational learning. Universities consist of discipline-based departments each with their own management structures and decision-making systems

(Becher & Trowler, 2001), built upon the implicit theories and assumptions of different disciplinary regimes. They are different types of "knowing organization" (Choo, 2001). In classroom teaching there are barriers to surfacing essential but tacit learning processes. Some of these learning processes are no longer appropriate for students in the 21st century. Similarly the traditional campus university has organizational systems that have been developed over many years, in an earlier political and technological environment, and which embody tacit organizational knowledge. Some of this tacit organizational knowledge may no longer be appropriate for the 21st century environment.

Achieving organizational change

The various perspectives on organizational change and organizational learning, as analysed above, show a tension between the self-organizing community as part of an organizational learning process and the need for accountability through formal management structures that have become established in an earlier technological and political environment.

Informal networks are important in spreading innovation, yet communities of practice are loose-knit, voluntary, self-organizing groups and no claims are made that they can substitute for, or change, formal organizational structures and priorities.

Organizational learning theories address the relationships between individuals and the formal organizations to which they belong. However there are difficulties in transferring these ideas into university practice – difficulties which are similar in pattern to, and are connected with, those described in the educational literature in relation to applying educational theories to learning and teaching practice.

Kezar points out that applying evolutionary models of change in universities illustrates a "complex interplay between internal and external forces", which can result in a homeostatic response to environmental changes such as new technologies (Kezar, 2001). In biology, **homeostasis** is the response by which organisms make internal adjustments to maintain their equilibrium and the integrity of their function in relation to the physical environment. Campus universities could be responding systemically to e-learning as a disruptive innovation which is creating uncertainty and stress (Rogers, 2003). A systemic homeostatic response would act to limit the impact of e-learning in campus universities, rather than immediately adapting organizationally to take full advantage of it, because of a need to maintain the integrity of the institution's formal organizational systems and processes.

Instead of accepting that the only path to change is through individual and informal community action, it is therefore necessary to examine the relationships between communities of teachers and change in formal organizational systems.

Research Question 2

How can individual teachers, even if they are able to organize in a cross-discipline community to develop e-learning, bring about the changes required in a university's formal organizational systems to enable and support widespread integration of e-learning into teaching practice?

3.2 Universities as complex adaptive systems

This thesis is concerned with a campus university learning and teaching system, as illustrated in Figure 1.1, within which individual teachers work in the context of disciplinary communities and formally organized departments, using institutional support services and technologies. The literature explored in previous Sections of this Chapter discusses how these system components interact with the higher education environment and with each other. However this literature spans a number of separate areas of academic knowledge. Some studies deal with large-scale patterns in the higher education environment, and institutional responses, while others focus on the role of educational technologies. There are theories to explain social and disciplinary perspectives on learning, and theories on individual learning. Even within the theories on individual learning, there are multiple perspectives; including different views on the significance of tacit knowledge, implicit learning processes and the role of social interaction in learning. The literature identifies some links between these different perspectives, for example where individual learning is supported by communities.

However, there are some gaps in knowledge. Research Question 1 arises from gap in understanding of individual teachers' motivation for sharing e-learning innovations across disciplinary boundaries. Research Question 2 arises from a gap in understanding of how the formal and informal types of organization interact with each other and with e-learning technologies.

Social cognition and evolutionary models of change management can deal with complex responses to a changing external environment, including both individual and organizational learning. There is a growing body of management literature that develops these ideas further, in the tradition of systems thinking, by drawing on concepts from evolutionary biology and from physical sciences to develop models of organizational change. Some of this work extends the general concept of organizational learning into more detailed modelling of the interactions of

individuals with their social and organizational contexts. This literature provides systems models that have the potential to link individual teachers' strategies with organizational and technological change in universities.

3.2.1 Systems thinking and complex adaptive systems

A **system** is composed of many interacting parts, with systemic properties that are more than the sum of the properties of the parts (Checkland, 1993). A **subsystem** might be defined in terms of an activity such as face-to-face teaching, a function such as information technology support, or a formal organizational unit such as an academic department.

Traditional campus university systems and practices embody tacit organizational knowledge. At the institutional level the whole of this system may be beyond the awareness of individual teachers, who are simply doing what works for them within local disciplinary subsystems. Checkland (1993) traces the development of systems thinking as a way of accounting for complexity, and distinguishes hard systems, which are technological and goal directed in nature, from soft systems, which are social and negotiated. The campus university learning and teaching system illustrated in Figure 1.1 includes formal and informal organization, hard technologies and defined departmental goals coexisting with informal networks and disciplinary communities. This thesis is seeking to understand how these hard and soft aspects of the university learning and teaching system work together.

Complex adaptive systems models from biology provide a way of combining the hard (material and technological) with the soft (negotiated and social), rather than treating these as two separate types of system. In biological systems, processes of interaction and material structures develop together:

> "The structure of living systems and their actual (material) components are complementary yet distinct aspects of any biological explanation: they complement each other reciprocally but cannot be reduced to one another."
> (Varela & Maturana, 1972).

So a single living cell, for example has a structural pattern or form that includes a cell membrane (system boundary) through which it exchanges material with the environment. Internally, DNA has the function of coding for proteins. The cell is a living adaptive self-organizing system in which the processes of exchange and the creation of proteins develop and change both the material and the structural form of the cell.

A similar systemic combination of structural form and material components in organizations is helpful for understanding the complex interdependence between technological development and social learning interaction identified in the literature on e-learning.

Capra (2002) brings together these ideas to propose a general model for the organization of life in cells and in complex multi-cellular creatures, and which he argues can also be applied to human social organization. The model identifies four interdependent components of any complex organization:

- process
- form or structure
- material
- environment.

Capra suggests that complex adaptive systems theory can be used as a model of human organization, rather than just as a metaphor. He quotes Morgan: "The medium of organization and management is metaphor." (Capra, 2002, p.89) and argues that it is possible to go beyond metaphor to explore a literal understanding of organizations as living systems. He maintains that the organization's "aliveness" resides in its communities of practice.

A university has many cultures, associated with the various academic disciplines and with other roles such as administration. Capra's framework for social knowledge creation is consistent with a model of academic disciplinary communities in which there are emergent disciplinary characteristics associated with knowledge creation processes and patterns of organization (Becher & Trowler, 2001).

Some writers on complexity in organizations focus on self-organisation, and question the viability of intentional management and strategic choice, giving reasons why change cannot be managed (Griffin *et al.*, 1999; Stacey, 2005; Stacey, 1996). These reasons are based on a definition of knowledge and learning as a taking place only within individuals. In this view, organizational processes and structures cannot be made explicit and managed, because organization emerges spontaneously from interpersonal interactions at the local level. This view offers an explanation of how strategic plans can fail in implementation, when they do not take account of local communities and cultures. However, it does account for the power of organizational managers to create the conditions whereby people come together, and under which work requirements and goals are defined (Wenger et al., 2002).

Other writers take a different view, and discuss the role of explicit organizational knowledge and deliberate planning. Nonaka (1994) outlines how organizational knowledge creation involves four modes of knowledge transfer between tacit and explicit knowledge in individuals and also in groups:

socialization (tacit to group tacit)

externalization (tacit to explicit)

internalization (explicit to tacit)

combination (explicit to explicit).

These modes of knowledge creation provide a conceptual link between individual learning processes and organizational learning processes – one which accounts for the interaction of conscious and unconscious learning in both individuals and organizations. This suggests that individual knowledge can become organizational knowledge through a process of socialization. Tacit knowledge held in the working practices of a group or organization can also become explicit, through externalization. Both of these processes are implied in the illustration in Figure 3.1, as part of a combined social cognition and evolutionary model of organizational change in university learning and teaching. The questioning and reshaping of discipline-specific beliefs and the resulting development of a new shared understanding of learning and teaching experience, would involve all four of these modes of knowledge creation.

Nonaka maintains that the Argyris and Schön (1996) concept of organizational learning does not address externalization and socialization adequately, because it assumes that someone has sufficient knowledge to apply double loop learning at the organizational level. "Organizational knowledge creation, as distinct from individual knowledge creation, takes place when all four modes of knowledge creation are 'organizationally' managed to form a continual cycle "(Nonaka, 1994). He refers to Varela's (e.g. Varela & Vermersch, 1998) concept of embodied knowledge, as also contributing to the quality of tacit knowledge. Individuals learn through interplay of tacit and explicit knowledge (reflection in action). So the manager's role is to understand and enable the organizational learning process; rather than to assume global understanding of how each particular change should take place.

Technologies have a role in this definition of organizational learning, in that the organizational mind requires a physical substrate - "patterns of behaviour traced by people and machines" (Nonaka, 1994, quoting Sandelands & Stablein). The concept of distributed cognition is based upon similar systemic thinking, which recognises the role of tacit organizational knowledge co-created by many people, embodied in technologies and existing beyond the awareness of individuals. Organizational structures and physical technologies emerge from learning and interaction between individuals who are learning different things in different ways at the same time.

In summary, having identified that the integration of e-learning in a university involves formal organization as well as the informal communities, and having adopted a definition of

organizational learning that includes changes in formal management systems and technologies, the remainder of this Chapter will focus on literature that deals with the intentional management of organizations as complex adaptive systems.

By **management** I mean not just formal measurement and control, but also the intentional creation of conditions that will cultivate and support self-organizing communities (Wenger et al., 2002). This definition of management is also referred to as the "duality of organizing", involving "a variety of social mechanisms, control mechanisms, incentives and authority structures all coexisting within organizational arrangements" and requiring a "deeper appreciation of organizational complexity" in which "organizing becomes a strategic act, one which must orchestrate holistic change and carefully manage contradictory organizational imperatives" (Fenton & Pettigrew, 2000b, p.9).

The nature of models

In using complex adaptive systems theory to understand complex organizations, it is essential to make modelling choices explicit. Models are attempts to grasp significant aspects of the structure of a complex system and are necessarily a simplification. Any model that fully reflects the complexity of a system would be as difficult to understand as the system itself. It is therefore better to work with a simple model where the limitations are explicit than to work with a complex model that may be a false friend (Cilliers, 2001).

Allen (2001) describes how models can simplify the representation of a complex system, and shows mathematically the implications of each simplification choice for the process of learning and the creation of knowledge. The assumptions/simplifications are:

1. defining a boundary between the system and its environment; for example selecting a particular university and treating other universities as part of the higher education environment
2. establishing rules leading to a taxonomy for classifying system components; for example departments, disciplines, professional roles within a university
3. assuming that the entities or agents underlying system components are either identical or normally distributed round an average; for example academic staff in a university are all alike, or on average have certain academic characteristics, whereas students and support staff each have their own respective sets of characteristics
4. assuming that the individual behaviour of sub-components can be described by average interaction parameters; for example assuming that the interaction between academic staff and students takes place primarily on campus in a classroom setting.

Different combinations of each of these four types of assumption underlie different types of model. Making all of assumption types 1–4 leads to a mechanical representation of change, whereas making only assumptions of types 1 and 2 leads to mathematical models of evolutionary processes where the environment, system components and sub-components all co-evolve in a mutual learning process.

Allen suggests that organizational learning requires a diversity of modelling approaches for making sense of experience in an organization, and furthermore that "diversity will occur naturally unless overcome intentionally by the desire for an organization to correspond to some particular stereotype". Therefore there is an argument for allowing non-average behaviour and internal diversity rather than taking a narrow focus on efficiency; a principle which Allen calls the "law of excess diversity" (Allen, 2001).

Diversity and adaptation

The role of diversity in organizations is followed through in detail by Andriani (2001), who applies complexity theories to organizational learning and develops ideas on the role of **microdiversity** in adaptive behaviour. In complexity theory, internal diversity is needed to achieve adaptability, and is a prerequisite for self-organization. Ashby's law of requisite variety states that, in order to respond to variation, a system needs the capability to generate least as much variety as is in the stimuli it experiences from its environment (Beer, 2004). So in stable environments, once the right degree of diversity is achieved, no further change is needed. A fast-changing environment demands **adaptability**, the ability to change internal functional structure. In evolutionary biology, adaptability is associated with genetic variance, redundant DNA that can be activated when established co-evolutionary strategies fail. In organizations, there is microdiversity in the behaviour of individuals, in that people are formally employed to use only a fraction of their total knowledge and skills. Networks allow people with diverse capabilities to self-organize, which increases diversity further by activating a wider range of capabilities in individuals. So diversity can be cultivated – an idea that contrasts with economic approaches, which seek to codify and quantify the value of organizational knowledge so that it can be exchanged.

An increased rate of technological innovation causes "tectonic shifts" in the structure of industries, including the boundaries between sectors (Andriani, 2001, p263). From the literature reviewed in Chapter 2, Section 2.1, the same may be said of technological innovation in university learning and teaching, with respect to the blurring of boundaries between part-time and full-time study and between off-campus and on-campus learning activities.

There is a corresponding shift in the models, or theories, of university learning and teaching. Theories grounded in e-learning experience make explicit the social nature of learning, which often remains tacit in classroom teaching. Theories focusing on individual learning reflect a different worldview, and a different system map of the university, incorporating different modelling simplifications. The concept of microdiversity can be used to interpret how these simplifications affect a university's response to technological change, and explain why staff development has had a limited impact on transforming university learning and teaching.

A focus on individual staff development for university teaching involves simplifying assumptions of types 3 and 4 in Allen's list (above) – generalizations about teacher skills and behaviours in relation to students. The systemic response of a group of teachers in this model is no more than the sum of their individual responses. A stress on individual learning limits microdiversity, resulting in incremental innovation (Andriani, 2001).

Another view is that systems can also learn, and that this learning can be tacit and experiential at the collective level, as described above (Nonaka, 1994). In this model, individuals can develop diverse and complementary sets of skills and experiences, and as a group can configure these in many different ways as their environment changes – without simplifying assumptions about individuals and how they interact. Self-organizing communities and networks allow for an increasing range of systemic organizational responses to rapid technological change.

In universities, however, self-organization is constrained by the need for accountability for use of resources. Rational allocation of resources is a diversity-reducing mechanism. Bureaucratic organizations have difficulty dealing with unplanned increases in internal diversity, which create resources from the bottom that are largely unaccounted for (Andriani, 2001). A university learning and teaching system with the capacity to adapt to rapidly changing e-learning technologies will therefore continually negotiate between formal and informal organization and will both encourage and constrain the expression of microdiversity.

In summary, integration of e-learning into campus university teaching practice involves mutual and context-specific influences between changes at three organizational levels:

- changed thinking and actions in individual university lecturers
- development and codification of new knowledge in communities
- change in formal organizational systems.

All three levels therefore need to be included a concept of organizational learning for this context. The modelling of organizations as complex adaptive systems leads to further clarification of the

nature of the organizational learning process, and in particular what is involved in double-loop learning (Argyris & Schön, 1996). Following Andriani's example, I will use the term **organizational adaptation** to refer specifically to systemic change spanning individuals, communities and formal organization, and including the physical embodiment of change in tools, technologies and infrastructure. Similarly, **organizational adaptability** refers to a capacity for continued organizational adaptation and technological innovation. Organizational adaptability is associated with diversity of modelling choices and strategies.

Allen's (2001) analysis makes explicit the types of modelling assumption underlying some of the organizational change theories that could be applied in universities. The work of Allen and Andriani (2001) indicates that the disciplinary diversity of beliefs, organizational systems and community behaviours in universities could be a strength at the institutional level. However a diversity of potential responses only increases adaptability if there are connections, or paths, between them to create the possibility of moving from one specialist strategy to another (Andriani, 2001; Kauffman, 2000, ch. 9). The literature reviewed in Chapter 2 indicates that there are systemic barriers to interdisciplinary connections in traditional campus universities, especially in relation to learning and teaching. Complex adaptive systems theory therefore provides a model of the process by which interdisciplinary barriers prevent innovation in learning and teaching.

Maps to navigate complexity and diversity

Individuals each operate with different mental models, which include those developed early in life for dealing with emotional or threatening issues (Argyris, 1999, p.231). Chapter 2 describes how, in universities, socialization into different academic disciplines is also associated with different mental models, including physical and emotional strategies, many of which remain tacit. Adults in a professional context rely on a complex multilayered network of mental models, most of which are unconscious, to make sense of the complex organizations in which they work. Each person in a university develops a different internal representation, or mental model, of how the university works.

Complex adaptive systems theory accounts for the ways in which all mental models, or cognitive maps, of an organization are simplifications of the organizational environment as seen from a particular perspective, each with different simplifying assumptions. Simplifying assumptions are necessary because no individual has the cognitive capacity to understand all perspectives. Different maps suit different roles and purposes. Those in senior management positions have an overview that necessarily lacks current operational detail, although it may incorporate some of their past operational experience. University teachers focus in depth on their own academic disciplines and only have a sketchy understanding of the needs of other disciplines. Support staff

have their own professional perspectives on how the university operates. Each group that works together develops common assumptions and shorthand (language), to allow efficient communication, which become part of each group member's individual cognitive map.

Organizational learning and knowledge is not merely the accumulation or sum or the information in many maps. It is a mutual adaptation of multiple maps to create the responses of a team or an organization as a whole. No individual can understand or control the responses of a whole organization in detail, but complex adaptive systems modelling allows for the identification of patterns of systemic organizational response, through examining how diversity in individual mental models shapes each organization's adaptability.

3.2.2 The mathematics of organizational change

Complex adaptive systems models of organizational adaptation offer some insights for understanding the relationship between organizational adaptability and the rate of technological innovation in universities. The theory supports mathematical modelling of organizational adaptation as a systemic whole; consisting of individuals who organize around their own priorities and within local organizational and social environments in relation to a wider environment. Such modelling could show how individual academics contribute to the systemic interaction of the whole university with new e-learning technologies. Modelling a university's adaptation to e-learning technologies in this way would therefore help in addressing Research Question 2, by linking individual, community and institutional changes.

Models of individual strategies as part of an organizational response

Mathematical modelling is used in economics to predict the systemic behaviour of markets based upon individual decisions. For example, game theory shows the interdependence of individual or organizational decisions, and is taught in management degree programmes (e.g. AGSM, 2003). The work of the Santa Fe Institute builds on game theory and applies complex adaptive systems theories from evolutionary biology to model economic systems (Kauffman, 2000; Kauffman, Lobo & Macready, 2000).

Evolutionary biology uses the idea of the fitness landscape to model adaptive responses to environmental change. Figure 3.2, taken from an MIT course on quantitative genomics, is an example (Berwick, 2005). Organisms evolve to reach a local peak of fitness within their environment. However, this may not be the optimum over a wider range of possibilities. If environmental conditions change, the fitness landscape shifts and species adapted to one local peak or niche can find themselves in a trough.

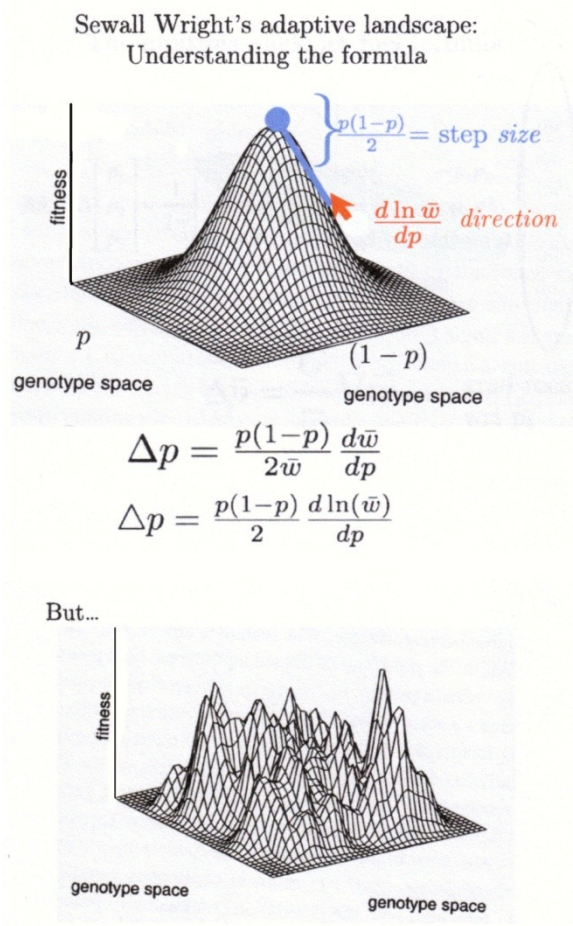


Figure 3.2. An example of fitness landscape modelling in genetics (Berwick, 2005)

Gavetti and Levinthal (2000) apply the mathematics of fitness landscape modelling to organizational strategy, placing established approaches to organizational strategy development (modelling choices), as defined in management literature, in three dimensions: online-offline, local-distant, limited-extensive.

- The online-offline dimension is the extent to which individuals engage in activity or theoretical reflection in order to evaluate alternatives. In university teaching, this would be equivalent to the balance of classroom trial and error with study of educational theories.

- Limited means that the number options being considered is small – for example an assumption that there are only two choices of teaching method. Extensive means that many options are being considered.

- Local search means that only small changes from the current practice are included in the options. Distant means that radical changes are considered, in other words transition to another peak in the fitness landscape.

The results of Gavetti and Levinthal's model show that organizational change prompted by a major shift in cognition can be costly, especially when there is a high degree of interdependence among actions, in that prior experiential wisdom may be negated (Gavetti & Levinthal, 2000). These findings are consistent with the observation in the previous Section, that university teachers and administrators may have good reasons to resist radical change in organizational practices. However, simplifying assumptions in the Gavetti and Levinthal model are that the landscape is static, and that learning takes place through individual experience. Social learning process are not included (Gavetti & Levinthal, 2000).

Empirical research on successful innovation

The mathematical models of complex adaptive systems described thus far in this Section have been theoretical. There are models which use similar mathematical methods to interpret the experience of change and innovation in particular industries and organizations. The following examples demonstrate patterns similar to those evident in the higher education literature.

One mathematical modelling study uses historical data from change in the US radio broadcasting industry to link individual cognition variables with observed organizational behaviour. The results show that the effect of one organization introducing an innovation is to cause many non-imitative changes in other organizations (Greve & Taylor, 2000). A conclusion from this modelling study is that learning about an innovation is a springboard which changes the high-level mental models used to interpret information and to evaluate outcomes. In terms of the Gavetti and Levinthal (2000) model, this is a cognitive shift that can extend the strategic search to more extensive and to more distant options. The outcomes will be different, and possibly less radical, choices than the innovation that prompted the cognitive shift. These findings could therefore have relevance for interdisciplinary sharing of teaching ideas, which introduces discipline specialists to the possibility of different teaching methods. Cross-discipline sharing of innovations need not lead to wholesale abandonment of current practices to move to a new teaching and learning regime. It may lead to an increased rate of incremental improvements, prompted simply by increasing the number of potential solutions that are being considered.

Another study uses data from 381 teams drawn from the Hong Kong and US branches of an international bank in a mathematical model of the effects of individualist and collectivist cultures on team performance (Man & Lam, 2003). The findings indicate that an increase in job complexity and/or task autonomy will increase group cohesiveness, which subsequently translates to better performance. The positive feedback effects of job complexity and autonomy on group cohesiveness are also found to be more prominent for individualistic than for collectivistic work groups. Some academic disciplines are more individualistic than others (Becher & Trowler, 2001).

The findings from the banking team model, transferred to university learning and teaching, would imply that an increase in the complexity of teaching work, for example through the introduction of new technologies, would be associated with more effective teamwork. The literature on higher education theory and practice indicates that the converse is happening in traditional campus universities, in that the lack of support for teamwork is associated with an inability to perform complex tasks using new technologies.

Complementarities

Empirical studies of technology-related change in manufacturing industries have applied complex adaptive systems theories in rigorous mathematical models based upon game theory. One analysis (Milgrom & Roberts, 1995a) develops a mathematical argument to show how any complex human organization will settle into a pattern of **complementarities** in which individuals and departments have adjusted mutually to each others' activities, to create a systemic adaptation to the organization's environment. Complementarities are a mathematical model of what is intuitively referred to as synergy (Massini & Pettigrew, 2004), corresponding to symbiosis in biological systems. The concept comes from economic theory, and means that "doing *more* of one thing *increases* the returns of doing *more* of another" (Milgrom & Roberts, 1995a, italics in original).

The complementarity analysis is significant because it establishes that detailed modelling of individual decisions is not needed in applying the theory to real organizations "so long as the firm's objective can be divided up among a set of complementary effects that extend across sub-units" .... "even mistaken variations from a plan are less costly when they are coordinated than when they are made independently". Complementarity is symmetrical: "If doing more of *x* increases the returns from doing more of *y*, then doing more of *y* will increase the returns from doing more of *x*. (Milgrom & Roberts, 1995a).

Large scale empirical studies across other types of organization have confirmed that successful organizational adaptation requires simultaneous management of complementarities across various aspects of organizational structure and process. A major international research programme on innovative forms of organizing (INNFORM) in 18 large companies between 1992 and 1996, explored the existence of complementarities, and found that complementary changes had a positive effect on performance (Massini & Pettigrew, 2004). Examples included those between human resource management practices and information technology. For formal organizations, identifying patterns of complementarity helps management of the transition from one way of working to another.

The main insight offered by the concept of complementarities is the case-based evidence that piecemeal change initiatives are unlikely to succeed because of the interdependence of different systems. Complementarities explain in detail how the homeostasis effect works in organizations. Tackling one change at a time means that the J-curve effect (things get worse before they get better) is prolonged. The J-curve is the profile of a path through the trough between a local peak in the fitness landscape and a neighbouring higher peak. For example, if a new structure, or a new technology, is introduced, it is likely to clash with existing belief systems, work practices and established relationships with other groups or organizations. The results will be worse than before, and the change will be rejected as a failure (Pettigrew et al., 2003, chs 6-9). Manufacturers who have successfully moved to from mass to flexible manufacture have changed several of these interdependent variables at the same time (Milgrom & Roberts, 1995a). The literature reviewed in Chapter 2 indicates that traditional campus universities have been lingering at the bottom of the J-curve in their attempts to integrate e-learning into mainstream learning and teaching systems.

Milgrom and Roberts (1995a) prove mathematically that the systemic pattern of complementarities applies regardless of detailed conditions. The validity of the detailed mathematical arguments are beyond the scope of this thesis (and beyond my own mathematical expertise) to judge. However, if taken on trust, as refereed academic work that has been cited in many other subsequent publications, the findings are relevant for introducing technological change in universities as well as in manufacturing industry. The implications are that even mistaken variations from a plan are less costly when coordinated than when undertaken independently. Therefore, identification of the complementary effects and associated strategic choice variables is more important than specifying detailed conditions and actions.

If there is no need to specify detailed modelling conditions, then there is no need to make simplifying assumptions that would render the model incapable of including the effects of microdiversity in adaptation, as described by Andriani (2001). For example, in modelling individual academics' responses in a university, there is no need to assume that all academics have similar characteristics when in reality they vary widely between and within disciplines, and individually are capable of a wide variety of responses in different circumstances.

The role of diversity in a complex environment

Barnett (2000a) characterizes the university environment as supercomplex. Complexity theory implies that there are universal patterns in human organization. If this is so, then empirical research into the internal response of organizations to external complexity will have some relevance for universities, in that the general patterns of adaptation will be similar, even if the

purpose and context of the organizations studied are different. A study across many hundreds of manufacturing plants showed that those operating in a high complexity environment developed corresponding internal complexity in the form of diverse and interconnected internal structures, which enhanced their inherent adaptability (Größler, Grübner & Milling, 2006). This study also found that different combinations of explicit (consciously managed) and implicit (without conscious management) adaptation processes are used as external complexity increases. These findings therefore not only support the theory that internal diversity is central to organizational adaptability, but also confirm that organizational adaptation involves both implicit and explicit organizational learning, as described by Nonaka (1994).

Dualities

The INNFORM programme cited above explored the management of **dualities**, an aspect of the internal complexity required to respond to external complexity and change. The concept of dualities corresponds to similar ideas in physics, philosophy and social science, in which options that are often described as binary opposites occur together. In physics for example, waves and particles are quite different phenomena, yet both models are needed to describe the observed behaviour of an electron. The term duality is used, rather than "paradoxes, dilemmas, dialectics, conflicting goals and values" (Sanchez-Runde & Pettigrew, 2004, p.245) because a diversity of maps and strategies is needed to adapt in a complex environment. Sanchez-Runde et al. (2004) list four complexities in the management of dualities:

1. Dualities are inevitable, endemic and cannot be escaped or solved.

2. Dualities are uncomfortable and messy, a little out of control and unpredictable.

3. Balancing of dualities has to be addressed in dynamic and spatial terms, within the context in which they are embedded, through exploring rather than suppressing tensions.

4. Managing of dualities requires being sensitive to both content and process, for example balancing continuity and change, sometimes escalating issues and sometimes confining them, linking micro and macro aspects, centralizing and decentralizing.

Evidence from the programme established that new forms of organizing are supplementing and not replacing more traditional organizational practices. Companies simultaneously build hierarchies and networks, centralize and decentralize (Sanchez-Runde, Massini & Quintanilla, 2004). Dualities are an aspect of diversity in organizational form. Several types of duality are evident in the literature on higher education: process and outcome focus, tacit and explicit knowledge, communities and formal organization. Similarly, research and teaching are often

placed in competition with each other (Metcalf et al., 2005), but are also considered to have a complementary role in innovation within disciplines, as part of the "research-teaching nexus" (Griffiths, 2004). Research and teaching therefore also form a duality – one which may benefit from systemic interdisciplinary perspectives (Porter, Roessner, Oliver & Johnson, 2006).

3.2.3 Models for the integration of e-learning in universities

The response of traditional campus universities to the introduction of e-learning displays characteristics of homeostasis. Complex adaptive systems theory suggests that the similarity with biological homeostasis is not just a metaphor, but is a universal pattern of organization occurring in many different types of complex system, which can be modelled mathematically.

Process, form and material

Modelling an organization as a complex adaptive system brings an understanding of organizational learning in which learning processes, forms of organization and material technologies co-create a whole that is part of a wider environment. Within the organization, a diversity of individual learning processes, mental models (cognitive maps) and capabilities co-create each other. Individuals are each influenced by their social/organizational context. This fundamental process–form–material model (Capra, 2002), provides a conceptual framework to account for multiple disciplinary perspectives and for the role of individual teacher strategies in the response of the university as an organizational system to the introduction of e-learning technology.

Mathematical models

Mathematical modelling of organizational adaptation offers several insights into the underlying organizational processes that help and hinder the integration of e-learning into traditional campus universities.

- Fitness landscape modelling explains how individual cognitive maps and strategic choices combine to create an organization's systemic responses to events in the organization's environment.
- Empirical modelling studies show (1) that innovations lead not just to imitation, but also to changes in high-level mental models, or metacognition that change is possible; (2) that there is a feedback loop between effective teamwork and the complexity of work tasks.
- Models of how organizations successfully managed a major transition in manufacturing technology demonstrate the concept of complementarities as a fundamental pattern that

applies to all complex organizations. Similar complementarities have been found in other industries.

- In a complex environment, organizations require internal complexity, diversity and the ability to accept and manage dualities.

Diversity of models and maps

Theoretical studies make explicit the limitations of all models of complex adaptive systems. Different choices of simplifying assumption result in different types of organizational model. The greater the need for organizational adaptability, the greater also is the need for a diversity of organizational models. Diversity, in the form of many individual cognitive maps and potential strategies, along with the ability for people to adjust their maps through social interaction across formal organizational boundaries, is how organizations adapt to change.

University learning and teaching contains much disciplinary diversity, and the literature on organizations as complex adaptive systems suggests that diversity plays a central role in adaptation. Cross-discipline networks enhance the diversity of models, maps and strategies available to the university as a whole. Successful organizational transformation will therefore involve managing a diversity of strategies across discipline boundaries.

Complementarities and dualities

Empirical research using complex adaptive systems theories explains organizational adaptation involving technological change. The concept of complementarities shows how successful organizational transformation associated with the introduction of a new technology requires simultaneous management of several interdependent organizational subsystems. Complementarities are a generic mathematical property of all complex organizations and do not depend on detailed modelling assumptions. Empirical research indicates that any strategy that addresses these complementarities simultaneously will be more successful in bringing about transformation than any piecemeal strategy.

Complementarities explain how a university's homeostatic response to the introduction of e-learning technologies comes about. Individuals and groups within the university experience the introduction of e-learning as something that does not fit well with the systems they work within, and which they believe they are unable to change. Their strategic options are constrained by discipline-specific or role-specific cognitive maps of the organization. The local experience of change is that it lowers rather than increases fitness for the task in hand, especially if that task is being carried out by an individual without the support of a team. To integrate new e-learning

technologies into campus university learning and teaching systems, it will therefore be necessary to identify what the relevant complementarities are and to coordinate changes in these complementarities.

Some of the diversity in a complex adaptive organizational system is in the form of dualities, binary opposites that coexist and complement each other. In universities these might relate to processes and tangible (material) outcomes, tacit and explicit knowledge, research and teaching priorities. These dualities need to be balanced dynamically rather than regarded as opposing strategies.

Consideration of research on complex adaptive systems modelling of organizational adaptation, combined with the findings from literature on higher education and on the management of change in universities, therefore leads to the following research question.

Research Question 3

How do the strategies of individual university teachers co-create the systemic organizational response of a university to e-learning technologies?

In particular:

(a) what systemic complementarities are important for the successful integration of e-learning in the teaching systems of traditional campus universities?

(b) how can management of disciplinary diversity and the various dualities inherent in university organization contribute to successful integration of e-learning?

Chapter 4. The university as a complex learning system: a conceptual framework

Abstract of Chapter 4

This Chapter uses complex adaptive systems theory to develop a conceptual framework for addressing the three research questions, suggesting research focusing on the strategies of individual lecturers.

Theoretical and empirical research provides examples of how human organizations and the technologies they use adapt together, to guide the search for the complementarities involved in adoption of e-learning in universities. Knowledge about those complementarities (Research Question 3) is distributed across university teachers who are developing strategies for using e-learning in their own disciplines.

University learning and teaching can be represented as an organizational system operating at different levels – individual, disciplinary departments or communities, and institutional. At each level there is interaction involving organizing processes, forms of organized activity, material resources and technologies, all of which co-create each other over time within a context. This conceptual framework enables clarification of the modelling simplifications used in different research perspectives. Once simplifying assumptions are defined, it is possible to model how e-learning may become organized in a campus university, involving individual lecturers, their disciplinary communities and the formal organizational systems (Research Question 2).

Adaptation of a campus university's learning and teaching system ultimately depends on how individual lecturers change their strategies. In particular there is a need for lecturers to make connections across disciplinary boundaries, to increase the diversity of strategies available to them, as part of an organizational learning cycle. Adding the dimension of material technologies to existing models of academic disciplinary knowledge and organization provides a model that can be used in a study of individual teacher strategies for using e-learning (Research Question 1).

A study of the influence of cross-discipline interaction on teacher strategies, in relation to themes identified in the higher education literature as problematic for the introduction of e-learning, would address all three research questions.

4.1 Systemic complementarities involving changes in organizations and their technologies

University learning and teaching can be viewed as a complex adaptive system, consisting of individual members of staff (academic and support) each with a different perspective and a different set of strategies available to them for doing their teaching-related work. These diverse strategies are co-created with the formal and informal organizational context of the university, at department and at institutional levels. Changing one component of a complex adaptive system will disrupt its interactions with other system components. A common systemic response to such a change is to make homeostatic adjustments that minimize the effect of the change. However, in an environment where students and governments require changes in learning and teaching, there is a need to coordinate change across several complementary subsystems. Theories developed from research into the adoption of new technologies in other contexts can help to explain the patterns observed in e-learning adoption in campus universities.

4.1.1 Manufacturing parallels and differences

Detailed mathematical modelling studies, supported by empirical evidence, have established that complementarities occur in technology-related organizational change in manufacturing and in other organizational contexts (Fenton & Pettigrew, 2000b; Massini & Pettigrew, 2004; Milgrom & Roberts, 1995a). Complementarities are a general characteristic of complex systems, which means that are always strategic advantages if individuals and subsystems coordinate their strategies. An example is the benefit to computer users of focusing on one or two standards, so as to ease the development of complementary operating systems, applications and hardware (Milgrom & Roberts, 1995a).

Figure 4.1 represents the network of complementarities found in companies that had successfully transferred from mass manufacture to computer-aided flexible manufacturing. Each box shows the mass manufacturing characteristic compared with the corresponding flexible manufacturing characteristic.

In university learning and teaching, an analogous shift might be from mass distance education methods using fixed media to online learning technologies. Fixed media are associated with sequential development of course materials, long production runs and infrequent updates. Online learning allows for more frequent updates, more customization and requires different configurations of specialist skills. The educational literature indicates that this transition has successfully taken place in a number of distance universities (OECD, 2005a).

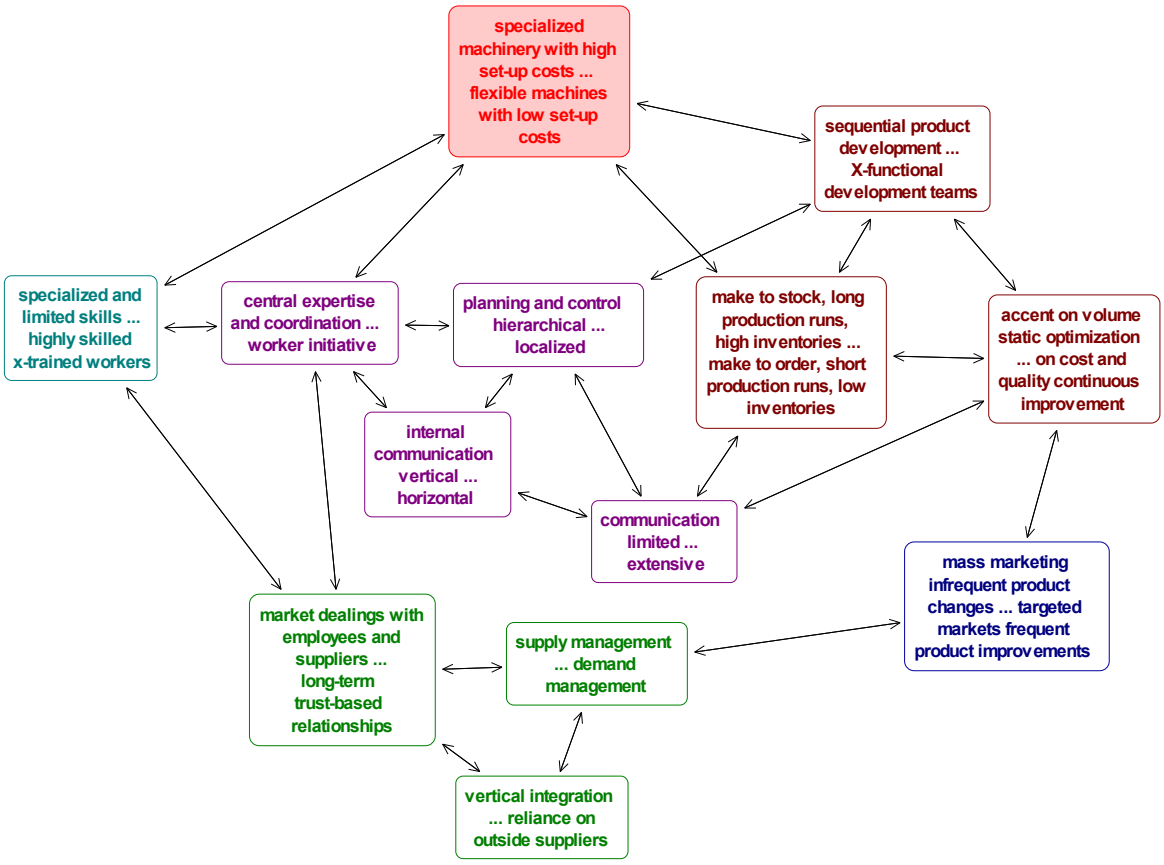


Figure 4.1. Complementarities in moving from mass to flexible manufacturing [mass manufacturing characteristic ... compared with flexible manufacturing characteristic] (based on Tables 2 and 3 in Milgrom & Roberts, 1995)

Figure 4.2 summarizes the organizational areas or systems involved in the changeover in manufacturing. Research spanning a range of industries has found complementarities similar to those illustrated in Figure 4.2. The double-headed arrows imply a mutual influence or interdependence. The INNFORM survey (Massini & Pettigrew, 2004) found that introducing boundary changes (e.g. outsourcing and alliances), internal processes (e.g. human resources and internal communications) and structural changes (e.g. delayering and decentralization) together improved overall performance. However, introducing only one or two of the three types of change is likely to reduce performance.

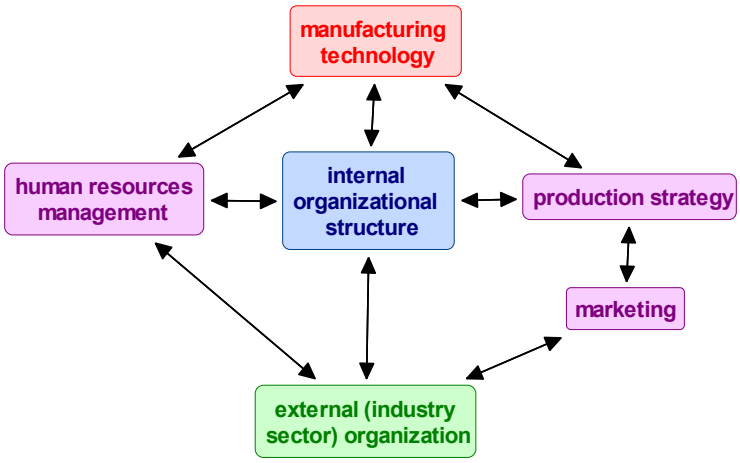


Figure 4.2. Aspects of organization involved in the complementarities in manufacturing

For campus universities, the educational literature indicates that face-to-face teaching is traditionally an individual or small-scale activity, in which many activities remain unorganized at the institutional level. Introducing e-learning in a campus university is more like moving a number of co-located but sparsely connected cottage industries directly to flexible manufacture, than moving from to mass to flexible manufacturing. The literature on higher education indicates that the advent of e-learning brings opportunities to extend the range and improve the quality of student learning experiences. But the changes needed are not limited to the practice of individual teachers. Other organizational factors within the campus university environment are also hindering the full integration of e-learning into teaching practice.

4.1.2 Finding complementarities in university learning and teaching

The mathematical theory of complementarities addresses the effect of simplifying assumptions inherent in any modelling exercise, and shows that the pattern of complementarities is not sensitive to detailed simplifying assumptions (Milgrom & Roberts, 1990; , 1995a; b). This implies that there is no need to model particular strategies or events in detail in order to manage complementary changes in university learning and teaching systems. It is enough to identify which parts of the university system are interdependent and to coordinate the changes in these (Research Question 3), rather than attempting to change one thing at a time.

The educational literature reviewed in Chapter 2 offers clues to some of the key complementarities for the transition from traditional campus classroom teaching to a blend of face-to-face and e-learning. The individual nature of classroom teaching contrasts with the teamwork involving support staff required for e-learning. The tacit and discipline-specific aspects of classroom learning contrast with the explicit design of social interaction required in e-learning

media. All of these factors are likely to be reflected in institutional support systems for staff recruitment, training and career development, and also in way that learning and teaching is organized and managed within academic departments.

The integration of e-learning technologies into mainstream teaching practices has the potential to help universities in designing curricula and study modes that meet changed student needs. But these changes are out of kilter with recruitment and career development systems, and with organizational structures and cultures that have co-evolved with traditional full-time undergraduate campus classroom teaching.

Figure 4.3 summarises types of internal organizational complementary change associated with the introduction of e-learning technology in a university corresponding to those shown in Figure 4.2. The additional link shown in Figure 4.3, between learning and teaching processes and the social and political context of higher education, is there because the value of learning and teaching (L&T) is realised through student participation in the process and not through subsequent marketing of a product.

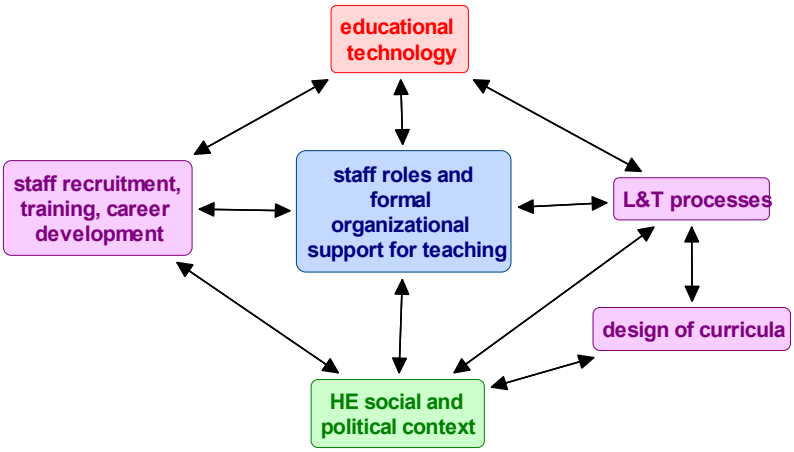


Figure 4.3. Aspects of teaching in HE analogous to manufacturing complementarities

A complementarities model based on similarity with manufacturing, however, has the limitations of all models and may over-simplify important aspects of campus university teaching. Figure 4.3 is intended to illustrate the general nature and scope of the interdependencies and not to suggest that what is shown summarizes accurately the key complementarities in university learning and teaching systems.

Complex adaptive systems theories of organizational change suggest that it is impossible for anyone to have a complete understanding of how a university's learning and teaching works as a

whole system. University leaders and managers are no more likely than anyone else to know what complementarities are influencing the detailed strategies of individual teachers in different disciplines. As organizational knowledge, the complementarities may be tacit rather than explicit. That is, departments work apparently separately to complement each others' functions, in much the same way that members of an established team perform complementary roles in a routine task without any need for discussion. Only with the introduction of new types of task is there a need to renegotiate and to make explicit who does what. By the same logic, teachers who are trying to adopt e-learning methods will become aware of which established university systems need renegotiation and reconfiguration. Each teacher has only a partial view, but together their collective knowledge is far more than the sum of its parts.

The knowledge sought in Research Question 3 is therefore distributed across many diverse individual teachers, and in particular those who are early adopters of e-learning.

4.2 A systemic framework for university learning and teaching

The university can be represented as a system in which processes, structures and material technologies are co-created in relation to the higher education context of the university. The co-dependence between these four aspects of organization is illustrated as a tetrahedron in Figure 4.4. For brevity, I will refer to this generic framework, which draws upon Capra's (2002) synthesis of complex adaptive systems ideas, as the **ProForMaC framework**

The complementarities represented in Figures 4.3 show relationships between all four vertices of the tetrahedron. Staff roles and formal organization complements learning and teaching processes and staff management processes, and there are also interdependencies with the higher education environment and with learning resources and technologies. Even the summary representation in Figure 4.3 shows ten different co-dependencies. Investigating all of the more detailed components of these co-dependencies, as represented in the higher education literature, would result in a model so complex as to be useless as a guide for action. Some simplifying assumptions are necessary to carry out meaningful research.

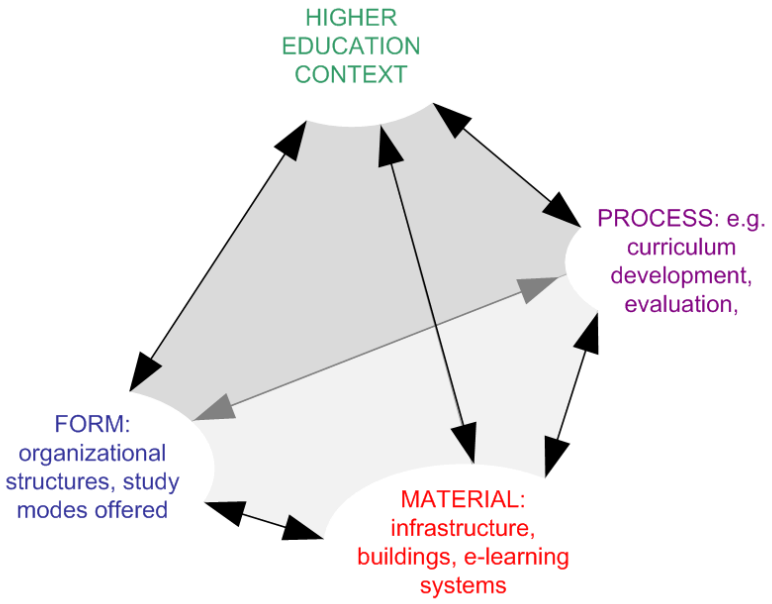


Figure 4.4 ProForMaC framework applied to a university learning and teaching system

4.2.1 Simplifying assumptions

The empirical work carried out as part of the INNFORM research programme included a large scale survey of organizational change, analysed for complementary changes in structure, process and boundaries. Figure 4.5 shows the categories of organizational change examined. Boundaries are the organization's relationship with its industry environment or social context. Processes are how the organization interacts internally and across boundaries with the environment. Structures refer to the organizational forms adopted, such as the size and formal responsibilities of departments and teams. Better performing organizations were characterized by denser connections between changes in structure, process and boundaries (Fenton & Pettigrew, 2000b). Specific technologies were not included, except as a process of investing in new technologies, as the research covered many different industries and service sectors. The survey therefore focused on the form–process–context facet of the tetrahedron.

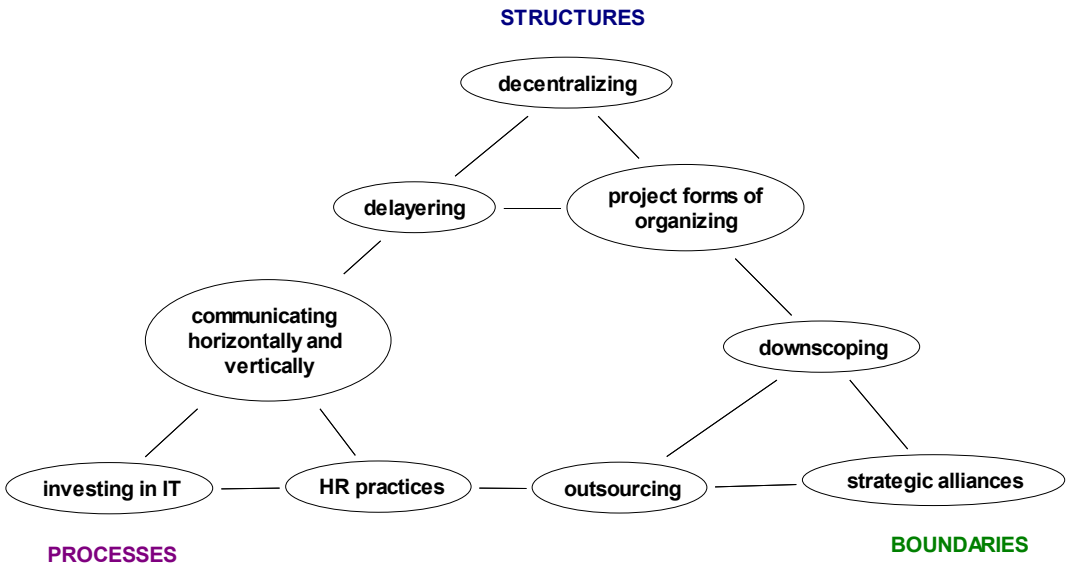


Figure 4.5 Variables in the INNFORM survey of complementary organizational change (based on Figure 1.2 in Fenton & Pettigrew, 2000b)

Research that focuses on how an organization's administrative systems and processes influence its strategic position (boundaries) is referred to as "strategy process research". Strategy process research is contrasted with "strategy content research", which focuses primarily on the organization's performance in relationship to its environment, and may also take into account technologies and resources, but without any attention to the internal organizational process involved (Chakravarthy & Doz, 1992). In terms of the tetrahedron representation in Figure 4.4, strategy process research is concerned with the context–form–process facet of the tetrahedron, and strategy content research focuses on the context-resources edge.

Research Question 2 focuses on the interrelationships between organizational processes, organizational structures, and technologies – in particular the role of interdisciplinary (horizontal) communication in the communities of practice, which Chapter 2 has identified as essential for organizational adaptation.

Boundary changes such as strategic alliances and outsourcing may be relevant for mass distance education. An example that comes to mind from my own experience is co-publishing or buying in of learning media. However the higher education literature indicates that the barriers to integration of e-learning in traditional universities are primarily in the internal relationships between individual and discipline-specific learning and teaching processes, decentralization of organizational structures along disciplinary lines with no provision for cross-discipline horizontal communication processes, and in the unsuitability of these arrangements for effective development of e-learning.

Interpreted in terms of the ProForMaC framework in Figure 4.4, Research Questions 2 and 3 relate primarily to mutual adjustments between the bottom three vertices of the tetrahedron in relation to changes in the higher education context. The literature reviewed in Chapters 2 and 3 indicates that campus universities are attempting to introduce new learning resources and technologies without complementary changes in the way that learning and teaching is organized and supported. The process of relying on individual teachers to adopt new technologies and methods is self-limiting, or homeostatic. The number of Individuals who have moved beyond mainstream learning and teaching systems may never reach the critical mass needed for systemic change.

A conceptual framework for addressing Research Questions 1–3 requires a model of how individual teachers interact with each other as part of this wider university system.

4.2.2 A systems model of a university

The literature on organizations as complex adaptive systems suggests that it is necessary to make modelling simplifications explicit. The development of the Research Questions incorporates some assumptions about system boundaries and about the nature of its components and the interactions between them. These assumptions are listed below in terms of Allen's (2001) four types of simplification.

System boundary

Research Questions 2 and 3 focus upon the mutual influences among organizational forms, organizational processes and e-learning technologies within a university, with respect to learning and teaching. The system boundary therefore encompasses all aspects of a single university's learning and teaching, within the Australian higher education environment. The environment includes factors identified in the literature cited in Section 2.1, as significant in the adoption of e-learning. These include other universities, the Australian and international markets for higher education and government funding bodies. Students are represented in the HE markets as are employers and other sponsors. It is assumed that the system boundary does not change in any way that is significant within the scope and timescale of this thesis.

System components

The educational literature identifies that there are different disciplinary communities, with distinctive teaching and learning regimes, belief systems and ways of organizing. Within the university these align with formal organization of disciplinary departments. One set of components of the university is therefore assumed to be the different disciplines, which may

be characterized in terms of their teaching and learning regimes, their views of knowledge and their traditions of departmental organization. Other components featured in the educational literature are cross-discipline communities, staff development initiatives and other central support for learning and teaching.

Differences between teachers

The agents of change in this system are individual teachers, each of whom belongs to a disciplinary community, and may also belong to other cross-discipline communities. Using the concept of complementarities means that it is not necessary to make any assumptions about teachers having uniform or average characteristics. On the contrary, their individual and disciplinary diversity, and their ability to interact and change each others' characteristics, is central to the research questions.

Interactions between teachers

The interactions between teachers, or groups of teachers and other components of the university learning and teaching system are also assumed to be changing dynamically, and are therefore neither uniform nor distributed about a mean.

Figure 4.6 shows the system boundary and components. Individual teachers are numbered only to indicate that the model allows for them to differ from each other. The numbers have no other significance.

Using the simplifications listed above results in a model of a university's learning and teaching activities as a system, within which disciplinary departments, central support for learning and teaching and cross-discipline communities are components. Individual teachers are the primary agents of change within each of the system components. Individual teacher strategies for using e-learning therefore contain information about the relationships between informal and formal organization components, and about the potential for these components to adapt (Research Question 2).

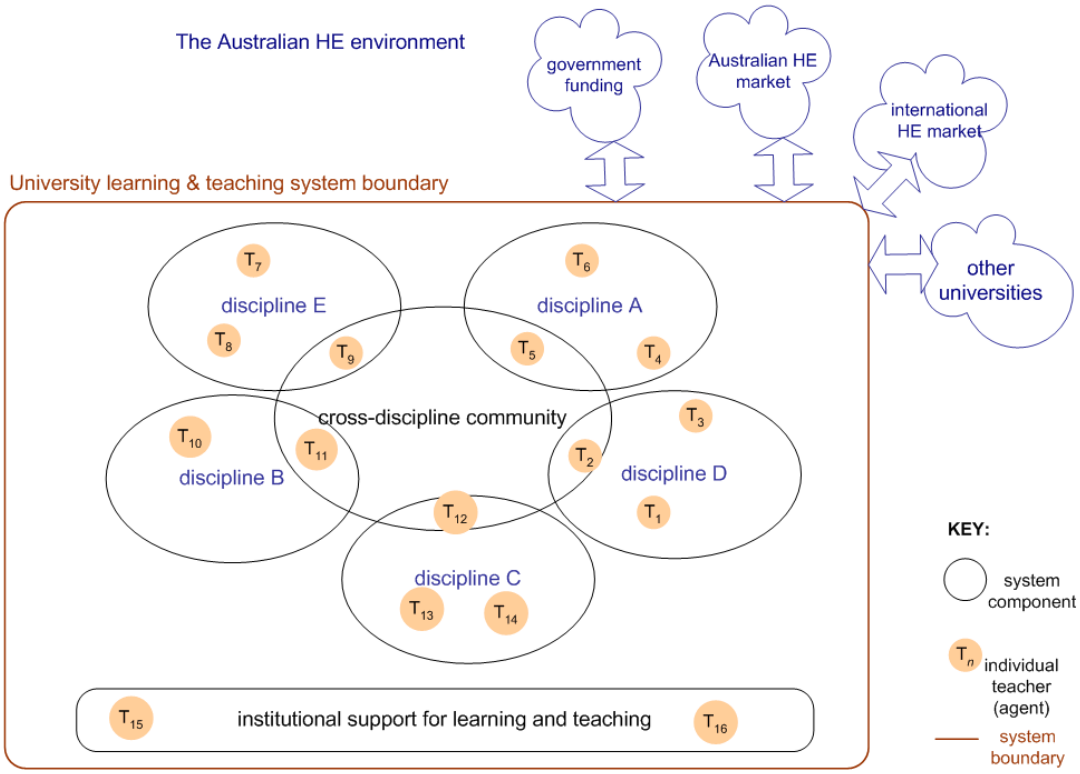


Figure 4.6 University learning and teaching as a system

4.3 Disciplines, departments and diversity

Although university teaching is organized within disciplinary departments, with support systems that work across disciplines, the educational literature indicates that teaching in traditional campus universities is largely dependent upon the strategies developed by individual lecturers. Institutional support systems and disciplinary departments can all be vewied through the lens of individual lecturer strategies. Links between theories of individual cognition and theories of organizational adaptation account for the role of diversity in individual strategies, including the influence of academic disciplines.

4.3.1 Disciplinary and individual diversity

Chapter 2 establishes that there is a wide variation in disciplinary understanding of knowledge, of learning and teaching, and of how teaching is best organized. There are different belief systems, different forms of academic community organization, different teaching and learning regimes. Some educational theorists seek to provide a uniting overview based on the principles of educational psychology. Others take a more pragmatic view and recognise the difficulties in attempting to rebuild teaching and learning regimes from first principles. E-learning literature pays attention to the social dimension of learning whereas classroom teaching literature often focuses on the individual teacher or learner, leaving the social dimension tacit.

This diversity is inevitable, in that disciplinary teaching is a result of many diverse influences. Any individual teacher, or educational support professional has access to only a limited subset of these influences. All have different maps of what it is to be a university teacher. Complex adaptive systems theory shows that this diversity is not only inevitable, but desirable, as it adds to the university's ability to adapt. The main barrier to adaptation in learning and teaching systems is not diversity, but a lack of connection between disciplines. There is a scarcity of pathways between the different disciplinary teaching and learning regimes (Trowler & Cooper, 2002).

On a learning and teaching fitness landscape spanning a whole university, teachers' strategies are stranded on isolated local disciplinary peaks, with only local knowledge, much of it tacit, to guide them. Metaphorically, a teacher might be able to see higher ground in the distance, but lacking larger-scale maps, will usually choose not to make the journey through the uncertain bottom of the J-curve (Figure 4.7).

Figure 4.7 Disciplinary learning and teaching fitness peaks?

The role of microdiversity, in the form of widely varying individual capabilities and potential strategies, explains how a small amount of networking and sharing of e-learning knowledge between disciplines can grow. An increase in the range of strategies available to some individuals drives a positive feedback loop that opens up more strategy options for others. In terms of the metaphor in Figure 4.7, once a few pioneers map out safe routes for others to follow, the routes can eventually become well-trodden paths as more people use them.

Cross-discipline networking therefore increases the diversity of strategies that individuals have available to them and are able to activate. Even if only a few individuals initially have the motivation and capability to adopt e-learning methods, the more diverse these motivations and strategies are, the more likely it is that they can link up to bring about an irreversible systemic change (Andriani & Romano, 2001).

4.3.2 Cognition in organizational change

Research into the role of cognition in organizational strategy development relates cognitive change to organizational change, as part of a learning cycle (Dijksterhuis, van-den-Bosch & Volberda, 2003, Fig. 5.1). This model has close parallels with the conscious–unconscious/competent–incompetent model described in Section 2.2, which in previous work I have applied to organizational change in a university (Russell & Peters, 1997). Figure 4.8 illustrates how individual learning (changes in beliefs and actions) underlies organizational learning.

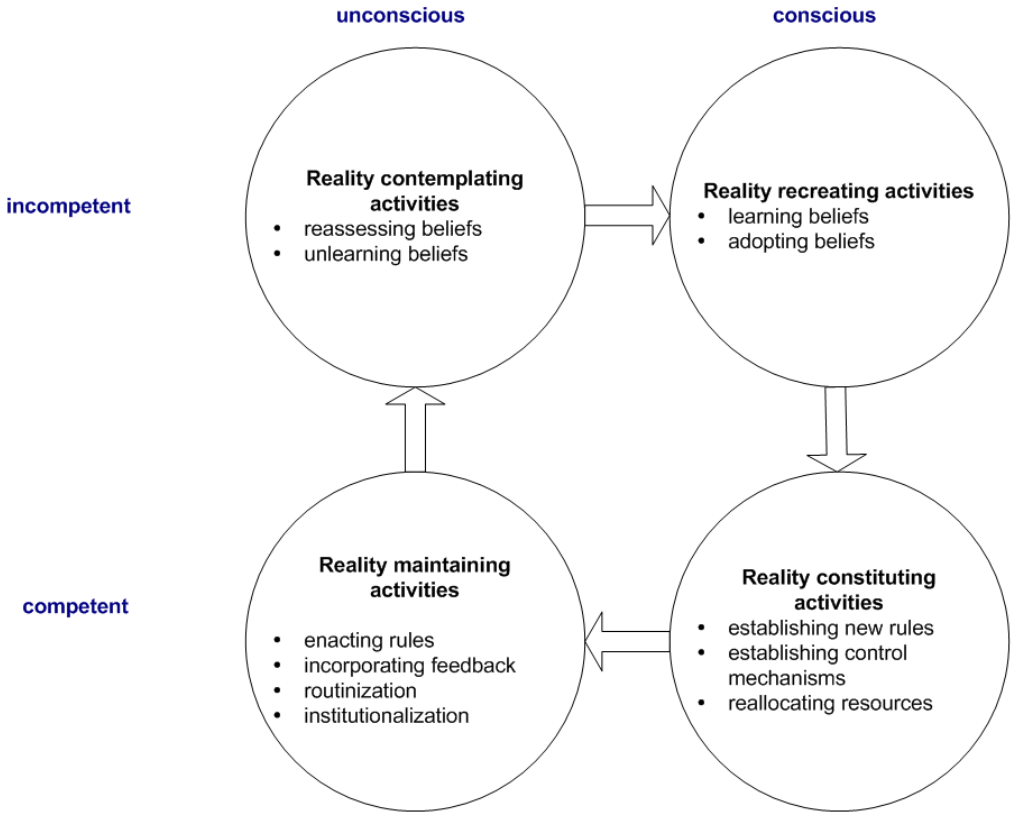


Figure 4.8 Organizational learning cycle, based on Dijksterhuis et al. (2003) and Russell & Peters (1997)

In the unconscious incompetence phase, reviewing and unlearning beliefs can take individuals out of their comfort or "flow" region into anxiety (Csikszentmihalyi, 1992). Without the help of codified knowledge, and without the support of a team, individual teachers need strong motivation to face the anxieties of setting off alone into unknown teaching territory. However, the ability to manage a moderate amount of anxiety, what Daniel Goleman (1999, p.110) refers to as "good stress", may be a difference in capability between those teachers who choose to explore e-learning innovations and those who do not. That difference in capability may be as much to do with the teacher's current career path and position as with their discipline context or with any inherent personal traits (Becher & Trowler, 2001, Ch.7). Therefore to find out what can motivate

teachers to adopt e-learning technologies (Research Question 1), it will be necessary to take account of discipline context.

Figure 4.9 illustrates the interplay between discipline context and the three components of individual teaching strategy in terms of the ProForMaC framework. The teacher's individual practice (the process of teaching), the form of their beliefs and theories, and the resources and capabilities afforded to them (including time and technology), all interact in the context of a disciplinary teaching and learning regime.

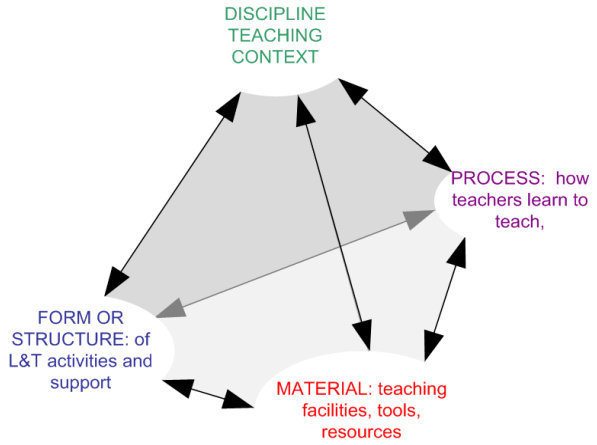


Figure 4.9 ProForMaC framework applied to Individual teacher strategies in the context of a disciplinary teaching and learning regime (TLR)

4.3.3 Mapping the tribal territories

The idea of disciplinary tribes and territories provides a basis for understanding how disciplinary differences in forms of organization and in beliefs about knowledge are part of a system in which diverse teacher strategies develop (Becher & Trowler, 2001). In terms of the framework shown in Figure 4.9, the disciplinary knowledge territories are equivalent to the beliefs, languages and constructs underlying learning and teaching. Individual motivations and teaching strategies are equivalent to individual teaching practices. The discipline or departmental organization and culture are equivalent to disciplinary context. For the purposes of identifying how these interact with each teacher's strategy for using educational technology, it is necessary to add the fourth vertex in Figure 4.9, in the form of capabilities, material resources and technologies. For brevity, I will refer to this model as the **KDIET model** (Knowledge, Department, Individual and Educational Technology) – see Figure 4.10.

The right hand side of Figure 4.10 shows how the model of disciplinary knowledge and organization can be extended to represent interdependencies in all four aspects of individual

teachers' strategies – as a basis for studying the microdiversity in these strategies. For example, the educational literature indicates that there are varying beliefs about the value of team teaching. One possible influence on beliefs about team teaching is whether the disciplinary organization is convergent or divergent, urban or rural (see Figure 2.3). Disciplinary variations in strategies for e-learning are therefore central to addressing how teachers can be motivated to begin crossing the divide between disciplines, and to share knowledge of e-learning (Research Question 1).

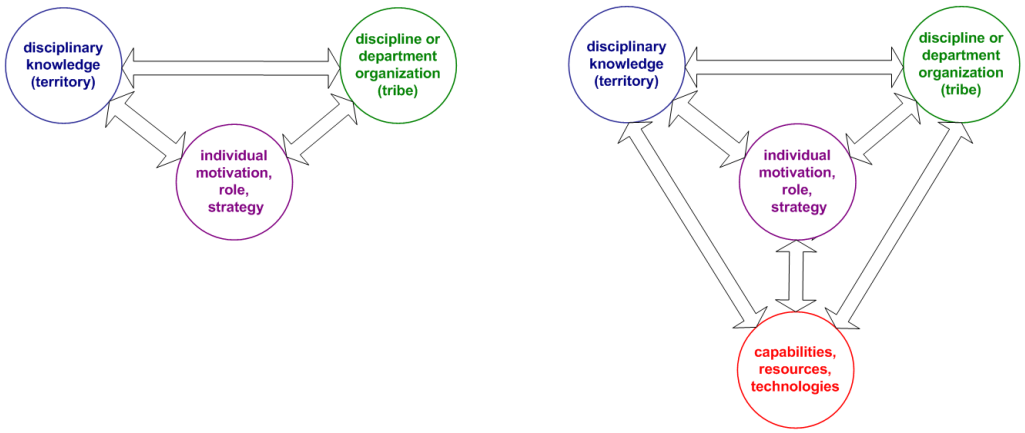


Figure 4.10 The KDIET model: the individual interacting with disciplinary knowledge, organization and with the physical capabilities associated with e-learning technologies

4.4 A cross-discipline systems perspective

Research Question 1 focuses on individual teacher strategies and motivations. Research Question 2 seeks to understand how linking up diverse individual teacher strategies across disciplines can set in train a positive feedback effect that will bring about irreversible change in the formal departmental and institutional systems. Research Question 3 is concerned with identifying which of the university's formal systems operate as complementarities and therefore require coordinated change.

The previous Sections of this Chapter have used complex adaptive systems theory and empirical management research findings to develop a conceptual framework for modelling university learning and teaching systems. The university system model illustrated in Figure 4.6 makes explicit some simplifying assumptions. The KDIET model of disciplinary diversity illustrated in Figure 4.10 incorporates these simplifying assumptions in terms of the ProForMaC framework, to provide a way of linking individual teacher strategies with changes at the level of disciplinary and departmental organization.

This Section describes relationships between the different disciplinary perspectives in terms of the ProForMaC framework and complex adaptive systems modelling. The various types of educational knowledge referred to in Section 2.2 can be placed within this cross-discipline perspective; leading to the identification of themes for an investigation of individual teacher strategies as part of a university's systemic interaction with e-learning technology.

4.4.1 Cognition and complementarities

The choice of modelling simplifications, or cognitive maps, required to interact with a university environment from a particular role or discipline perspective will constrain the strategies available to individuals. Making disciplinary modelling assumptions explicit is therefore an important first step in extending the range of strategic options available. Individuals in an academic tribe in an isolated knowledge territory lack the capacity for making unconscious assumptions explicit, thus limiting the diversity of their ideas and their adaptability. When discipline-specific perspectives are made explicit, they can be shared in a way that builds metacognition of how disciplinary teaching relates to teaching in other disciplines.

The ProForMaC framework provides a way of comprehending the infinite range of possible mental models, or cognitive maps, of how a university works, and of making explicit the assumptions and simplifications in each. Particular research perspectives and educational models can then be compared with each other using this framework, to support metacognition of what each disciplinary and methodological perspective contributes. The literature on organizations as complex adaptive systems shows how diversity among a university's disciplines and individuals can contribute to organizational adaptability. Disciplinary diversity can be understood in relation to universal concepts of organization as different choices of modelling simplification.

More specifically, the various cyclic models of individual learning and cognition outlined in Chapter 2 can be re-interpreted. Complexity theorists argue that theories, or mental constructs, are co-created with a learning process or experience. The concept of co-creation of theory and process is consistent with Schön's (1983) description of "reflection-in-action" and allows for tacit knowledge and intuition. Therefore, rather than necessarily going through sequential stages of experience, reflection, theorizing, and acting, there can be continuous adjustment between all four phases of Kolb's learning cycle. Furthermore, this mutual adjustment need not always take place consciously.

Empirical research into the role of cognition in organizational strategy development (Figure 4.8) establishes a link between individual and organizational learning, through the parallel changes required in individual cognition as part of organizational change (Dijksterhuis et al., 2003). Kolb

(1984) characterizes preferred learning styles, related to the four phases of his learning cycle, and establishes that learning styles vary with academic discipline. Becher and Trowler (2001) draw upon Kolb's work in developing the model of disciplinary knowledge territories illustrated in Figure 2.4. Together, these ideas offer a way of understanding the contribution of disciplinary diversity to organizational learning, with different strengths of perception combining to form the academic capability of the whole university across different fields of knowledge. Figure 4.11 shows how the different learning phases might be represented as different quadrants of a learning system, operating in parallel at the level of the individual and the university.

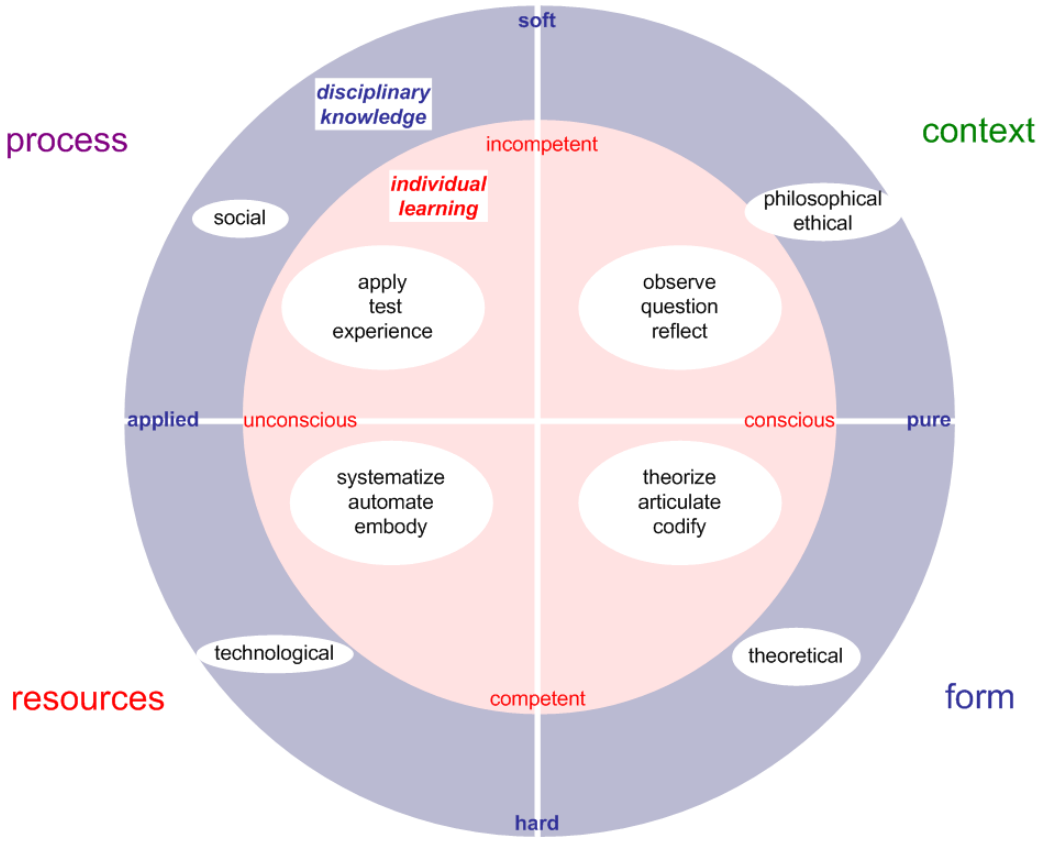


Figure 4.11 Disciplinary knowledge as four phases of a learning system

With the possibility of mutual adjustment between all four quadrants, as suggested by the ProForMaC framework, the system can be represented in a tetrahedral relationship (Figure 4.12). For example, the establishment of new theoretical constructs and codified knowledge in the sciences is part of the creation of hard pure disciplines. The application of codified knowledge to build material resources and technologies in hard applied disciplines is also a social process, the province of soft applied disciplines. The soft pure disciplines have the role of questioning the values and beliefs inherent in the processes and resources in relation to a wider social or ethical context.

A similar relationship occurs within discipline-specific learning and teaching, in that discipline context provides the philosophical approach for learning and teaching, which shapes the relationship between the forms of knowledge and the use of technology in teaching practice (Figure 4.9).

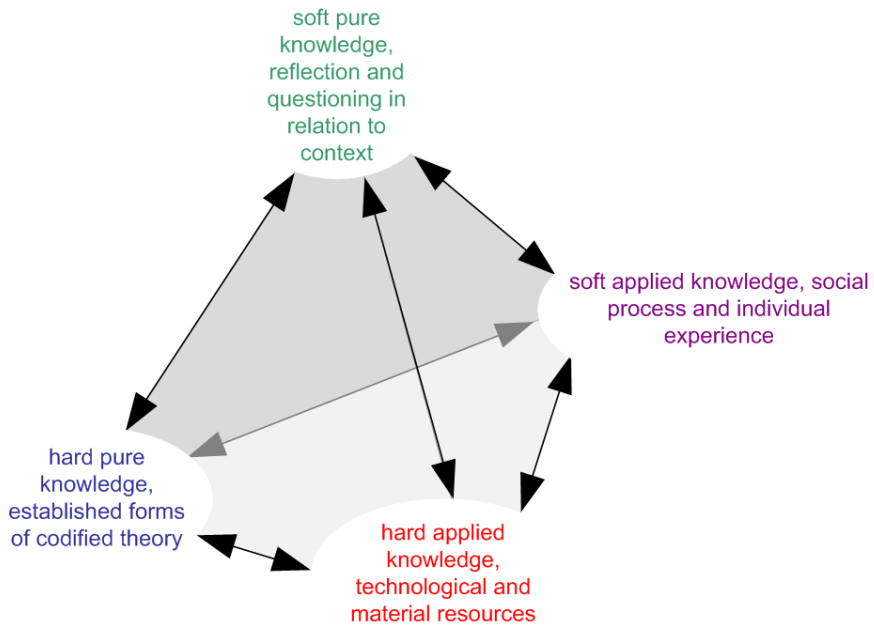


Figure 4.12 Disciplinary knowledge domains interpreted by the ProForMaC framework

Therefore interpreting different disciplinary perspectives as part of a complex adaptive system allows for them to co-exist as complementary aspects of the university learning system. Individuals, and disciplines, will vary in the weight they each give to different aspects, and overall this combines to create knowledge that no individual and no single discipline can lay claim to.

Management research on organizations as complex adaptive systems has found that successful organizational innovation requires synchronized change in complementary organizational structures, processes and boundaries. The higher education literature indicates that, to innovate the organization of university learning and teaching requires a similar synchronization of complementary internal changes in organizational structures, in learning and teaching processes and in the use of e-learning technologies.

The transformation associated with full integration of e-learning into mainstream campus teaching is yet to be achieved in traditional campus universities (OECD, 2005a). Early adopters of e-learning technologies find themselves moving down the J-curve, unsupported by university systems and overworked as a result (Laurillard, 2002, p.229). The research questions relate to the need for more knowledge on how teachers can be better supported in making this transition, on

how cross-discipline communities can ease the process, and on how university managers can identify where institution -wide support is required.

4.4.2 Diversity and dualities

A complex adaptive systems perspective of university organization can also accommodate dualities, as part of diversity. This contrasts with higher education analyses that place a focus on process in opposition to measurable outcomes and which portray this opposition as a problem (Barnett, 2000b; Walsh, 2006).

The model of organizational adaptability developed using complex adaptive systems theory explains that no one set of cognitive maps can adequately represent a university's response to changes in the higher education environment. The diversity of cognitive maps in a university will encompass dualities such as those found in the INNFORM research (Sanchez-Runde et al., 2004). The complementarities for a move from mass to flexible manufacturing technology are presented as binary opposites in Figure 4.1. However, the INNFORM research indicates that it is not always appropriate to deal with organizational innovation as a one-off change from one state to another, as implied by the either/or model. Adaptability requires the capacity to deal with constant transition, involving a co-existence of both the old and the new. Innovations supplement and coexist with, rather than supplant, established ways of doing things. Applying the idea of dualities to the adoption of e-learning in a university implies that new ways of working will coexist with traditional classroom practice. The research questions are therefore not to be interpreted in terms of single transformations associated with current e-learning technologies, but in terms of increasing the adaptability of a university learning and teaching system, through making available a greater diversity of teaching strategies, both at the level of individual teachers and at the level of the university as a whole.

There is a relationship between organizational levels, in that the actions of individuals and their communities both shape and are shaped by the processes through which the university coordinates its work, the forms of organization, and the physical facilities available to support these. The aim of this thesis is to use the simplifying assumptions listed above and illustrated in Figure 4.6 as a framework for finding out how the various components interact in relation to the external environment of a university. Central to this interaction, and therefore central to the investigation are the strategies of individual teachers:

1. The way that individual teachers from different disciplines link up experiences and perceptions of university learning and teaching to form their strategies for using e-learning

technology will provide information about the diversity of perceptions and motivations in those strategies.

2. The effect of cross-discipline networking on the diversity individual teacher strategies for using e-learning, will show how organizational adaptation can develop as a result of networking.

3. Patterns that are common to many strategies for e-learning will indicate complementarities at the institutional level, as experienced in different ways by individual teachers who are attempting to innovate in their teaching by using e-learning technologies.

Since the agents of change are individual teachers, the three research questions all require an investigation of how the themes identified in Chapter 2 are represented in the cognitive maps of teachers from different disciplines.

Chapter 5. Methodology and methods

Abstract of Chapter 5

This Chapter translates the conceptual framework developed in Chapter 4 into methods for addressing the research questions. Applying a complex adaptive systems framework to the use of e-learning technologies in universities suggests a context-specific study in one university, with teachers from a diverse range of academic disciplines and roles as the core source of data.

Research Question 1 asks what motivates academics to make the effort to develop and share knowledge of how e-learning technologies may be used in teaching practice. This suggests a study of early adopters in a typical campus university where the majority of academics are still using traditional disciplinary face-to-face methods.

The university is the University of New South Wales (UNSW), a member of the Group of Eight (Go8) longer-established campus universities in Australia. The teachers who provide the core data, are participants in a cross-discipline Fellowship in Innovative Teaching and Educational Technology (ITET).

My active involvement in co-ordinating and facilitating the ITET programme, along with the context-specific, subjective and diverse nature of the information being sought from the participants, requires a phenomenological rather than a positivist methodology. Also, the elicitation of tacit beliefs and theories has an influence on the outcomes for the participants, a situation in which action research rather than detached observation is appropriate. However, systems thinking requires that positivist perspectives are also given some consideration.

There were four action research phases, including a pilot study and three further phases that provide the data reported in this thesis. Cognitive mapping interviews and analysis form the core research process and are described in detail. Triangulation between different types of data and research methods is part of the interdisciplinary approach of this research.

5.1 The context for the research

The focus of this thesis is on the ability of campus universities to introduce new learning and teaching technologies in ways that improve the quality of learning and teaching across an institution, as measured in Australia by external indicators such as the Course Experience Questionnaire (CEQ). The higher education literature reviewed in Chapter 2 identifies some problem areas at the level of teaching practice. The research questions are seeking links between individual university teachers' use of educational technologies and the overall organizational patterns that are the concern of senior university managers and government funding bodies. Chapter 4 develops a systemic conceptual framework for addressing these.

The conceptual framework developed to address the research questions uses complex adaptive systems modelling, which draws upon a wide range of research traditions and methodologies. Applying a complex adaptive systems framework to the use of e-learning technology in universities suggests a context-specific study in one university, with teachers from a diverse range of academic disciplines and roles as the core source of data. Patterns of commonality and diversity in the strategies of those teachers can then be matched against immediate organizational outcomes to identify specific links with change at the institutional level, including both the formal and the informal systems.

Research Question 1 asks what motivates academics to make the effort to develop and share knowledge of how e-learning technologies may be used in teaching practice. The strategies of early adopters of e-learning in a typical campus university are likely to include such motivations. To address Research Question 2, the study should also be in a university where the majority of academics are still using traditional disciplinary face-to-face methods. This would allow for investigation of changes in formal organization associated with changes in the mainstream or majority learning and teaching practices. Research Question 3 requires that the context is one where academic work is sufficiently diverse and complex to require mutual adjustment between different departments, different priorities and different disciplinary perspectives. This would suggest a university that places a high priority on disciplinary research, where academics who teach are also required to be active researchers, and where some of the reported tensions between research and teaching priorities (Jenkins, 2004) are likely to be occurring.

The context for the research, the Innovative Teaching and Educational Technology (ITET) Fellowship in the University of New South Wales (UNSW) is described in relation to the research questions and the conceptual framework used to address them.

5.1.1 E-learning and innovation in UNSW

The University of New South Wales (UNSW) in Australia is a metropolitan campus-based university with 40,000 students, which has major research and teaching activities in areas such as medicine, commerce, engineering and the applied sciences. UNSW is one of the Group of Eight (Go8) that identify themselves as "Australia's leading universities" (Go8, 2007) and in which campus-based study is the norm, especially at undergraduate level. UNSW is also a member of the Universitas 21 (U21) international network of "leading research-intensive universities" (Universitas21, 2007).

UNSW's use of online learning, in terms of students enrolled in courses with an online presence, has been rising steadily. At the institutional level, e-learning activity is measured by the number of courses with an online presence, and by the number of student seats, which is the number of students using online learning times the number of online course modules each student is enrolled in. Figure 5.1 shows a graph of the increase, from 70 course modules and 17,000 online student seats in October 2001 to 1100 course modules and almost 100,000 student seats in 2006. In other words, the average UNSW student by 2006 was taking 2 or 3 courses with an online presence. This increase shows that use of an e-learning environment is becoming the norm, but says nothing about how it is being used. As with other campus universities, the main use of online learning is in web-supported mode (EDTeC, 2005; OECD, 2005a).

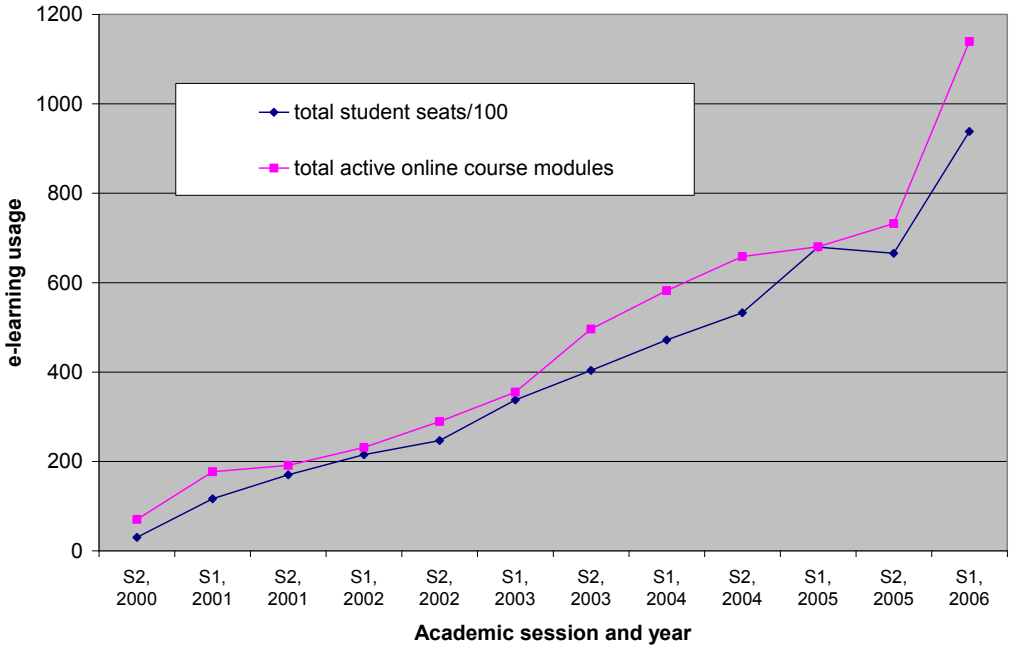


Figure 5.1 E-learning usage increase in UNSW 2000-2006

Improvements in the quality of learning and teaching, which might result from well-designed online resources and learning activities, are not yet evident. While a few teachers are using e-

learning in innovative ways to enhance student learning, most use it to deliver lecture notes and administrative information. The quality of student e-learning experience is variable. An Australian Universities Quality Agency (AUQA) audit of the university in 2005 recommended that UNSW needs governance arrangements for the future development of online learning and online courses throughout the University (AUQA, 2006); indicating that formal organizational systems have also still to adapt to e-learning.

UNSW's strategy for improving learning and teaching has included an initiative to bring together teachers from different disciplines who are interested in using e-learning technology to address teaching quality issues in their disciplines. Innovative Teaching and Educational Technology (ITET) Fellows take time out from their departments to work together for 6 months, with educational development support, in a cross-discipline group. Mixed discipline action learning groups form the core support for each Fellow's project. Between 2001 and 2005 there were five Fellowship cohorts, involving 75 members of UNSW staff. The fourth of these Fellowship cohorts provided an opportunity to carry out a study for this thesis, between 2003 and 2005.

As a change management strategy, the Fellowship is consistent with social cognition and evolutionary models of change management, in which there is recognition of the need for formal and informal change processes; for organizational learning that involves not just individuals, but also discussion and negotiation between communities and formal support for change. Rather than a focus on institutional reward systems and the role of the manager in motivating and inspiring individual staff members to accept change (e.g. Ramsden, 1998), the Fellowship is more like the "interactional leadership" model for higher education advocated by Knight & Trowler (2000), which allows for negotiation and adjustment between discipline and department cultures. The Fellowship aimed to address some of the issues already identified in the higher education literature, such as the difficulty of finding time and support to develop new teaching methods required for new technologies. The overall goal was to develop institutional capacity to use new technologies to enhance the student learning experience, illustrated in Figure 5.2.

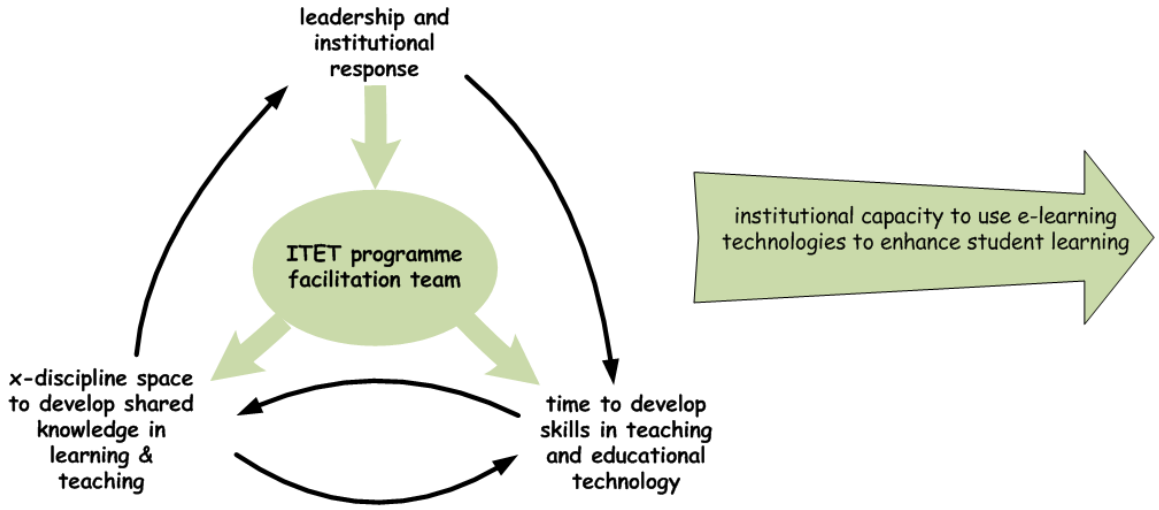


Figure 5.2 UNSW's strategy for developing innovative teaching with educational technology

The first four ITET programmes were funded as a strategic initiative to address teaching quality as a key success factor for the university. The Fellowship was intended to have organizational outcomes, in that the Fellows are expected not only to change their own teaching, but also to promote departmental and institutional change.

In 2001, in an initiative under the new leadership role of Pro Vice Chancellor Education and Quality Improvement, UNSW took part in a voluntary pilot of the new Australian Universities Quality Audit (AUQA) process. The AUQA pilot report commended the ITET Fellowship and suggested that it required evaluation (Lee, Wainwright, McConkey & Ingleson, 2001).

The Fellows are released from other duties so that they can attend workshops together and work on a project with the support of educational and media development staff, away from their usual departmental environment. The ITET facilitation team for the first four programmes included the Pro Vice Chancellor, staff from the Educational Development and Technology Centre (EDTeC), staff from the Learning and Teaching Unit, and a consultant in organizational behaviour.

Figure 5.3 illustrates diagrammatically how each ITET programme built upon the experience of earlier programmes, while changes were taking place in the Australian HE context. Four programmes were supported by institutional funding as a strategic initiative, at a time when the AUQA audit system was being implemented nationally. In 2002, a number of government policies on higher education were launched (DEST, 2002a; b; c; d). One of these DEST documents, *Striving for Quality*, expresses government concerns about the quality of management in Australian universities as large-scale organizations, about university accountability to the public for quality of education, and about the need for innovation in teaching methods and technologies. In September 2003 there was a proposal to set up a National Institute for Learning and Teaching in

higher education (DEST, 2003), which was announced in 2004 as the Carrick Institute with AU$22M of government funding allocated from 2006. Meanwhile, UNSW began a major programme to upgrade its e-learning systems (infrastructure and software), to cope with increased usage, to integrate e-learning with other IT systems, and to support a wider range of online learning activities and tools.

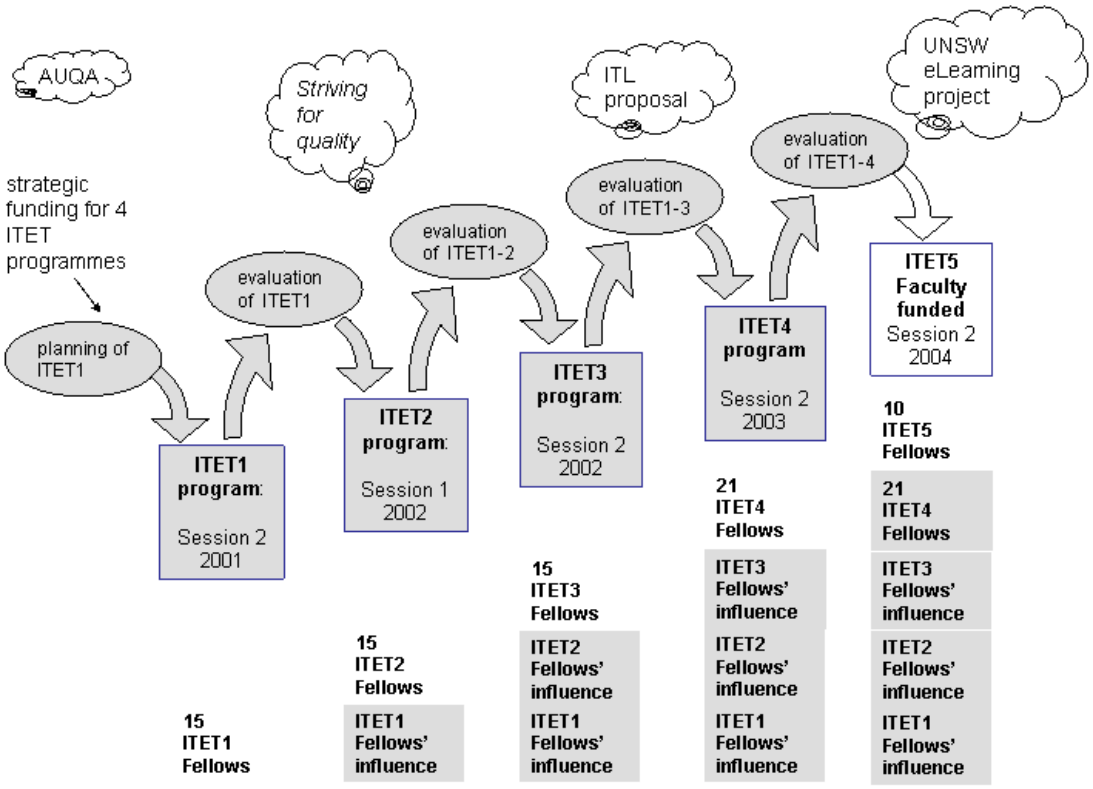


Figure 5.3 The context of the ITET Fellowship programmes

In the midst of all of these developments, the role of the Fellowship was to create a cross-discipline community of practice in e-learning, to support systemic innovation in UNSW's learning and teaching. Evaluations of the Fellowship have shown:

- that the Fellowship is making a substantial contribution to organizational change
- changes are more substantial in some parts of the university than in others
- Fellows are coming across many of the difficulties reported in the literature, in engaging with cross-discipline work on learning and teaching.

The ITET evaluations show that cultivating interdisciplinary communities of practice in educational technology, although essential, is no trivial task and may have its limits (Russell, 2003; 2004; Russell & Lee, 2005), confirming the findings in the literature on disciplinary differences in teaching described in Chapter 2.

5.1.2 The ITET programme and its evaluation

Each ITET programme incorporated learning and feedback from earlier programmes. As the programme progressed the Fellows were able to shape the events themselves. They chose workshop topics, ran workshops for each other, requested specific skill development support for their projects. Common components of all four ITET programmes include an intensive introductory 3-day workshop and several regular meetings each week, including mixed discipline action learning groups to support each Fellow's e-learning project. More programme details are given in the supplementary material provided on CD-ROM (A1).

The fourth ITET programme forms the specific context for this thesis. The ITET4 Fellows were the largest cohort (21). They represent a broad mix of disciplines, more mixed than the general balance of UNSW staff disciplines. Figure 5.4 shows an estimate of discipline mix, derived by grouping staff into soft or hard, pure or applied discipline categories based on the departments and disciplines to which they belong.

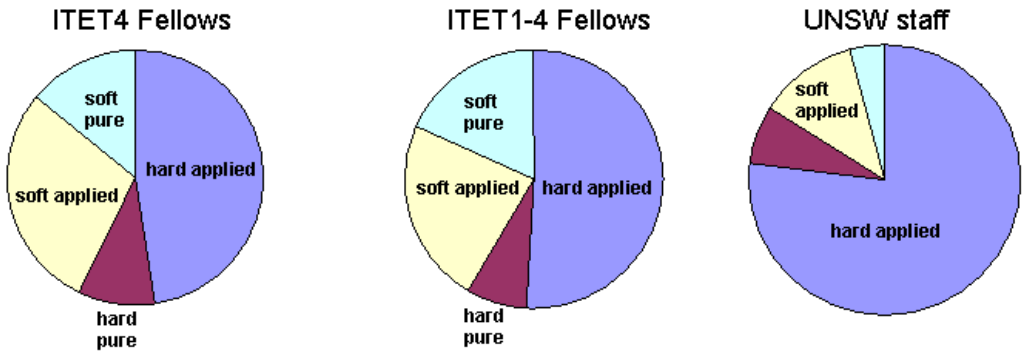


Figure 5.4 Discipline distribution of ITET Fellows in terms of knowledge areas

The Fellows form a group of change agents with the characteristics of those in the university learning and teaching system model established in Chapter 4 – the teacher agents in the cross-discipline community subsystem shown in Figure 4.6. Research to find out how their strategies for using e-learning vary, and how their strategies change after the Fellowship experience, addresses all three research questions. Their motivations for adopting e-learning are likely to include individual motivation factors (Research Question 1). They will also reflect disciplinary and institutional contexts, and provide evidence of organizational complementarities (Research Question 3). A comparison of strategies before and after the Fellowship will show the influence of the cross-discipline experience at the individual level. Research Question 2 can be addressed by finding out whether there are changes in formal organizational systems that can be directly linked to the post-Fellowship actions of the Fellows.

To address the research questions for this thesis, in addition to evaluation data, I gathered data on the ITET4 Fellows' strategies and motivations for using e-learning technologies, before and after their participation in the programme. The Fellows' strategies will be shaped by their own disciplinary experiences and contexts, formal and informal. Patterns in the strategies, for example change across the whole group after the Fellowship, or discipline-specific characteristics, can then be related to organizational contexts.

I also collected data on organizational learning and change associated with the activities of all the ITET Fellows during the period of the study, to triangulate with the patterns observed in the strategies of individuals in the ITET4 group.

5.1.3 Researcher role and perspective

As the person responsible for evaluating the ITET initiative, and for co-ordinating the team and the programme, I was a central participant in the context of the research for this thesis, and not a detached observer. It is therefore important to clarify my role as researcher, in relation to my role as a team member, facilitator and evaluator in the ITET Fellowship programmes. The research for this thesis builds on the ITET evaluation, which I carried out as a team member in an organizational context. However, the core of the research for the thesis, including the conceptual analysis and gathering of the core data, is additional work, which I designed and managed independently of the ITET team. My role as PhD researcher could not be completely independent of my other work, in that the roles shared a common context, and there were mutual benefits. For example, my working relationships with the ITET4 Fellows gave me a degree of access to, and cooperation from, participants in the study that would have been difficult for an external researcher. The additional reading of literature for the thesis also informed the evaluation reports written for UNSW.

This recognition that the researcher is not a detached observer of the research context has been referred to as **reflexivity.** Alvesson & Sköldberg (2000) describe reflexivity as a particular type of reflective research practice, which acknowledges the complex relations between the process of knowledge production, the context of this process and the researcher. They argue "that both 'recipe-book research' and 'theorizing in a vacuum' should be replaced by reflective activities, where the collecting, processing and analysis of qualitative data is regarded as a misleading description of what goes on". Reflexive research methodology is discussed in literature from several different fields of research, including education, sociology and healthcare (Gewirtz & Cribb, 2006; Humphrey, 2003; Kenway & McLeod, 2004; Lessard, 2007; Mauthner & Doucet, 2003; McGhee, Marland & Atkinson, 2007; Moss, 2005; Roberts & Sanders, 2005). Like the systems thinking described in Chapter 1, reflexive research methodology suggests research in

phases, including reflection on multiple levels and/or themes, and making explicit how the researcher's worldviews and assumptions are shaping the research process.

Becher and Trowler (2001, pp. 19-22), describe different levels of analysis in higher education research. They observe that most research has either been at the "macro" level, dealing with access issues, globalization and massification, or at the "micro" level, dealing with individual academics and students. They describe their research into disciplinary differences as at the "meso" level, incorporating cognitive, community and social aspects of academic life. The research questions in this thesis are also pitched at the meso level, seeking to make links between cognition, communities and formal university organizational systems. Becher and Trowler were able to gather interview data from hundreds of individuals in different institutions and different countries to identify patterns of disciplinary difference. Related research by Trowler and Knight follows a similar pattern (Knight & Trowler, 2000; Trowler & Knight, 2000).

Research on disciplinary differences, across many university contexts, therefore provides a starting point for selecting a methodology for this thesis, which focuses on the complex interaction of influences on teachers within one university in relation to e-learning. My research questions require research at the meso level, which can take account of the way that multiple influences combine to shape individual strategies in a particular university context.

5.2 Methodologies

Research into complex organizational change in a particular context requires multiple research methods (Fenton & Pettigrew, 2000b; Mitleton-Kelly, 2003). A study into network forms of organizing in a professional services company of about the same size and complexity as UNSW, assembled pluralistic accounts of organizational change to demonstrate how different individuals mobilized to create change at different organizational levels (Fenton & Pettigrew, 2000a, p.53). That study used an iterative process and collected different types of data and triangulation. Although technology was not included as a dimension and the focus was on strategy process, and boundary changes, the scope and nature of that study was similar to context-specific research on e-learning in a university, in that the findings added to understanding of the interaction between informal social processes and formal organizational change. In that case, in-depth interviews with 17 people from different roles and professional groups were combined with organizational data. The Fenton and Pettigrew study therefore provides an example of how multiple methods may be combined in research to understand complex interactions of individuals as part of organizational learning that includes formal and informal systems – networks, communities and cultures as well as formal rules and leadership. Mitleton-Kelly (2003) describes a research process involving a similar mix of methods.

The research for this thesis was not, as in these other studies, carried out by a team of independent external researchers. The research questions and the context chosen to investigate them involve me, as an individual researcher, in close interaction with the participants in the study, in order to elicit and understand their individual strategies for e-learning. The intention is to not just to gather strategies that are already explicit, but also to elicit some of the underlying tacit beliefs and values. The extent to which these become explicit and codified during the course of the Fellowship is also of interest.

The context-specific, subjective and diverse nature of the information being sought requires a phenomenological rather than a positivist methodology (Hussey & Hussey, 1997; White, 1990). Positivist research seeks to carry out experiments that test hypotheses based upon defined theory. Phenomenological research seeks to develop new theories or models from data or observations. The systems thinking underlying this thesis regards these two methodologies as complementary approaches to creation of knowledge, as illustrated in Figure 5.5. The methodological approach and the methods chosen are explained below.

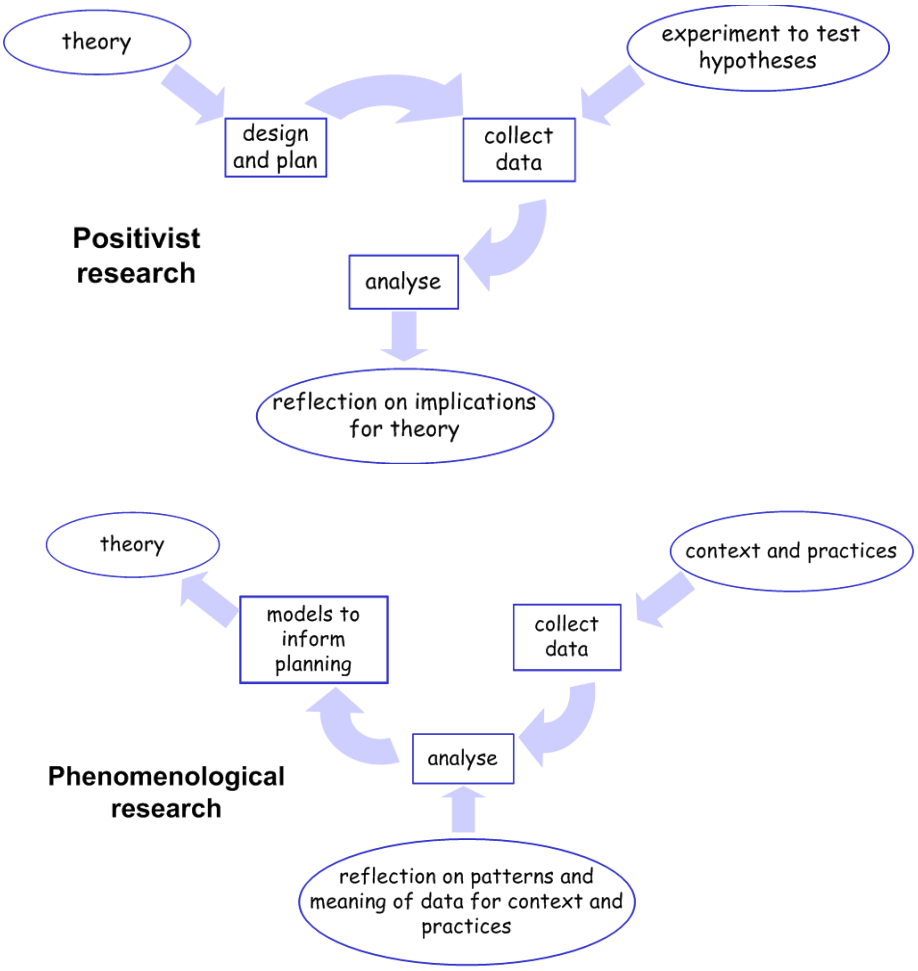


Figure 5.5 Positivist and phenomenological research as complementary parts of a learning cycle

Chapters 3 and 4 argue that complex adaptive systems theory is a valid framework for modelling the adoption of e-learning technologies in a campus university. This theoretical framework predicts the existence of complementarities in campus university learning and teaching systems. From a positivist perspective, the research is testing the hypothesis that these patterns of complementarities will be evident in the data from the UNSW context. However, the identification of complementarities will rely upon my analysis of qualitative data on the perceptions of 19 interviewees. From a positivist perspective the resulting patterns arising from the data could be seen as a reworking of my initial assumptions through the way I choose to categorize the data. Systems thinking, as described in Chapter 1, therefore requires that the worldviews or theories upon which the analysis is based are explicit and the processes used systematic.

Phenomenography is a specific form of phenomenological enquiry used in educational research. It is a methodology that involves documentation and analysis of people's experiences and thoughts, for example as expressed in interviews, focus groups, recorded conversations or written work, to develop theory (Åkerlind, 2005; Ballantyne, Bain & Packer, 1999; Marton & Trigwell, 2000).

The ITET evaluation (Russell, 2003; 2004) formed a pilot study for the main research for this thesis. The evaluation included thematic analysis of textual records from ITET Fellowship discussions, following a broadly phenomenographic approach in which topics raised were identified, categorized and grouped. The results provided a starting point for identifying elements in the strategies of the ITET4 Fellows, as part of a broader action research approach. This approach sees the research as part of a learning cycle that has elements of both parts of Figure 5.5, and allows for the combination of hard and soft systems methods – an approach similar to that suggested for educational research into the combination of educational theories, practices and technologies (Bopry, 1999; Looi, Hung, Bopry & Koh, 2004).

5.2.1 Action research: but not participatory

The Fenton and Pettigrew study described above is defined as strategy process research (Chakravarthy & Doz, 1992), which instead of progressing linearly from fact-finding to analysis, iterates between data collection and analysis. **Action research** methodology allows for a similar development of the research methods in cycles as the research progresses, rather than being driven by a researcher's need to test a particular hypothesis (Lomax, 1994). However, action research also allows for the research process itself to be part of the system that is being studied, rather than assuming that the research is an independent investigation with minimal impact on the changes taking place. For the study of ITET Fellows in UNSW, the elicitation of tacit beliefs is a purposeful contribution to the changes taking place; in line with soft systems methodology (SSM),

which is in the tradition of action research (Checkland & Scholes, 1990). As explained in Chapter 1, SSM is an underlying philosophy, rather than a series of conscious steps and methods. I will therefore describe the methods used in this research in terms of action research methodology.

Action research is an established methodology for educational research in university teaching (Zuber-Skerritt, 1992). It allows for cycles of action, data collection and analysis, reflection and planning, which can be matched with the successive academic sessions or terms in which a course is run, with student feedback driving continuous improvement. For classroom teaching, action research based upon academic terms allows for use of tacit knowledge and intuition during the teaching term, followed by reflection and planning for the next term. Bhattacharya et al. (2000) place educational action research on a continuum spanning feedback, evaluation, action research and generalizable educational research. Salmon (2001) advocates context-specific action research as a way of building new theory through reflective practice. Action research is also advocated for context-specific studies of organizational change management (Eden & Huxham, 1996; Gill & Johnson, 1997; White, 1990). Since this is a context-specific study involving both education and change management the research methods used are framed within an overall action research approach.

The research questions focus on the practice of individual teachers in a social and organizational context, and on the co-creation of changes in the systemic relationships between individuals, communities and formal organization. Kemmis and McTaggart (2005) characterize different approaches to the study of practice in terms of individual and social perspectives, and in terms of objective and subjective approaches to research. As noted in Chapter 2, much of the research into student learning in higher education focuses on the individual. Some of the research on individual learning is focused on measured outcomes (objective) and some of the research is focused on meaning and values (subjective). There is e-learning research and organizational research that focuses on social aspects of learning. Where the research approach is objective, the focus is on structures and social systems. Where the research approach is subjective, the focus is on discourse, traditions and different ways of understanding. The theoretical framework developed in Chapter 4 combines all these different research traditions, and is consistent with the description of a fifth approach, characterized as "Practice as socially and historically constituted and as reconstituted by human agency and social action" (Kemmis & McTaggart, 2005, Table 23.1). For this fifth combined approach Kemmis and McTaggart suggest multiple methods, within a **participatory action research (PAR)** framework. They refer to Habermas's idea of communicative action, which Capra (2002, pp. 67-70) also draws upon; as a way of interrupting action to question whether understandings are comprehensible, accurate, authentic and

appropriate for the circumstances. Figure 5.6 interprets communicative action in terms of the ProForMaC framework.

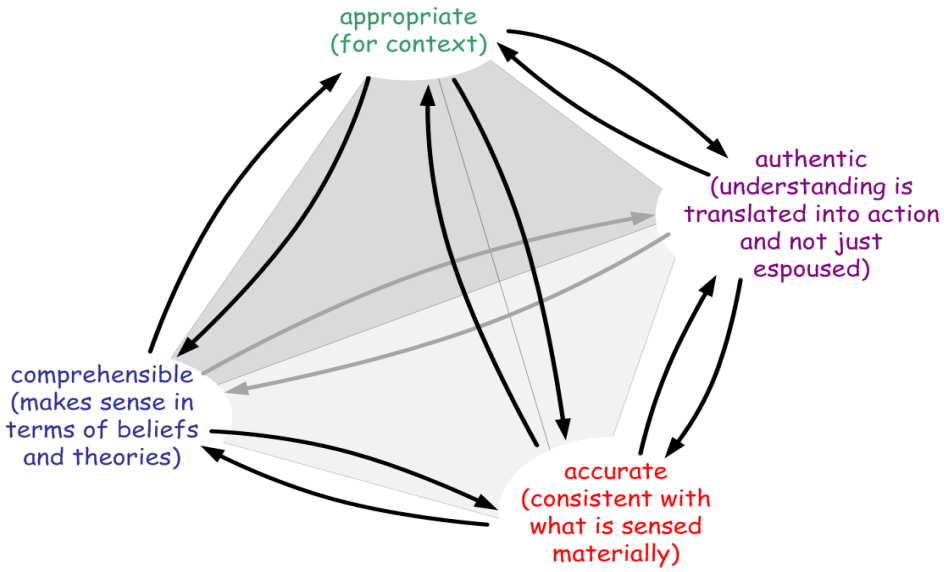


Figure 5.6 Communicative action in terms of the ProForMaC framework

Moore (2004) surveys definitions and summarizes PAR as involving collaborative approaches to knowledge production, research for the purpose of change, concerned with empowering the participants to bring about change using a wide variety of methods, and related to group activity and community. All of these characteristics match well with the research questions, with the conceptual framework developed to address them and with the ITET Fellowship in UNSW as a research context. Moore also characterizes PAR as involving the participants in creating the research questions, designing the study and analysing and interpreting the new knowledge. The participants were involved in these activities in relation to the evaluation of the ITET Fellowship, but not in relation to the research for this thesis.

Despite the resonance of PAR with the research questions, the conceptual framework and context for this thesis, I am unable to use it consistently. The ITET Fellowship programme development itself is closer to the ideal PAR model than the specific research undertaken for this thesis, which requires that I put forward my own arguments and provide my own evidence to support them.

I therefore characterize the methodological approach for this thesis as action research, with elements of the participatory nature of PAR, but falling short of being truly participatory.

5.2.2 Action research phases

The action research for this thesis is constructed around iterative development of specific research questions and methods to address them, with the ITET programme as an organizational context. Some of the data collection and analysis has also been part of my work as an ITET team member, but the thesis includes only those aspects that I have been able to design and implement as my own work. The work of others is treated as data in relation to the context of the research.

The action research period for this thesis spanned the years 2002–2005 through phases shown in Figure 5.7. I use 'phase' rather than 'cycle' because the action and data collection for the different phases overlap in time, rather than strictly following from the analysis of earlier data. This compromise was necessary because I could not control the timing of events. I could, however, control the data collection methods and analysis. Each analysis phase has informed the next, and the underlying principles of action research have been followed.

Phase (i)

A pilot phase involved gathering and analysis of textual records of ITET Fellowship discussions over the second and third ITET programmes, from 2002 to 2003. The analysis indicated that there were a number of influences upon strategies for using educational technology, spanning the educational and organizational, and suggested more detailed capturing of the influences for individuals. This informed the main PhD research project proposal and the development of the research questions.

Where possible, I typed the textual records from the ITET Fellowship discussions live, as they were happening, while my colleagues and the Fellows themselves facilitated the discussions. In this sense I was a semi-detached observer, listening and touch-typing to capture their words as closely as possible. Earlier experiments with recording and transcription had proved labour-intensive and produced large amounts of text data that was hard to analyse reliably. Typing live records into a word processor proved better as a routine evaluation exercise.

During the break between ITET3 and ITET4, I analysed the text records using NVIVO™ software, to identify and summarise recurrent themes over two programmes involving 30 Fellows who took part in a total of 75 Fellowship events. The outcome of this analysis was a categorized list of the most frequent themes discussed. The analysis process showed that the various themes interact in complex ways that the frequency of their occurrence in discussions does not represent adequately.

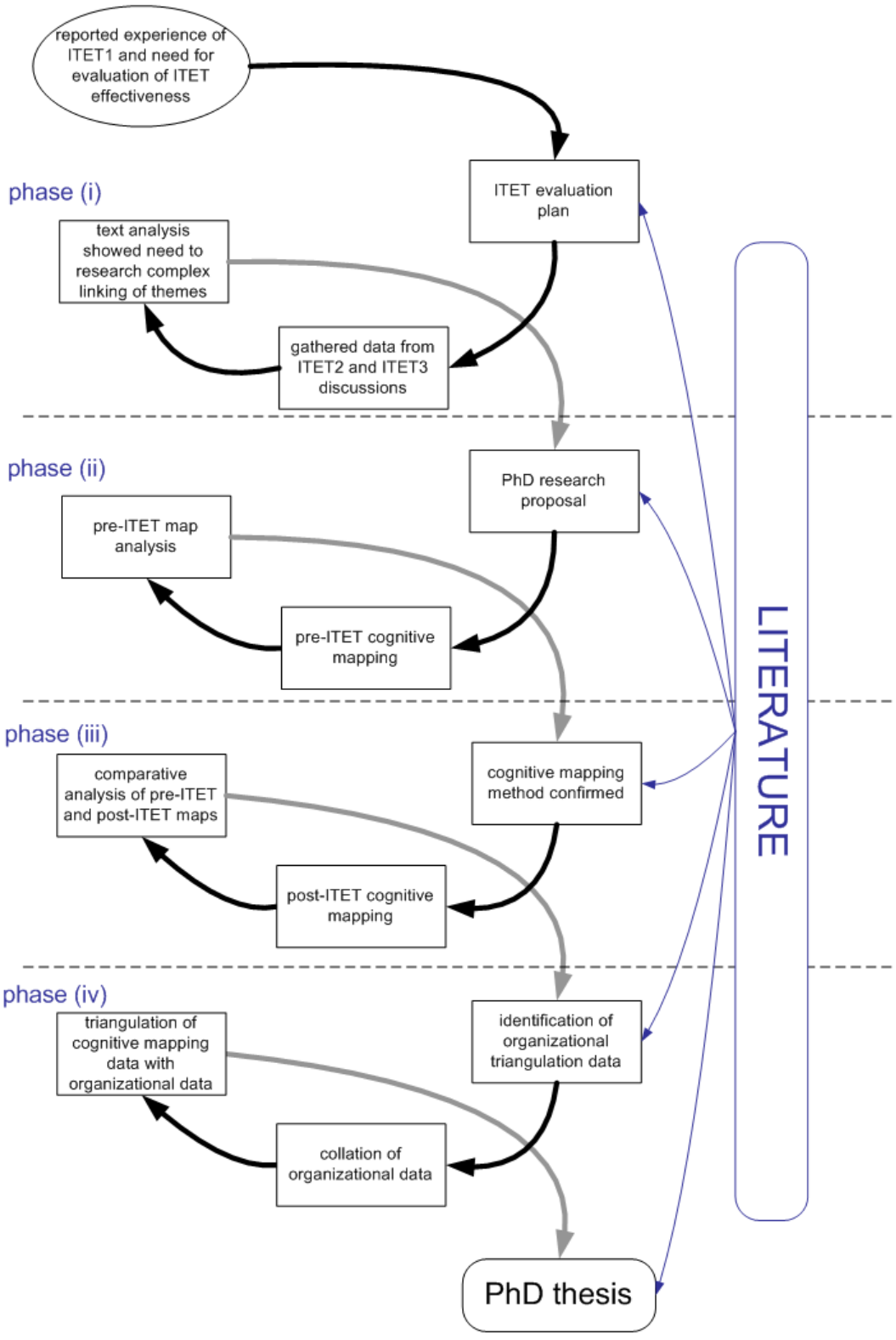


Figure 5.7 Action research cycles

The literature on complex adaptive systems, and the experience of the pilot study, suggested that individual strategies in a specific organizational context would be better represented graphically in cognitive maps, rather than in texts and lists. The rationale and the methods used for the cognitive mapping is explained below in Section 5.3.

Phase (ii)

I carried out cognitive mapping interviews with a fourth group of 21 ITET Fellows, before they began the Fellowship programme in 2003, using the themes identified in phase (i) as a guide for the interview questioning. Analysis of the resulting maps identified patterns, and confirmed that cognitive mapping is an appropriate and practicable method of capturing and analysing patterns of influence in the strategies of individual.

Cognitive maps were each collected in a one hour interview, using a consistent process which is described in detail below (Section 5.3.1). In creating each of the maps during the interview, the participants were asked to describe their own reasons for using educational technology and were given the wide-ranging list of themes produced in the pilot as an optional prompt. Their responses were captured and later analysed using Decision Explorer™ software to identify patterns in the influence links across 21 maps.

Phase (iii)

I carried out cognitive mapping interviews with 19 of the same people after they completed the Fellowship programme in 2004, and were back working in their departments, to find out how their strategies for using educational technology had developed.

The interview process was identical to that in Phase (ii), except that there was no need to use the prompt list. Instead the interviewees were asked to identify, categorize and link the components of their current strategies, post-ITET.

I then used Decision Explorer™ and other software tools, including NVIVO™, in a comparative analysis of the pre-ITET and post-ITET maps. This phase included re-analysis of the initial maps to allow a direct comparison with patterns emerging in the 19 post-ITET maps. Re-analysis was necessary because of the removal of two of the maps from the data set, and also to confirm that the process for the pre-ITET and post-ITET maps was identical. Over a year had passed since the initial analysis, and although I had logged the process in some detail at the time, I found that even more rigour was needed in recording exactly how I performed each stage to ensure consistency.

Phase (iv)

A final phase involved collating data on organizational changes associated with the activities of ITET Fellows between 2001 and to 2005. The organizational data was used to link the strategic changes achieved and those sought, but not yet achieved, with the results from phase (iii), to identify key systemic complementarities and dualities associated with educational technology in UNSW in the period of the study.

The core data for addressing the research questions comes from the cognitive mapping interviews in phases (ii) and (iii). The analysis of these data in phase (iii) provides the main results, which are then triangulated with the additional data compiled in phase (iv) to address the research questions.

5.3 Cognitive mapping

The pilot study followed the tradition of qualitative research using recording and interpretation of textual data. The results suggest that there are complex links between the themes identified, which may reflect organizational complementarities. Individuals' internal (mental) representations of their work context can be understood as cognitive maps of a complex reality, which can be modelled mathematically and which influence range of options they consider in their strategies for action (Gavetti & Levinthal, 2000; Greve & Taylor, 2000; Man & Lam, 2003).

The use of complex adaptive systems as a conceptual framework for the study of ITET Fellows' strategies requires that assumptions used in identifying patterns in the data are made explicit. Therefore, rather than using phenomenography, I have used a cognitive mapping method which allows interviewees to represent the connections between different components of their strategies in graphical form.

The modelling of strategies has its roots in positivist approaches to characterization of human cognition. In Kelly's constructs for visual mapping of "the geometry of psychological space" (Shaw & Gaines, 1992), choices are represented as composed of a number of binary options, forming a network. Research using these theories elicits a person's conceptual structures by asking them to classify what is important in terms of a grid of alternative concepts. This method has been used to research lecturer strategies (Nicholls, 2005). Cognitive mapping is based on a similar intention to elicit and visualize thinking, but it allows the participants in the study to define for themselves what concepts are considered, as part of action research (Eden & Ackermann, 1998; Eden & Huxham, 1996).

Cognitive mapping is used in strategy development in organizations, as a way of eliciting and representing visually how each participant perceives influences in the organizational environment, and forms decisions and plans. The interviewee defines separate concepts (events, goals, processes, etc.) that they believe are influential; in this case in relation to their reasons for exploring new educational technologies. Then they specify the causal or influence links between these, in terms of what might help or hinder each event, process or goal (Eden & Ackermann, 1998).

Cognitive maps are appropriate for eliciting lecturer strategies for using e-learning technologies because:

- The maps are a visual representation, more suitable than (linear) spoken or written text, for describing the multiple influences in individual thought and action.
- The participants can articulate and think through complex tacit connections during the interview. So the interview itself helps to develop and clarify strategies for using educational technology, by making the tacit connections explicit.
- The mapping process allows for exploration and recording of the connections between the participants' disciplinary knowledge, their departmental context and their use of educational technology.

Cognitive maps can be created and analysed using Decision Explorer™ software. The software supports systematic identification of patterns in the links made between concepts, which satisfies the need to make explicit the assumptions and criteria used in the analysis process.

An additional pragmatic reason for using cognitive mapping is that it is a quick and direct way for a single researcher to capture and analyse different individual perceptions of complex linking between different aspects of university teaching.

5.3.1 Cognitive mapping interviews

Each interview with the ITET4 Fellows took an hour, with the mapping process taking 30–45 minutes. At the start of the pre-ITET interviews, each interviewee was given a sheet listing pedagogical and organizational issues that other Fellows had raised during previous programmes, from which they could, if they wished, select a starting point for discussion of their own issues. The issue list came from thematic analysis of transcripts of previous discussions among ITET Fellowship groups, and represented the full scope of issues already raised. Each map was created live during the interview, using Decision Explorer™ software, with the interviewee providing the

concepts and deciding how to link them; prompted by questions and using a "laddering" process to elicit influences and goals at different levels (Eden & Ackermann, 1998).

When cognitive mapping is used as a tool for strategy development, the facilitator would normally encourage reframing of negative influences as positive, and the software supports bipolar concepts of the form '*A* rather than *B*'. Although there was an element of encouraging the participants to articulate positive strategies for using e-learning technology, the conceptual framework outlined in Chapter 4 indicates that there will be mutual dependencies and dualities, which might appear as negative influences. The one hour mapping interviews were intended to surface issues and how they are connected, but not necessarily to resolve the connections into a well defined positive strategy.

During the interviews I asked the participants to say whether each concept in the map was related to:

their identity or role in the university (who - mission, purpose)
a belief or value they hold (why - permission, motivation)
a capability or skill they have (how - direction)
an action or behaviour on their part (what - actions)
part of their work environment (where and when - reactions).

These concept categories are based on a framework used in neuro-linguistic programming (NLP) for eliciting the logical structure of strategies independently of their content (Dilts, 1996, Ch 3). Where the participants were able to categorize a concept, I coded the concept accordingly on the map, so that it appeared with a particular colour and shape. This helped to give each map an identifiable visual pattern that the participant could engage with, rather than being a jumble of similar-looking boxed phrases connected by lines. In most cases, after an initial conversation to clarify what I meant by the concept categories, assigning categories to concepts proved to be unproblematic and became part of the conversation and mapping dialogue. Figure 5.8 shows the coding scheme. The yellow tinted box is the default uncoded concept style. The direction of an arrow represents the participant's perception of influences. Where the influence is preventing or hindering, there is a negative sign. A two-way arrow indicates mutual influence. The software can represent concepts expressed in binary form, and displays them separated by an ellipsis, as 'do it this way... rather than do that way'. If I were investigating strategies for a single transition, as in the mass to flexible manufacture example described in Chapter 4, it could be appropriate to ask participants to structure their concepts in binary form, as 'before ... after' statements. In the context of this research, the aim is to capture the participant's interpretation of a complex and continuously changing organizational context at a particular point in time. Therefore I used the

binary form only where the participants themselves expressed a concept in that way. Later, when I combined maps as part of the analysis, I used binary concepts to show where dualities were emerging from different perspectives on the same topic.

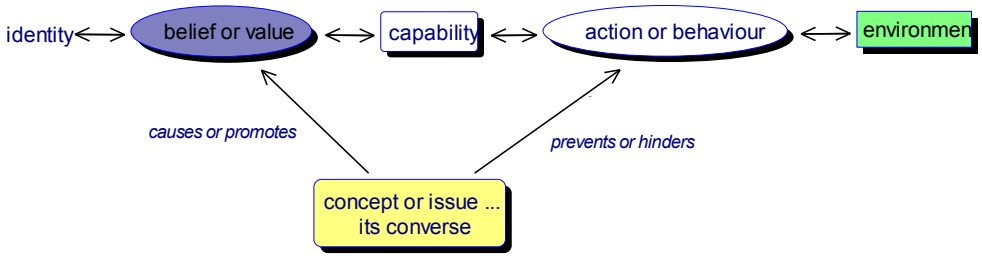


Figure 5.8 Concept coding scheme for cognitive mapping interviews

Thinking and feelings

The educational literature reviewed in Chapter 2 indicates that the emotional aspects of learning and teaching often remain tacit. The emotional and affective components of experience are as important as conscious cognition in individuals' strategies within an organization, and affective processes may sometimes precede cognition (Fox, Amichai-Hamburger & Evans, 2001). In other words, sometimes a person will feel first, then justify a behavioural response to the feelings in terms of an espoused theory. The concept of emotional intelligence (Goleman, 1999) includes a self-awareness that allows a person to manage such responses consciously, and that some people are better able to do this than others.

The cognitive mapping interviews aim to surface tacit responses to an organizational environment including some that may have an emotional dimension; such as professional identity, gender or power relationships. Emotional factors can affect both learning and teaching strategies and behaviours, but in some disciplines may not be part of an explicit discourse. The interview discussions therefore may include some emotional responses, and it was important that, as the interviewer, I managed these effectively for a positive outcome.

Participation and permissions

All 21 of the ITET4 Fellows agreed to do the initial cognitive mapping interviews and many said they found it very useful in helping them sort out their ideas for the Fellowship. The interviews were carried out between early June and early August 2003, before the start of the ITET programme events.

The second set of cognitive mapping interviews were between May and September 2004, after the completion of the ITET4 programme. Two of the previous participants declined the interview invitation. One said she was busy and had not found it particularly useful the first time, but would be willing to attend an interview later if I really needed the data. The other expressed general concerns about the research ethics, although would not be specific about what those concerns were and how I might deal with them. The remaining 19 agreed to a second interview and all signed a consent form based upon UNSW's research ethics guidelines, in which I undertook to keep the detailed content of the maps confidential. [A copy of the form is included in the supplementary material provided on CD-ROM (A2)]. I removed from the data set the maps from the two people who declined a second interview. The other participants said they had no significant concerns about confidentiality and indicated that they trusted me to make appropriate use of the data. One participant gave specific permission for his maps to be used to illustrate the mapping process.

5.3.2 Map analysis themes and schemes

The main purpose of the map analysis is to find patterns in the way that individuals link their concepts together. Where several individuals are making the same kind of link in relation to their plans to develop and use educational technology, it may indicate a systemic pattern within the organization. Chapter 2 suggests analysis in relation to the following themes:

- differences between disciplines (identified in the literature on individual teaching strategies)
- individual work and teamwork (also identified in the literature on individual teaching strategies)
- empowerment of the individual (to make changes in teaching, as an indicator of systemic constraints upon the options they consider)
- beliefs and values (to indicate the systemic influence of tacit knowledge)
- metacognition (related to identifying options beyond discipline-specific experience).

In order to analyse the maps for links representing these themes I used two different schemes for categorizing the individual concepts in each map. One scheme was the original concept coding attributed by the participants during the interviews, as illustrated in Figure 5.8. The other scheme involved recoding the concepts following discipline-related patterns using the KDIET model developed in Chapter 4, as described below.

Recoding for discipline difference analysis

To explore disciplinary differences in strategies for use of educational technology and in beliefs about learning and teaching, in terms of the influence of different disciplinary learning and teaching regimes. I recoded each concept as relating to discipline knowledge (*K*), disciplinary organization (*D*), individual motivation (*I*) or educational technology (*ET*). The recoding scheme resulted in a map which was colour coded as shown in Figure 5.9, and I used the labels *K*, *D*, *I* and *ET* to denote the different concept categories as shown.

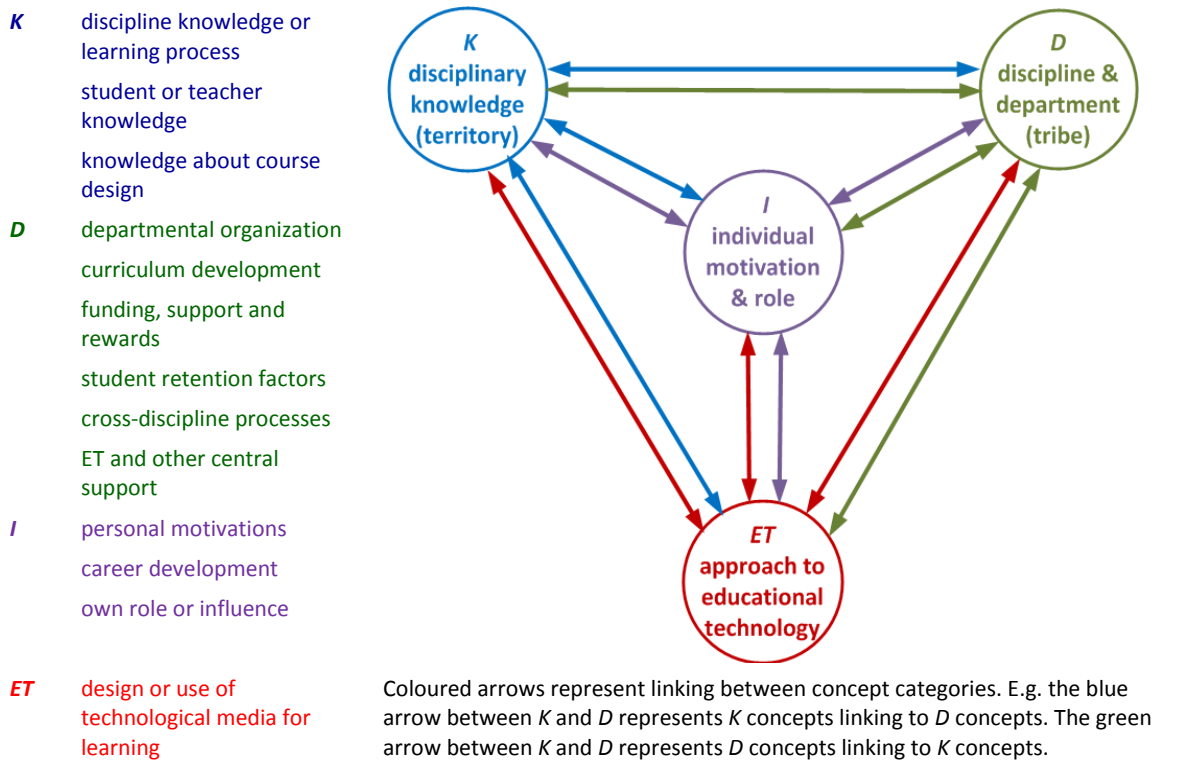


Figure 5.9 Framework for recoding cognitive maps for analysing discipline-related patterns

Each map then represented an individual's strategy as network of paths through these towards a goal in one area, or perhaps several goals. For example, an individual (*I*) has an intrinsic interest in how students acquire disciplinary knowledge (*K*) and belongs to a department (*D*) that is looking for more efficient use of teaching resources. These combine to motivate the individual (*I*) to explore educational technology (*ET*) as a way of helping students to gain core disciplinary knowledge (*K*). In this example, the main goal is related to disciplinary knowledge.

The links between concepts are those identified by the interviewee prompted by my open questions about the relationships between concepts. During the interview, I continually rearranged the map to put goals or outcomes above causes and influences. The arrows therefore represent the interviewee's perception of the direction of influence or causality between concepts. In the process of creating the maps we clarified the representation by merging some

concepts, adding others, and changing links, until either the interviewee was satisfied with the representation or we ran out of time.

Figure 5.10 shows one of the pre-ITET cognitive maps as originally coded. Figure 5.11 shows the recoded version. Once a concept style is attributed in Decision Explorer™, the concept becomes part of a set that can be analysed in various ways using the software tools. Representing the strategies in this way allowed analysis of the maps for:

- the distribution of concepts among sets representing the areas of concern
- the issues represented in the content of each concept set
- the number and density of links between sets.

The Decision Explorer software has functions that will list and count sets of concepts, and will list and count the concepts linking between two sets. So, for example, the command 'sort K into D' will generate a list of all the *K* concepts in a map that are shown as directly influencing *D* concepts. I used this function to generate summary maps representing the number of concepts in each of the four categories and the density of links between them. For example the summary of the map in Figure 5.11 is shown in Figure 5.12. In this map, educational technology (*ET*) appears as the strongest links with disciplinary knowledge (*K*), and also is a motivating influence on the individual and the department. Knowledge and departmental organization are also linked. The supplementary material CD-ROM (A5) contains copies of the link summary diagrams and explains how I derived the set and link numbers shown.

In the initial analysis in phase (ii), I grouped the 21 maps by visual patterns in these summary maps, without any reference to the content. The only personal bias was therefore in the recoding process, and not in the pattern identification. In phase (iii) I revised and repeated the recoding process for the pre-ITET maps to ensure that I had applied the concept categories in the same way across both sets of maps.

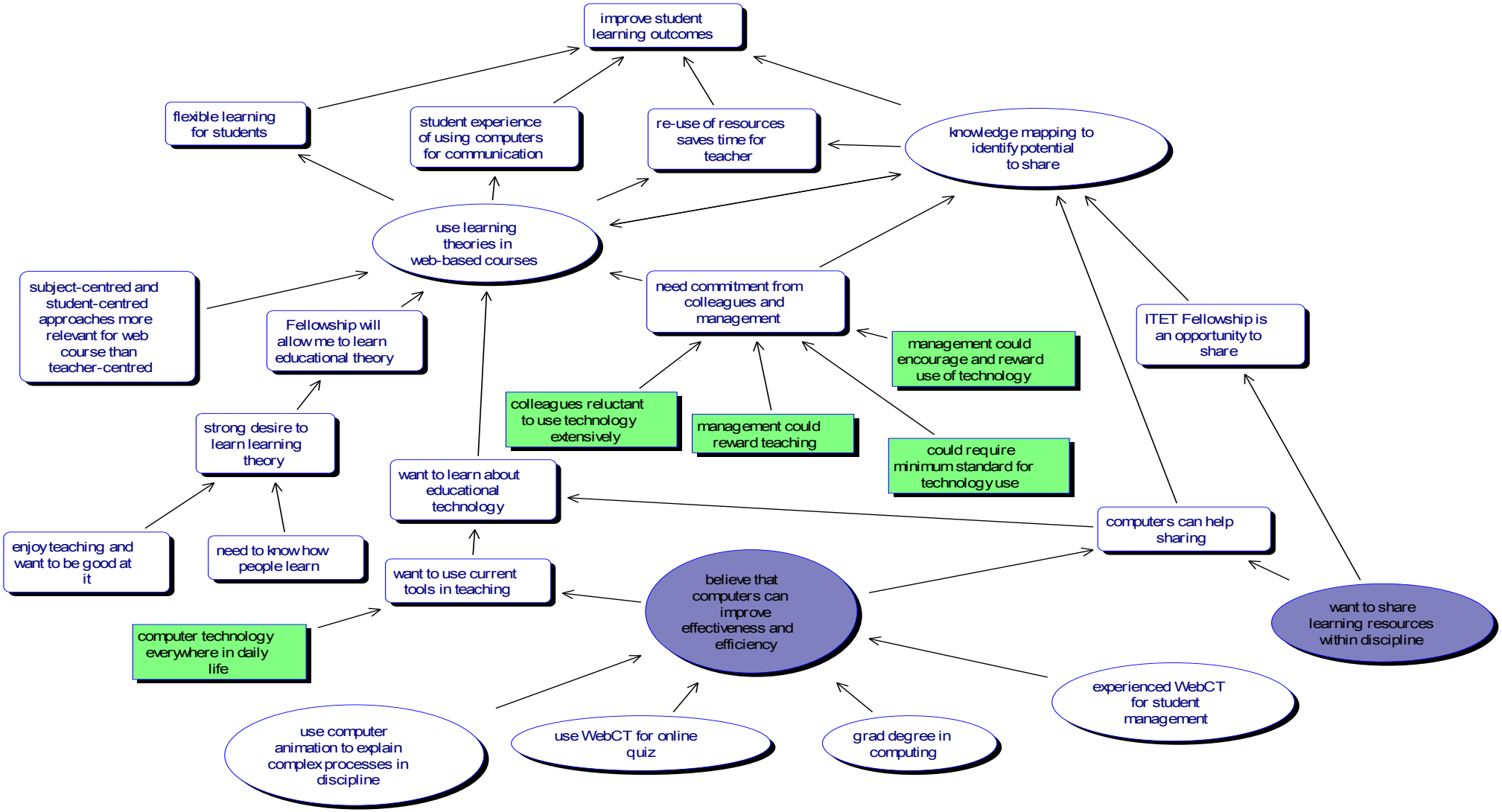
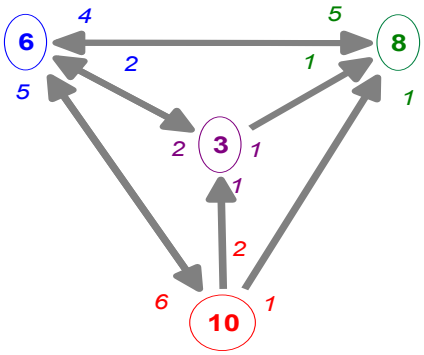


Figure 5.10 Example of pre-ITET cognitive map

Figure 5.11 Example map recoded for discipline analysis



The italic numbers on each arrow represent the link density. In this map, there are 8 concepts relating to discipline or department (green), 5 of which are linked to knowledge (*K*) concepts, 1 to individual (*I*) concepts and 1 to educational technology (*ET*) concepts. Where only one arrowhead is shown there are only influences in one direction.

Figure 5.12 Example of diagram showing pattern of concepts, link direction and density

Link analysis by theme

I used the Decision Explorer™ software functions in a number of different configurations for comparative analysis of the pre-ITET and post-ITET maps in relation to the themes of interest. The analysis involved identification of patterns in the concept sets and links between them, using the maps as originally coded by the participants and as recoded. However, with the original coding (Figure 5.8), there are five concept types, and with the recoded maps (Figure 5.9) there are four concept types. As the number of concept types increases, the number of links between them increases following the triangular number sequence as follows:

no of concept types (sets)	1	2	3	4	5
no of possible link types	0	4	12	24	40

The basic cognitive limit for the number of separate concepts a person can keep in short term memory is around 7. Beyond this, some structuring or pattern is necessary for comprehension or cognitive processing (Miller, 1956). An attempt to identify manually the patterns in 24 or 40 (not yet structured) lists of linked concepts is unlikely to succeed. I therefore analysed for one theme at a time, and extracted only the concept sets and links relevant to that theme. In all there were five types of analysis, two of which used the participants' original categorization of their mapped concepts and three of which used the recoded maps. The five analysis processes were:

recoded maps for academic discipline patterns

recoded maps for individual and teamwork patterns

recoded maps for empowerment patterns

original maps for empowerment patterns

a combination of original and recoded maps for patterns in beliefs and values.

In phase (ii) I also attempted to develop a map analysis method to show metacognition of teaching methods as discipline-specific, in relation to a broader context or range of possibilities. In

the pre-ITET maps I looked for references to other disciplines or to institutional factors for evidence of placing disciplinary strategies for e-learning within a broader context. I found that all the pre-ITET maps identify and describe discipline/profession knowledge, and student acquisition of knowledge and that none explicitly contrast it with other disciplines. Similarly, concepts about departmental teaching or organization are discipline-specific. I therefore did not repeat this analysis in phase (iii), and instead compared the pre-ITET and post-ITET analyses by the other themes for evidence of metacognition of disciplinary perspectives. Table 5.1 lists the link configurations used to explore each theme.

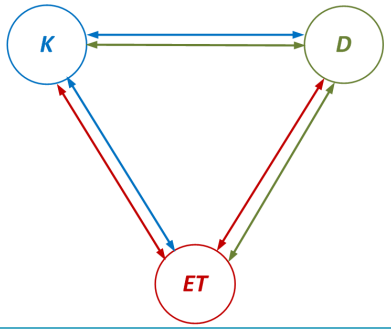
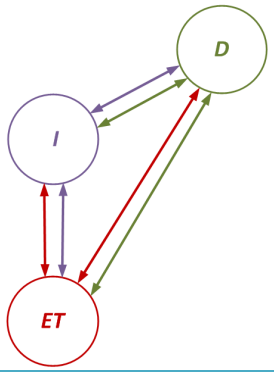
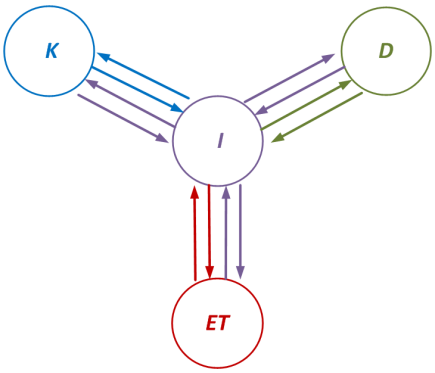
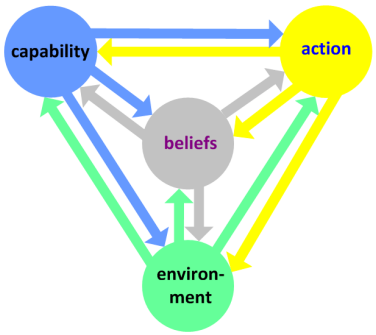
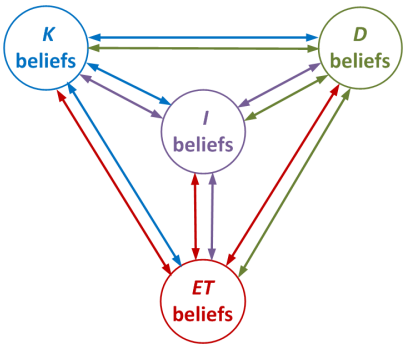
To produce the final results and compare the pre-ITET and post-ITET maps, I analysed the link density patterns and the concept content patterns separately. The raw results from the mapping analysis were in the following formats:

- link summary maps for each individual, showing the density of links between concept categories for each of the analysis processes listed in Table 5.1 to compare between individual participants' maps and identify patterns of perceived connection between categories
- concept summary maps for each individual, where ideas occurring commonly across the group were merged into a standard concept, to allow for comparison between individuals in how various themes were connected [for example any reference to the time required for developing teaching was represented as 'time for developing teaching']
- merged maps showing different strategy patterns for each analysis theme
- lists of common concepts and link patterns, to compare pre-ITET and post-ITET maps for persistent ideas and changes in strategy.

For the discipline theme analysis I used a combination of Decision Explorer™ and NIVIVO™ with word processing and spreadsheet software. I then combined text and link patterns to identify pattern groupings within the pre-ITET maps and within post-ITET maps. I identified pattern groups separately for the pre-ITET and post-ITET maps. Then I compared the two sets of results and cross-checked for pre-ITET patterns in post-ITET maps and vice versa.

The discipline analysis was the first and most exhaustive search for patterns. Findings from the initial pre-ITET map analysis in phase (ii) showed patterns in the density of links between concept types, but not in the causal directions of those links. Also, I later realised that the concept merging process destroys information about the directionality of links. In phase (iii), I therefore did not distinguish or attach any meaning to the direction of links in the analysis for discipline-related patterns.

Table 5.1 Summary of map link analysis by theme

Theme	Coding used	Linked concepts compared
discipline/profession differences in approach to adoption of educational technologies		***K***, ***D*** or ***ET*** (i.e. Figure 5.8 model with individual dimension ignored): ***K*** influencing or influenced by ***D*** ***D*** influencing or influenced by ***K*** ***K*** influencing or influenced by ***ET*** ***ET*** influencing or influenced by ***K*** ***D*** influencing or influenced by ***ET*** ***ET*** influencing or influenced by ***D***
individual or team orientation to teaching work and use of educational technologies		***I***, ***D*** or ***ET*** (i.e. Figure 5.8 model with knowledge dimension ignored): ***I*** influencing or influenced by ***D*** ***D*** influencing or influenced by ***I*** ***I*** influencing or influenced by ***ET*** ***ET*** influencing or influenced by ***I*** D influencing or influenced by ***ET*** ***ET*** influencing or influenced by ***D***.
empowerment – whether actions and capabilities influence or are influenced by the environment or context		***I***, ***K***, ***D*** or ***ET*** (Figure 5.8 model, but with only links to and from I considered): I concepts with influence on others ***I*** concepts without influence. ***K*** concepts influenced by ***I*** ***D*** concepts influenced by ***I*** ***ET*** concepts influenced by ***I*** ***K*** concepts influencing I ***D*** concepts influencing I ***ET*** concepts influencing I
		environment, actions, capabilities and beliefs, as in the original maps
values and beliefs		values/beliefs concepts as identified in the original coding, summarized in terms of links in the recoded maps.

The process used to analyse for individual/team orientation was similar to that for discipline, and involved identifying strategy pattern groups. There was no value in repeating the comparison of pre-ITET and post-ITET concept content as carried out for the discipline analysis, because the common *ET* and *D* concepts would be no different and the additional changes in *I* concepts would be represented in the pattern maps.

In analysing the maps for the sense of personal empowerment or influence, the direction of the perceived influence between concepts is significant. I therefore did not create merged concept maps in the empowerment analysis but counted the overall number of concepts in each of the relevant concept categories and the density of links in each direction between categories. In the recoded maps I quantified the overall perceived direction of influence to and from the individual (i.e. to and from *I* concepts). In the maps with the participants' own original coding, I carried out a similar analysis, but for influences between actions, capabilities, environment and beliefs-values. For both the recoded and original maps I summarized across all the participants and compared the pre-ITET and post-ITET results for the whole group. I also looked at the spread across the group.

An additional analysis combined both sets of coding, by adding to the NVIVO™ model used in the discipline analysis a further set of nodes for the belief-value concepts in the original maps. The reason for selecting only concepts that the participants themselves identified as beliefs or values is that these are concepts that they do not question, but simply to state as given. Belief concepts therefore indicate some of the deeper tacit understandings or assumptions that are influencing the explicit strategies expressed in the maps. I summarised the belief concepts in each of the recoded categories using a similar process to that used for the discipline and individual-team analyses, before combining the individual summaries across the whole group. Comparing the pre-ITET and post-ITET results from this exercise enables identification of any changes in values and beliefs resulting from participation in the ITET programme.

The supplementary CD-ROM (A3, A4) contains details of the analysis processes and their development through various stages of iteration.

5.4 Triangulation and interpretation of methods

Triangulation between different types of data and research methods is part of the interdisciplinary approach of this research. Data on recorded changes in the formal organizational systems of UNSW are used to triangulate with the cognitive mapping data from individuals.

5.4.1 Selection of triangulation data

Between 2001 and 2006 I logged events and collected relevant documents and additional interview material, to record organizational changes that Fellows have been involved in or have been affected by. In phase (iv) of the research, I selected the following as directly useful in addressing the research questions:

- interviews and cognitive mapping with a traditional classroom teacher who does not use e-learning, and with a teacher who is recognised as using technology innovatively in teaching and is not an ITET Fellow
- an e-learning innovation that has been funded and supported entirely within one discipline
- use of e-learning across UNSW
- developments in the School of Physics, and in the Faculty of Science as a whole
- an interview with the PVC Education and Quality Improvement, who initiated and sponsored the ITET Fellowship, for an UNSW senior management and formal leadership perspective
- activities of ITET Fellows in formal roles in UNSW.

These data, detailed in Chapter 6, are used to triangulate with the findings from the comparative analysis of pre-ITET and post-ITET cognitive maps reported in Chapter 5.

5.4.2 Summary of methodology and methods

This Chapter has described a context-specific cognitive mapping study of the strategies of 19 ITET Fellows in UNSW within action research methodology. Patterns in these individual strategies can be triangulated with organizational data to develop a more detailed understanding of how new e-learning technologies are interacting with the people and processes in campus university learning and teaching systems.

The analysis of the cognitive maps, and the selection of organizational data for triangulation, places some reliance on my judgement as to what is relevant and significant. Therefore the details of the map analysis process, and the assumptions and categorizations used, have been documented in detail. Similarly the selection of organizational data has been based on a model of the UNSW learning and teaching system, in which assumptions are made explicit.

Chapter 6. Results from cognitive mapping

Abstract of Chapter 6

This chapter presents the results of the analyses of cognitive maps from 19 ITET Fellows. These teacher strategies are analysed in relation to the five themes identified from the higher education literature reviewed in Chapter 2:

- discipline differences
- teamwork
- empowerment
- beliefs about learning and teaching
- metacognition.

The analysis shows patterns in the motivations of the Fellows for adopting e-learning (Research Question 1) and some common factors that may indicate organizational complementarities (Research Question 3). Comparison of the pre-ITET and post-ITET maps shows how the cross-discipline Fellowship experience changes patterns in teachers' strategies for using e-learning. These changes can be then be combined with data on formal organizational change related to ITET Fellows' activities (Research Question 2).

The findings from the analysis for the first four themes are summarized in separate subsections with references to relevant detailed results, which are provided in the Supplementary material. A final subsection interprets the combined results across all the map analyses methods, including observed changes in metacognition of disciplinary approaches to learning and teaching.

The results show that pre-ITET discipline-related patterns in strategies for using e-learning are replaced post-ITET by a broader range of strategies, in which there is more consideration of how to work with others in an institutional context. The fellows have a strong intrinsic motivation to develop innovations that will improve the student learning experience. After exposure to codified educational knowledge and cross-discipline discussion this motivation is strengthened by extrinsic factors, such as the potential for recognition of scholarship in teaching. However, there remain concerns about constraints on time for developing teaching in a research-focused academic environment.

6.1 Discipline patterns

The cognitive mapping data consisted of 38 cognitive maps, representing the strategies of 19 ITET Fellows before and after their participation in the 6 month cross-discipline Fellowship programme. The average number of concepts per individual map was 30, both before and after ITET, indicating that amount of strategy detail elicited in the pre-ITET and post-ITET mapping interview processes was comparable.

The pre-ITET maps and the post-ITET maps could be grouped by patterns in the links between knowledge (*K*) concepts, departmental organization (*D*) concepts and educational technology (*ET*) concepts, as illustrated in Figure 6.1, and also by the content of these concepts groups. The supplementary CD-ROM (A5,A6) contains the detailed results, which are summarized here.

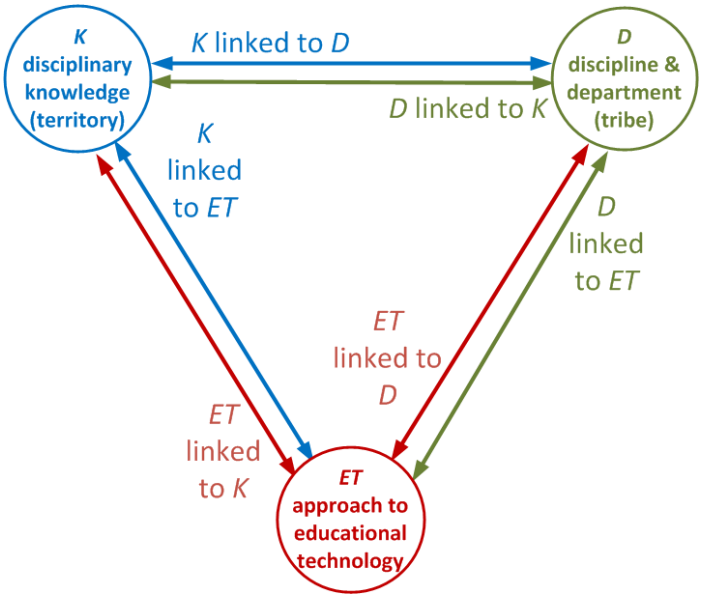


Figure 6.1 Link patterns for analysis of discipline patterns

Pre-ITET discipline patterns

I identified seven patterns in the pre-ITET maps, which aligned with discipline categories. Each pattern group had 2 to 5 (average 3.4) common concepts. Patterns A, B and C occurred in hard applied disciplines. Pattern D occurred in hard pure disciplines. Patterns E and F occurred in soft applied disciplines. Pattern G occurred in soft pure disciplines. These pattern groups are not mutually exclusive, as one map shows both pattern A and pattern B. This alignment of patterns with discipline types indicates that strategies for using educational technology are shaped by academic discipline. For example, the three maps that focused on professional knowledge changes, teaching and departmental change, and without any reference to educational technology are all from soft applied disciplines.

Post-ITET discipline patterns

In the post-ITET maps I identified five patterns, which were not aligned with discipline groups. Even when I first grouped the summary maps by discipline and then looked for common link patterns and themes within each group, I could find no discipline-related commonality. There were fewer common concepts within each pattern (1–4, average 1.8) than in the pre-ITET maps. The lack of discipline-related patterns, and the increased diversity of the strategy content both provide evidence of a broadening of the range of options being adopted.

The content of the post-ITET maps reflects some new ideas or strategies not present in the pre-ITET maps. For example eight maps specifically mention cross-discipline links. There is also frequent reference to educational design. Neither of these ideas occur in the pre-ITET maps. Educational design is often linked to learning and teaching knowledge – showing that the Fellowship has, as intended, encouraged the application of educational knowledge to use of learning technologies.

Comparison of pre-ITET and post-ITET patterns

The pattern recognition process for both sets of maps was independent, and came up the two different sets of patterns. A specific search for post-ITET patterns in the pre-ITET maps, and vice-versa confirmed that the patterns reflect a change related to interdisciplinary sharing of ideas and strategies.

All of the post-ITET patterns, or key elements of them, had also occurred in pre-ITET maps. Four of these patterns had persisted in a few individuals and had been adopted by several others post-ITET. By contrast only three of the seven pre-ITET patterns appeared post-ITET; in three different individuals from quite different disciplines. The post-ITET strategy patterns were therefore all present pre-ITET, and have spread. The pre-ITET discipline-specific patterns have largely disappeared post-ITET.

This result indicates that discipline-specific strategies have been replaced from a larger pool of shared strategies. Post-ITET, some new topics emerge. In particular, the idea of using educational technology for core learning, rather than as an adjunct or support for classroom teaching, has become more prominent.

Persistent and changed topics in individuals

There were also changes in the content of the strategies. I used NVIVO software to identify and list the frequency of concept topics, without reference to links between topics. Table 6.1 outlines of the results, which provided in detail on the supplementary CD-ROM (A6).

There is a persistent interest in developing learning and teaching knowledge, and in working on curriculum development. New themes appearing only in the post-ITET maps reflect increased awareness of the support available for learning and teaching with technology in the broader university context.

Some topics in the pre-ITET maps spread more widely in the post-ITET strategies, indicating that there has been sharing of knowledge of learning and teaching with technology and ideas about planning resources. By contrast, references to individual and discipline-specific uses of educational technology did not spread.

Table 6.1 Changes in content (concept topics) in teacher strategies

Knowledge	Departmental organization	Educational technology	Individual
Topics persisting in the strategies of individuals			
Educational knowledge Discipline or professional knowledge Student learning	Curriculum development ... constraints	Learning resources	Interest in teaching and/or educational technology Role in School or Department
Topics that appear only in post-ITET strategies			
–	Cross-discipline links Community and sharing	Institutional IT/ET systems	External recognition of teaching
Topics that spread to others in the group			
Educational knowledge	Time and money for teaching work	Educational technology for core learning Learning resources	Planning of work and career
Topics that did not spread to others in the group			
	Teaching deficiencies Form/organization of teaching in the discipline	Individual use of educational technology.	

Summary of discipline-related patterns

Pre-ITET patterns were aligned with disciplinary knowledge types, while post-ITET patterns occurred across discipline types. This indicates that discipline-influenced (discipline-constrained) strategies were largely discarded after exposure to, and time to discuss, a broader range of strategies. Other patterns, which were present pre-ITET but not widely shared, were more widely adopted post-ITET and became more coherent within the group.

Analysis of specific concerns, as reflected in concept topics, shows persistent interest in educational knowledge and innovation. After ITET, the strategies for pursuing this interest reflect a broadened range of ideas and perspectives, including cross-discipline, institutional and external support.

6. 2 Individual work and teamwork patterns

This map analysis sought patterns reflecting common strategies for individual teaching or for teamwork in use of educational technology. The analysis followed a similar process to that for the discipline analysis, but involved a different subset of links, those between *I*, *D* and *ET* (See Figure 6.2). The supplementary CD-ROM (A7) contains details of the results described here.

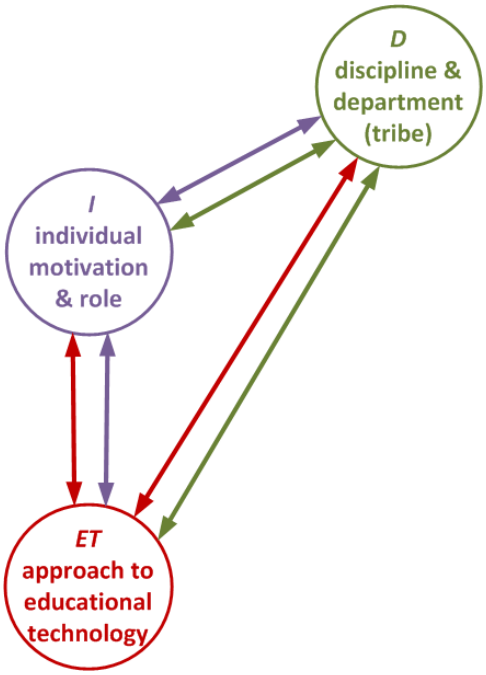


Figure 6.2 Link patterns for analysis of individual or teamwork orientation

Pre-ITET

I identified five patterns. The largest group had a pattern of personal motivation for using educational technology that was linked with departmental issues and constraints and also with meeting student learning needs. Two of the other four groups articulated some personal motivation, and some aspects of departmental organization. One of these included both individual and shared use of technology, but the other made no reference to educational technology strategy at all. The remaining two groups articulated little or nothing about their individual motivations; nor about educational technology as part of a strategy for themselves or their departments/colleagues. Each pattern group represents a mix of discipline types, so the patterns show no signs of disciplinary influence on the tendency of individuals to work individually or in a team.

Post-ITET

I identified four patterns, all of which represent strategies for working within departments, with others across disciplines or externally, and featuring some new concepts as listed in Table 6.1.

External recognition of teaching appears as an individual motivation or strategy in three of the four patterns, and is associated with a perception that disciplinary research is prioritized over teaching.

Cross-discipline links appear in two patterns, in both cases associated with use of educational technology for core student learning (rather than as a supplement to class activities or for administration).

Sharing with colleagues features strongly in one pattern, in association with cross-discipline links, support systems for teaching, and the use of educational technology for core student learning.

Where there is most focus on individual components of the strategy, this is accompanied by departmental constraints. A contrasting pattern is a focus on using technology for student learning across the institution rather than on an individual role in the department.

Summary of individual/teamwork patterns

The pre-ITET maps show a concern for developing the curriculum to meet student needs, and constraints upon that. However there are few specific strategies for addressing these concerns, although the idea of shared use of technology is present as well as individual use.

The post-ITET maps show clear strategies for using educational technology in a departmental or institutional context. Some include access to cross-discipline sharing, and there are several strategies for dealing with constraints, which did not occur in the pre-ITET maps. These changes are evidence of an improved capacity to work with others, in an organizational context, to develop teaching using educational technology.

Although departmental constraints feature significantly, the mapping data does not show any patterns where particular disciplines are associated either with teamwork or with working alone.

6. 3 Empowerment patterns

Using three different analysis methods, I generated three sets of results related to the individual teachers' perception of their own ability to make changes in learning and teaching.

1. Changes in the variation across the group of perceived individual influence, before and after the ITET programme, based upon an individual empowerment score derived from links in the recoded maps.
2. The direction and nature of concept linking in the recoded maps, between concepts coded as I and those coded as *K*, *D*, or *ET*.

3. The direction and nature of links between actions, capabilities and the environment in the original coding.

Only 14 of the pre-ITET maps and 14 of the post-ITET maps contained *I* concepts and could therefore be included in analysis by methods 1 and 2. Empowerment is the only map analysis theme in which the direction of the concept linking is significant. The results from all three methods are summarised below and are available in detail on supplementary CD-ROM (A8, A9).

Comparison of influence scores for individuals

Using the recoded versions of the maps, I gave each individual map a score derived from the numbers and direction of links between *I* concepts and *K*, *D* or *ET* concepts. This score was intended as a numerical indicator of each individual's ability to influence learning and teaching, as reflected in the strategy map. A positive score indicates a strategy where the individual has a net influence on the knowledge, department or technologies they are working with. A negative score indicates a strategy where these factors have a net influence upon the individual's actions.

The scores from the pre-ITET maps vary widely across the group, from –10 to +10, with a small majority of the group having positive influence scores. The distribution of scores is similar for the post-ITET maps. The only conclusion that can be drawn from this analysis is that the Fellows, on average, joined the Fellowship with some confidence in their own ability to influence learning and teaching, and had a similar level of confidence after participating in the Fellowship programme.

These influence scores give no information about which aspects of individual actions, motivations and roles are perceived as influential. Nor do the scores show which aspects of the learning and teaching environment exert influence upon, or are susceptible to influence from, individual teachers. The results from the disciplinary and individual/teamwork analyses show some significant changes in post-ITET strategy patterns, both in the concept linking and in the concept topics included. The results from the second and third methods of analysis for empowerment patterns give more information about the nature of individual influence and about the factors that the teachers feel able to influence.

Concept linking in the recoded maps

For this part of the analysis, I examined I concepts linking to *K*, *D* and *ET* concepts. I also examined *K*, *D* and *ET* concepts linking to I concepts. The concept links analysed are illustrated in Figure 6.3.

Links from I concepts to other concept categories were counted as positive and links into I concepts counted as negative, as follows:

- To evaluate which aspects of individual actions, motivations and roles are perceived as influential, and which are perceived as responses to the environment, I counted the total numbers and directions of links for each I concept topic.
- To evaluate whether a particular aspect of knowledge, discipline and department organization, or educational technology is perceived as a source of empowerment for individuals, or as something they are constrained by, I counted the total numbers and directions of links for each concept topic.

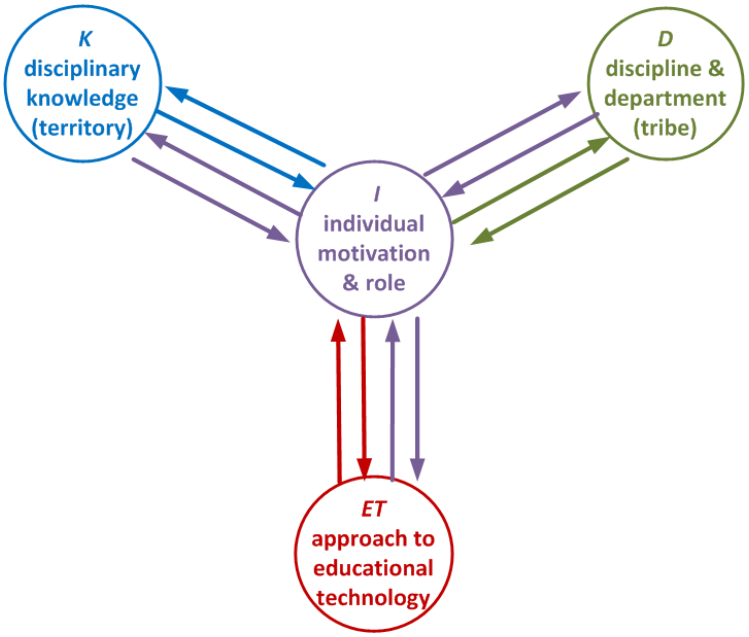


Figure 6.3 Link patterns for empowerment analysis of recoded maps

The resulting scores are quantitative indicators of how the participants in the study, as a group, perceive their ability, through their individual actions, motivations and roles, to influence the factors represented by each concept topic. I then compared the pre-ITET scores across the whole group with the post-ITET results.

Pre-ITET, the most influential *I* concepts are about the individual's interest in educational technology, personal values or characteristics and their role in the School or Department. *I* concept topics with many two-way links to other categories include experience of, and interest in, teaching. *I* concepts related to work and career planning have negative scores, indicating that on average the Fellows perceive these as factors over which they have little influence.

Table 6.2 lists *K*, *D* and *ET* concept topics according to whether they are more often influenced by individual teachers. Individuals think they can influence use of educational technology individually, and for support of classroom activities. But time and resources for developing teaching are not seen as open to influence.

Table 6.2 Influence of learning and teaching environment in pre-ITET maps

	Topics that individual teachers influence (positive influence scores)	Topics where there is a mutual influence	Topics that individual teachers are influenced by (negative influence scores)
K	Educational knowledge	student learning in discipline	
		discipline or professional knowledge	
D	Curriculum development… constraints	support for teaching and educational technology	time and money for teaching
	Industry or profession needs	research valued more than teaching	teaching deficiencies
		change in department… and resistance to change	
ET	ET for classroom support [rather than core learning activities]	use of current IT in teaching	educational technology development time
	individual use of ET		

The pre-ITET pattern is therefore one where individual teachers, although interested and motivated to develop innovative teaching with technology, do not feel empowered to do so. Nor do they feel able to control planning of their work time and their careers. What they can influence is their own teaching practice, curriculum development, and their own use of technology for non-core learning activities.

Post-ITET, the most noticeable change is the presence of strong two-way links between *I* concepts about external recognition of teaching and about career and work planning with *K, D* and *ET* concept topics. Personal values and characteristics, and an interest in learning and teaching with technology, remain influential.

The *K*, *D* and *ET* concept topics contributing to this pattern (Table 6.3) show resources for teaching as a strong mutual influence for individuals, indicating that this is now something they are planning to deal with actively, rather than being passively influenced (constrained) by. Other changes in perception of the department environment are the inclusion of community and sharing as something that the individual can influence. In relation to educational technology, learning resources are shown as a something the individual has influence upon, and sharing of educational technology has also become a topic where there is two-way interaction.

Overall, the analysis of the linking of *K*, *D* and *ET* concept topics with *I* concepts shows a pattern of more empowered strategies post-ITET than in the pre-ITET maps. Post-ITET, external recognition of teaching is identified as part of plans to allocate time and resources to pursuing an interest in innovative teaching. There has also been a shift away from focusing on individual use of educational technology, towards strategies that involve sharing technology with colleagues.

Table 6.3 Influence of learning and teaching environment in post-TET maps

	Topics that individual teachers influence (positive influence scores)	Topics where there is a mutual influence	Topics that individual teachers are influenced by (negative influence scores)
K	Educational knowledge		
	Student learning		
D	Curriculum development… constraints	Support for teaching and educational technology	Research valued more than teaching
	Community and sharing	Time and money for teaching	Student needs and responses
ET	Learning resources and objects	Sharing educational technology with colleagues	
	individual use of ET		

Results from analysis of original coding

The third analysis method, using maps with the original coding as assigned during the interviews, offers another way of measuring how participants in the study perceive their own influence – one which does not depend on my categorization of the concepts in each map, but on the interviewees' own categorization. This method involved counting total number of concepts coded in each of the original concept categories, across the whole group, along with the number and direction of links between them, as shown in Figure 6.4. The supplementary material provided on CD-ROM (A9) gives the detailed results, which are summarized below.

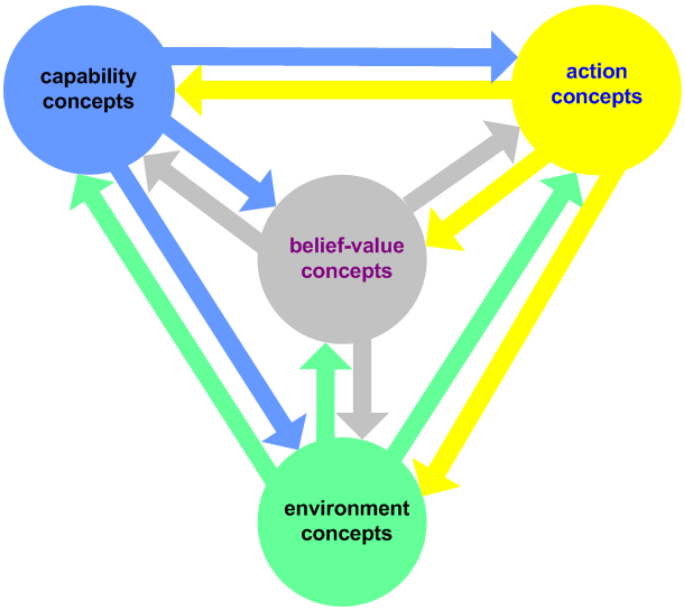


Figure 6.4 Link patterns for empowerment analysis of original maps

The results are that the total number of concepts categorized as environment and beliefs-values is significantly lower post-ITET, and the number categorized as actions or capabilities increases correspondingly. This indicates that the participants have reframed their relationship with the academic environment in terms of a more interactive and empowered stance. For example:

Pre-ITET, the Fellows' ideas about their organizational environment is strongly influencing their actions and is significantly influencing their perception of capabilities (what is possible for them). There is a mutual influence between capabilities and actions. Some beliefs and values are also influencing action.

Post-ITET, the environment influence is now more strongly related to capabilities. There is also a significantly stronger positive feedback loop between actions and capability. This implies that actions determined by the environment have become reframed as capabilities: 'In this context I can ...' rather than 'Because of this I must ...'. Similarly, the number of beliefs has fallen, which is consistent with less passive acceptance of how things are.

Summary of empowerment patterns

The analysis for empowerment patterns, using both the original and recoded cognitive maps, provides evidence that the cross-discipline Fellowship experience has changed the participants' responses to their organizational contexts to one that is more proactive or empowered.

Analysis of the topics and directional linking in the recoded maps show that, both pre-ITET and post-ITET, individual teachers feel able to influence learning and teaching knowledge and curriculum development in their disciplines. However, new possibilities and strategies are being considered post-ITET, in particular the possibility of external recognition of teaching (i.e. as a scholarly activity) and the strategy of actively planning workloads to enable development of teaching. There is also shift from influence only upon individual use of technology to influence upon sharing of educational resources.

The shift towards a more enabled or empowered approach to teaching work is confirmed by analysis of the original concept coding, as attributed by the participants themselves.

The Fellows' are therefore more empowered after the Fellowship programme, in the sense that their strategies for using educational technology involve more proactive, and less reactive responses to the organizational context.

6. 4 Patterns in beliefs and values

The analysis for discipline and teamwork patterns involved using NVIVO to attribute a concept topic to each concept in the maps, to enable comparison and combination of concepts across different maps. The same concept topics provided a way of analysing those concepts that the participants had identified as values or beliefs.

Four of the pre-ITET maps, and five of the post-ITET maps had no belief-value concepts. In the remaining 29 maps, I combined the belief-value concepts from all the pre-ITET maps into a single map showing concept topics represented in more than one map (i.e. belief topics identified by at least two people). I repeated this process for the post-ITET maps. The results are listed in the supplementary material (A9) and described here.

The pre-ITET results gave a list of eight topics. Of these, the most common by far is a personal interest in learning and teaching (in 8 maps). Knowledge (*K*) concepts classed as beliefs or values relate to student learning and to educational knowledge. The only *D* topic labelled as a belief is the organization of teaching, and the only *ET* topic relates to discipline-specific uses of technology.

The post-ITET results are similar, although there are only five concept topics that are classified as beliefs or values by more than one person; a reflection of the more empowered and questioning stance reflected in the results reported above. The more common belief concepts relate to educational knowledge (in 8 maps). The valuing of research more than teaching is the only common *D* belief and there are no *ET* concepts commonly classified as beliefs. Intrinsic interest in (valuing of) learning and teaching with educational technology has persisted, as has a belief that that research is valued more than teaching, and if anything this belief has strengthened. By contrast, discipline-specific use of educational technology and beliefs about how teaching has to be organised have gone. Beliefs about the nature of professional/discipline knowledge are still present, but not those about student learning, which appear to have been reframed in terms of educational knowledge (i.e. as theory rather than empirical observations).

Summary of changed patterns in beliefs and values

The following changes have taken place:

- Assumptions that teaching has to be organised in particular ways, or that technology use is discipline-specific have been replaced by strategies for action involving a broader range of choices.

- Some of these strategies for action are influenced by the assumption that research is valued more than teaching.
- More beliefs about learning and teaching refer to (codified) educational knowledge, replacing beliefs about student learning and about the specific types of professional/discipline knowledge the students require.

6. 5 Overall findings from cognitive mapping

Figure 6.5 gives an overview of how the cognitive mapping analysis results relate to the themes identified in the literature as relevant to the adoption of e-learning in universities and a model of UNSW learning and teaching as a complex adaptive system that includes educational technology as a material component.

(i) Discipline-related patterns

The pre-ITET maps show patterns of discipline-based differences in strategies for the use of educational technology. Post-ITET, these differences are no longer evident. Some of the pre-ITET strategies are adopted more widely within the group post-ITET; while others disappear. The discipline analysis provides evidence that participation in a cross-discipline community of practice can increase the range and thoroughness of a university teacher's search for strategies to use in adopting educational technology. This finding is also supported by the results from analysis for beliefs and values, where discipline-specific beliefs are broadened by codified educational knowledge.

(ii) Move from individual to team focus

Pre-ITET strategy maps focus on individual concern for meeting students' needs. Post-ITET maps show more strategies for working with others, in a departmental or cross-discipline environment, to improve student learning. This is evidence that the Fellowship led to e-learning strategies that are less individualistic, relate more to department and institutional contexts and take more advantage of opportunities for cross-discipline collaboration and support.

(iii) Individual motivation and confidence

Individuals' perception of their own influence varies across the group. On average, both before and after ITET, the Fellows thought they could influence knowledge, departmental organization and the use of educational technology. The Fellows as a group have a strong and persistent intrinsic motivation for their teaching and learning activities. However, post-ITET, external recognition of teaching and the scope for planning of individual work become significant additional sources of influence within the individual teachers' strategies. Therefore, among

university teachers who already have some confidence that they can make a difference to learning and teaching through use of technology, extrinsic motivators such as external recognition of teaching and support for planning of individual workloads can reinforce intrinsic motivation.

(iv) Codified knowledge is empowering

Analysis of pre-ITET and post-ITET strategies for the influence of environmental factors on actions and capabilities show an increase in confidence, for example in influencing curriculum development. This is evidence that building shared educational knowledge that is explicit (codified) and externally acknowledged, within a cross-discipline community empowers the individual teachers to make changes to learning and teaching systems and curricula in association with their use of e-learning technology.

(v) Some constraints persist

Post-ITET strategies include assumptions that research will continue to be valued more than teaching; which ties in with continuing concerns about being able to find support, resources and time for developing learning and teaching. These persistent shared concerns and beliefs are evidence that, for many teachers, the institutional research focus is still constraining the time they can devote to developing use of new technologies to meet changing student needs. The constraints co-exist with availability of individual rewards for scholarly teaching, which acts as an extrinsic motivation for overcoming the constraints.

(vi) Metacognition and beliefs

The valuing of learning and teaching and an interest in teaching with technology are present in both pre-ITET and post-ITET maps. However, some discipline-specific beliefs about learning and teaching disappear post-ITET, or are reframed in terms of educational knowledge. The replacement of discipline-specific beliefs and assumptions by references to educational understanding implies metacognition of disciplinary learning experiences as part of a broader field of knowledge.

Figure 6.5 Overview of cognitive map analysis results

Chapter 7. Systemic change in UNSW

Abstract of Chapter 7

This Chapter presents evidence of changes in the UNSW's formal organizational systems that can be related to the activities of ITET Fellows, in order to address both Research Question 2 and Research Question 3. The data collected to triangulate with the cognitive mapping analysis comes from several different perspectives:

1. the senior university manager who initiated and sponsored the ITET Fellowship as a strategic initiative, representing the institution-level management perspective
2. a teacher with a similar level of motivation to that of the ITET Fellows, but who prefers traditional classroom teaching methods and has no interest in using e-learning technology
3. a discipline-specific e-learning innovation supported at departmental level; not involving ITET Fellows or other cross-discipline collaboration and not supported by any other institution-wide learning and teaching initiatives
4. e-learning developments at the institutional level; the hardware and software tools available and how the majority of teachers and students are using them for learning
5. the UNSW Faculty of Science, where ITET Fellows' activities can be tracked at the Faculty and School level and linked to broader changes
6. a summary of ITET Fellows' formal roles across the institution, after completing the Fellowship.

Each perspective is in the form of short narrative case study, followed by an interpretation of the organizational pattern represented. These findings can be combined with those from the cognitive mapping analysis to show how the cross-discipline community has influenced formal organization, and to relate the patterns in the ITET Fellows' strategies to observed events and changes in the organization.

7. 1 Senior management

This study of UNSW learning and teaching as a complex adaptive system is based upon a conceptual framework that includes a role for the intentional management of change in a university. The manager's role is to understand and enable the organizational learning process. It is therefore important to include in the data on systemic change in UNSW learning and teaching the perspective of someone with formal responsibility for outcomes at the institutional level.

The ITET Fellowship was a strategic initiative sponsored by the Pro-Vice Chancellor Education and Quality Improvement (Russell & Lee, 2005). In early 2006, shortly before his retirement, I interviewed Professor Lee to find out more about how he perceives the origins and outcomes of the ITET programme.

I captured the content of the conversation using Decision Explorer cognitive mapping software. In this interview I did not check the visual representation with the interviewee. The cognitive map would not be combined with others, and was simply a faster and more efficient way of capturing the strategies than would be possible taking only textual notes. The density of the content, and the strategies described, along with time limitations, meant that rather than lose content by interrupting the flow of conversation, I typed in concepts, added linking where possible, and worked on the cognitive map representations immediately afterwards while my memory of the conversation was still fresh.

After removing repetition, an initial 67 concepts were reduced to 50, which I was able to group into three areas, representing individual background and motivation, the origins of the ITET Fellowship initiative and the development of ITET in terms of its interaction with the organizational context. These are summarized below.

Background, motivation and leadership role

Professor Lee has a long-standing personal interest in teaching, and has been involved locally and internationally in disciplinary teaching and staff development since 1973. Some of this experience has been in running cross-discipline workshops. He was among the first recipients of the UNSW Vice Chancellor's award for excellence in teaching. He also has an outstanding record as a researcher in microbiology, having contributed to Nobel prize-winning work on *Heliobacter* (the bacteria that are now known to cause stomach ulcers and cancers). He has spent most of his career, 27 years, at UNSW and has been a Head of School and Associate Dean. He said that his own experience of national discipline-specific grants for educational technology development had been more influential in forming his ideas on educational technology than educational research had been. [The grants he referred to were under the Australian government's CUTSD scheme in

the 1990s. The evaluation of this scheme concluded that project success, in terms of improving student learning, required multi-skilled teams and involved a scholarly approach to teaching (Alexander, McKenzie & Kershner, 1998).]

In summary, Professor Lee is a senior academic with credibility both as a researcher and as a teacher. He also has considerable experience of UNSW as an organization and of higher education in general, from a number of perspectives. It was because of this background that he was asked to take on the new PVC Education role in 2000, which he accepted because of his intrinsic interest in teaching, instead of retiring as he had been planning.

The origins of the ITET Fellowship

Before 2000, UNSW had nobody on its senior management team with specific responsibility for learning and teaching. The CEQ feedback indicated that the quality of UNSW teaching was poor. A central educational research and consulting service had not been enough to penetrate Faculty teaching practices. UNSW senior management were therefore seeking a new staff development strategy to improve teaching and decided to create a PVC Education role. Initially they tried to fill the post by external advertisement, but were unable to appoint anyone.

When Professor Lee took on the new PVC role, by invitation, he had no formal position description. He therefore picked four priority areas and set up working groups to explore each area. One of these groups looked at the government action plan *Learning for the knowledge society* (DETYA, 2000), noted the emphasis on imaginative use of educational technology, and put forward the idea of an Innovative Teaching and Educational Technology (ITET) Fellowship.

Professor Lee took this idea on board and wrote a document proposing a $9M strategic initiative. There was no specific funding for learning and teaching, as income from student fees was not recognised as strategically significant [although teaching-related income accounts for around two-thirds of the university's annual budget]. There was, however, a strategic priorities fund. As well as the Fellowship, the final proposal for strategic priorities funding also included a staff development strategy and covered research as well as teaching, with named involvement of other senior managers. It was agreed and funded in full as a strategic priority initiative.

The development of the ITET Fellowship

The AU$9M strategic funding paid for a number of initiatives, including the ITET Fellowship. A specialist in Learning and Teaching was recruited, and established a team which became the Learning & Teaching Unit (LTU). The existing Student Learning Centre developed a student mentoring scheme. The Educational Development and Technology Centre (EDTeC) and the LTU

jointly worked with ITET Fellows whose Faculties had been paid for their time release. A Quality Systems Development Group was set up, and with the LTU, developed an instrument for student evaluation of teaching.

Professor Lee was closely involved with the ITET Fellowship, especially at the beginning. When the ITET Fellowship groups began to develop into a community, this resonated with Professor Lee's experience of cross-discipline workshops. The idea of cultivating communities of practice (UNSW, 2002; Wenger *et al.*, 2002) became a deliberate strategy for ITET and other learning and teaching initiatives. The Fellowship also made Professor Lee aware of some of the barriers to improving learning and teaching. The most significant of these barriers were the internal funding and staff promotion processes. To address these he supported changes in promotion practice (see the account of Science Faculty changes below), and the allocation of a budget for Faculties, tied to their support for learning and teaching.

From Professor Lee's perspective, by early 2006 the significant outcomes from the ITET Fellowship included:

- ITET Fellows' input in developing the Guidelines on learning that inform teaching at UNSW (UNSW, 2003a)
- ITET Fellows in the fifth programme provided educational trial and evaluation of a new institutional learning management system
- UNSW gained an institutional award for cultivating communities of practice in learning and teaching
- changes in academic staff promotion criteria and practices.

Interpretation

The creation of a new senior management role was an intentional response of UNSW senior management to changes in UNSW's external environment, in which the Australian government was asking for more attention to teaching quality. The existence of a champion who understands the culture of the University, and whose authority is respected, has been an important factor in facilitating organizational change. Professor Lee was able to obtain funding and support for learning and teaching initiatives in a context where research was considered the main priority. His direct participation in discussion with the ITET Fellows, and the community atmosphere of these discussions, allowed identification of barriers to change that had not been taken into account by senior management.

Prior to 2000, the failure of central staff development and educational research to change disciplinary teaching practices exemplifies the pattern identified by the analysis of higher

education literature in Chapters 2 and 3, in which individual staff development in learning and teaching has had limited effect.

Like many other academics, Professor Lee has relied on experience more than on educational literature to inform his judgements on the significance of e-learning technologies. However, his experience has included cross-discipline discussion of learning and teaching, and involvement with higher education at the national and international levels. Therefore, when Professor Lee has acted intuitively, the intuition has come from a tacit knowledge base that is both broad, in terms of understanding disciplinary differences and the higher education environment, and deep, in terms of long experience as an academic in the UNSW internal environment.

In discussions with the ITET Fellows, Professor Lee was alerted to complementary systems in UNSW's funding and promotion processes that were hindering change in learning and teaching. Although the Fellowship scheme itself recognises the need to dedicate staff time for redevelopment of learning and teaching, the departmental funding and promotion criteria were still blocking the implementation of systemic change, and he sought to change that. Professor Lee also experienced the value of communities of practice for beginning the process of change in formal university systems. He has therefore both initiated and been an active participant in an organizational learning process.

7. 2 The traditional lecturer perspective

The perspective of a UNSW lecturer who has chosen not to incorporate e-learning technology into his teaching provides an example of the influences that have been discouraging e-learning use.

During phase (i) of the research, in 2002, I carried out an informal unstructured interview with one of the contributors to UNSW's Foundations of University Learning and Teaching (FULT) programme, a 7-day course that new lecturers are encouraged to attend. The interviewee is an experienced teacher, who presented a session on “bringing intellectual excitement to teaching and learning”, in the form of a talk about his teaching experiences with a few minutes for direct questions at the end. He also presented a lunchtime seminar early in 2002, in which he outlined his experiences and theories on inspirational lecturing. At various points, and again at the end, he emphasised the importance of *affect*, and commented that the emotional dimension is largely missing from educational theory (see the discussion of emotional aspects of learning in Chapter 2). His paper for the lunchtime seminar cites several of his own publications on his teaching experience, in which most of the references are concerned with discipline content.

The interviewee had received a Vice Chancellor's award for excellence in teaching and had published several papers on teaching in his discipline. He was not using, and did not intend to use,

e-learning in any form. My aim was to find out more about his views on e-learning, as an enthusiastic and motivated traditional lecturer. The views he expressed in this initial interview, in summary, were that he:

- focuses on making traditional methods more engaging for the student
- is not convinced that e-learning has anything to offer
- has seen examples of other teachers putting second rate materials online.

In June 2003, during phase (ii) of the research, when I was carrying out the pre-ITET cognitive mapping interviews with ITET Fellows, I interviewed the same teacher again, this time using cognitive mapping as with the ITET Fellows. The map we produced depicts a three-way interaction between student, teacher and the subject content. There is no representation of colleagues, the academic community or the academic department, as part of the student or teacher experience. The concepts in the map are abstract and general, and do not refer to specific actions or behaviour. It was therefore not possible to analyse the map in the same way as those from the ITET Fellows, all of which contained some specific details of actions and had references to departmental context.

In October 2003 the interviewee presented part of a session on *Improving Lectures,* in an event run by the UNSW Learning and Teaching Unit, in which participants were offered "the opportunity of considering the learner-teacher-subject interaction in a more structured way" (UNSW, 2003b)

In July 2004 I carried out two further follow-up interviews. In the first, although I attempted to elicit specific teaching strategies, and gave examples of some of those described by the ITET Fellows, the interviewee again preferred to describe in general terms the interaction of student, teacher and subject matter. We then had a conversation about the disciplinary and departmental factors influencing a teacher's strategy. Of 30 or so staff in his department, he said, only about five have any interest in improving the quality of teaching. When new ideas had been raised it had been by younger staff on short-term contracts, which were subsequently not renewed. He has therefore been confined to working on his own teaching, and had sometimes found this a painful and demoralizing process. He did not want to represent these difficulties in a cognitive map and did not want to discourage younger teachers by discussing them. He thought that the ITET Fellowship might provide a better environment for teachers to explore such issues.

A week later we met for another interview, in which we produced a revised version of the cognitive map generated a year earlier, and attached concept styles to suit the teacher-learner-subject model. At no point during any of these interviews did he refer to constructivism or any other recognised educational theory. The educational references in the interviewee's publications

on his teaching are sparse, and the few educational references that do occur are from the behaviourist tradition. [I have not cited these publications to respect confidentiality, because I did not ask the interviewee for explicit permission to reveal his identity.]

Interpretation

The information from this one teacher gives some insight into the isolation experienced by an enthusiastic classroom teacher in a traditional research-focused university environment. Like the ITET Fellows, he has a strong intrinsic motivation to improve his teaching, but has had few opportunities to share experiences and ideas with other teachers, or to engage with and apply codified (scholarly) knowledge in the form of published educational research. Reflection and personal theories on teaching can therefore only draw upon on the empirical discipline-specific classroom experience of the individual teacher. The emotional dimension of this situation is evident in the interviewee's avoidance of discussion on discipline department or community, from which he has derived little support. Instead, he focuses on the emotional dimension of his own interaction with his students. He feels very much in a minority within his own department. Only after the introduction of institutional-wide initiatives to support learning and teaching has he had the opportunity to share his experience of teaching at cross-discipline events. The sharing process follows a similar didactic pattern to that of sharing his subject knowledge with students. A didactic form of interaction may be the most familiar and comfortable for someone who has had little opportunity to participate in other forms of sharing his experiences of teaching.

This case shows how one enthusiastic and motivated classroom teacher has been limited in his ability to innovate in his teaching, and provides evidence of how academic departments can constrain innovative teaching practice. It was only at my third meeting with this interviewee that he discussed some of the more difficult aspects of his experience, in confidence. Open cross-discipline events to facilitate sharing of ideas can contribute to support for isolated individual teachers, but on their own may not be enough to change established forms of learning and teaching. This case suggests that more sustained and supportive cross-discipline community of teachers is required.

7. 3 Discipline-specific e-learning innovation

Within some UNSW academic departments there is support for innovation in learning and teaching. One such example has resulted in successful development of a discipline-specific e-learning innovation, without the help of any university-wide sponsorship such as the ITET Fellowship.

The case in question is the Omnium project in UNSW's College of Fine Arts (COFA). Omnium is an online environment for small groups to work collaboratively in the visual arts. The account given here is based upon my notes from a number of presentations, publications and digital information on the project, combined with information from my own work on organizing support for the UNSW eLearning programme.

Omnium was initially set up as research and development project in 1999, and involved 50 design students across 11 countries. Its founder sought to develop a new collaborative learning environment that could link design students and practitioners across international and cultural boundaries. Research and Faculty funding supported development of the software environment and research into how it could be used. By 2004, the software was in its third version, incorporating an online studio environment, a portfolio tool and a community space. In 2006, the website reported that a total of 5000 people had been linked up internationally through the system. Other universities have obtained licenses to run their own versions of this software, and the project has been commended for its educational excellence by numerous awards (Bennett, 2006).

The Omnium project is presented and funded as a disciplinary research project, involving international collaborations, rather than as a mainstream learning and teaching initiative of UNSW. Published papers on the project describe the software environment (Bennett, 1999) or focus on discipline-specific aspects of learning (Bennett & Dziekan, 2005). For example, one paper (Broadfoot & Bennett, 2003) integrates the theories of Kvan (1994) and Schön (1983; , 1987) on studio-based learning. Omnium is therefore an example of successful discipline-specific innovation in learning and teaching.

There is active interest in Omnium from other disciplines such as genetics, biochemistry and architecture. Despite this interest, the Omnium system has not been integrated with the institutional online learning management system, even at the basic level of having a common authentication to allow users to switch easily between systems without entering IDs and passwords. Such integration is technically feasible and has been discussed many times since 2003, but without agreement or progress. Students are enrolled into Omnium manually, and interaction with students is managed by a small COFA-based team. Use of Omnium is effectively confined to fully online distance learning courses run for an international specialist community, rather than providing an online collaborative environment for campus-based students. Many COFA teachers use the main UNSW LMS rather than Omnium to provide an online learning environment for their students.

It is worth comparing the number of Omnium users with the number of users of the main UNSW online learning management system, which is integrated with institutional library and administration systems and caters for automated enrolment of students into online courses. In Session 2 of 2006, 28,000 students out of a total 40,000 were enrolled in at least one course in the main UNSW LMS, which has 100,000 student seats (Russell, 2006). By comparison Omnium, with its labour-intensive administration and its focus on small numbers of distance students, has had a cumulative total of 5000 users over 7 years (Bennett, 2006). Without integration into institutional systems, Omnium is not scalable for larger numbers of students. The majority of UNSW students will therefore not be able to benefit from Omnium's advantages as an online educational environment. In 2007 Omnium was released as open source software. So it could now be technically integrated in UNSW's or other institutional systems without the participation of its originators.

Interpretation

The Omnium project is an example of successful discipline-specific innovation for learning and teaching with technology, which has been limited in its application across disciplines and at institutional level. Its benefits are not being spread to UNSW's campus-based students. Omnium is not the only example of this pattern. A similar tendency to frame e-learning innovation as disciplinary research and software development, and the focus on international distance education instead of a blended approach involving campus-based students, were among the reasons given for the poor response to the UK E-university (House of Commons, 2004). The research focus of the Omnium project results in priorities related to discipline-specific funding and to a particular academic community. Discipline-specific criteria are discouraging changes that would allow broader use of, and control of, the Omnium software.

The Omnium example provides evidence of another mechanism that acts as a disincentive to institution-wide systemic innovation in learning and teaching in traditional campus universities. Where innovation is sponsored within a department or discipline, it is likely to be framed as disciplinary research in order to attract funding and support. Researchers who develop an innovation to meet the requirements and norms of one disciplinary research community may be unwilling to surrender control of the further development of that innovation so that it can meet broader needs. Omnium was developed for the graphic design discipline, where studio-based learning is a tradition. Its founder has an interest in ensuring that the environment is used in ways that reflect well upon its value within that discipline (Bennett, 2003). There is little, if any, incentive to spread, and by implication dilute, that value through adaptation for other disciplines.

7. 4 Use of e-learning across UNSW

Quantitative data on the scale and nature of e-learning use across UNSW as a whole gives an idea of how e-learning technologies are being used in mainstream learning and teaching practices. The forms and processes in the majority of UNSW learning and teaching are reflected in changes in technologies and infrastructure supported at the institutional level.

The UNSW LMS

Since UNSW introduced an institutional online learning management system in 2000, the use of e-learning, in terms of the numbers of staff, students and courses has been increasing steadily at 30% a year (Russell, 2006).

Provision includes an online tutorial in information literacy, customized for each Faculty, which all new students are required to complete. The tutorial consists of self-paced activities and exercises, with formative and summative assessment by online quizzes.

The majority use of the online environment is for administrative information such as course outlines and timetables, and supplementary content. Some programmes, such as undergraduate Medicine, set up online discussion group areas for student project work, where no active online facilitation is required from academic staff. The School of Modern Languages has a default level of online presence for all 180 of its courses, with basic question and answer discussion areas, course outlines and the facility for teachers to post notes if they wish. Although a few teachers in the School make substantial use of interactive online learning activities using a variety of digital media and tools, the majority stay at the basic level and rely on traditional lectures and tutorials for core learning. (Russell, 2006)

The most common pattern of e-learning use is therefore one where the core learning process is via lectures and tutorials, rather than classroom work being part of a blend of learning activities that also involve learning in an online environment. However, this pattern is beginning to shift as more online learning tools are integrated into the learning management system (LMS). In 2007 these included:

- Turnitin similarity detection, to help prevent plagiarism.
- Library systems, enabling easy direct access from online courses to digital publications
- MapleTA, which is used for mathematical modelling activities in science and engineering disciplines
- Lectopia, which provides digital recording of lectures and podcasting.

E-learning tools are also supporting new types of learning. For example, a 1st year Engineering course introduced in 2006 is structured around group work on a design project. This course is studied by 1000 students at a time. As well as use of the LMS tools to support the design projects, there is increasing use of additional e-learning tools to support students' review of each others' designs and also of each others' contribution to group activities.

UNSW still has to extend the innovative uses of the available technologies to reach the majority of learning and teaching practice. ITET Fellows, particularly the fifth group, have been centrally involved in trialling these new systems, exploring the innovations in educational practice that they support, to test their practicability in the UNSW setting.

Digital recording of lectures

In 2005 UNSW introduced digital recording of lectures using the Lectopia system developed at the University of Western Australia, like UNSW a member of Go8. The system replaced an audiotape recording and lending service previously operated from the UNSW Library. In 2006 Lectopia was available in all 41 main lecture theatres on UNSW Sydney campuses, with students able to access digital sound via a streaming service and in some cases the recordings are also available in the form of podcasts.

Student use of Lectopia in UNSW has expanded as fast as availability allows, and is limited only by the number of lecturers who choose to request the service. In 2006 Session 2, an average of around 200 lectures a week were recorded (Stoddart, 2006a; b). A survey of UNSW students who use the Lectopia service (Goodwin, 2006) showed that all of them found it either essential or useful for their studies, with the majority using it for reviewing and revising the concepts covered after attending a lecture (see Table 7.1), rather than as a substitute for attendance. Over 83% of the respondents said they attend lectures always or regularly.

Table 7.1 Students' reasons for using digital lecture recordings (Goodwin, 2006)

reasons for use of lecture recordings	% of UNSW users	% of users across 4 universities
revision	75	62
review concepts	68	57
timetable clash	39	42
work commitments	25	35
prefer recorded format	23	24
family commitments	8	14
regional location	4	3
disability	4	3

While there are concerns that recording of lectures will limit interactive teaching practices, students say it helps them learn (Alexander, 2006). Students in the UNSW survey, asked what could be improved, responded that, apart from wanting improved sound quality, they thought all lectures should be available, streamed and as podcasts, along with visual materials. Over 97% of UNSW respondents have an internet-enabled computer at home, and of these over 90% are on broadband connections. Over 60% own a portable media device that they can use to play back podcast recordings. Although the sample is from existing users, other reports within UNSW indicate that there are frequent complaints from students about the lack of availability of lecture recordings (Stoddart, 2006a).

UNSW has already allocated funding to upgrade the system, to cater for an opt-out arrangement where lectures will be recorded by default, and to extend recording of visual materials used in lectures. Around 1200 lectures recordings a week are predicted. (Stoddart, 2006c)

UNSW is also developing the facility for remote participation in small group discussions. The system is a significant improvement on the sound quality of older videoconferencing technologies and makes possible effective recording of small group discussions. The technology allows student groups to interact remotely with individual professional practitioners, and supports effective discussion between two distant classrooms. Along with Lectopia, this technology means that many types of classroom activity could be made available as a digital recording.

Interpretation

Although mainstream teaching practices have changed relatively little, the growth in use of the institutional LMS, and its integration with other systems, is leading to some qualitative changes at the institutional level, which are beginning to have an impact on student learning. Students expect campus-based courses to have an online component, even if this is used mainly for

information, assignment submission and lecture notes. Increasingly they are asking their lecturers to make more use of e-learning, especially where they experience effective use of e-learning in one course and find it lacking in others.

The influence between technology and pedagogy is mutual. E-learning tools are being introduced to help with management of small group learning processes in large engineering classes. Conversely, the growth in use of digital recording of lectures has been driven not by changes in the form of learning and teaching activity, but by the availability of a technical service and infrastructure, in a context where students have ready access to the equipment and skills needed to make use of the service. Student use of digital lecture recordings might be seen as a less than optimal use of e-learning technology. But students faced with the reality of learning from lectures are using the available technologies to make the lectures work better as a learning experience.

Lecture recordings also have the potential to stimulate changes in teaching practice. Planning and reflection upon classroom teaching has been difficult because of a reliance on tacit knowledge and unconscious actions in the heat of the classroom, as discussed in literature reviewed in Chapter 2. Digital recording technology now has the capacity to bring about a systemic change in the processes by which classroom teachers learn to teach, because recorded classroom sessions are becoming available for both teachers and students to replay and reflect upon at will. Classroom interactions with students are no longer ephemeral.

7. 5 The UNSW Faculty of Science

UNSW's Faculty of Science has 17 ITET Fellows, the largest group from one Faculty, which includes several non-academic support staff. The Faculty as a whole employs over 500 staff in 10 academic departments. Together the Fellows have initiated a number of systemic changes in the Faculty's learning and teaching systems. Changes within one academic department, the School of Physics and at the level of the Faculty, are described here.

The next largest Faculty group among the ITET Fellows is the Faculty of Arts and Social Sciences, with 13 Fellows, all of whom are academic staff. Although these Fellows represent a higher proportion of the 350 staff than in Science, by 2006 few systemic changes had taken place that could be directly attributed to the activities of ITET Fellows; indicating that it may take more than just a critical mass of ITET Fellows to bring about organizational change.

Arts and Social Sciences disciplines typically organize as rural and divergent disciplines with many separate specialisations, infrequent communication, loosely knit organization and a more individualistic culture. Science on the other hand has a high proportion of disciplines that are urban and convergent, in which both research and teaching are organized in teams and in which

communication is frequent (Becher & Trowler, 2001). One of the urban convergent disciplines is Physics.

7.5.1 Changes in 1st year Physics teaching

There have been two ITET Fellows from the School of Physics. One is the school webmaster the other a lecturer on a short term contract (initially part-time) in a predominantly teaching role, who is now working in another university. The following account has been compiled from:

- a recorded interview with one of the Fellows
- my own collaborative work with the other Fellow
- my records of ITET events in which Physics projects were discussed
- published accounts of changes in the School.

Why change is hard

Changing the way Physics teaching is done in UNSW is not easy for a number of reasons:

1. Teachers generally prioritize research work over teaching, because they are appointed and promoted for research work, not for teaching.
2. The undergraduate curriculum has become established over many decades. There have been few, if any, processes for regular review.
3. Each component of the programme (lectures, tutorials and laboratories) is managed separately. It is intended that the student is able to integrate learning from all components, and so changing one component radically may damage, rather than improve, student learning.
4. First year teaching in particular involves large numbers of students most of whom are not majoring in Physics. Specifically, the first year laboratory classes involve organising:
    a. 1800 students from other disciplines, mostly from the Faculty of Engineering, representing 7 different degree programmes, along with around 40–60 students who are majoring in Physics
    b. 20 laboratory demonstrators who need to be trained
    c. 18 experiments (some of which have been run the same way for many years), each involving equipment, pre-work for students, instructions and assessment, with each student group doing a different subset of the experiments
    d. 5 lecturers.

Given the number of interacting elements in the 1st year lab programme, and the lack of a strong incentive to change, it is not surprising that it has stayed as it is. Standardization and division of labour is a way to cope with complex demands.

Although most the students and departmental staff are familiar with information technology, it has had little impact on learning and teaching – for some of the reasons listed above. The relatively junior status of the School's ITET Fellows may indicate a relatively low priority given to teaching innovation in the department.

Anecdotal evidence and surveys indicated that most 1st year students find Physics unengaging, and yet little had been done to address this. When the first year laboratories had been refurbished in the 1990s, the proposal for the work had included provision for group projects. However, this was not implemented, and, although the students worked in pairs or small groups, they still did traditional recipe-based experiments. (Wilson & Russell, 2003)

How change is happening

The School webmaster completed the ITET programme having developed an online course component for an academic colleague. From Fellowship discussions he had picked up a lot of new ideas about learning and teaching, and had developed an interest in collaborative learning. While he took the few opportunities available at School meetings to suggest solutions to teaching issues that were raised, there were no other immediate outcomes.

The other ITET project involved using an online reflective diary to gain direct feedback from students about how they were experiencing the 1st year labs. Analysis of this feedback indicated that many of the lab activities were ineffective for learning, and some had been completely misconstrued by students. The diary project continued for another two sessions, and I contributed to this, by analysing and quantifying the qualitative feedback. Previous feedback had all been from quantitative multiple choice questions, with no opportunity for students to define their own issues. Before this ITET project, the School had no understanding or experience of educational research, or of qualitative analysis methods.

Meanwhile, the School of Physics had been offered University funding to renovate its teaching laboratory spaces in return for vacating part of another building. Renovation plans were duly developed and submitted to the Dean of Science, whose response was to ask for an educational justification for the proposals. The Head of School then asked the two ITET Fellows – now considered the School's experts in educational theory – to develop the educational justification. They raised the possibility of introducing more flexible spaces that could be used for project work, rather than simply providing more of what existed before. They backed this up by some research

and found examples of collaborative learning spaces in top US universities. They consulted an educational developer who provided more examples. Together this group also found and dusted off the old proposal for 1st year group lab projects, and developed some educational criteria for the laboratory design.

The revised proposal argued for an annexe with a new flexible 1st year teaching space to be built; on the basis that Physics graduates require teamwork skills, and the existing facilities were inappropriate for activities that develop such skills. The proposal was accepted and became School policy.

At this point the director of the 1st year Physics lab programme became interested in the idea of running group lab projects, and was supported in taking time off from research to pursue this. She and one of the ITET Fellows went on a Universitas 21 Fellowship visit to the University of British Columbia in Canada, and gained more ideas from there. A pilot was run in 2002 session 2, with one group of 1st year students. Some of the students doing projects also participated in the diary project, and their feedback was overwhelmingly positive, contrasting with many negative comments about other aspects of the 1st year physics courses (Wilson & Russell, 2003). Since 2003, all 1st year students in Physics courses with a laboratory component have taken part in a group project (Hunt, 2004). At various stages, the team disseminated the outcomes of the project through a number of educational, Physics-specific and internal UNSW publications and conferences (Cunningham, Wilson, McAlpine, & Russell, 2006; McAlpine, Wilson, Russell & Cunningham, 2004; Wilson, Cunningham, Russell & McAlpine, 2004; Wilson & Hunt, 2002; Wilson & Russell, 2003).

Mid-way through the design phase for the new laboratory facility, the University changed the architects who were drawing up the plans, and it seemed that the new flexible space might be dropped. However, by this time it was easy to remind everyone concerned about School policy decisions and the underlying educational rationale. The annexe extension plans stayed and were completed in 2003 – but now with four flexible teaching spaces instead of the one space originally proposed. Ironically, changes in the senior University management portfolios meant that the building move that had prompted the new laboratory in the first instance was then cancelled, but only after the new 1st year lab facilities were already in place and the new form of lab learning activities was established. (Hunt, 2004)

The change in the laboratory spaces, combined with strong messages from the introduction of qualitative evaluation feedback from students, is now leading to plans for substantial changes in the rest of the Physics curriculum. There has been further work on *Exploratorials* (combined hands on and theory sessions, see UNSW, 2004), also based on ideas from overseas and drawing

on positive student feedback on the few lectures where teachers had introduced live demonstrations and real life examples. The School has been awarded external funding to adapt the Exploratorials for use in primary schools (Hatsidimitris, 2006).

Interpretation

The changes in 1st year Physics teaching illustrate the complex interaction of learning and teaching *process*, *material resources* and infrastructure, the *form* of learning and teaching and the organizational *context* within the university. The ITET Fellows were in a position to take advantage of a change at the level of the organizational context to bring about irreversible change in the School's learning and teaching systems as a whole.

The organizational context provided an initial stimulus by making funding available for a new lab space. Institutional leaders also asked for educational justification before releasing funds. The ITET Fellows were in a position to provide this justification. They set up a feedback process to respond to student experience and learning outcomes. They enlisted support from colleagues to follow through with changes to the form of the learning design and to the material infrastructure in the physical spaces and technologies required to support the changed forms of learning and teaching. Once three complementary aspects of the system had shifted, there was no going back. The change was irreversible. Figure 7.1 illustrates the changes in terms of the ProForMaC model developed in Chapter 4.

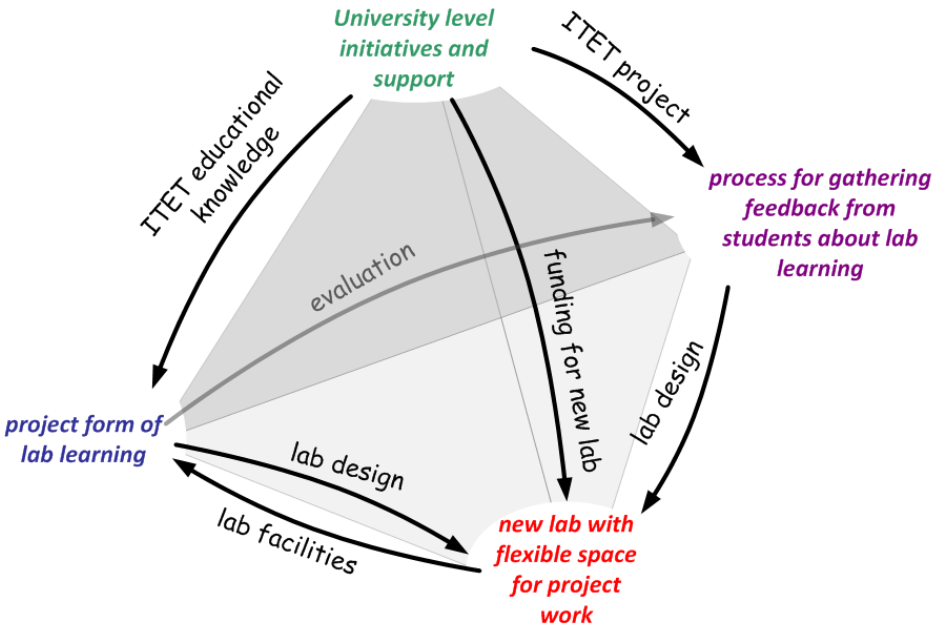


Figure 7.1 Changes in the UNSW School of Physics in terms of the ProForMaC model

The ITET Fellows had the advantage of contacts across the University, upon whom they could draw for support. This included myself and other central educational development support staff. It also included an organized group of ITET Fellows from other Schools across the Faculty, as described below.

7.5.2 Faculty of Science support for change in learning and teaching

There is a formally constituted Science Learning And Teaching Interest Group, known as SLATIG, which meets regularly to discuss Faculty educational issues. Figure 7.2 illustrates how this group initially developed from cross-discipline and cross-faculty initiatives. The group started informally when Physics and Chemistry staff from UNSW's campus at the Australian Defence Force Academic (ADFA) in Canberra and from UNSW's Kensington campus in Sydney met at a university-wide workshop on the experience of 1st year students.

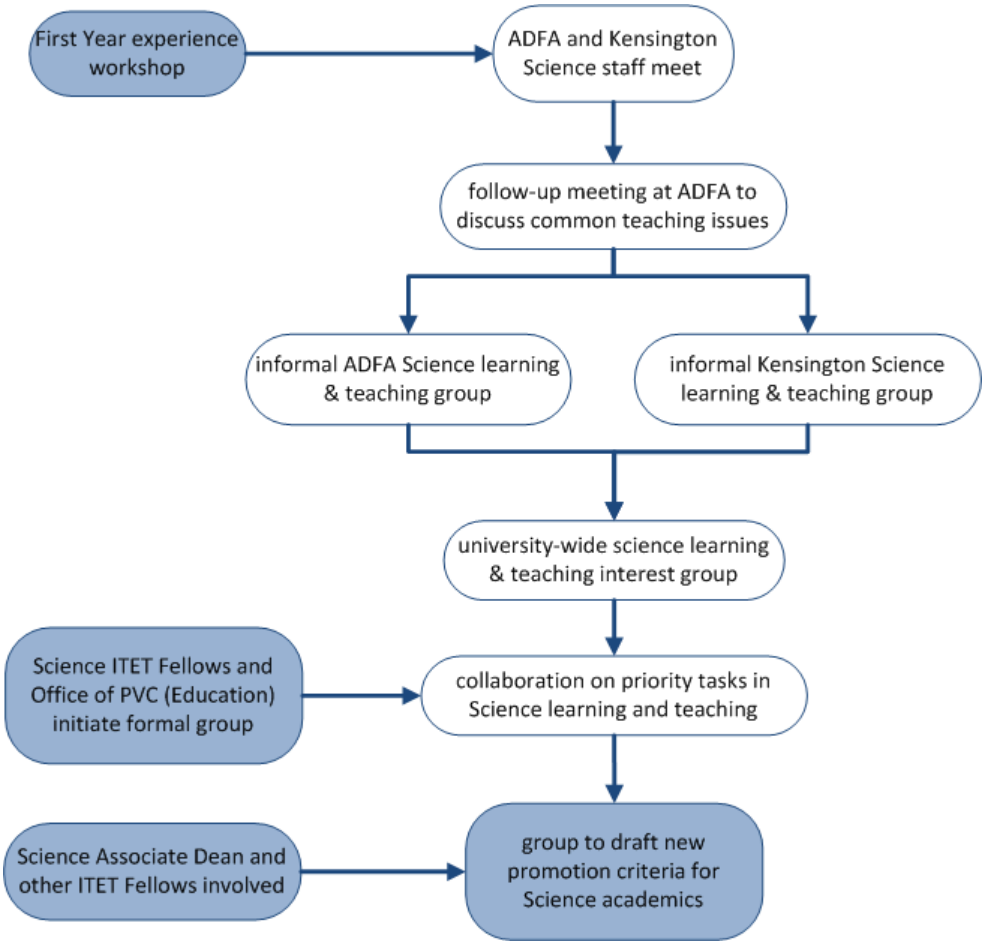


Figure 7.2 Initial development of the Science Learning and Teaching Interest Group

In 2006, ITET Fellows still formed the core membership, and typically constituted at least half of the attendees at meetings. SLATIG has been instrumental in:

- drafting and piloting new criteria and processes for academic staff promotion on the basis of teaching work, which have now been implemented across UNSW (UNSW, 2005a)
- establishing Faculty level formal support for educational policy and practice (Rifkin, Whitaker, Kofod, James & Dalton, 2005)
- contributing to a number of institution-wide initiatives, such as a student portfolio framework for recording graduate attributes (Brawley, Jensen, Kofod, & Whitaker, 2003; Cranny, Kofod, Huon, Jensen, Levin, McAlpine, Scoufis & Whitaker, 2005; Rifkin, Whitaker, Kofod, James & Dalton, 2005; UNSW, 2005b)
- playing a leading role in regional and international forums on teaching, such as the Sydney basin Network of University Science Educators and the International conference on Scholarship of Teaching and Learning, which UNSW hosted in 2007, chaired by an ITET Fellow.

SLATIG is now coordinated by the Faculty Edsquad of four, which includes the Faculty's Associate Dean Education, who is an ITET Fellow, and the Faculty Educational Technology Coordinator, also an ITET Fellow. There is therefore formal Faculty level support, linked to cross-discipline organization in learning and teaching; which is helping to share experiences, develop scholarly knowledge, and integrate new educational technologies and new forms of teaching into systems and practices.

Interpretation

The changes in learning and teaching systems in the UNSW Faculty of Science illustrate how a relatively small number of individuals can organize to make substantial and lasting change in learning and teaching systems. Where there is change, it has been coordinated with support at the institutional and at the departmental level. Individuals, in the right conditions, as happened with the ITET Fellows in the School of Physics, can act as agents of change. The right conditions involve being able to coordinate change in the forms of learning and teaching with feedback processes that establish the value of these changes and with material resources (facilities and funding) to support the change.

At the Faculty level, the same ability to spot opportunities and coordinate different aspects of support for learning and teaching is evident. Individual change agents within departments have a supportive community to work with, and are not dependent upon immediate colleagues to set change in motion. The most coherently organized disciplines can be harder to shift initially. But once coordinated change in learning and teaching is underway, the same coherence and

connectedness that underlies homeostatic responses to change will act to maintain the momentum of change and involve more people. Another example, which I have not described in the same detail as the Physics case, was in the School of Mathematics. One ITET Fellow, despite initial lack of interest from colleagues, worked with central support staff to research software and then involved collaborators within the School in implementing its introduction. In 2007 the software will benefit maths learning for 5000 students across four UNSW faculties.

All of the Science initiatives have involved cross-discipline and cross-function teamwork, and have codified and shared new knowledge through conferences and publications, both within and beyond disciplines

Change in the organization of learning and teaching in UNSW Faculty of Science is demonstrating the same principle that was established by the INNFORM research; coordinated change in several complementary aspects of the system is more likely to succeed than uncoordinated initiatives (Massini & Pettigrew, 2004).

7.6 ITET Fellows in formal roles

Between 2002 and 2006, ITET Fellows from all five programmes have been able to influence change by their participation in formal roles across the University; both in their core functions and in their membership of the UNSW's policymaking committees. Of the 75 ITET Fellows, 65 are still employed in UNSW, and a significant proportion are in a position of formal influence on strategy, policy and teaching practice at different levels.

The Academic Board is the principal academic body of the University responsible for academic policy setting, academic strategy via its eight standing committees, approval and delivery of programs, and academic standards. The Board comprises 56 members, 7 of whom are ITET Fellows, including the Deputy President and 3 of 10 Presiding Members for Faculties. ITET Fellows are also represented on all the sub-committees of Academic Board, with 5 members on the Committee for Education and at least 2 on all other sub-committees. The total number of staff in UNSW is over 5300, about 2400 of whom are academics. ITET Fellows are therefore disproportionately represented. The 65 still at UNSW form 1.2% of staff as a whole and 2.7% of academics, but have 12.5% of the Academic Board membership.

ITET Fellows also hold positions of formal influence in academic units. Two are Faculty Associate Deans, and several are Heads of School or coordinators of teaching programs. Table 7.2 summarizes ITET Fellows' representation in various roles.

Table 7.2 ITET Fellows' formal roles and responsibilities

Role	number of ITET Fellows represented
Head of School or department	4
Faculty Associate Dean or Dean	2
Member of Academic Board	7
Presiding member for Faculty	3
Program Director or coordinator	3
Faculty executive members	1
Faculty Director of Learning and Teaching	2
other formal learning and teaching support role	2

Interpretation

ITET Fellows in a variety of roles across the University, including positions of formal authority and representation on policymaking bodies, provide another mechanism for influencing change. The Fellows are part of an informal cross-discipline community that discusses topics to which the formal systems might otherwise be blind. Informal discussion in a cross-discipline community helps to identify which are shared interests, representing legitimate causes for action, and which are specific to an individual or to one specialist perspective. Someone who participates in a cross-discipline discussion will therefore be better prepared to argue for policy change at the institutional level in those areas where they know there is a common concern.

The data on ITET Fellows activities does not on its own provide evidence that participation in the Fellowship leads to greater participation in formal University governance. The Fellows' post-ITET activity is just as likely to reflect the same intrinsic motivation which prompted them to apply for the Fellowship. What their activities indicate, however, is that the ITET Fellows as a group are in more formally influential positions than the average staff member.

7.7 Combined findings on organizational change in UNSW

The findings from the various perspectives described above combine to provide evidence of how the individual teachers' strategies interact with the university's formal organizational systems.

Individual motivation

The case of the traditional classroom teacher who is intrinsically motivated to help students learn, but who feels isolated and discouraged by the departmental context, shows how the ability of individual teachers to innovate can be limited by a research-focused campus university environment. Where there is no extrinsic motivation for teaching work, it becomes an activity in which teachers are alone with their students, left to develop their own practices and theories by trial and error over many years – practices and theories that they will be reluctant to abandon even once cross-discipline sharing and support becomes possible.

The constraints described in this case, if typical of those experienced by individual teachers in a traditional campus environment, explain the reports in the higher education literature of the lack of connection between mainstream classroom practice in traditional campus universities and either educational theory or the opportunities afforded by e-learning (Elton, 2003; Oliver, 2004; , 2005; Trigwell *et al.*, 2000; Trigwell & Shale, 2004). Teachers either respond to departmental priorities and focus on disciplinary research rather than the scholarship of teaching, or follow their intrinsic motivation as teachers unsupported by colleagues.

Where motivated individuals have had support from a community or from their department, as in the case of the Faculty of Science and Omnium, there is a qualitatively different engagement with the scholarship of teaching. An common characteristic of both cases is collaboration with others to achieve outcomes beyond the capacity of one individual.

The role of discipline boundaries

The developments in the Faculty of Science have had an effect across discipline boundaries, for example in initiating and piloting university-wide changes in academic promotion criteria. Omnium has been more focused within one discipline. Even where an academic department is supportive of innovation, as in the Omnium case, the research focus also has an effect, in limiting the application of the innovation beyond that discipline. Each discipline has its own approaches to learning and teaching (Trowler & Cooper, 2002). When a department has invested in developing an innovation that is well adapted for one disciplinary environment, there is reluctance to set off down the J-curve to adapt the innovation for other disciplines – especially when recognition for the innovation is based upon an international disciplinary community. Instead the tendency is to

build further within the discipline. Omnium, although highly effective as scholarly research in disciplinary teaching, is not benefiting the bulk of UNSW students. Unlike cross-discipline initiatives linked to the institutional LMS, or to institutional academic promotion criteria, Omnium is not yet influencing mainstream learning and teaching systems. However, this may change if there is demand from other disciplines for making it available as an institutional system.

Institutional e-learning

The technologies that are able to reach large numbers of UNSW students are being used primarily to support traditional learning methods. Nevertheless the technological tools themselves are becoming pervasive, and are shaping the nature of student learning. Technologies that are becoming available across the university – such as similarity detection tools, library systems, information literacy support and mathematical modelling tools – are beginning to involve teachers in more active use of the online environment for learning. Pressure from students is resulting in expansion of digital lecture recordings and podcasts; effectively opening up the classroom to reflective teaching practice and linking it to the online environment.

In terms of the fitness landscape and adaptation model developed in Chapter 3, UNSW is beginning to climb up from the bottom of the J-curve in its use of educational technology overall – through mutual adjustments that involve students and technologies as much as through the scholarship of individual teachers. The final outcomes are not predictable and may be nothing like those sought by the educational theorists, nor like those imagined by educational technologists.

The role of change agents

Events in the Faculty of Science, one of the University's biggest Faculties, which teaches many students across disciplines, including those in other Faculties, show how individual change agents can organize in communities to bring about irreversible change in formal systems.

As suggested by the research on organizational change in other contexts (Massini & Pettigrew, 2004), simultaneous complementary initiatives were required. In the Faculty of Science these complementarities span different levels of organization – community, department, Faculty and institution. In the case of the changes in 1st year Physics teaching, systemic change involved support from an institutional context that acted simultaneously upon the forms of learning and teaching, the processes of evaluating learning and teaching and the material facilities used for learning and teaching within the School.

At the Faculty level, it was only when significant numbers of the ITET community were able to organise along with others, and gain formal status, that there were changes in the formal

systems. Coherently organized departments and activities may be harder to shift initially because of corrections in the established systemic interconnection of people and activities (the homeostasis effect). But where complementarities were addressed, the re-organization was helped by the same interconnection of activities, as exemplified by developments in the School of Physics.

In the Faculty of Arts and Social Sciences, which also has a significant number of ITET Fellows, there are many separate academic disciplines (14 Schools in 2006), with no large-scale teaching across disciplines as there is in Science. The absence of systemic change in Arts and Social Sciences, indicates that it may be harder to bring about change in rural and divergent disciplines (Becher & Trowler, 2001), where staff operate primarily as autonomous specialists and have few opportunities to interact with broader Faculty or institutional planning of learning and teaching, than in urban and convergent disciplines, such as physics.

Communities and institutional strategic leadership

Senior managers are in position to exert influence upon the formal organization at the institutional level, but they, like everyone else in the organization, have only a partial understanding of the whole university system. In this case the ITET Fellowship provided an environment that was able to develop a sustained connection across disciplines and create a broader community interested in learning and teaching. The cross-discipline community is able to identify systemic issues that are not apparent from one disciplinary perspective, and the members of that community can then raise these issues more formally. The active participation of one senior manager in this community, and its formal sponsorship as a strategic initiative, gave it a voice that an entirely informal self-organizing community may not have had, and through this a direct influence on institutional policies and systems. The changes in policies and systems that have taken place involved simultaneous (complementary) action at different levels of the organization, some planned and some fortuitous.

ITET Fellows have also been able to exert influence through their formal roles and in this way they have extended the influence of the informal community into the formal organization. The cross-discipline community is able to identify systemic issues that are not apparent from one disciplinary perspective. The members of that community have been able to follow through these issues at different levels in the formal organization, supported by a sponsor in senior management. Formally, UNSW academics can now choose the proportion of teaching to research in their submissions for academic promotion. The University has sufficiently improved the institutional performance indicators for learning and teaching to receive additional government funding (dependent upon these indicators), which has been allocated to Faculties for work on

further learning and teaching support in 2007-2009. A significant proportion of this funding is being used to support 2-year Learning and Teaching Fellowships, in which Faculty-based Fellows will work as a cross-discipline group as well as in their own discipline areas.

Academic recruitment priorities send a different message to funding and promotion criteria for learning and teaching. Only 2 of the 11 lecturer positions advertised on the UNSW website in early June 2007 emphasised teaching. One was a permanent appointment at Associate Lecturer level (the most junior academic grade), which was also presented as an opportunity to build a research profile. The other was a two-year Senior Lecturer contract to develop web-based learning. The rest all emphasise research activity and have explicit research qualifications in the selection criteria. Teaching is mentioned in most cases with no such explicit requirements. In addition to these lecturing positions there are another 11 research-only roles advertised. For the majority of individual teachers, the difficulty of finding time to develop teaching innovations that are not framed and funded as research is set to continue.

In 2006 the Pro Vice Chancellor who was the main sponsor of the ITET Fellowship retired. A new Vice Chancellor took office and restructured the UNSW senior management team, with restructured portfolios. In 2006, the new Vice Chancellor identified strategic goals for the institution as a research-focused university in which all academic staff are required to be research-active, and in which the proportion of non-academic staff is to be reduced (Hilmer, 2006). However by October 2007, UNSW had shown further improvements in external indicators of learning and teaching quality, including the CEQ, ranking 3rd nationally and outperforming all other Go8 universities (UNSW, 2007). The additional funding resulting from government rewards for improved learning and teaching outcomes will be allocated to further developments at the institutional level, including investment in e-learning support services. Long-term irreversible changes are underway.

Chapter 8. Implications: a model for systemic change

Abstract of Chapter 8

This Chapter combines the results from cognitive mapping analysis with the triangulation data on organizational change in UNSW. The findings are then related to each of the research questions for the UNSW context. For each research question, there is also discussion of what the systemic patterns found in the UNSW data imply for learning and teaching systems in other campus universities.

UNSW is typical of campus universities where, during the period of this study, there has been little change to traditional learning and teaching practices, and limited integration of e-learning technologies into mainstream teaching. The cognitive mapping analysis in UNSW provides detailed understanding of how individual lecturer strategies interact with the organizational context that supports university learning and teaching. The UNSW study shows how institutional support for cross-discipline interaction among a motivated minority of early adopters of e-learning technologies increases the diversity of strategies available to these individuals. Enhancing the capacity of some lecturers in this way promotes adaptation in the university's learning and teaching system as a whole.

The implications for other universities are summarized in a systemic model of university learning and teaching, in which interacting feedback loops both contribute to adaptation and at the same time constrain it. In this model, the way that individual teacher strategies interact with discipline-based academic departments, cross-discipline communities and formal institutional structures and processes are detailed. Together these interactions form a system which is part of a wider higher education environment nationally and internationally. The ProForMaC framework introduced in Chapter 4 shows how adaptation of campus universities can be managed by facilitating coordinated change in complementary aspects of the university learning and teaching system.

8.1 The findings in terms of the research questions

The ITET Fellows whose cognitive maps were analysed are representative of all those participating in ITET programmes in terms of their disciplinary diversity. Also, the ITET Fellowship programmes were sufficiently similar to each other to support the assumption that patterns of change between pre-ITET and post-ITET strategies represented in the cognitive maps will be representative of those in the wider group of all ITET Fellows in the university. In particular, a common feature of all ITET programmes was a mixed-discipline action learning group, to support work on discipline-based e-learning projects. The Fellows also had easy access to hands-on educational technology development support. It is therefore valid to relate the findings from the cognitive mapping study with data on how the wider group of ITET Fellows' have been involved in changing UNSW learning and teaching systems, and to compare this with the activities of academics who have only discipline-specific experiences to draw upon.

The results of the cognitive mapping analysis, combined with the various perspectives on change in UNSW learning and teaching, address each of the research questions as described below – both for the UNSW context and for campus universities in general.

8.1.1. Individual academic motivation

Research Question 1

What can motivate individual academics in a campus university to put time and effort into:

(i) developing innovative teaching practices using e-learning?

(ii) building shared cross-disciplinary knowledge of e-learning in universities?

(i) Motivation for innovation using e-learning

Analysis of the cognitive maps of the ITET Fellows shows that they have a strong intrinsic motivation to improve student learning, and that extrinsic factors can reinforce this motivation. Motivating factors include the recognition of teaching as a scholarly activity.

Exposure to a wide range of educational theories (codified knowledge) increases teachers' confidence in influencing curriculum development. When opportunities arise, as they did in the School of Physics, to use this educational knowledge in a departmental context, even those with relatively little formal authority over curriculum development can bring about substantial changes in learning and teaching, especially if they are able to work as a team and recruit others to help their efforts.

The experience of success and recognition from others was supported by participation in the Fellowship and this has set up a positive feedback loop that sustains individual motivation.

(ii) Motivation for building shared cross-discipline knowledge

After the experience of working with others across disciplines on e-learning projects, the ITET Fellows developed more strategies for working with others within their own departments and more widely. While the initial motivations for developing e-learning innovations came from discipline-specific teaching experiences, the cross-discipline Fellowship gave them a wider range of ideas and strategies for using e-learning to enhance teaching. Cross-discipline sharing of ideas therefore brings some rewards for individuals, but only once they have experienced its benefits. This is another positive feedback loop set up by the ITET Fellowship.

The case of the lone lecturer in a department where there is little interest in teaching shows that without support, even the most motivated and determined of lecturers will be constrained in the options they are able to consider, because of their reliance on personal and discipline-specific theories and experiences. The lone lecturer has no strategies for working with others, and has had little motivation to seek out support from those in other disciplines, because he lacks experience of how this might help with his own teaching practice.

One of the benefits of the ITET cross-discipline group support is that it not only gives the participants more strategies for using e-learning technologies effectively, but also allows them to develop more strategies for overcoming the constraints on their time. One such strategy is for individuals to seek external recognition and rewards for scholarship in teaching; resolving tensions between teaching and disciplinary research by framing teaching innovation as academic research.

Where learning and teaching innovation is framed as a discipline-specific research, as in the Omnium case, it provides similar motivations to those listed above. Funding, recognition, and membership of a scholarly community enable the planning of time and resources to introduce further innovations. The same factors that can motivate the individual to share across disciplines, if satisfied entirely within one disciplinary context, may also work against cross-discipline sharing.

The results of the UNSW study show how to reinforce an individual's intrinsic motivation for introducing e-learning innovations to improve the learning experience of students. However, the strategies in the post-ITET cognitive maps reflect competing demands on academic staff time, from disciplinary research and teaching. The organizational data confirms these perceptions, in that the option of a teaching-focused academic career is not widely available within UNSW,

despite changes to promotion criteria and increased formal support for development of learning and teaching.

The results therefore also show why there is still little evidence of widespread change in the practices and strategies of the majority of academics in UNSW. Academics who are less intrinsically motivated to improve student learning than the ITET Fellows will be less inclined to make the effort to engage with educational theory, or with ideas from other disciplines. The majority of academics will be likely to contribute to the homeostasis effect by refusing to make the effort required for a major redesign of courses and learning activities to incorporate new media and methods.

Implications for other campus universities

The cognitive mapping study with the ITET Fellows in UNSW provides empirical evidence that a significant minority of teachers in a traditional campus university can have a strong intrinsic motivation to improve the learning experiences of their students through use of e-learning. These teachers are responding to their own experiences of discipline-specific learning and teaching environments, and are looking for ways to deal with a variety of teaching challenges, and are aware that university students now expect to use e-learning tools in ways that meet their diverse and changing learning needs.

Limiting the growth in individual motivation to develop e-learning innovations, there is the difficulty of finding enough time and support to develop teaching knowledge, in an environment where academics are largely recruited and promoted on the basis of disciplinary research. Figure 8.1 shows how this corresponds to Senge's limits to growth system archetype (Senge et al., 1994, p.130). What could be a runaway growth process leading to widespread adoption of e-learning is eventually limited by lack of time to devote to continuing development of teaching innovations. Innovators and early adopters will initially be willing to spend extra time and effort to develop new methods, encouraged by success and by recognition for their efforts. However, they cannot sustain this indefinitely (Laurillard, 2002) without continuing formal support, and others will not follow them.

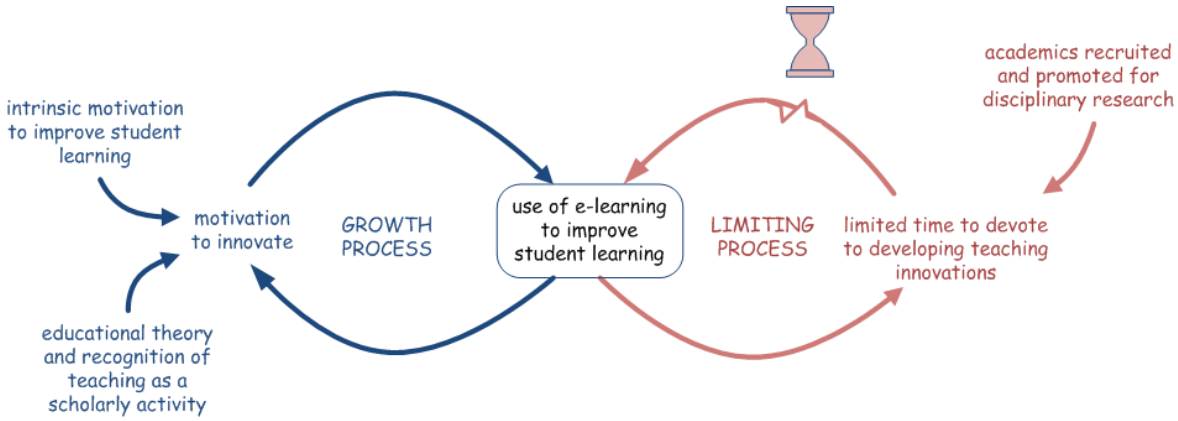


Figure 8.1 Limits to growth in academic motivation to use e-learning technologies (based on Senge et al., 1994, p.130)

Figure 8.1 is a much-simplified representation of complex interactions through which the growth and limiting processes interfere with each other, showing only the motivation of individual academics. The UNSW study shows how established disciplinary teaching and learning regimes (TLRs) initially act as a constraint upon strategies for innovation. In isolation, innovation can be hard lonely work. Teachers who have no strong intrinsic motivation to improve teaching will continue to direct their creative energies into discipline research; and they may even express disapproval of those who rock the boat by trying to change the way teaching is done. Rewards for individual scholarly teaching may sustain isolated innovators, but such rewards will fail to attract the majority and will not necessarily change departmental learning and teaching systems. Similarly, framing e-learning innovation as disciplinary research may enable individuals or small teams to develop innovations, but this can act to reinforce the limiting process rather than encouraging the spread of innovation to the majority. Figure 8.2 summarizes these systemic interactions. Negative signs on arrows indicate a counteracting or constraining influence.

The UNSW study shows that sharing knowledge of e-learning innovations across disciplines, once experienced, also adds to individual motivation, because it counteracts the limitations of discipline-specific experiences because it gives academics access to more ideas and strategies for innovation in their own disciplines. Cross-discipline sharing can therefore add to the individual rewards from e-learning, encouraging self-sustaining communities to develop and share new knowledge. A relatively small amount of cross-discipline contact might therefore lead eventually to widespread sharing – and help to balance the constraints of disciplinary TLRs.

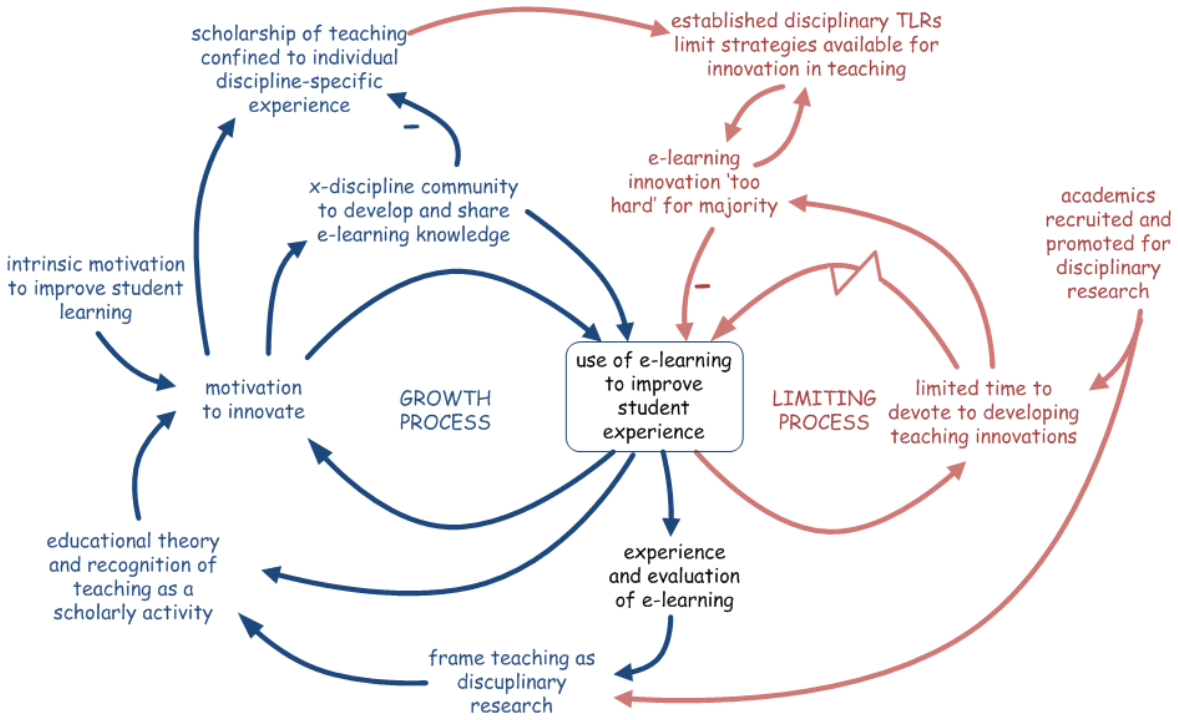


Figure 8.2 Systemic interactions influencing adoption of e-learning innovations

Cross-discipline communities might not seem an obvious way of motivating busy academics to adopt e-learning innovations in their own teaching. From the traditional individual lecturer viewpoint, community participation simply means more work, most of which is unrecognised and unrewarded. But the cognitive mapping study has shown that the cross-discipline community does help to motivate individual lecturers, by increasing the diversity in the strategies available to them. Participation in the cross-discipline community allows them to find more ways of innovating, which in turn enhances the community's value for its individual members, as in a self-sustaining community of practice (Wenger, 1998; Wenger *et al.*, 2002).

8.1.2 Communities and formal organizational change

Research Question 2

How can individual teachers, even if they are able to organize in a cross-discipline community to develop e-learning, bring about the changes required in a university's formal organizational systems to enable and support widespread integration of e-learning into teaching practice?

UNSW context

The cognitive map analysis focuses on individual strategies, providing data about the Fellows' inherent motivation and confidence. The maps on their own do not provide evidence to answer the question of how the Fellows, however resourceful and motivated they are as individuals, and however well they organize informally in cross-discipline communities, can bring about changes in

the formal university systems. To answer Research Question 2 requires that the cognitive mapping results are combined with information on change in the formal organizational systems.

The examples of events in the UNSW Faculty of Science, and the ITET Fellows' central role in these, show how informal communities can interact with formal organization. In the School of Physics, the School of Maths, at the Faculty level and throughout the university, changes in learning and teaching support were first developed informally and then became legitimized and formalized. A necessary condition for change was the presence of a network of people with motivation, confidence, educational knowledge and connections that enabled them to seek resources and knowledge beyond the departmental context, and to introduce processes and expertise from other disciplines. In Physics, educational knowledge combined with support for using e-learning tools to gather student feedback initiated changes that became formalized, material and irreversible.

The role of cross-discipline networks in promoting integration of e-learning innovation into mainstream teaching is further clarified by comparison with the Omnium case. Omnium, as a discipline-based e-learning innovation has remained largely isolated from the university's mainstream learning and teaching. By contrast, the deployment of technologies at the institutional level has combined with student pressure for teachers to use them and is beginning to change practices across a large number of courses.

The introduction of automatic digital recording of lectures exemplifies how change does not always happen in ways that educational theorists would advocate, through conscious redesign of teaching based upon codified pedagogical knowledge. There are mutual influences between teaching methods and material technologies, confirming that educational theory is only one part of a complex system of feedback loops. However, ITET Fellows have been in a position to influence the deployment and use of some institutional technologies, and to link the use of e-learning technologies with guidelines based upon educational research and theory.

The case of 1st year Physics shows how a few individuals who are connected to a wider community, with access to codified educational knowledge, were able to shift a previously change-resistant learning and teaching system to adopt new methods. In this case e-learning technology provided the evaluation evidence from students, which led to change in other aspects of the course design.

At the institutional level, the ITET Fellows provide a link between the cross-discipline community of innovators and the university's formal systems, through departmental, Faculty and institutional roles. Teaching systems are also embodied in the institutional technologies and infrastructure,

and ITET Fellows have played a role there too. Senior management sponsorship has been important in facilitating the change processes, by allowing space for, and listening to, cross-discipline discussion of what is needed for innovative teaching using e-learning. The formal organizational changes that can be identified with the activities of ITET Fellows include new institutional promotion criteria for academic staff and the development of Faculty learning and teaching support systems in Science. At the institutional level, external funding resulting from improved performance indicators is paying for longer-term cross-discipline Fellowships that are more integrated into mainstream learning and teaching support systems.

There are therefore a number of ways in which UNSW cross-discipline communities have initiated a transformation of the formal organizational and technological systems in the University. At the same time, there are individual and discipline-specific innovations that lack cross-discipline connections, and which remain limited in the scale of their adoption.

Implications for other campus universities

The UNSW study shows how a cross-discipline community can have a systemic influence not just at the level of supporting individuals, but also at the departmental and institutional levels. A relatively small number of individuals who are organized as a community can bring about change in a university's formal learning and teaching systems, by building collective awareness of systemic problems and the changes needed to address them. Formal institutional systems are also reflected in resources such as funding and technological infrastructure.

Integrating new e-learning methods in campus universities requires that the organization of campus university teaching becomes urbanized, to link up what has been a sparsely connected and slow-changing set of specialist crafts, operated by self-sufficient artisans. There is now a vast and growing set of methods and technologies available to enhance the quality of the student learning experience. Individual academics will not be able to make effective use of e-learning technologies in their teaching unless they accept that they cannot do everything themselves, and institutions develop appropriate support systems. The UNSW study shows that appropriate support involves teamwork in which there is diversity of skills and perspectives; and requires opportunities for some to take part in sustained cross-disciplinary work on learning and teaching. Teaching-only academic roles and rewards can encourage innovators and early adopters, who can then pave the way for others by building up and institutionalizing new types of support for new types of learning activity.

Figure 8.3 illustrates how cross-discipline communities, through influencing formal institutional systems, can promote growth in e-learning and counteract the limiting processes inherent in

established disciplinary teaching and learning regimes (TLRs). There will always be limits on the academic staff time available for learning and teaching innovation. However, the UNSW study shows how institutional support for cross-discipline communities can shift the balance towards growth in adoption of e-learning innovations and thus enable university teaching and learning regimes to become more adaptable.

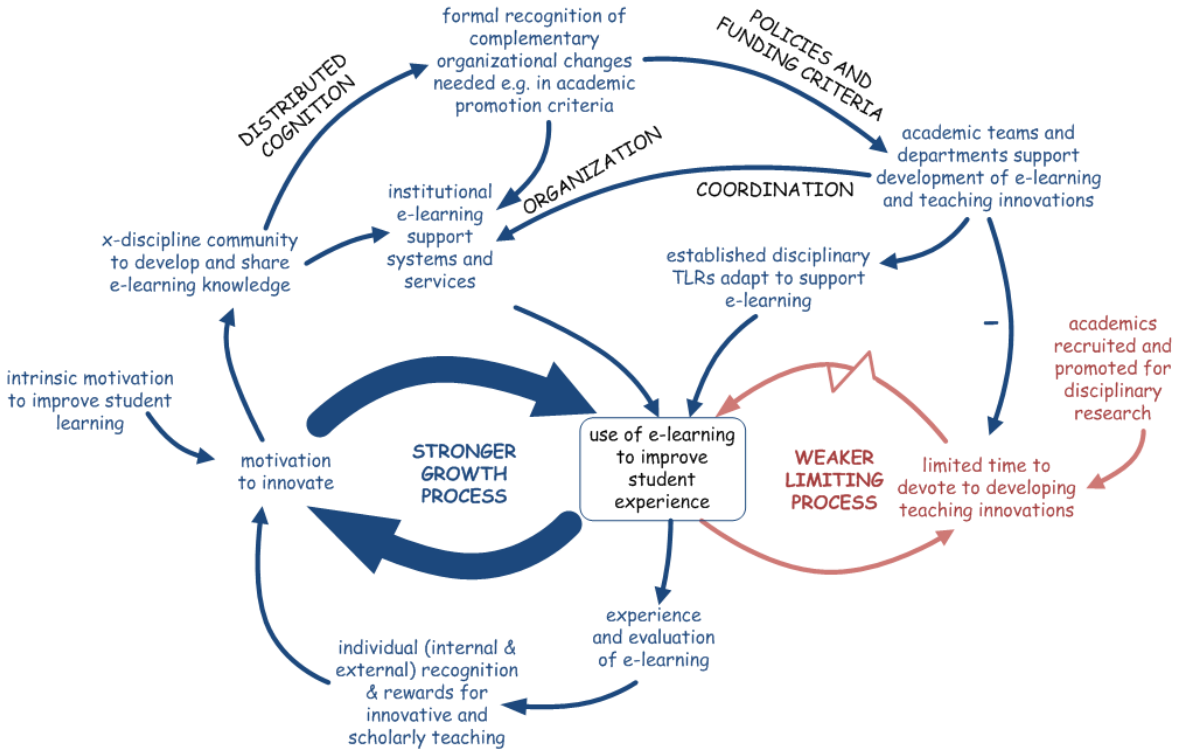


Figure 8.3 Feedback loops reinforcing growth in e-learning use and influencing formal systems

8.1.3 Systemic organizational adaptation

Research Question 3

How do the strategies of individual university teachers co-create the systemic organizational response of a university to e-learning technologies?

In particular:

(a) what systemic complementarities are important for the successful integration of e-learning in the teaching systems of traditional campus universities?

(b) how can management of disciplinary diversity and the various dualities inherent in university organization contribute to successful integration of e-learning?

UNSW findings

A number of common influences in the internal and external university environment are present in teachers' strategies both before and after the ITET experience. These influences represent systemic organizational complementarities that are continuing to shape individual teachers' options. In particular:

- changing student needs
- established curricula and teaching systems
- the need to organize time and resources for teaching
- the valuing of research work more than teaching.

The post-ITET maps were gathered some time after the Fellowship events were over, well into the following semester. By then the Fellows were back working full-time in their departments and were interviewed about their plans for future work in that context. They had also had an opportunity to discuss their strategies in a departmental context, in a workshop to which their Heads of School or Department were invited. So the strategies represented in the post-ITET maps are not a short-term effect of the Fellowship, but have been through a reality check in context.

The map analysis in relation to the individual/teamwork theme showed that recognition and rewards for teaching are a feature in a significant proportion of individual strategies. Post-ITET, the persistent intrinsic interest in teaching and/or educational technology becomes associated with external recognition for scholarly in teaching, particularly where there is concern that research is valued more than teaching. The map analysis on the empowerment theme shows that codified educational knowledge becomes more important to the Fellows post-ITET.

Figure 8.4 is a summary of the complementarities influencing individual teacher strategies for e-learning in UNSW, as found from the cognitive map analysis. Each of the complementarities is represented as a binary concept: in the format 'transforming mode ... homeostatic mode'. The concepts are grouped using the KDIET model used in the map analysis, to show how individual lecturer strategies interact with disciplinary knowledge, with departmental organization and with use of educational technologies.

The pre-ITET cognitive maps, combined with the cases of the sole traditional lecturer and the department-specific innovation, exemplify the patterns identified in the higher education literature reviewed in Chapter 2, in which there is reliance on discipline-specific tacit knowledge of learning and teaching rather than engagement with codified educational knowledge. These patterns are explained by models of the university as a complex adaptive system. Without cross-discipline interaction, individual teacher strategies are discipline-specific, with a limited range of

options considered possible. Tacit organizational knowledge embodied in established disciplinary and institutional learning and teaching systems remains unquestioned. Innovators and early adopters remain isolated and unsupported. The combined effect is a homeostatic response at the institutional level to e-learning technology, where the majority adjust to e-learning in ways that maintain current teaching practices, working relationships, and departmental cultures. In Figure 8.4 this pattern is represented by the second part of each of the binary concepts listed.

The post-ITET maps show a shifted pattern of individual strategies, in which cross-discipline interaction has empowered teachers in various ways to bring about change. The extended cross-discipline interaction in the ITET programme has expanded the teachers' perceptions of what is possible in their organizational contexts; for example through arguing for and finding funding for teaching developments. It has developed teachers' use of codified educational knowledge rather than tacit and discipline-specific approaches to teaching; leading to greater confidence in influencing curriculum change. It has shifted teachers' focus beyond individual teaching activities to shared departmental and institutional initiatives.

The shifted pattern in ITET Fellows' strategies, along with evidence that ITET Fellows' have made a significant contribution to change in UNSW learning and teaching systems, shows how individual teacher strategies and organizational responses are co-created. The pre-ITET pattern of the isolated individual teacher relying on tacit and discipline-specific knowledge, and correspondingly limited strategic choice, reinforces a homeostatic response to e-learning technologies. The post-ITET pattern shifts towards one where individual teachers are able to:

- access a wider range of solutions in their own teaching
- use codified educational knowledge in influencing curriculum change
- organize with others to find resources that extend their influence upon formal systems.

Figure 8.4 Summary of strategic complementarities for e-learning, as found from cognitive map analysis

Complementarities to coordinate

The post-ITET strategies show that individual academic career and work planning, as a complementarity of the learning and teaching system, is still out of kilter with the need to devote time to developing and integrating e-learning technologies. Cross-discipline sharing of ideas and development of codified educational knowledge provides more solutions for the individual participants in this study. However, in many cases the individual solutions are constrained, rather than enhanced or supported, by formal departmental systems.

While the formal systems within academic departments continue to value research above teaching, it is mainly innovators and early adopters who will be encouraged by institutional and external support for individual scholarly teaching. In some parts of UNSW there has been a critical mass of early adopters to bring about related formal organizational change, but not yet everywhere.

Even where a discipline-supported educational innovation was framed and funded as disciplinary research, there are other systemic disincentives to effective cross-discipline adoption and incorporation in institutional systems.

The two-way nature of the influence between teaching methods and material technologies is significant, and confirms that educational theory is only one part of a complex system of feedback loops.

Dualities to manage

The relationship between teaching and research is a systemic duality that operates at the institutional and departmental levels as well as at the level of individual teachers. Cross-discipline communities, codified knowledge and teamwork give systemic support to enable effective integration of e-learning technologies with curriculum development and with institutional learning and teaching support services. However, in UNSW there is still reliance on the intrinsic motivation of individuals to overcome the inherent disincentives of a research-focused environment, and to find ways of organizing time and resources and communities to develop e-learning innovations. Relatively few academics have the option of a teaching-only career. Yet a few academics and teaching support staff who are highly motivated, once given an opportunity to expand the diversity of their strategies and to organize across discipline boundaries, have increased the adaptability of the whole UNSW learning and teaching system.

Another duality to be managed is the simultaneous need to support individual innovators in informal communities, and also to address the formal systems and conditions of employment that

affect all teaching staff. The ITET Fellows' activities show that communities and formal systems both play a part in organizational change. The feedback loops shown in Figure 8.3 show how the balance in the research–teaching duality and in the formal–informal duality can be shifted to allow for greater use of innovative e-learning methods to enhance the student learning experience.

For the period of this study in UNSW there was support from senior management for building communities of practice around learning and teaching. Communities provide an environment for developing knowledge that can be deployed at the institutional level, to change the infrastructures and institution-wide environment experienced by all teachers. Where there is no such institution-wide support, discipline and department cultures may hinder the translation of new community-generated knowledge and understanding into formal organizational systems at the departmental level. It is not yet clear whether the changes in UNSW's learning and teaching systems, and the progress on integrating e-learning into mainstream teaching practices, will continue and will become an irreversible transformation. It is still possible that the changes achieved so far will be absorbed as part of a homeostatic response that will constrain UNSW's systemic capacity to develop and integrate new e-learning technologies and methods as they become available.

Implications for other campus universities

The specific complementarities and dualities identified in the UNSW study indicate that one subsystem is still problematic for teaching innovation – academic recruitment and career progression. The UNSW study provides examples of how changing one element in a system of complementarities will have limited effect. Similar complementarities may be working to discourage the integration of e-learning innovations in other traditional campus universities.

For example, teamwork in learning and teaching, which often lacks support (Benjamin, 2000; Letterman & Dugan, 2004), is considered necessary for bringing e-learning into mainstream teaching (Laurillard, 2002; Torrisi & Davis, 2000). Teamwork cannot be imposed as a single solution. It depends on accepting a diversity of learning and teaching roles that can co-exist with research activity. Metcalf et al. (2005) show that research remains the main driver for academic careers and Jenkins (2004) shows that it can be difficult for academic staff to combine research and teaching in practice. Academic career paths therefore need to be structured to allow for a diversity of roles, including support staff as part of a teaching team. Otherwise, teaching is treated as a low-status activity for junior researchers, rather than being a core interest of the academic disciplinary community. So the introduction of teamwork for e-learning needs to be coordinated with changes in staff appointments and promotion.

A duality: codified and tacit educational knowledge

The cross-discipline analysis of individual teacher strategies in UNSW supports the arguments put forward by Trowler and Cooper (2002) to explain why individual staff development that introduces academics to educational theory has had limited impact. Such an approach does not allow for the development of new cross-discipline understanding of learning and teaching. The UNSW findings show how discipline-constrained individual strategies limit the overall response of the university learning and teaching system to e-learning innovation.

Both individual scholarship of teaching and academic units specializing in educational research and staff development are part of a duality, in which professional teamwork in learning and teaching is advocated, but in which the teamwork between disciplinary teachers and educational specialists is being promoted by individual staff development and research. Separate academic departments which provide research and staff development in higher education will therefore both encourage and inhibit the adoption of e-learning innovations, through the feedback processes shown in Figure 8.2. Academics who treat their teaching as a scholarly activity often do so at the expense of their disciplinary research, and some may shift towards becoming educational specialists themselves if this career option becomes available. The alternative is to try to be equally excellent in teaching and in disciplinary research. Examples of both of these strategies are present among the UNSW ITET Fellows in 2007.

At the institutional level, it is also possible to provide hands-on support for educational and e-learning development. If the academic leadership in a discipline is focused on discipline research priorities, then hands-on support and teamwork provides a practical solution by sharing around the cognition of disciplinary learning and teaching. However the educational knowledge developed in this way is likely to be distributed and tacit, in that it is built through, and embodied in, the team roles and relationships rather than being the work of a single scholarly teacher who can articulate the whole educational strategy through reference to educational theory and research. If the team is based within one (non-education) discipline environment there may be little incentive to codify and spread this knowledge to other disciplines, just as with specialist surgical teams adopting new technologies (Edmondson, Bohmer & Pisano, 2003a). The UNSW case study of the discipline-specific e-learning innovation shows that, even when e-learning innovation is framed as codified discipline research output, there is insufficient incentive to spread the innovation institution-wide.

So staff development that promotes scholarly teaching can encourage academics to shift away from their disciplinary communities rather than to transform them. Hands-on educational teamwork leads to tacit and distributed cognition that may not be codified and shared as

scholarly educational knowledge. Neither strategy will work on its own. The ITET Fellowship combined both staff development and hands-on teamwork. Early evaluations confirmed that any attempt to impose standard educational approaches or theories on the participants would be rejected (Russell, 2003; , 2004; Russell & Lee, 2005). Although offering access to a range of educational theories, the Fellowship events supported the development of shared cross-discipline understanding within each group, as is suggested by Trowler and Cooper (2002), who say that educational development programmes in universities need to build a commonly understood discourse about learning and teaching, which recognizes disciplinary diversity.

8.2 Modelling complex systemic change in a university

Complex adaptive systems models explain how individual cross-discipline experience enables organizational learning, by increasing the diversity of strategies available to individual change agents (Andriani & Romano, 2001). The UNSW study has provided empirical evidence of how this systemic process operates in one university; evidence which has implications for other similar university contexts.

Complex adaptive systems models can also clarify how the UNSW findings might apply in other contexts, by providing a framework for identifying simplifying assumptions in models of organizational change in universities, and by identifying systemic feedback loops that link individual and organizational behaviour in universities.

8.2.1 Cross-discipline communities, educational theory and teaching practice

The UNSW study shows how support for interaction across disciplines, as in the ITET Fellowship programme, can bring about change in formal institutional systems. Figure 8.5 illustrates the relationships that support the change process. Participants are able to draw upon a rich pool of ideas, creating an environment in which innovation is cultivated and the formal learning and teaching support systems are able to adapt. In this model, institutional support combines staff development in educational theory with hands-on support. Central learning and teaching support staff participate in and facilitate the community, rather than attempting to control its agenda. The aim is not to translate existing codified educational knowledge into practice, but to develop new shared understanding of the diversity and complexity of teaching practice in an organizational context.

The institutional support model shown in Figure 8.5 differs from models in which central support systems is dominated by educational specialists who work on educational research projects and run staff development programmes in educational theory, with the expectation that individual participants will then integrate the theory into their teaching practices. Figure 8.6 illustrates how the same teachers will have a much more limited experience from individual participation in pre-programmed staff development activities. Instead of sharing and creating a diverse range of new educational knowledge, the primary process is transmission of established codified educational knowledge. Individual staff development in educational theory has had limited results (Trigwell *et al.*, 2000; Trigwell & Shale, 2004) and has failed to connect with mainstream teaching and learning regimes (Trowler & Cooper, 2002).

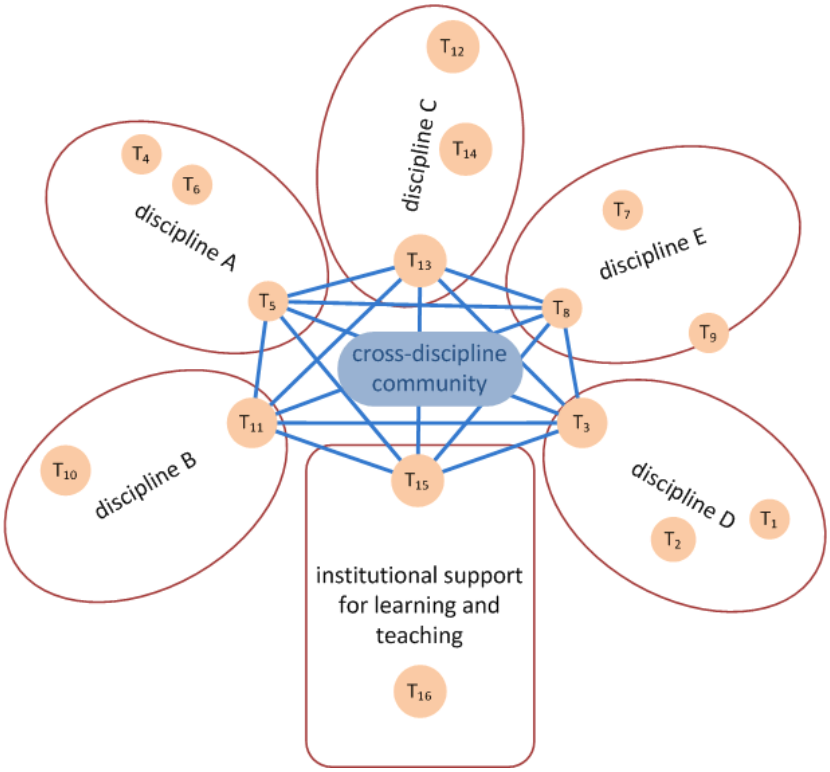


Figure 8.5 Relationship diagram showing institutional support for cross-discipline communities

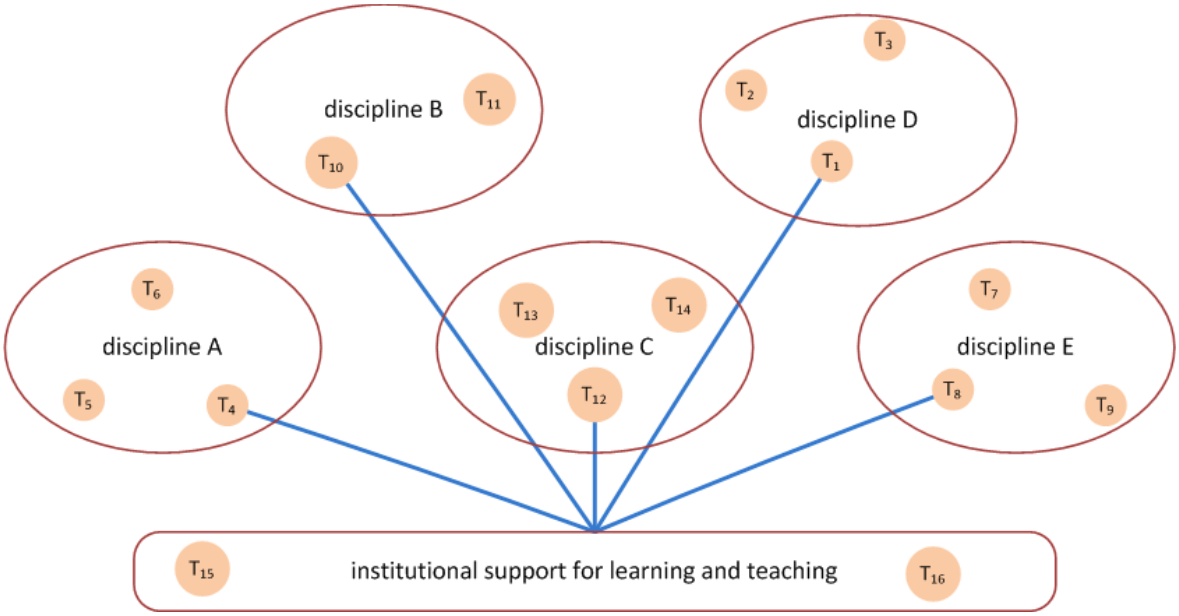


Figure 8.6 Relationship diagram showing institutional support focused on individual staff development in educational theory

At the individual level, introducing new concepts, in the form of codified educational knowledge, does not translate theory into action (Devlin, 2005; Kane *et al.*, 2002). The UNSW study has shown how systemic feedback loops in the university organizational context operate both to encourage and to constrain adoption of e-learning innovations in individual teaching practice. The systemic pattern of limits to growth in individual scholarship of teaching (Figure 8.2) is also played out at the institutional level, when central educational support units are set up to carry out higher

education research and staff development (Figure 8.7). These units are tasked with developing codified knowledge to support innovation in university learning and teaching practice. Higher education specialists are faced with the same pressures as other academics, and are likely to focus on publishing high quality discipline-specific research, rather than providing routine hands-on support services to help academics improve in the quality of e-learning.

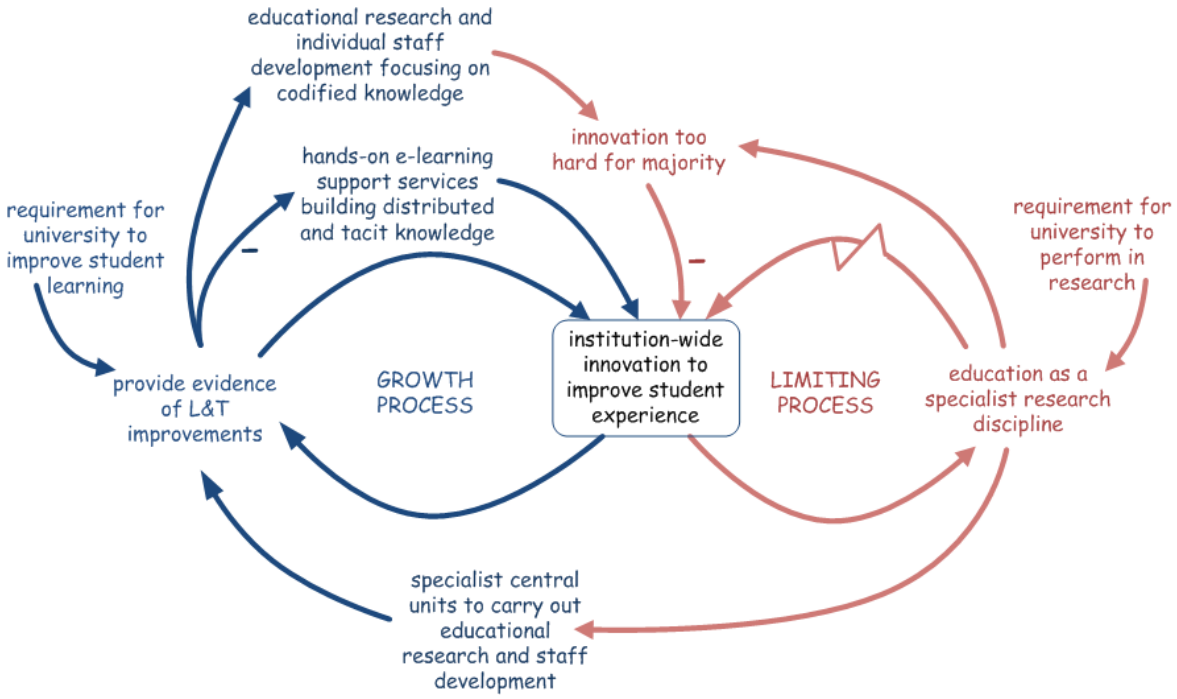


Figure 8.7 Systemic feedback loops at the institutional level

A survey of 21 Australian universities (Uys, Buchan & Ward, 2006) found that only a third have any mainstream-funded support available for developing online learning resources. Two-thirds have limited support for e-learning development or none at all, and are relying on academics to do it for themselves. The disjunction between theory and practice is being reinforced at the institutional level as well as at the individual teacher level, through the systemic interaction of external requirements for universities to perform both in research and in teaching.

Codified scholarly educational research knowledge is therefore best treated as a duality with the tacit and distributed knowledge that is embodied in team roles, working relationships and administrative and technical systems. Both parts of this duality need to co-evolve as the university learning and teaching system adapts to use e-learning tools. The UNSW study shows why support for cross-discipline communities and networks, combined with hands-on support for e-learning is more likely to succeed in changing mainstream campus university learning and teaching systems than staff development delivered by educational specialists.

8.2.2 Simplifying assumptions

Chapter 5 establishes that UNSW is typical of established campus universities where the majority of academics are still using traditional disciplinary face-to-face methods, and where research often takes priority over teaching in academic work. The UNSW study found some systemic patterns that influence the adoption and integration of e-learning, which have implications for the integration of e-learning in similar campus universities. In order to generalize from the UNSW findings to build a model that is applicable in other campus universities, it is necessary to revisit the assumptions inherent in the UNSW study, and to relate these to a broader higher education context.

The UNSW study was based upon a learning and teaching system model with the following simplifying assumptions:

- an institutional boundary within which UNSW learning and teaching occurs, and through which interaction with the wider HE environment takes place
- a series of disciplinary subsystems, within which individual teachers (agents) operate
- a subsystem constituting the UNSW-wide support for learning and teaching, which includes lecture theatres and e-learning infrastructure, as well as staff development and hands-on support for developing new e-learning activities to meet discipline-specific needs
- a cross-discipline community (in this study the ITET Fellowship), through which some teachers share learning and teaching strategies across disciplines and which has institutional support.

Modelling the individual teachers as agents of change could involve making assumptions about average or typical teacher characteristics (Cilliers, 2001). Such simplifying assumptions would remove the element of disciplinary and individual diversity that is central to organizational adaptation and to the research questions addressed in this study. Fortunately, there is theoretical and empirical research showing that complementarities will occur in any complex human organization (Massini & Pettigrew, 2004; Milgrom & Roberts, 1990; , 1995a). Therefore it is not necessary to make simplifying assumptions about individual teacher behaviour because there will be identifiable patterns of systemic complementarities that can be determined empirically without modelling individuals in quantitative detail.

The UNSW study has been informed by empirical research in manufacturing and in other industrial or commercial organizations. Like the INNFORM survey of complementary organizational changes referred to in Chapter 3, the UNSW study of e-learning innovation in UNSW has examined changes in the internal structures and organizational processes, and it is

here where the parallels with manufacturing are drawn. The UNSW study differs from the INNFORM study in that it does not include change in the boundary between the university and its external context, in the form of outsourcing or strategic collaborations with other institutions. It does, however, include material resources and technologies as an explicit dimension of the model, which are not part of the INNFORM research, but are included in the original Milgrom and Roberts (1995a) empirical work on organizational complementarities.

The findings in the UNSW study are relevant for other campus universities where the same simplifying assumptions are valid. In particular, system characteristics such as defined disciplinary communities and departments with devolved organization of learning and teaching, supported by central institutional services, administration and infrastructure. The systemic feedback loops that limit adoption of e-learning in UNSW involve competing demands on academic staff time from research and teaching. External demands for universities to meet performance criteria in both teaching and in research can lead to internal university policies that reinforce systemic resistance to adoption of e-learning innovations in campus universities. These demands are common to UK and Australian university environments.

8.2.3 Microdiversity and adaptability in university learning and teaching

Campus universities' continuing capacity for incorporating new e-learning tools and methods, as they become available, into mainstream learning and teaching will depend on:

- individual and disciplinary microdiversity in learning and teaching strategies, which has the same systemic role in organizational adaptation as genetic diversity has in the evolution and adaptation of biological systems when there is environmental change
- cross-discipline communities that nurture and maintain this microdiversity and which, by linking diverse perspectives, provide environments where organizational complementarities can be identified and new distributed cognition can develop
- formal recognition and involvement of individuals who participate in informal communities around learning and teaching, to enable new ideas to influence processes, forms of organization and material resources provided for learning and teaching the institutional level
- growth of internal feedback and management processes built upon an acceptance of, and trust in, distributed leadership and cognition .

None of the practices in the above list are fundamentally alien to traditional academic culture. However, in attempting to adjust to an external environment that is calling for more efficiency, transparency and accountability, universities may be inadvertently losing some of the qualities

that enable them to adapt their learning and teaching systems to change in the 21st century technological and social environment (Barnett, 2000a; b). By analysing university learning and teaching as a complex adaptive system which includes material technologies, it is possible to make more explicit and to codify how the adaptive processes work, so that they may be better managed as a whole.

In campus universities, decisions about use of e-learning technology are typically being made by individual teachers. So it is necessary to understand the university-level learning and teaching system in terms of the mutual influences between the institutional context and individual academics. Using a complex adaptive systems interpretation of the interactions between individual, department and university explains how individual members of staff in a university can be agents of change, and how cross-discipline interaction enhances the adaptability of the whole system.

Most campus universities, regardless of their location, will have disciplinary differences in knowledge territories and departmental organization (Becher & Trowler, 2001), with associated teaching and learning regimes (Trowler & Cooper, 2002). There are reports that staff development initiatives offered to individual teachers by educational specialists are failing to connect with practice (Trigwell *et al.*, 2000; Trigwell & Shale, 2004). Knowledge about e-learning innovations is not spreading as fast as expected (Hannafin & Kim, 2003; Oliver, 2005) and as a result teaching practices are failing to keep up with student expectations (Corbit, 2005; Oblinger, 2003; , 2004; Oblinger, 2005). Communities of practice are advocated to develop and spread new knowledge about technologies and teaching (Allan & Banks, 2003; Bell, 2003; Hung, 2002; Hunter, 2003; Moore, 2002; Oliver, 2003; Turner, 2003), but there are questions about whether communities of practice as defined by Wenger (1998; Wenger *et al.*, 2002), are achievable or necessary (Eraut, 2002).

The literature on higher education identifies barriers to cross-discipline exchanges in learning and teaching, including those between educational experts and other disciplines (Fanghanel, 2004; Meyer & Land, 2002; , 2005; Trowler & Cooper, 2002). Analysis of individual strategies in UNSW, using complex adaptive systems theory has shown that cross-discipline engagement with different teaching and learning regimes has made a significant difference to strategies for use of e-learning technologies, and to university systems. In a UNSW submission for a national teaching award (Scoufis, 2004), the ITET Fellowship was characterized as a community of practice. However, the findings from the UNSW study show that it is the cross-discipline nature of the community engagement that is central, rather than its conformity with the community of practice model as defined by Wenger et al. (2002). These findings support the argument that the key

qualities for change in mainstream learning and teaching systems are mutual cross-discipline and cross-profession engagement, joint enterprise and shared repertoire, and that there is no need to define a community of practice (Eraut, 2002). The cross-discipline interaction need not be whole informal and self-organized. The process can be managed and encouraged through formal systems in which there is some accountability for use of resources and for outcomes.

8.3 Modelling learning and teaching in a campus university as a complex adaptive system

The contextual study in UNSW has shown complex interactions among individual, departmental, institutional and external influences. The study provides empirical evidence for a more general model of how university learning and teaching systems can adapt to incorporate new e-learning technologies as they become available.

8.3.1 Influences for individuals

Individual teachers develop their strategies for use of e-learning technologies in the context of university departmental organization and in the context of external change in the higher education environment. Figure 8.8 is an influence diagram showing in more detail than Figure 8.3 how the cross-discipline community supports individual academic strategies for using e-learning technologies in ways that will improve the student learning experience. Each of the concepts in the influence diagram comes from the UNSW cognitive mapping analysis findings, as summarized in Figure 8.4.

In UNSW the individual maps had far more diverse and complex interconnections than those shown. For example, some of the teachers in the study were in departments where the curriculum was being redesigned in response to changing student needs, while others expressed a need to work within the constraints of an established curriculum structure, which they felt unable to change in the short term. A common factor that was consistently negative in its influence was the valuing of research over teaching, which both the data from UNSW and literature on other universities suggest is a persistent problem.

The map analysis results represent strategy patterns among innovators and early adopters of e-learning, who have the capacity to initiate systemic change in the university's learning and teaching. So although the participants in the study may not be typical of the majority of university teachers, the patterns in their strategies are significant for the learning and teaching system as a whole.

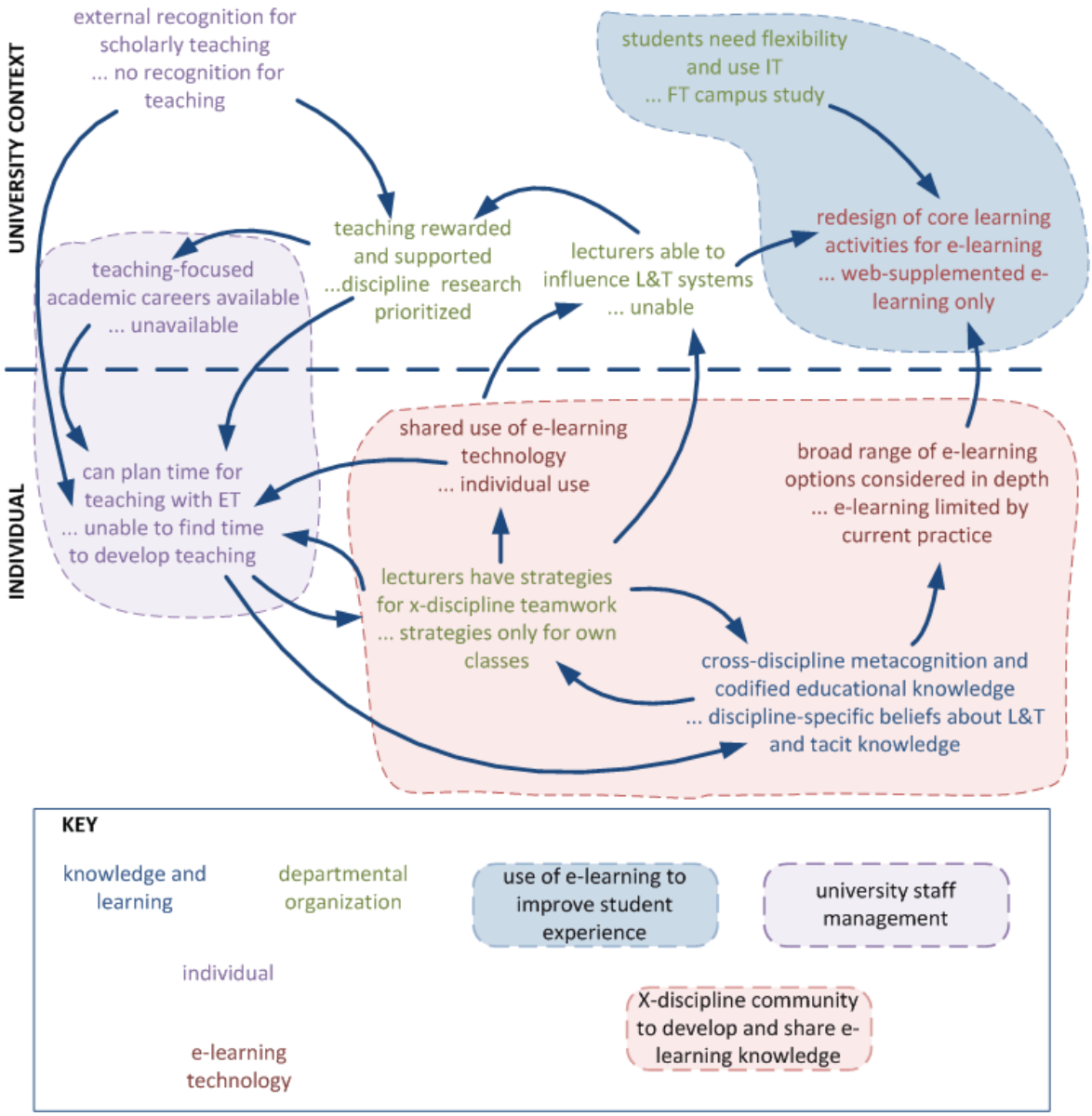
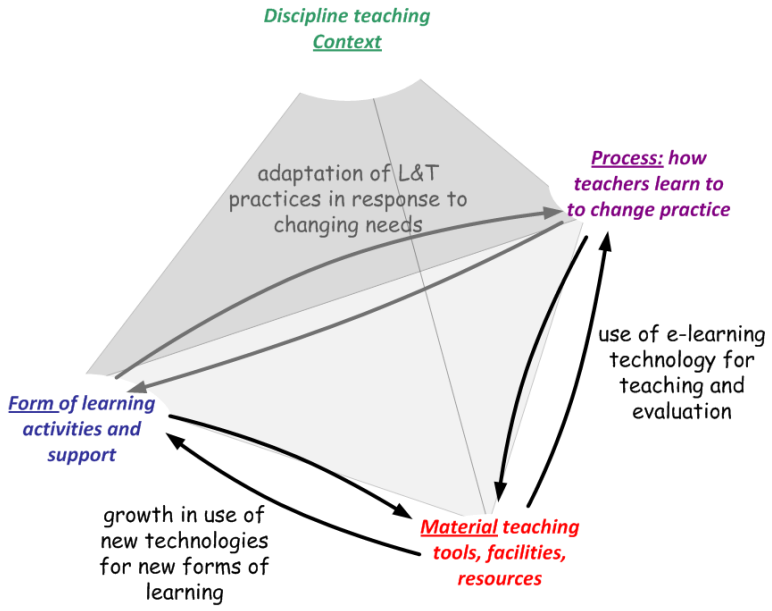


Figure 8.8 Contextual influences on individual teachers' strategies

The findings from the UNSW study can be interpreted in terms of the ProForMaC framework introduced in Chapter 4. Participation in a cross-discipline community influences:

- process, in that individuals become more motivated and empowered to bring about change in learning and teaching systems
- forms of learning and teaching, in that university teaching staff have a wider range of strategies for using educational technologies, and shift from individual to team approaches
- material resources, as formal support for time release to innovate and evaluate new methods, and as codified educational knowledge (e.g. embodied in printed guidelines, web resources, templates).

Figure 8.9 represents a model of these aspects of individual teacher strategies in terms of the ProForMaC framework.



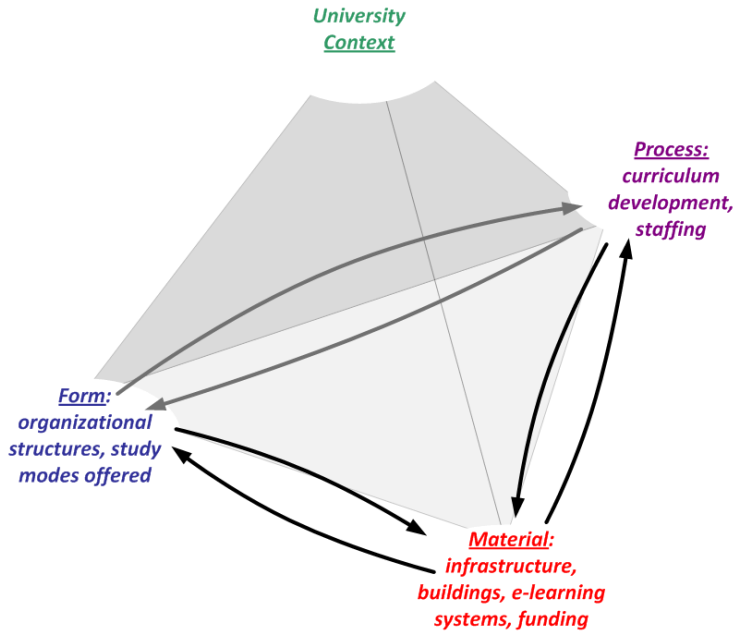
Processes: feedback from student evaluations, experience of teaching, seminars, participation in communities

Forms: team or individual learning activities, classroom or online, large or small classes, shared or individual teaching

Material resources: time and funds allocated for teaching, support services and staff, guidelines, templates, physical spaces, e-learning infrastructure.

Figure 8.9 ProForMaC model of interdependence among aspects of teacher strategies in a discipline teaching context

The same three aspects of the learning and teaching system also exist at the departmental and institutional level (Figure 8.10).



Processes through which curricula are reviewed, developed and changed, departmental behaviour is rewarded or discouraged, staff appointed and promoted

Forms of organizational support for learning and teaching, whether centralized, localized in academic departments, directed at individuals or arranged for groups; mix of part-time distance and full-time study offered

Material resources, such as physical and e-learning infrastructures, libraries and the funding flows for curriculum and staff development.

Figure 8.10 ProForMaC model of interdependencies in institutional organization

In the external higher education environment too, there are:

processes, through which universities and individual academics are funded and rewarded, institutional audits and evaluations are carried out and feedback is given

forms of government and industry support for learning and teaching, such as accreditation arrangements and grants for learning and teaching; which may be focused on institutions, projects or individuals.

material resources, such as IT and telecommunications infrastructures, new technologies, higher education funding allocated to each university or obtained from student fees and other sources.

8.3.2 Implications

The ProForMaC framework represents an understanding that learning and teaching development processes, forms or modes of learning, and material or technological resources all co-create each other within each university context. The models developed from the UNSW study, using his framework, clarify what is needed for effective integration of e-learning innovations in university teaching. In particular the models show how to make effective e-learning experiences available for the majority of students, and not just those being taught by innovators and early adopters. Figure 8.11 summarizes how university management initiatives can address all three areas in a coordinated way, and can respond to feedback from all three areas as they adjust systemically to new student needs and new technologies.

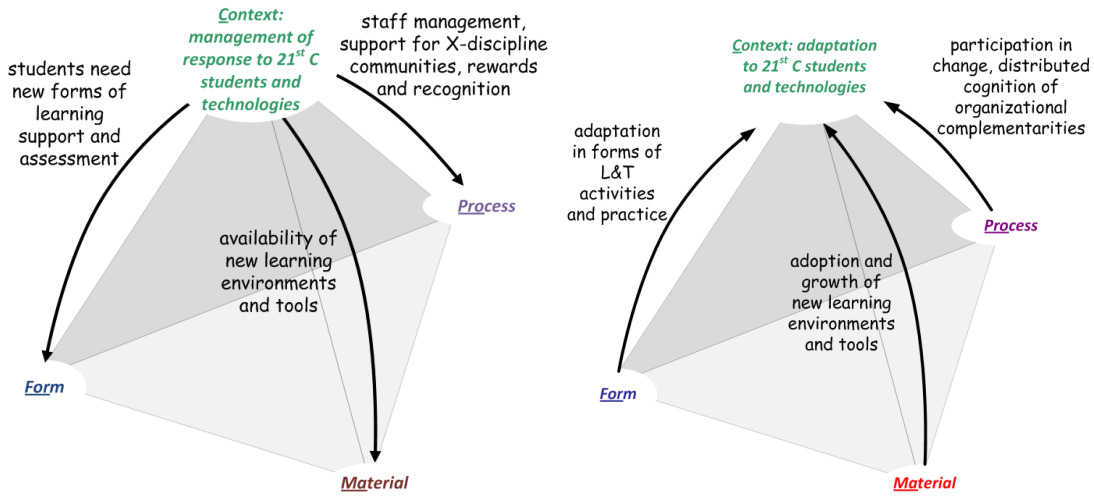


Figure 8.11 Summary of findings in terms of a university-level ProForMaC model

It may be inevitable that university teachers will rely to some extent on tacit knowledge, implicit learning processes and intuition (Eraut, 2000a; b; Lattuca, 2002). Although e-learning offers a more reflective environment in which to interact with students, few teachers will have the time or the skills to use this environment individually to monitor, evaluate and enhance their teaching, given the pressures to perform in disciplinary research.

E-learning becomes accessible and used for higher level learning activities when it is taken for granted as part of the learning environment, and both the students and the teachers have moved beyond the initial phase of having to pay conscious attention to how things are done online (Salmon, 2000). Just as physical spaces are currently managed on behalf of academic staff in most university campuses, it is necessary to manage the e-learning environment in ways that minimize effort for individual teachers.

At the departmental level, one way of managing the e-learning environment is to use templates and shared e-learning resources, to avoid the need for every teacher to work on e-learning design and development. This requires a move towards a more organized approach to learning and teaching, and a substantial shift towards the kind of teamwork identified as essential in the e-learning literature, as outlined in Chapter 2. Such teamwork would enable some teachers to change their teaching simply through participating in a broader system, without any conscious intention to do so.

If universities are to continue to introduce new technologies into the mainstream of learning and teaching, then innovators still need support and sponsorship, even if they sometimes fail to communicate effectively with their peers and fail to spread their innovations more widely, as happened with educational technology sponsorship in Australia in the 1990s (Alexander et al., 1998). Early adopters also need support and sponsorship in identifying and developing strategies to overcome the systemic barriers to change in their own teaching, so that they can pave the way for others, as the ITET Fellows in the UNSW study were able to do.

The UNSW study shows that cross-discipline professional communities are essential for a research-intensive university to adapt its formal learning and teaching support systems to take advantage of new educational technologies, as part of the institutional response to wider changes in the HE environment. Isolated individuals confined to discipline-specific strategies will be unable to bring about a shift in all the complementarities in the university's learning and teaching systems. Nor will top-down planned and engineered approaches be adequate, because of the complexity and disciplinary diversity of teachers' strategies. It takes the combined knowledge created in a cross-discipline community to identify what complementary systemic changes are needed.

Modelling university learning and teaching as a complex adaptive system presents mixed messages from the external higher education environment in terms of systemic dualities. For example, external support that focuses on individual teachers or projects, such as recognition for scholarship in teaching, is insufficient on its own to bring about change. However, individual recognition still makes a positive contribution to change because it encourages the individuals

who form cross-discipline communities of early adopters. The implication is that at the level of national policy, *both* individual *and* institutional rewards for teaching quality have a role to play.

8.3.3 Conclusions

Going back to the metaphor shown in Figure 4.7, and the comparison between university teaching systems manufacturing technologies, the cross-discipline community begins the process of urbanization in what has been a sparsely connected set of cottage industries, and individual artisans.

Disciplinary teaching and learning regimes (Trowler & Cooper, 2002) and threshold concepts (Meyer & Land, 2002; , 2005) are a significant barrier to cross-discipline exchange of learning and teaching strategies. The ITET Fellowship involved 6 months full-time cross-discipline engagement, fully facilitated and supported, and the results of the UNSW study show how it was able to overcome cross-discipline barriers. The Fellowship provided a kick-start for change. Theories of organizational innovation (Allen, 2001; Cilliers, 2001; Elton, 2003; Greve & Taylor, 2000; Rogers, 2003) explain how this cross-discipline exchange of ideas enhances organizational adaptability.

Figure 8.12 Bridging the disciplinary divide

Some, but not the majority of teachers will publish scholarly work on their teaching. If there is a process for codified educational knowledge to develop through sharing across disciplines, even if in a minority community, then that knowledge can become available more widely. If this codified knowledge is shared systemically through support services, guidelines and resources for curriculum development, and all this becomes embodied in institutional e-learning technologies, then many students can benefit. Adaptability in university learning and teaching requires that the process of creating, codifying, sharing and systemically embodying new knowledge is ongoing. Much of the learning and teaching knowledge used routinely at any point in time, whether in classrooms or in online learning, will be created through socialization and internalization in

departmental communities, as described by Nonaka (1994), rather than learned and shared explicitly as education theory.

The concept of distributed cognition emerging from "social interaction and partnerships with intelligent technology" (Salomon, 1998) therefore has practical implications beyond the use of technology for student learning activities. Effective and efficient use of e-learning technology in universities will also require the development of distributed cognition among university staff, their departments and their communities. The ProForMaC models summarized in Figures 8.9-8.11 clarify how this can happen.

Processes of embedded learning and improvement involve individuals, communities and formal organization. Allowing for a diversity of strategies and approaches is central. Innovators operate individually and create diversity, early adopters connect and start organization through community interaction, and take a consciously scholarly approach to evaluation and improvement of learning and teaching. Later adopters implement and embed new processes as part of the mainstream systems that affect all students, often through tacit rather than explicit learning. People develop and use technologies to facilitate, organize, automate and embody the processes they use in their teaching work.

Forms of knowledge and learning are distributed rather than centred on individual teachers and students. There is a move away from the lone lecturer model. Team teaching involving multiple skills and roles will provide support for content experts who need not always articulate and codify the learning process individually. Teaching teams are guided by formal institutional processes, supported by services and technologies. Students learn in an academic environment that models teamwork skills as well as providing team-based learning activities.

Material resources for learning and teaching includes mainstream funding and services for technological tools, integrated with funding and services for use of campus spaces. There also needs to be funding for innovation processes, including the establishment of institutional services incorporating e-learning innovations.

Contexts in higher education vary between types of university (e.g. how many international students, how much research funding). They also vary with time, as government policies, funding regimes, economies and student demographics change. Universities need adaptability to survive. The adaptive process will include a complex mix of homeostasis and systemic transformation. Technologies are an important part of this mix and interact with the other contextual factors. For example in Australia the availability and speed of broadband internet is being debated nationally, and affects educational design decisions in university e-learning.

The ProForMaC models represent different aspects of a learning system in which organizational routines and technologies will continue to systematize and embody distributed knowledge so that the majority can benefit without giving conscious attention to everything that is happening. Many people use mobile phones, computers, cars and bridges without having designed or built them, and without understanding of the underlying principles of their structure and operation. They trust that someone somewhere does know and understand. Some people choose to learn about the curriculum evaluation and improvement processes. Some focus on learning theories and the forms of e-learning activities. Some focus on the technological implementation. Some focus on the broader strategic context of university learning and teaching. Most academics just use the teaching resources and facilities that are already there, do what the disciplinary and departmental environment expects of them, and direct their creative energies into disciplinary research.

One of the dualities inherent in the models developed from the UNSW study is the concept that universities can simultaneously be a home for disruptive innovators and be highly organized as a learning system. Research and teaching priorities can also be accepted as a duality that need not operate at the level of the individual academic. Diversity among individual academic staff priorities needs support from the institutional cultures, formal organization and funding. What is important is that these different roles and perspectives can become organized in relationship with each other. When the university is understood as a complex adaptive system, formal organization and accountability is achieved both by coordination and support for diversity. Teleological approaches to change in universities, such as those described by Kezar and Eckel (2002) address only the need for top-down organization, but not the complementary need to cultivate individual and disciplinary diversity.

The research in UNSW to develop models of the university as a complex adaptive system has been informed by research outside higher education. Campus university teaching has traditionally been treated as an individual activity and this has made it appropriate to focus on individual teacher strategies. However, the underlying organizational principles are not peculiar to universities. All organizations are made up of intelligent individuals who make choices about which aspects of organizational life and learning they consciously engage in, and which aspects they simply ignore and/or go along with because they cannot pay conscious attention to everything. Using disciplinary differences in cognition and organization (Becher & Trowler, 2001) to explore how this process works in a university in relation to e-learning technologies may therefore provide understanding that could be relevant for organizational learning more widely.

The ProForMaC models provide a framework in which higher education research from differing perspectives, with different simplifying assumptions, can be treated as complementary

perceptions of the university as a complex whole, which no one research approach can adequately represent. Such a framework may help teachers and university leaders make sense of the "supercomplexity" (Barnett, 2000a) of the higher education environment and its technologies, without relying on partial impressions. In management literature the story of six blind men's investigation of the elephant has been used as a metaphor for this problem (e.g. preface to Cummings & Wilson, 2003). The model suggested here is a framework through which the blind men are able to listen to each other and discuss why something that one person perceives as a snake, another perceives as a tree.

This Chapter has drawn out some general principles that may be applied in other universities. The next and final Chapter revisits the research questions and interprets the findings more generally in relation to some of the knowledge gaps identified in the literature; before reviewing the research process, the contribution it has made to knowledge, and what further research is suggested by the outcomes.

Chapter 9. Final reflections and recommendations

Abstract of Chapter 9

This final chapter:

1. reflects on the experience of the cross-discipline action research process and the development of the research methods, commenting on strengths and limitations

2. summarizes what this thesis has been able to add to previous research, and in particular where it links aspects of university learning and teaching systems that have previously been researched separately

3. identifies where there is scope for further research to follow up some of the findings, and to address relevant questions that the thesis has not been able to address.

9.1 Reflection on the experience of cross-discipline action research

Cross-discipline research has the advantage of being able to break new ground and make new connections between established areas of knowledge. However it also has some disadvantages. There is a risk of superficial engagement with previous work in the disciplines covered, and an accompanying difficulty of communicating the findings convincingly to any one academic community (Lattuca, 2002).

I have chosen to sacrifice depth in coverage of current educational and e-learning research in order to interpret an overview of these knowledge areas in terms of complex adaptive systems models (as distinct from metaphors) of university organization. Similarly, my application of complex adaptive systems modelling of organizational behaviour may lack the detail that specialists in this area might expect.

The research methods used were developed through cyclic action research methodology. This was an initial exploration of unknown territory linking established research areas. With hindsight, some of the paths taken seem more tortuous than was necessary. For example the cognitive map analysis methods could now be simplified. As explained in Chapter 1, systems thinking underlies the whole thesis, and has shaped the choice of methodology and the exploration of different research methods, through a series of action research cycles. Below is a retrospective account of the learning journey.

9.1.1 Action research as a cross-discipline methodology

Learning cycles

Bateson (pp 23-25, 1973), an early systems thinker whose own work ranges across physical science and anthropology, puts forward a cross-discipline interpretation of research methodologies, covering a spectrum from deductive to inductive. Induction and deduction are part of a cyclic learning process, in which observed data by induction leads to the development of hypotheses. The hypotheses are used in a deductive process that directs further observation. Bateson raises questions about whether any data is truly 'raw', in the sense that all data is necessarily selected and filtered on the basis of previous thinking and hypotheses.

In Chapter 4 (Figure 4.11) I put forward a similar overview in placing the various disciplinary knowledge areas in a cyclic learning model, drawing upon previous empirical research into disciplinary differences in teaching and learning (Becher & Trowler, 2001; Knight & Trowler, 2000; Trowler & Cooper, 2002; Trowler & Knight, 1999; Trowler & Knight, 2000). The concept of learning which cycles between action and reflection is central to a number of organizational and individual

learning theories in the literature described in Chapters 2 and 3. Cyclic learning is also the basis of action research, which I adopted as the methodological framework for this thesis.

There were four phases in the action research. In each phase there was empirical observation and data collection, followed by analysis to develop a theoretical basis which subsequently informed further action and observation. The findings reported in Chapters 6 and 7 span phases (ii)–(iv) of the action research, and involve several different types of data collection and analysis; from individuals, groups, departments and from the university as a whole.

I started with a broad problem area – the difficulty of integrating new e-learning methods into campus university teaching practice. This is a problem I am faced with in my own professional practice. The higher education literature available at the beginning of the study, in 2002-3, verified that the problem has been widespread in campus universities, and that there were no established solutions. Phase (i) of the action research arose from the need to evaluate one campus university's initiatives to integrate innovative e-learning in mainstream teaching practice. This formed the pilot study for the PhD thesis.

The pilot investigation identified issues raised when a cross-discipline group of e-learning innovators came together in a Fellowship programme, through which they were able to share strategies for using e-learning. These innovators reported resistance and scepticism about e-learning among their colleagues, but their individual interpretations of the underlying causes of the resistance varied widely. When I analysed textual records of group discussions, as part of the evaluation of the Fellowship programme's effectiveness, I found a number of recurrent themes that were being linked in varied and complex ways. Some of the themes related to the institutional environment as a whole. Others seemed to be discipline-specific. There is also variation among any group, in how each individual responds to a particular discipline and institutional context.

The literature on education and on e-learning identifies various symptoms of a general problem in integrating innovation into mainstream campus university teaching practice. These symptoms are outlined in Chapter 2. Research on the influence of disciplinary differences upon teaching and learning regimes has not been applied explicitly to the adoption of e-learning technologies. The empirical research literature on e-learning has tended to focus on the new learning experiences it affords for the students (Hannafin & Kim, 2003). Separate analyses focus on the various individual and contextual factors influencing academic decisions about learning and teaching (e.g. Becher & Trowler, 2001; Kekale, 2002; Knight, 2001; Knight, 2002; Knight & Trowler, 2000; Trowler & Cooper, 2002; Trowler & Knight, 1999; Trowler & Knight, 2000).

The research for this thesis arose from a desire to understand how individual teachers' strategies for using e-learning are influenced by their organizational and disciplinary context. At this stage I had an intuitive notion that there is a connection between discipline-specific contexts and adoption of e-learning, and that cross-discipline interaction facilitates adoption and integration. However, this was an intuition based on tacit knowledge built from experience of different university contexts, combined with explicit knowledge of educational theories and change management theories. I lacked verifiable research evidence to support my ideas. Working with the cross-discipline ITET Fellowship programme in UNSW therefore provided an ideal opportunity to carry out research into the relationships between discipline differences and e-learning use, and between changes in individuals and changes in the university as a whole.

As outlined in Chapter 5, an in-depth qualitative action research study with one group, in one context, was appropriate for the nature of the problem. This choice of methodology was also best suited to my own situation as a part-time researcher, in that I was able to use my working knowledge of the organizational context and had access to information that an external observer would have found more difficult to obtain and to interpret.

There are disadvantages in being so closely involved with the organizational research context, as also discussed in Chapter 5. Throughout the research I was aware of a tendency to make assumptions based upon intuitive knowledge that may or may not be reliable. Rather than ignore my intuitive knowledge, I have followed Eraut's (2000a) recommendations and attempted to check out and test my intuitively derived ideas in a disciplined, rational manner. The literature on complex systems models of organizations (in particular, Allen, 2001; Cilliers, 2001) provided a way of articulating where I was making simplifying assumptions, and allowed me to compare these with other research. It was this process of examining how simplifying assumptions vary in different research approaches which led me to propose the ProForMaC framework.

Methodologically, the UNSW study crossed several boundaries. The overall approach was through action research which applied the principles of soft systems methodology (SSM) by defining "purposeful activities as activity *models*, each made to encapsulate a worldview, the model being a cluster of linked activities which together make up a purposeful whole" (p. xvi, Checkland & Poulter, 2006b). The purposefully organized activities in this case are university learning and teaching activities, in which world views of individual academics and the forms of collective organization they adopt are shaped by academic disciplines (Becher & Trowler, 2001). As outlined in Chapter 1, SSM was originally developed to apply methods from the study of relatively simple hard technological systems in a way that takes account of the complexity of human interaction; aiming to building a holistic understanding of systemic interconnections. The research for this

thesis has combined some aspects of SSM with a study of the way that people use hard systems, in this case e-learning technologies. Complex adaptive systems theory has provided a conceptual framework for combining hard and soft systems, through recognising that technologies embody, and interact with, other facets of purposefully organized human activity.

I have been familiar with systems thinking for many years and have often found it useful in my work, both for clarifying my own thoughts and for communicating them with others. With hindsight, I recognise that I have applied some systems techniques without always making a conscious decision to do so, especially diagramming and graphical methods. As well as writing textual notes, I have used cognitive maps, mindmaps, metaphorical sketches, systems maps, multiple cause diagrams, process flow charts and various combinations of those representations. A few of these diagrams appear in the thesis in some form. Many more were part of my sense-making as I read, analysed and wrote. The research for this thesis has therefore involved transitions and interactions between my own tacit and codified knowledge (Eraut, 2000b). It has also involved elicitation of, and interaction with, the tacit and codified knowledge of others in an organizational context (Eraut, 2000b; Nonaka, 1994).

Languages and theories of learning: tacit and explicit

Definitions of words, as well as graphical representations have been an important part of the research process. For example, the broadening of the concepts of learning and cognition beyond the individual began as an analogy. Complex adaptive systems theory suggests that the concept of adaptation and adaptability can be applied to human organizations and technologies as a model, and I have used this to define and justify my use of the terms 'distributed cognition' and 'organizational learning'. Similarly, I have drawn on literature that acknowledges implicit learning and tacit knowledge.

I therefore put forward the ProForMaC framework, and chose to include tacit knowledge, implicit learning and distributed cognition as significant aspects of a university learning and teaching system. There are many academic specialists who would disagree with these definitions.

A narrower focus on formal learning and cognition as exclusively individual is widespread in the educational literature. Academic knowledge is defined as that which is explicit and codified. However, the kind of knowledge that is made explicit varies widely between academic disciplines. So to focus on learning as acquisition of individual, explicit and codified knowledge denies the complexity and diversity of university learning and teaching systems.

There is an inherent problem how knowledge and learning are defined and measured in academia. The attempt to measure particular types of learning inevitably narrows the definition

of what it is to know about a particular professional context. Tacit knowledge and skills are, by definition, not included. In UNSW, moves to clarify evidence for graduate attributes (e.g. Brawley *et al.*, 2003; Cranney *et al.*, 2005; UNSW, 2003a) are an attempt to make some of this tacit knowledge explicit. Learning outcomes that have been internalized as tacit knowledge are only possible to measure as behaviour.

Although the thesis has not included an explicit discussion of behavioural theories of learning, the role of tacit and explicit knowledge in learning recognises some aspects of behavioural learning theories. Some of the basic principles of behavioural psychology are hard-wired into the feedback processes of the university learning and teaching system. For example, methods of formal assessment of student work, or promotion criteria for academic staff have become tacit at the organizational level, as described by Nonaka (1994).

University students adapt to the discipline environment through responding to a variety of signals from that environment about the consequences of their behaviour. They get better or worse marks. They make friends and are approved of by teachers, or not. They find some things are easy and other things are hard work. They experience more rewards (pleasure, fun, marks) from some kinds of hard work than from others. They will be consciously aware of some of this adaptation, but not all of it. No-one can possibly be conscious of all the sensory signals influencing their adaptation in a social environment. Younger students have grown up surrounded by computer technologies and take them for granted, unconsciously, as part of their environment. University academics are no different ... except that most have not grown up with the same technologies and have used different technologies for learning.

Systemic thinking about university learning and teaching, and the application of the ProForMaC framework in cross-disciplinary research needs language and communication that avoids triggering misunderstanding and defensive debate between different specialist perspectives. Each discipline articulates and values its own set of explicit knowledge and makes assumptions based on its own set of tacit knowledge.

9.1.2 Research methods

I started work on the research for this thesis aware that complex adaptive systems concepts have been applied to organizational learning, in many cases as a metaphor rather than as a way of modelling organizational behaviour in terms of individual decisions. So I sought out literature on more rigorous, mathematically based, modelling of individual and organizational behaviour. Many mathematical modelling studies make simplifying assumptions about the nature of individual change agents, which would not apply to university academics. For example Gavetti and Levinthal

(2000) provide insights into how the strategy options considered by individual managers shapes the capacity of an organization to adapt to changes in its environment, but make some simplifying assumptions about how the managers influence organizational response. It would not have been possible to draw upon this type of research, were it not for theoretical proofs and empirical evidence that complementarities are a fundamental property of any complex human organization (Fenton & Pettigrew, 2000a; b; Massini & Pettigrew, 2004; Milgrom & Roberts, 1990; , 1995a). The mathematical modelling in this research is highly specialized, and while I can follow the overall arguments, some of the mathematical detail is beyond my understanding. I have therefore had to take on trust the mathematical proofs, on the basis that there was also empirical evidence. This is one of the limits of cross-discipline research.

In reading the complexity literature, I realised that the main challenge was going to be in finding a coherent way of bringing together the different strands of educational literature and complex systems theories, without confusing myself and others. There was also a need to take account of my own intuitive and tacit knowledge. As a practitioner in educational technology development working with university academics over many years, I have accumulated a great deal of tacit knowledge of educational theories and practices across disciplines. So, as well as using cognitive mapping to surface the tacit knowledge of the participants in my research, I also used it as a personal thinking tool, to visualize and make explicit my own thinking and assumptions, in relation to ideas in the educational literature.

Consideration of alternative methods

It might have been possible to address the research questions using analysis of textual data from transcripts – a more common method for qualitative research in education. However, in carrying out textual analysis in the pilot (phase (i) of the action research), I realised that qualitative research relies on the individual judgement of the researcher, particularly about how to structure categories. How I categorize various components of a group discussion on e-learning technology will depend on my own mental constructs, or maps.

My aim was to find out how individuals are linking their perceptions of the university environment with decisions about adoption of e-learning technologies and methods. Discerning patterns in links between concept categories in text takes time and relies heavily of the researcher's interpretation. Had I been a full-time researcher, working with a group of other researchers with similar interests and skills, it might have been possible to arrange for someone to repeat the analysis independently, to check for bias.

So taking into account my experience in Phase (i), and the context for my research, I concluded that textual data from a group of 15–20 individuals would not reliably and without bias yield the broad patterns of conceptual linking that I was looking for. It seemed much simpler, and more accurate, to ask the teachers to identify these links directly and visually, in cognitive maps of their strategies. Another factor in the decision to use cognitive mapping was that I felt confident in my own skills in learning to use the mapping software live in the interviews, and in using the analysis tools to find patterns. Other researchers who are less confident about learning to use mapping software might have chosen other methods, with good reason.

Developing research skills

The cognitive mapping methods relied on using a number of skills, in the interviews and in the data analysis methods. The skills, preparation and practice involved in collecting the cognitive maps are outlined in Appendix 2, so that others may know what would be involved in using a similar method of data collection. The cognitive map analysis methods were developed through trial and error, as described in the research log extracts in Appendix 3. Were I to do another similar cognitive mapping study, I would first develop a simpler and more streamlined analysis process, possibly using newer software tools than were available at the time.

The selection of data collection and analysis methods was very much a trial and error process, developed during the various cycles of action research. Learning about the methods is therefore also an outcome of the research, which is easier to explain with hindsight of what worked and what did not work. For example, during phase (iii) I had to repeat some of the analysis in phase (ii) because I realised that there were inconsistencies in the way I had been categorizing the concepts that would have invalidated the comparison of pre-ITET and post-ITET map patterns. Some suggestions on how the methods might be simplified to avoid this problem in future studies are made below in Section 9.1.3.

I have access to a huge amount of detailed information about events surrounding e-learning developments in UNSW. The organizational data selected in phase (iv) is intended to provide qualitative narrative illustrations of the relationships between individual teachers' strategies and tangible change in organizational processes, forms and technologies. I selected cases where I could explain the relationships between observed events and individual strategies in terms of the ideas presented in this thesis. The organizational findings, while accurate in observation, offer only a few specific perspectives chosen to give the equivalent of the blind men's combined senses of the elephant's leg, trunk, tail, tusks and flank.

I have used a variety of systems modelling techniques through a series of action research cycles to explore different parts of UNSW's e-learning elephant, but with a particular focus on finding out what influences are operating in the strategies of individuals who are seeking to use e-learning technologies in their teaching. As in scientific measurements, there is a need to check that sampling decisions do not introduce systematic errors of perception, as discussed below in relation to choices of simplifying assumptions and system boundaries.

9.1.3 Cognitive mapping

The empirical evidence for the thesis is based primarily upon collection and analysis of cognitive maps, to identify patterns in individual strategies, on the basis that patterns occurring across diverse maps would reflect characteristics of the university's systemic response to e-learning technologies.

The initial maps, before the cross-discipline Fellowship experience, provided an overview of what was similar across the university and what differed between disciplines. However, the sample size is small. Although representing a mix of disciplines, the participants in the study are teaching and e-learning enthusiasts, early adopters who are not typical members of their discipline communities. The choice of sample has advantages and disadvantages. It is focused on those who are willing and able to develop their strategies for integrating innovative e-learning methods into their teaching. Those strategies will be more organized and articulate than the strategies of those who have given little thought to using e-learning. A larger sample across a wider range of university staff might have given a more complete picture of the diversity in individual strategies related to e-learning. However my experience with the traditional lecturer indicates that a wider sample of strategies for use of e-learning would have been harder to represent and analyse as cognitive maps.

The cognitive mapping interview and analysis techniques

The cognitive mapping interviews, limited to an hour each, proved to be an effective and efficient way of collecting complex information about individuals' strategies. I took some care in eliciting the participants' linking of their ideas, as outlined in Appendix 2. Nevertheless, I may unconsciously have introduced some bias. Each mapping interview is a unique context-specific conversation, and not a detached information gathering process that can be repeated independently. In shaping the research process for efficient capturing of complexity, there is inevitably a trade-off with objectivity.

I developed the cognitive map analysis techniques mainly by trial and error. It was time consuming to take multiple analytical 'slices' through map data (see Appendices 3–8) and, with

hindsight, this process could be streamlined. In particular, it took time and effort to re-code the maps consistently in terms of the KDIET model, because I was working out how best to use the model. Two of the analyses used the original coding assigned during the interviews, and the findings overlapped to some extent with those analyses using the recoded maps.

A simpler approach would be to use the KDIET model in the cognitive mapping interviews, asking the interviewees to identify which map concepts are about discipline knowledge, about discipline/department context, about themselves as individuals or about technology. The categories would then reflect the interviewee's understanding of the words used, rather than the researcher's. For example, it is likely that the patterns of individual beliefs and empowerment in relation to the *K, D* and *ET* would be more evident in concepts coded by the participants themselves.

Ideally, the pattern recognition processes used in the map analysis should have involved independent verification by another researcher applying the same processes to the same data. Given the time and the combinations of software skills involved (Decision Explorer, NVIVO, Excel, Word all used at a fairly advanced level) this was not practicable. However new software tools may become available to simplify the analysis process.

It is worth noting that the research process itself exemplifies the connection between technology and knowledge creation. Some of the research methods rely on software tools that would not have been available a few years ago, and which will have been superseded in a few years time.

Therefore, if I were to carry out another cognitive mapping study of this type, I would aim to:

- clarify the model for categorizing concepts (e.g. KDIET), and the simplifying assumptions underlying it, before beginning any mapping interviews, and use this model in the mapping interview
- develop a streamlined analysis process based upon the modelling assumptions, using better software tools if available, to make it easier for others to repeat the analysis
- involve other researchers in verifying the pattern recognition results.

9.1.4 Triangulation with organizational data

The cognitive mapping analysis showed patterns in how individuals perceived learning and teaching with e-learning technology in an organizational context. This was checked against other sources of data on the organizational context at that time, to verify that the patterns were not merely an artefact of the imaginations of the ITET Fellows' group.

I gathered and presented organizational data from UNSW as a series of case study narratives about individuals, departments and institution-wide systems during the period of the cognitive mapping study. Narratives have the advantage of being able to show specific situations in some of their complexity, including chance events.

In selecting the organizational examples I was able to draw upon 5 years experience of working with people across the university to organise and support the use of institutional e-learning systems. There were many potential examples to choose from and I chose those that, in my judgement, best illustrated the numerous interacting influences at each level of organization, in terms of the learning and teaching system model being used. There are, no doubt, some tacit influences on my selection, as well as the criteria and assumptions that I have been able to articulate. For example, on reflection I realise that some parts of UNSW, which were not represented either in the cognitive mapping analysis reported in Chapter 6 nor in the organizational changes described in Chapter 7, have been involved in boundary changes that affect learning and teaching systems. The implications of this selection are discussed below in Sections 9.2 and 9.3.

Eraut (2000b) suggests that one role of the researcher is as an expert in knowledge elicitation, so there may be scope for further research in surfacing tacit knowledge related to the professional context in which the research for this thesis was carried out.

9.2 Crossing boundaries and joining up dots

My thesis develops a systemic overview of what is involved in integrating e-learning technologies technology into campus university learning and teaching practices. Systems thinking implies that "clarity must not come at the expense of oversimplification and trivialization of complex issues" (Senge, Lichtenstein, Kaeufer, Bradbury and Carroll, 2007, p.47). In an online article Senge (undated)[1] describes three dysfunctions that prevent transformation in a learning community: fragmentation, competition and reactiveness. The literature reviewed in Chapters 2 and 3 show how, in the context of campus universities, these three characteristics are hindering the integration of 21st century e-learning technologies into mainstream teaching practices, and fragmentation in particular. Research on student learning experiences, teacher experiences and university management is presented in the literature in a fragmented way. Disciplinary perspectives on learning and teaching are also fragmented. Research and teaching compete as priorities in individual academic careers. As a result, the short-term reactive response of many

1 First accessed 17/5/2005, and referred to as a prepublication draft for *Sloan Management Review*. I was unable to find the corresponding published paper in this journal.

academics is to stick to traditional teaching methods rather than explore fully the potential of e-learning technologies, so that innovations have remained isolated (Gosling, 2004). The thesis shows the systemic feedback loops connecting fragmented forms of knowledge, reactive processes and competition for limited academic time.

White (2006) notes that the challenge in integrating e-learning into mainstream teaching practice is to identify the reality of local contexts, and to adopt a mix of approaches – linking individuals and also working at the institutional level. My thesis provides evidence to show that such a mixed strategy can work in practice, and also puts forward a theoretical explanation for how it works.

While the UNSW study itself is context-specific, it has provided some models that can be adapted for use in other contexts. The thesis therefore demonstrates a process for gathering the empirical context-specific information needed to build and use systemic models that can inform management of a university learning and teaching system, without oversimplification.

9.2.1 What my UNSW study has added to previous work

The higher education research that informs this thesis includes:

- theories of individual learning, based upon observation of learners and teachers
- models of the relationship between disciplinary knowledge and academic organization, based upon studies of individuals in different university contexts
- social theories of learning, which draw upon both individual and organizational observations.

Much of the literature on empirical research on university learning and teaching is focused on particular methods and methodologies that are accepted within a specialist area of knowledge. Kolb (1984), for example, used empirical data from a population of students and analysed the data statistically to develop evidence for a learning cycle, assuming that the students sampled were representative of all learners. Becher and Trowler (2001) collected data from academics across many institutions, to develop theories of the relationship between discipline knowledge and the forms of disciplinary organization. Schrire (2004) compares several research methods, based upon different theories, within one context in which e-learning methods are being used, to establish that social theories of learning are best able to explain how individual students develop knowledge in a collaborative online environment. These research perspectives offer different types of insight into university learning and teaching.

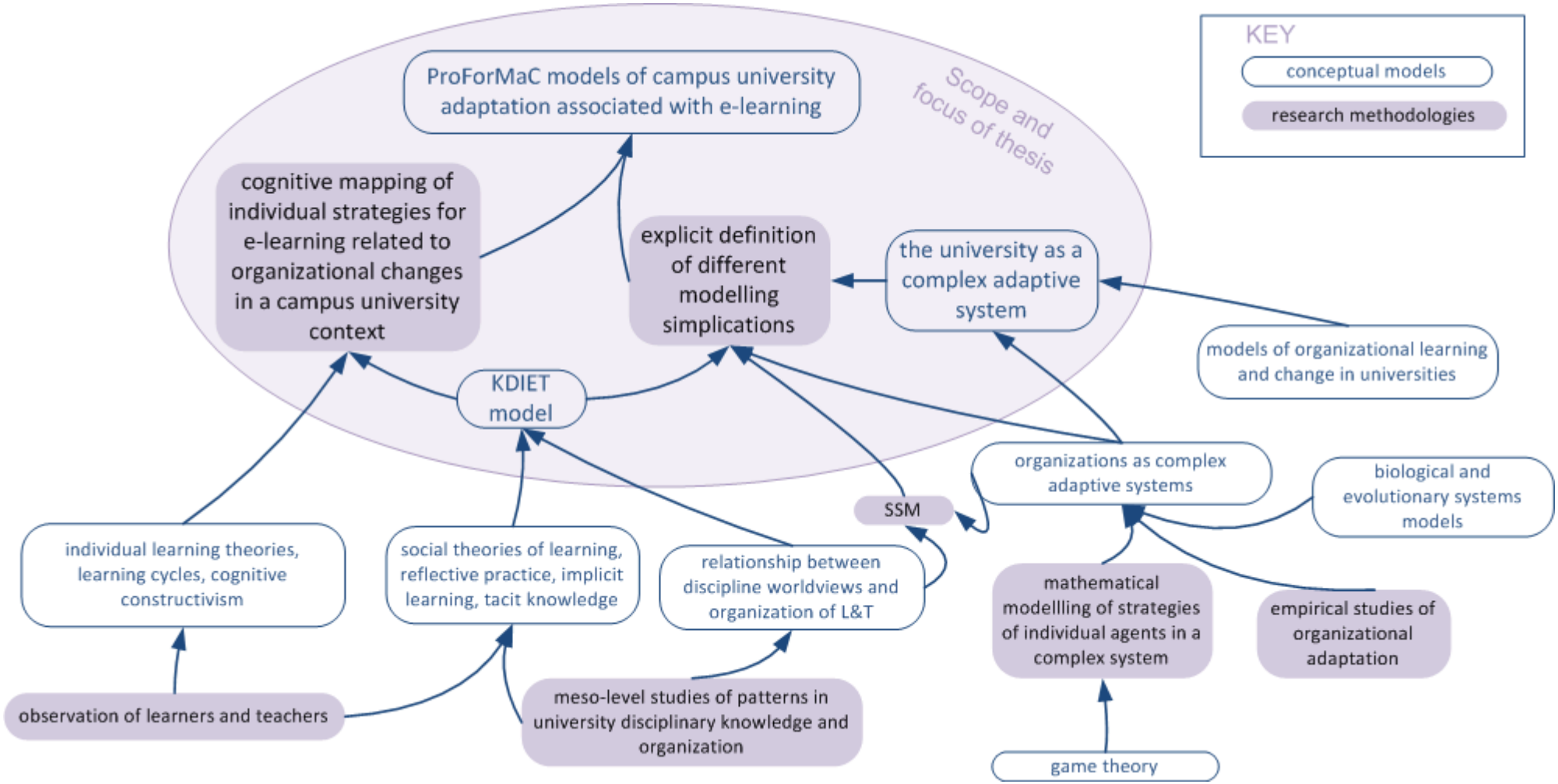


Figure 9.1 Graphical summary of the thesis scope and contribution to knowledge

Complex adaptive systems models of the relationship between individual and organizational learning can combine knowledge from several specialist perspectives on learning and teaching in higher education and to build an understanding of how these perspectives form parts of a whole system. The ProForMaC framework has enabled interpretation of the empirical results from UNSW to create models of the interactions between different aspects of university organization. The findings show how individual university teachers are influenced by, and can in turn influence, the way that departments and institutions build their formal structures, rules, policies and material technological infrastructures. Figure 9.1 summarizes how the thesis builds upon previous research, and extends the network of knowledge about how universities organize, as explained below.

Purposeful change and accountability

An important consequence of the models arising from the UNSW study is that purposeful change, supported by formal management, can be part of a complex adaptive organizational response in which individuals and formal organization adjust together. This finding contrasts with the view that organizational adaptation takes place primarily through self-organization of individual learners, and that purposeful management has a limited role (Stacey, 2003; , 2005). Universities in Australia and the UK are formally accountable to government funders, students and employers for providing learning and teaching that meets their needs.

During the period of the UNSW study, the requirements for Australian universities to be accountable have involved increasing government scrutiny of internal university systems (DEST, 2002b; c; d; 2003; 2004). This thesis has accepted rather than questioned the need for purposeful management of university resources and activities by senior managers, and has focused on how the resulting internal university environment adjusts through changes in disciplinary learning and teaching systems and practices.

Complementary changes

The integration of e-learning technologies as a core part of university learning and teaching also requires mutual adjustment among different aspects and levels of the university's learning and teaching system, and has a complementary relationship with other university systems, such as staff recruitment and promotion. Some writers (Barnett, Harwood, Keating & Saam, 2002; Barnett, 2000a; b; 2005; Knight, 2001) have pointed out difficulties in reducing complex university activities to simplistic performance measures. This thesis has developed a way of identifying which of the many complex interactions in a campus university's learning and teaching system are most important for integration new e-learning technologies into mainstream teaching practices.

The findings from the UNSW study indicate that it is possible to manage change in order to achieve measurable outcomes without resorting to simplistic measures that would split a complex whole into meaningless parts.

There is empirical and pragmatic understanding of complexity and complementarities in universities. Scott (2004), for example, describes how changes in one aspect of university activity will trigger a need for change in another, and enumerates guidelines for practice based upon experience of technology-related changes in particular university learning and teaching contexts(Scott, 2003). However advice such as this does not make explicit an underlying analysis of systemic patterns and feedback loops. The UNSW study used complex adaptive systems theories in conjunction with cognitive mapping to analyse basic patterns underlying observed outcomes, in terms of systemic feedback loops. The relative strength of the various components of those feedback loops may vary between institutions, but I argue in Chapter 8 that the patterns of influence upon individual academic strategies are likely to be common in many universities. The thesis therefore adds systems analysis to existing pragmatic guidelines for management of complexity in higher education. A rigorous analytical framework is needed to transfer organizational knowledge from one context and time to another. Such transfer of organizational knowledge is particularly important when there is rapid change in the technological environment of university learning and teaching, and when the accumulation of case study experience in one period may become outdated within a few years.

Diversity in educational language

The development of a shared language is advocated as necessary for transformation of university learning and teaching (Scott, 2004; Trowler & Cooper, 2002). The analysis presented in this thesis implies that a single common shared language may be neither achievable nor desirable. What is more important is metacognition of language differences; the ability to recognise when someone is speaking a different language. Allowing for diversity increases the organization's adaptability. Different languages have different strengths and weaknesses. Rather than dismissing communication which is not readily understood, or insisting that everyone speak the same language, it may be better to call in an interpreter and allow for ideas to be exchanged across language barriers. My own use of findings from mathematical studies that are beyond my own mathematical understanding are an example of this approach, in that I have relied on the work of others to interpret the organizational significance (Milgrom & Roberts, 1995a; b) and to develop meanings in different contexts (Fenton & Pettigrew, 2000a; b; Massini & Pettigrew, 2004).

9.2.2 Understanding systemic adaptation in universities

Interpreting the results from the UNSW study provides some conceptual models to link aspects of university learning and teaching systems that have previously been researched separately, from different worldviews and using different research methodologies. I have proposed the ProForMaC framework for representing how complementary areas of knowledge about university learning and teaching may be mapped out and combined. Underlying this approach is an acceptance of the concept of distributed cognition as part of organizational learning. Van Fenema (2005) describes how distributed cognition supports reliable organizational responses to environmental change. Other researchers have shown how distributed cognition operates in the management of change in schools (Halverson & Clifford, 2006) and how distributed knowledge is built in groups interacting in virtual environments (Daradoumis & Marques, 2002; Henning & Van der Westhuizen, 2004; Karasavvidis, 2002; Kim & Baylor, 2006; Salomon, 1998; Schrire, 2004). The thesis has developed models to link:

- processes for improving learning, forms of teaching and material e-learning technologies
- different levels of context, including individual teacher strategies, academic departments and institutional responses to the higher education environment
- formal and informal interactions between people operating across of these levels.

In analysing the influence of disciplinary variation on teachers' strategies for adopting e-learning technologies, I extended the Becher and Trowler (2001) model of disciplinary diversity to form the KDIET model. The relationships found from cognitive map analysis, using the KDIET model to characterise individual teacher strategies, can be mapped as ProForMaC influences. These disciplinary influences shape whether e-learning is used for core learning or only as a peripheral extra in classroom learning (Figure 9.2).

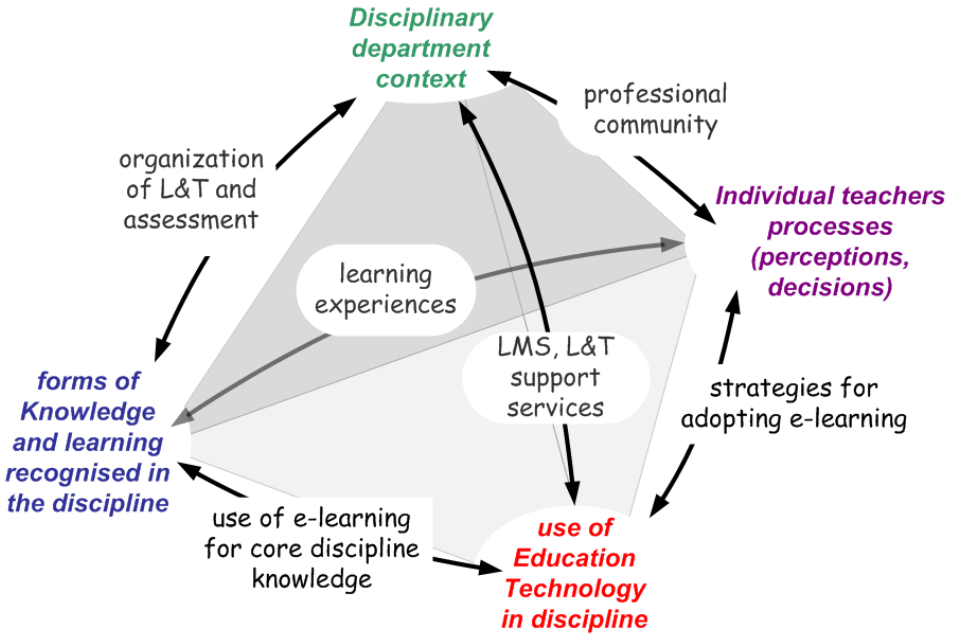


Figure 9.2 The KDIET model in the ProForMaC framework

The role of microdiversity

Significantly, the findings from the UNSW study demonstrate how the connections between diverse individual and disciplinary perspectives are central to the university's ability to adapt to a new technological environment. The role of microdiversity is explained by theoretical models of complex adaptive human organizational systems and the variety of options available to individuals (Andriani, 2001; Gavetti & Levinthal, 2000). The cognitive mapping study in UNSW has provided some evidence that this theory has real meaning in the context of university teachers whose strategies for adopting e-learning technologies and methods have been expanded by cross-discipline interactions. The findings have been triangulated with corresponding data on organizational developments in UNSW, which shows how expanding the strategies of some individuals can set up positive feedback loops that support e-learning adoption by others.

If each individual in a university accepts that nobody has a complete understanding of how the university's learning and teaching system works, and that this is not just an espoused theory but a theory in action , then some of the tensions of supercomplexity that Barnett (2000a) describes may become easier for individual academics, and university managers to deal with. Responsibility and accountability shifts from the individual academic performance in teaching and research to the systemic organizational performance, which can be achieved better by diverse individuals doing different things together. The university's adaptability, particularly its capacity to learn how to incorporate new technologies into its learning and teaching systems, depends on individuals being supported in selecting from a wide range of options in their teaching (microdiversity).

Boundaries and simplifying assumptions

The university learning and teaching system model outlined in Chapter 1, and used to interpret the findings from the UNSW study, has made some simplifying assumptions. One is that there are no boundary changes associated with the introduction of e-learning, in the sense that the university learning and teaching system is essentially made up of disciplinary teaching and learning regimes within an institution in which there is central support for teaching activities. The case narratives described in Chapter 7 were chosen to triangulate with the cognitive mapping data and therefore focus only on internal perspectives where there is no significant boundary change. The UNSW study therefore does not provide any insights into the relationships between change in the university's boundaries with the rest of the higher education environment and changes in adoption of e-learning.

Research on complementary organizational change elsewhere has included change in the boundaries between the organization and its environment. The INNFORM survey included boundaries in the complementary changes studied (Fenton & Pettigrew, 2000b). In manufacturing industry there were changes in relationships both with the labour market and with the market for manufactured products associated with the change from mass manufacture to flexible manufacturing technology (Milgrom & Roberts, 1995a; b).

In the UNSW study, changes in organizational boundaries were excluded from the analysis. There have, however been some boundary changes since the core data were collected. Although too late to have an impact on the findings of the study, some of these may have implications for the future adoption of e-learning technologies in UNSW.

1. Although the Omnium project has had little impact on mainstream teaching within UNSW, it has established links with several other universities who are now also using the Omnium system. In 2007, Omnium was released as open source software. This move does not change my conclusions about the limited impact of Omnium within UNSW. But it does illustrate what has been excluded as a result of the system definitions and boundaries adopted for this thesis.
2. Another boundary change, which also had potential to shift the institutional use of e-learning, was the launch of UNSW Asia in 2006-7. The Singapore campus required much greater use of e-learning facilities linked to classroom study, and was making use of the same institutional e-learning support systems and services as the main Sydney campus. However, the campus was closed after only one academic session.
3. UNSW's Canberra campus at the Australian Defence Force Academy (ADFA) decided in 2006 to maintain a separate e-learning management system and a separate e-learning support

team rather than joining the main UNSW systems. ADFA is small, geographically separate, relatively well funded for learning and teaching, and provides higher education only for defence force personnel. This isolation may mean that innovations introduced in ADFA are well-integrated into mainstream practices locally, but will not spread across UNSW.

4. The Australian Graduate School of Management (AGSM) was physically located in Sydney, and jointly owned by UNSW and the University of Sydney. AGSM had a separate learning and teaching system, separate programmes and academic departments, and used an outsourced learning management system to support different teaching modes and methods. In 2006 AGSM was taken over wholly by UNSW. Its operations, academic programmes and staff, including e-learning and other learning and teaching support have now been merged with UNSW's Faculty of Commerce and Economics, to form part of a new Australian School of Business.

Organizational boundaries can therefore be a significant influence on the spread of e-learning innovation into mainstream campus teaching. A similar study in a different context, or in the same institution at a different time, might therefore require different assumptions and different definitions of the system of interest than I used in my study of UNSW between 2002 and 2006.

Although there is already a general understanding of university learning and teaching as a complex interconnected system, management decisions often rely on intuitive judgements and tacit organizational knowledge. By using cognitive mapping to identify key influences upon individual strategies, it is possible to develop more reliable methods of identifying key systemic feedback loops and complementarities. If the same methods were used in context of changing organizational boundaries, the results might help to clarify how organizational change and technological changes in learning and teaching systems affect each other.

9.3 Suggestions for further research

The previous parts of this chapter have identified some strengths and limitations in the cross-discipline action research carried out for this thesis, and have summarized what the findings add to previous knowledge about integration of new e-learning technologies into university learning and teaching systems. This final section draws out some implications and suggestions for future research in this area.

9.3.1 Influences on individual teacher strategies

The UNSW study focuses on a group of innovators and early adopters of e-learning technologies. From this it has been possible to develop a systemic understanding of what encourages and discourages innovation in university teaching practice. Research with academics who are not

innovators and early adopters of e-learning, or with academics who are experiencing a different institutional context would confirm the general applicability of the systemic models developed from the UNSW Study.

Discipline differences and cross-discipline interaction

The UNSW study established how the ITET Fellowship programme enabled innovative teachers to build bridges between disciplinary teaching and learning regimes and thus extended the range of strategies available for adopting e-learning innovations. However, the participants in the study were taking part in a 6 month full-time cross-discipline Fellowship. There are other examples of cross-discipline interaction with longer or shorter time spans and degrees of intensity.

The new UNSW Learning and Teaching Fellowships involve full-time work for two years, with 10% of the time spent in shared cross-discipline activity. Staff development activities in university learning and teaching often involve less intensive cross-discipline interaction. For example, most universities in the UK and Australia run graduate certificate courses in university learning and teaching. More research of the type carried out for this thesis, covering different university contexts and different types of cross-discipline experience, could establish what types of cross-discipline interaction are most effective for facilitating integration of new methods and technologies into mainstream university teaching.

Teamwork

I was able to triangulate the cognitive mapping findings with other empirical data, but the whole study is context-specific and some care is needed in transferring the conclusions to other contexts. For example, lack of teamwork has been highlighted as a barrier to campus universities' ability to adapt to use e-learning (Laurillard, 2002). Australian campus university culture may differ from other contexts in its acceptance of teamwork.

There are some significant differences between Australian and UK university systems. One is that in Australia there is no formal requirement for external examiners to act as disciplinary peer reviewers. The UK system may make it more likely that individual academics will accept peer scrutiny of their teaching practice. Australian universities only use external review where programmes need external accreditation by professional bodies, for example as in engineering or medicine. As a result, some of the conclusions in this thesis relate to an academic culture that is perhaps more individualistic than would be typical in the UK or in other countries where external examiners are required. The thesis has not taken into account research on the relationship between academic culture and different national academic peer review systems.

Studies of patterns in individual strategies in different contexts, using cognitive mapping or other strategy elicitation and analysis methods, could show how attitudes to teamwork vary in different types of institutional culture. For example a comparison between campus universities and distance universities, or between similar universities in countries with different national policies, would show how these differences affect individual strategies and are reflected in departmental organization.

9.3.2 Department and discipline boundaries

The findings from the UNSW study have shown how disciplinary cultures and disciplinary teaching and learning regimes influence the adoption of e-learning technologies. The use of the ProForMaC framework in the UNSW context suggests that there is scope for more research of the type identified as 'meso-level' research (Becher & Trowler, 2001), to link individual academic strategies with organizational forms, and also to take into account the role of e-learning innovations as an embodiment of changing learning and teaching regimes. The framework can be used to make explicit where the gaps lie in discipline-specific perspectives perspective, and could therefore also be used to identify areas where there are overlaps and gaps between existing knowledge areas.

Becher and Trowler (2001) note that discipline configurations vary between universities. They also vary with time. Some of the ITET Fellows in UNSW entered the Fellowship programme from one School and Faculty, and returned to a different School and Faculty after organizational restructuring. In defining whether the participants in this study were from a hard or soft, pure or applied discipline territory, I judged on the basis of academic departments and in some cases distinguished between specialisations within departments. While the thesis has shown that discipline-specific components of the teachers' strategy patterns disappeared after a cross-discipline experience, these findings may include some context-specific effects.

As noted above in the discussion on boundary assumptions (Section 9.2.2), boundaries between departments and disciplines change in ways that shape the university's learning and teaching systems, and the use of e-learning technologies within these systems. UNSW has been established for many decades, and has traditional strengths in applied disciplines such as business studies and engineering. Despite some changes in departmental boundaries, UNSW overall has stable discipline-related organizational structures. Older and younger universities in Australia have different disciplinary profiles, and may show different relationships between disciplines and e-learning integration. Kezar (2001), notes that life-cycle models can help in understanding change in terms of developmental stages in organizations, and that there is a lack of such studies in higher education. Life cycle models are another potential area for further research in relation to e-learning adoption. For example new institutions or in new discipline areas might be compared

with those that have a have a longer tradition as organizations or are working with long-established bodies of knowledge.

9.3.3 Institutional systems as contexts for individual strategies

The UNSW study has shown how complex adaptive systems concepts can be used in empirical research to model the interaction of individual university teacher strategies, technologies and university organization. Further empirical studies of this type would strengthen the claim that this is not only a widely applicable approach for research into use of e-learning technology in higher education, but one that is necessary if academics are to build a more explicit, codified understanding of how new e-learning technologies become integrated into mainstream university teaching practices.

In re-reading my early notes on the papers on mathematical modelling of complementarities in manufacturing industry, I found the following quote:

> "In particular, suppose that the managers directing the different activities and functions in a firm each select their decision variables to maximize overall profits as a function of their environmental parameters. If they are not able to coordinate their choices, but rather each acts on the assumption that the others' choice variables are fixed at their current levels, then they will systemically under-respond to environmental changes." (Milgrom & Roberts, 1995a),

It is possible to change a few words to apply this to university learning and teaching:

> "... suppose that the *[academics]* directing the different *[disciplinary learning and teaching]* activities and functions in a *[university]* each select their *[strategies]* to maximize overall *[benefits]* as a function of their *[departments']* environmental parameters. If they are not able to coordinate their choices, but rather each acts on the assumption that the *[other departments' strategies]* are fixed ... , then they will systemically under-respond to environmental changes."

Chapter 8 discusses how cross-discipline community links can support the coordination of a university's systemic response to environmental change. Formal organization can draw upon distributed cognition of change to build positive feedback that enhances a university's ability to adapt. The feedback loops relate to perceived benefits for individuals, and also for teams and departments. This thesis has shown some of the complex intrinsic and extrinsic motivations that influence individual academics. In early adopters, recognition and promotion enhance an intrinsic motivation to innovate and improve teaching. Community support (or lack of it) is also a significant influence on individual strategies. These patterns of reward and motivation are also played out at the departmental and institutional levels.

Further empirical and theoretical research using complex adaptive systems theories could lead to better models of academic responses to particular reward and recognition systems, individual and institutional. Is there a particular configuration of rewards for innovation in learning and teaching

that would encourage more cooperation and teamwork among academics, rather than individualistic or competitive responses? Are there some underlying systemic patterns that we could use to identify key feedback loops, and which are applicable in different contexts as with Senge's system archetypes (Senge et al., 1994)?

It would be possible to build upon particular aspects of this thesis, in more depth and with greater thoroughness, to confirm the validity of the conceptual approach and of the findings. The concept of distributed cognition implies that such research might be best carried out by multidisciplinary teams, to link knowledge from specialist areas of educational research into a greater whole. The ProForMaC framework is proposed as an initial basis for identifying the simplifications and assumptions in each area of knowledge. The framework could be thought of in the same way as a set of Lego® bricks – not a model in itself but a toolkit designed to enable the building of models.

This thesis has explored how some behaviours are encouraged and others discouraged in the academic learning and teaching system. In particular, I have discussed how teaching innovation in academic departments and institutions is constrained by a reward system that prioritizes research at the expense of teaching. Academic funding and reward systems recognise formally refereed conference papers and presentations. So academic conferences, even those on e-learning and educational innovation, still generally follow the standard paper presentation format (Figure 9.3). Most academics would find it hard to get time and sponsorship to attend at academic events run on different principles.

Figure 9.3 A typical e-learning conference presentation?

The thesis has analysed why academics in traditional campus universities are apparently reluctant to adopt e-learning innovations in their teaching practice. This analysis has shown that, rather than arguing between disciplinary perspectives about what learning and cognition mean, and what constitutes academic knowledge, it is more useful to think in terms of systemic adaptation involving individuals in community and formal organizational contexts that incorporate the development of e-learning technologies.

In general, there is a need for research that develops a systemic distributed cognition in university learning and teaching. Educational knowledge is distributed across diverse disciplinary perspectives. In order manage the complex processes through which new learning technologies

become part of mainstream disciplinary and institutional learning and teaching systems, some urbanization of the inter-disciplinary territory is needed.

My thesis provides an initial exploration of the application of complex adaptive systems theories, to research the adaptation of a university's learning and teaching systems in a changing internal and external university environment. These changes both drive and are driven by the development of new e-learning technologies. The thesis provides a framework for further research to understand how a university's learning and teaching may be managed as a systemic whole that includes the development and use of new e-learning technologies.

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