A LEARNING ECOLOGY FRAMEWORK FOR COLLECTIVE, E-MEDIATED TEACHER DEVELOPMENT IN PRIMARY SCIENCE AND TECHNOLOGY

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LACHLAN FORSYTH

University of Technology, Sydney
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CERTIFICATE OF AUTHORSHIP / ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student

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Abstract

This thesis reports on the development and testing of a framework for making sense of the collective professional learning of primary Science and Technology teachers in an e-learning mediated context.

Web-based networks and collaboratories are playing an increasingly prominent role in private and public sector knowledge building and innovation. In Education, online communities now frequently support teachers' professional learning. However, despite the pervasiveness of this network zeitgeist, such studies rarely describe or analyse (let alone theorise) teachers' collective learning, focusing paradoxically instead on the learning of individuals, albeit in group contexts. Without a clear understanding of collectivity, the design of initiatives for systemic professional renewal is significantly impeded.

This investigation addresses this urgent need to describe, analyse and theorise teachers' collective learning. Serendipitously, an Australian Research Council Linkage Project, DESCANT (SciTech), provided a context that confronted those ethical, theoretical and pragmatic challenges necessary to make collective learning both possible and likely. Cohorts of primary Science and Technology teachers, supported by consultants, Education Department officers and University researchers, worked together, in networked ways, to conceive, prototype and trial an e-learning environment for the professional development of cohorts of their peer teachers. Democratic participation was assured, a generative theory of learning adopted and pragmatic steps taken so as to establish a principled, yet experimental, trial for studying collective learning. Group learning at every stage of this process was documented, and examined for ethical, theoretical and pragmatic evidence of collectivity. That is, judgements were made as to whether the learning that occurred at each stage of the project could be understood as a complex, dynamic learning ecology.

The study's findings reveal that collective professional learning did occur, to a greater or lesser extent, at every stage of the DESCANT process. Furthermore, the collective learning of these teachers could be well described and explained by considering how those ethical,

theoretical and pragmatic challenges - the pillars of the learning ecology framework developed here - were met. The account makes clear just how complex, dynamic, highly nuanced and ecological in nature collective learning is. It was then a small step to theorise systemic professional renewal in terms of collective conceptual movements on an adaptive (learning) landscape and, in the light of what occurred, to extrapolate, speculatively, from the generative theoretical pillar with which the study began.

Of course, this study has acknowledged limitations. Nevertheless, its successful small-scale piloting of a learning ecology framework for making sense of collective, networked professional learning demonstrates that the framework has a range of epistemic benefits - not least, internal and external coherence. As well, it provokes thinking about key characteristics of networked approaches to collective professional learning. Above all, this study suggests the worth of continuing to test and refine this learning ecology framework in those diverse settings where systemic renewal is critical.

Chapter 1
Justifying and Preparing for this Investigation

This thesis asks and answers the broad and deep question - How do teachers learn collectively? - by examining the e-learning mediated professional development of groups of teachers in a novel, empirical research investigation. In so doing, it aims to make a theoretical contribution towards addressing the challenges of systemic renewal of K-6 Science and Technology education.

Education systems, both in Australia and overseas, have typically struggled with the means by which to enact professional development that supports both systemic reform and teacher professionalisation. Addressing this challenge has increasingly been associated with nuanced conceptions of learning that incorporate, for instance, the learning of individuals, groups, communities and systems. Nevertheless, such endeavours are complicated by the shifting nature of collaboration within contemporary society, brought on by increasingly sophisticated network technologies.

With the increasing propensity towards networked professional learning, there is a renewed need to interpret and understand the complex learning dynamics that may be occurring at various levels within novel collaborative forums. This may be particularly relevant where such initiatives are claiming to be participatory and community-based. In such cases, gaining a more adequate understanding of the relationship between individual and collective dimensions of learning may foreground how professional knowledge was negotiated within these, so-called, deliberative contexts.

This thesis is an attempt to redress this problem by contributing an empirical study of collective learning within an online network, and a possible framework for understanding, supporting and theorising that learning. In doing so, the study hopes to inform educational researchers, teacher educators and Departments, interested in the potential of e-mediated networks for supporting participatory teacher development. Beyond Education, the study may inform those interested in the theoretical and pragmatic issues surrounding participatory e-learning design and the potential of e-mediated forums for deliberative community development and knowledge building.

This first chapter justifies asking how teachers learn collectively, and prepares conceptually for answering this question. In order to do so, it is necessary to identify two underlying conceptual shifts. First, to conceive of the question in the way it is meant here it is necessary to recognise that such entities as groups, organisations, networks, systems and cultures (as well as individuals) are learners. In this view, learners exist within a *nested structure*. Once it is recognised that nested collective entities can learn, it follows, as will become clear, that their learning has a self-organising, adaptive quality. Both ideas strongly underpin this chapter's three sections.

In the first section, I sketch some relevant aspects of the conceptual terrain in which this thesis is located. I identify the concept of the network as approaching what might be called a zeitgeist, illustrating its centrality in a range of contexts beyond education, and I attempt to differentiate some of its qualities there. Then in the second section, I can review research reports of teachers' professional learning with particular attention, by comparison and contrast, to the nature of collectivity in learning. In the third section, I can focus on the substance of what is actually being learned, in this case K-6 Science and Technology education. The chapter ends with an overview of the large Australian Research Council project (DESCANT-SciTech: Designing E-learning Systems to Celebrate and Nurture Teaching in Science and Technology) in which this investigation took place.

Once this preparatory work of Chapter 1 has been done, I can outline the research design and methodology of my investigation (in Chapters 2, 3, 4 and 5), report my findings (in Chapters 6, 7, 8 and 9), and proceed to summarise and conclude with suggestions for further work (in Chapters 10 and 11).

1.1 A Network Dynamic: towards a contemporary zeitgeist?

Networks are increasingly prominent as a means of understanding complex and developing phenomena. In Kelly's (1994, p. 27) words, for example:

> *A dynamic network is one of the few structures that incorporates the dimension of time. It honours internal change. We should expect to see networks wherever we see constant irregular change, and we do.*

A network, or a networked system may be defined as a "set of elements [or nodes] which are connected to each other by links" (Csermely, 2006, p. 323). It has become a unifying idea within such diverse fields as:

- Biology (for example, metabolic networks, Jeong, Tombor, Albert, Oltvai & Barabasi, 2000)
- Ecology (for example, food webs, Cohen, Briand, Newman, 1990),
- Social science (for example, social networks, Milgram, 1967; Young, 2003),
- Neuroscience (for example, neural networks, Edelman, 1992)
- Technology (for example, the World Wide Web, Berners-Lee, Hendler & Lassila, 2001).

In all of these cases, the behaviour of networks has become central to understanding how such systems grow and change. In this first section, I use three examples to illustrate how such growth and change in complex networked systems might signal collective learning.

1.1.1 The Amazon.com Recommender Network: a distributed learning system

Online recommender systems, such as Amazon.com, are hybrid social, technological and information-based networks (Resnick & Varian, 1997; Goldberg, Nichols, Oki & Terry, 1992). As individuals engage with them, they leave traces of their actions, opinions or preferences (often through ratings and reviews). By co-ordinating or *coupling* (Waldrop, 1992; Benzon, 2001) autonomous agents in this manner, the recommender system affords the network (and its population) potentially adaptive capabilities that would otherwise be unavailable, including an economical method by which to appraise the value of books.

Anderson (2006) reports how recommender systems have revolutionised economics, using Amazon.com as an example. Collective patterns of user behaviour in Amazon.com emerge or self-organise through a bottom-up dynamic as autonomous agents use the actions and recommendations of other users as a social strategy for their own decision-making (Anderson, 2006). Supported by the technological network of the internet, these feedback loops help regulate the enormous diversity, or 'long tail' (Anderson, 2006) of products available through Amazon.com. This decentralised, self-organising dynamic is in contrast to the traditional top-down decision-making often seen in market networks when (often large) organisations choose which products will be available to consumers (Anderson, 2006).

As users of Amazon.com continue to engage with the network, the structure of the system changes to maintain a dynamic representation of the collective's intelligence (Surowiecki, 2004; Rheingold, 2001). The Amazon.com network thus *learns* which books are currently considered worthwhile, based on the collective actions of users. In doing so, the network functions as an *adaptive learning system*, responding quickly to collective trends that may reflect wider environmental factors. Web-based recommender networks therefore possess the qualities of complex adaptive systems. They are self-organised, bottom-up emergent and utilise weak, short-range relationships rather than centralised top-down organisation (Csermely, 2006).

A range of studies has suggested that a group or population's collective intelligence has the potential to outperform actions based on individual decision-making and even, in some cases, expert knowledge. For example, Huberman (1995 cited in Surowiecki, 2004) demonstrated that group forecasts within information markets were more accurate than individual expert forecasts, an outcome supported by other small group experiments simulating economic decision-making (Surowiecki, 2004). It is not yet clear if such findings also apply to more challenging intellectual tasks. Lanier (2006, para. 50) notes:

> *The collective is more likely to be smart when it isn't defining its own questions, when the goodness of an answer can be evaluated by a simple result (such as a single numeric value,) and when the information system which informs the collective is filtered by a quality control mechanism that relies on individuals to a high degree.*

Nevertheless, despite these cautionary qualifications, Huberman's findings suggest that distributed collectives and populations, when networked, may possess capabilities that are 'more than the sum of their parts' (Rheingold, 2002). This acknowledgement of the potential learning capacity of collectives supports the worth of investigating it further in this study.

The attribution of intelligence to a collective represents a significant shift from individualistic conceptions of it. Davis and Sumara (2006, p. 86) state, "…the intelligent unity is one that generates a diversity of possibilities and that has a mechanism for critically debating the merits of those possibilities." This definition allows the concept of intelligence to apply, not only to individuals but also to any collective entity that possesses these qualities. Huberman (cited in Rheingold, 2001, p. 179) writes:

> *Intelligence is not restricted to single brains; it also appears in groups, such as insect colonies, social and economic behaviour in human societies, and scientific and professional communities. In all these cases, large numbers of agents capable of local tasks that can be conceived of as computations, engage is collective behaviour which successfully deals with a number of problems that transcend the capacity of any individual to solve...*

Importantly, collective intelligence need not invalidate the learning or agency of individuals. Learning occurs at *nested levels*. Individual users, Amazon.com employees and researchers, may learn through engagement with the network. Furthermore, the hybrid network itself (social, technological and information-based) may be conceived as learning.

This nested structure is another common quality of complex adaptive systems (Davis & Sumara, 2006).

The nested structure of the recommender network, and other web-based networks, recasts the relationship between individuals, organisations and the market, creating *small world networks* (Milgram, 1967). Such networks exhibit a *scale-free* organisation described by Davis and Sumara (2006, p. 50):

> *…nodes cluster into larger nodes that cluster into larger nodes, and so on…. This manner of organisation means that most of the interactions of an "agent" (ie. node, selected at any level of organisation) are with its closest neighbours…. However, with the clustered arrangement, every agent is also reasonably well connected to every other agent in the network through a relatively small number of connections.*

It is the increasing propensity of these scale-free, small world networks that has revolutionised modern economics in many industries (Anderson, 2006). The same potential may exist for revolutionising professional and systemic learning in education, by establishing small world innovation networks which are essentially learning systems (Baraniuk, 2006; Snyder & Wenger, 2004; Bentley, 2003; Laszlo, 2003; Banathy, 2000). In such systems individuals, professional collectives and the educational system as a whole are learners. Supporting this vision, Bentley (2003, p. 15) asserts that utilising decentralised learning systems for professional development in education may overcome the tendency for teachers and local school-based communities to resist, quite legitimately, overly prescriptive systemic reform agendas:

> *The payoff is that a series of [centralised and top-down] initiatives that bend the performance of resilient [localized] systems could be replaced with a continuous effort to equip the system to learn for itself.*

Nevertheless, whilst learning networks such as Amazon.com provide illustrative examples for ICT small-worlds, both Bentley and Hargreaves note that we still do not know how to achieve such networks for professional learning in education. We currently "…know too little about the dynamics of online communities, both in general as well as in education…" (Hargreaves in Bentley, 2003, p. 63), thereby justifying the empirical work of the present investigation.

So, this first case study illustrates not only the distributed nature of learners and learning but also the potential of ICT networks for distilling the intelligence of populations, or collectives. By recasting the relationship between individuals, populations and systems, small world networks such as Amazon.com foreground new ICT possibilities for enacting models of systemic educational reform that harness the professional learning of individuals (Baraniuk, 2006).

Nevertheless, individuals within such collectives as Amazon.com may remain independent, to a greater or lesser extent. In contrast, with regards to teacher professional development, research spanning two decades has indicated that *collaborative* communities of practice are "important contributors to instructional improvement and school reform" (Little, 2002, p. 936). A second case study demonstrates a particular collaborative network model, perhaps more useful for education.

1.1.2 The Shell Communities of Practice: a collaborative learning system

The Shell organisation's strategic development of three distributed communities of practice aimed to support collaborative learning through the sharing of knowledge regarding deep ocean oil exploration (Wenger, McDermott and Snyder, 2002). The strategy sought to promote lateral communication between workers so as to develop a decentralised learning dynamic within the organisation.

Participants of the Shell project, including professionals from both scientific and engineering disciplines, formed local groups or 'cells' (Wenger, McDermott and Snyder, 2002). This allowed them to self-organise their actions on the basis of local needs, understandings and cultures. Using Internet technology, these local cells were networked into a global community that spanned numerous independent Shell companies around the world. This developed a nested or fractal structure through which professionals could share insights, understandings and develop knowledge collaboratively (Wenger, McDermott & Snyder, 2002).

Two of the three communities became successful for promoting networking and learning within the organization (Wenger, McDermott & Snyder, 2002). The other community failed to reach a critical mass leading those interested to merge with other groups. The case study provides an illustrative example of strategic professional learning that takes place, not only in individuals, but also across professional collectives as shared practice and knowledge develop through collaboration and networking (Wenger, McDermott & Snyder, 2002). This professional collaboration represents a different form of collective learning to the previous case study in that the links between the individuals in the network are stronger, characterised by communication.[1]

Nevertheless, the collaborative Shell network still maintained the characteristics of a *complex adaptive system*. For instance, the nested structure of the Shell communities allowed local populations to *self-organise* in a way appropriate to their particular contexts (Wenger, McDermott & Snyder, 2002). Through lateral communication (or short-range relationships) with both local and distributed communities, individual professionals at Shell could contribute either as part of a local collective (based on their shared practice) or as part of the wider global collective (Wenger, McDermott & Snyder, 2002). Changes in practice resulting from this professional network, could therefore take place at either of these collective levels: that is, at the level of the local group (or cell) or the global network.

This change in professional practice, or the "mini-culture that binds the [professional] community together" (Wenger, McDermott and Snyder (2002. p. 39) has been conceived as a form of learning that incorporates, yet extends beyond individuals (Lave & Wenger, 1991). Central to this perspective is a conception of learning as a sociocultural phenomenon

[1] Surowiecki (2004) asserts that collaboration in this regard threatens the independence of individual actions in a population, thus lowering the group's collective intelligence. This cost-benefit trade-off emphasises the tension that may exist between a distributed and collaborated conception of collective learning.

(after Vygotsky, 1986; 1978). Learning, in this view, takes the form of changes to a community's 'mini-culture' that may include many types of knowledge including common approaches, stories, standards, theories, rules, principles, tools, experts, articles and heuristics (Wenger, McDermott and Snyder, 2002), again, enlarging individualistic conceptions of professional learning.[2]

In a nested system, as existed at Shell, professional learning may be conceived, not simply as individuals striving towards a common best practice, but as populations or communities of professionals contributing to a field, both locally and globally, on the basis of their diversity. Wenger (1998, p. 131) emphasises the interconnection that exists between the local and global dimensions of such communities and networks:

> *In the context of [nested] constellations of practices, the local and global are… related levels of participation that always co-exist and shape each other.*

Community-based professional learning models that leverage knowledge existing within all levels of the system are increasingly common. As part of a ten year study into professional learning at the Carnegie Foundation, Shulman (2005) describes an example of collective learning in medicine, stating:

> *Everyone in the system was learning. In fact, an assistant professor ran the session, with full professors learning alongside third-year clerks….This kind of communal questioning and learning is compelling… What I watched at this teaching hospital was an institution actively investigating the quality of its*

[2] There is a growing body of psychological research (for example, Arrow & Burns, 2004) that demonstrates how cultural norms emerge within groups, shaping the ideas, knowledge and values that will be accepted and articulated by individuals. Such findings blur lines that were previously much more marked between individualistic psychology and social cognition, adding weight to collective-level conceptions of learning (Plotkin, 2003). Yet, this research may also emphasise a tension in conceiving groups and cultures as a basis of educational endeavours. For instance, Arrow and Burns (2004, p. 118) assert "…there can be no culture, as this term is generally understood, without at least a modicum of closed mindedness. Culture represents a set of constraints upon what is believed, cherished, or valued. It represents an elimination of possibilities, via choice and community… [yet our research indicates] excessive closed mindedness may undermine societal effectiveness in a variety of respects. It may promote humdrum homogeneity, suppress creativity and innovation…and may be inimical to democratic and egalitarian ways of self-governance."

work, knowing, caring, and operating corporately to improve and learn from its collective experience…. it was a model not only of a powerful pedagogical process but of something else—something we see far too seldom in education.

Similarly, in education, the professionalisation of teachers is commonly associated with the need for teachers and teacher collectives to contribute in their own right to education's professional knowledge base (Groundwater-Smith & Mockler, 2005; Hiebert, Gallimore & Stigler, 2002).[3] A model of localised learning systems (or cells) generating knowledge for the wider (or global) profession sits well with this vision. However, the political implications underpinning such a strategy are clear in Bentley's (2003, p. 15) assertion:

The central idea should not be to select one form of organisation and impose or replicate it. It should be to create systems that challenge and motivate a critical mass of participants, and provide the capacity to reinvent the structures and practices from within.

This alludes to a participatory and democratic conception of professional learning and systemic reform in education, one based on the collective learning and collective intelligence of networked populations. As such, this conception may reflect a model of professional learning based on *population thinking*, a conception introduced by Darwin in biology.

Population thinking rejects the typological or essentialist position that the variation apparent in nature is fundamentally derived from a limited number of types, essences or classes (Mayr, 2000). In contrast, population thinking holds that the variation between

[3] This vision may conflict with "strongly hierarchical" models of public sector reform increasingly influential to education in (amongst other places) Australia, the UK and the USA (Groundwater-Smith & Sachs, 2002, p. 341). Groundwater-Smith and Sachs (2002) assert that the state-driven reform of professions such as education can lead to an "audit society [which] uses its resources to achieve pre-determined outcomes which themselves are measurable. Not surprisingly there is little room for negotiation or professional judgement. The more intense the gaze of the audit, the less the trust invested in the moral competence of the practitioners to respond to the needs of those they serve. In effect, there is a bureaucratic rather than professional domination of expertise and practice (Elliott, 2001)."

individuals, and the manner in which this diversity contributes to populations is fundamental to their nature. Mayr (2000, p. 70) writes:

> *By rejecting the constancy of populations, Darwin helped to introduce history into scientific thinking and to promote a distinctly new approach to explanatory interpretation in science.*

As such, population thinking may underpin a dignified, participatory model of professional learning at all levels, local to global, of an education system. By acknowledging both the diversity and commonality of individual and collective learning at various nested levels, a model of professional learning based on population thinking may more adequately represent the unique contributions of individual professionals, as well as the contributions of local collectives and patterns in the wider system.[4]

So, whilst collaborative communities (or populations) leverage the network dynamic in ways that may progress professional practice, a third case study suggests the particular epistemological potential of conceiving of a knowledge network. Science offers archetypal examples of such knowledge networks.

1.1.3 The World Health Organisation's Response to SARS: a knowledge-building learning system

The World Health Organisation (WHO) utilised a global network of eleven research laboratories to discover the source of the deadly SARS virus (Surowiecki, 2004). Although the various labs worked independently on the task, they reported to the network daily with findings and data. This network demonstrates another nested model for collective knowledge building, whereby local collectives operated semi-autonomously whilst

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[4] This has already been suggested as a way forward for understanding the influence of autonomous individuals and groups within organisational learning. In this regard, McLaughlin (2001, p. 17) states "…social scientists can take a major step towards integrating structure, agency and environment by fully absorbing the major lessons of the Darwinian revolution. That is, they need to reject *both* essentialism and nominalism and replace them with population thinking and an historical yet realist approach to categorization (Mayr 1976)."

contributing to the global knowledge building initiative. As already noted, this combination of weak links from local nodes to a global system is typical of *adaptive learning systems* (Csermely, 2006; Davis & Sumara, 2006).

Using this strategy, the professional network was able, collectively, to establish the virus responsible for SARS in only one month. Surowiecki (2004) notes that the WHO did not attribute the discovery to an individual scientist. Instead they noted that a distributed group of laboratories collectively discovered the virus responsible for SARS. Thus whilst learning occurred within local scientific collectives, it also occurred within a distributed collective that had been developed for the task. Furthermore, the scientific community also learnt through this process; thus collective learning may be conceived at three levels in this case study.

The World Health Organisation has also effectively used network strategies for collective action in responding to local outbreaks of viruses, which are also decentralised networks (Bloom, 2000). Brilliant (2006) describes the means by which the World Health Organization (WHO) enacted a health program of "early detection, early response" that has successfully eradicated the smallpox virus. This program relied on a sophisticated network of health professionals, communities, households and individuals and utilised local self-organisation to allow fast, adaptive collective patterns of response. With the enormous rise in global travel, viruses such as SARS or Avian Birdflu now have a far greater capacity to spread (Brilliant, 2006). In response to this increased challenge, efforts are currently underway to develop a massively, distributed network system, using internet technology, that could more efficiently detect local outbreaks thus allowing a collective adaptive response (Brilliant, 2006). Once again, network technology may be "revolutionizing our capacity for collective action" (Noveck, 2005).

In contemporary science, this nested structure and the utilisation of localised research teams and laboratories, has become a crucial form of collective knowledge building. This model of collective knowledge building has been credited to the German Universities of the 19th Century (Whitehead, 1948). With the recognition of the potential of research teams for collective learning, came their adoption in other fields such as corporate management (Scardamalia & Bereiter, 1994). The similarities then, between the nested collective learning of the Shell communities (detailed above) and the WHO case study may therefore have significant historical roots.

Science is paradigmatic in its focus on progressing theory development through professional discourse and collective enterprise, including peer review and critique (Latour & Woolgar, 1979). As such, the reliability of scientific knowledge may be judged, not on its distance from subjectivity, but instead, in terms of the replicability of research statements and on the grounds of a consensus within relevant peer collectives (Ziman, 1978). Thus, Ziman (1978) asserts, “the objectivity of scientific knowledge resides in its being a social construct, not owing its origins to any particular individual but created cooperatively and communally.”

This conception situates collective knowledge building firmly within scientific communities. Yet research has demonstrated that, as a basis for the reliability of knowledge, these communities possess serious weaknesses. For instance,

- Scientists utilised the published work of other scientists more frequently when the work was easy to convey to others, suggesting the importance of the communicability of knowledge for remaining in the collective domain. (Schaller, Bordes, Conway & Tanchuck, cited in Crandall & Schaller, 2004) This represents a selection process that was in a significant way divorced from the scientific *strength* of the findings.
- Psychologists were documented *collectively* misremembering, and thus misrepresenting the findings of a seminal study (Ross, 1999 cited in Crandall & Schaller, 2004). This suggests scientists, like the wider population, may adjust their opinions, attitudes and beliefs not only on the basis of objective standards, but on the basis of a ‘social reality’ (after Festinger, 1954) that exists within their specific culture as shared beliefs, assumptions and knowledge. In discussing these findings, Crandall and Schaller (2004, p. 218) note that “this certainly isn’t consistent with

any ideal of science, but it is consistent with the epistemic goals of individual scientists."

- An elaborate network of both human and non-human factors appears necessary for sustaining the relevance of a particular scientific finding (Callon, Law & Rip, 1986). This finding emphasises the, often implicit, social, political and economic dimensions that may contribute to the course of scientific knowledge progression.

Furthermore, the political and cultural implications of science have become increasingly explicit as diverse fields seek to attend to complex systems that cannot be categorised as only natural or sociocultural. The Kyoto summit is a case in point. It sought to address the complex issue of global warming using a hybrid network of specialists for collective knowledge building:

> *...politicians and scientists, industrialists and militants found themselves on the benches of the same assembly without being able to count any longer on the ancient advantages of salvation from the outside by Science, or to murmur with a shrug of the shoulders: "what do these arguments matter to us"* (Latour, 2004, p. 56).

In such a collective, according to Latour (2004) knowledge building and collective action require negotiation between diverse complex networks including ecological, political and social systems. His is an ecological and democratic conception of collective learning: a systemic knowledge-building network that expands the boundaries of collective consensus through which knowledge may be deemed 'reliable' (after Ziman, 1978).

In yet another affirmation of this expanded conception of collective learning, Gibbons (1999, p. 81) notes "…there are no longer clear demarcation lines between university science and industrial science, between basic research, applied research and product development, or even between careers in the academic world and in industry. Science may be conceived then, as developing knowledge within increasingly open systems (Gibbons, 1999). This increasing integration between fields requires, according to Gibbons (1999), an expanded and socially just, collective basis for generating and validating knowledge.

In education, there are now signs that educators are beginning to seek to integrate their own professional knowledge with the knowledge of a wider range of fields including neuroscience, psychology, and cognitive science (for example, Bransford, Brown & Cockling, 2000). To this extent, education like science, may be beginning to develop knowledge within the kind of open system Gibbons (1999) describes: a system that incorporates both teachers' localised professional knowledge and the collective knowledge of their field and other fields. The means of best supporting this process through professional development and educational reform remain an important agenda for research (Little, 2007), and one to which the present study aspires to contribute.

Contemporary moves towards the professionalisation of teachers (as discussed in 1.1.2) may well be assisted if the professional knowledge of educators were to be more powerfully aligned or simply even integrated with knowledge derived from other disciplines and their recognised professional practices. Supporting such a conception of collective knowledge building and professional learning in education may involve new types of social networks as well as new conceptions of the knowledge networks that result (for example, Bentley, 2003). In this regard, education could well draw on the kinds of ecological and democratic models Latour (2004) advocated for collective learning and knowledge building.

Indeed, there is a strong recent history, in education, of collaborative knowledge building within learning communities (after Brown & Campione, 1990) deliberately echoing the work of scientific communities (Scardamalia, Bereiter, McLean, Swallow, Woodruff, 1989; Scardamalia & Bereiter, 1994). A knowledge building approach (after Scardamalia & Bereiter, 1994) differs from inquiry-based approaches through the explicit focus on *knowledge objects* that become the basis of group discourse. Here, knowledge building "…refers to the creation and improvement of ideas that have a life out in the world, where they are subject to social processes of evaluation, revision, and application" (Scardamalia & Bereiter, 2003).

In schools, scholars recognise computer technology, particularly network technology, as a means of supporting "decentralised, open knowledge building with a focus on collective knowledge" (Scardamalia & Bereiter, 1994, p. 278). More recently, networked learning contexts have been designed specifically as *knowledge-building environments*, as a means of supporting and enhancing "…collaborative efforts to create and continually improve ideas" (Scardamalia & Bereiter, 2003). Such environments may offer a means of enacting an expanded forum, or 'New Agora' (Banathy, 2000) for progressing and legitimating professional knowledge in education as part of networked professional development initiatives.[5]

So, in summary, the three case studies described here reveal a multi-faceted conception of collective learning in networked systems including, in particular:

- A technologically-generated representation (or collective intelligence) of the specific distributed population, as in the Amazon.com recommender system.
- Shifts in the mini-culture of a networked community, both at the local (cell) and global level, through a dynamic exchange within and between these levels, as in the Shell initiative (Wenger, McDermott and Snyder, 2002).
- A disciplined process of networked knowledge-building through professional discourse and collective enterprise to establish collective consensus, as in the WHO's response to SARS.

As will be expanded in subsequent sections, this decentralised and self organising dynamic, has features in common with contemporary visions of teacher professional development and professionalisation. Of particular significance in this regard, and justifying the present attempt to understand and theorise the workings of such collective networks, may be their ability to allow nested populations of teachers to renew the knowledge base of their profession (and perhaps others), whilst regulating the knowledge of the wider system through negotiation and consensus.

[5] Espinosa & Harnden (2007, p. 402) describe a 'New Agora' (Banathy, 2000) as "a public sphere of enquiry and communicative action able to foster a new public and global citizenry of autonomous, conscious and socially responsible individuals and groups working for enhanced local and global welfare."

In the following section, I examine some case studies from teacher professional development for the nature and extent to which this field has been able, thus far, to enact a vision for collective learning.

1.2 Existing Network Approaches in Teacher Professional Development

Not only have networks been central to contemporary forms of collectivity outside education, there has been a parallel growth in their prominence with respect to professional learning within the education sector as well. That is, teacher professional development has been advocated within:

1. Distributed Web-based networks
2. Inquiry-based networks
3. Knowledge Building networks

In the following three sections, I describe each of these networked contexts for professional learning by case study exemplars, giving particular attention to the manner in which teachers' collective professional learning appears to be supported, recognised and interpreted.

1.2.1 Distributed Web-based Networks for Teacher Professional Development

In education, the notion of professional networks as adaptive learning systems has both preceded and paralleled web-based strategies. For example, Lieberman and Grolnick's (1996) review of 16 sustained educational reform networks demonstrated that these professional networks were "continually learning and reinventing themselves" in response to shifting aims, environments and populations (Lieberman, 2000, p. 223). In doing so, Lieberman and Grolnick (1996) emphasised that learning within professional networks may occur at collective levels. Similarly, reporting on the National Writing Project, a professional network in operation for over two decades, Lieberman (2000, pp. 221-222) writes:

> *Unlike bureaucratic organizations, networks are organized around the interests and needs of their participants, building agendas sensitive to their individual and collective development as educators. They can change quickly and invent new structures and activities that are responsive to their members.*

Lieberman (2000) emphasises here the self-organising, adaptive quality of networks: a quality that, for her facilitates their potential for addressing both individual and collective dimensions of professional learning in education. In describing the benefit of such networks Lieberman (2000, p. 226) alludes to the nested quality of these local and global systems:

> *By providing avenues for members to deal with real problems, to work collaboratively, and to communicate more effectively with a diverse population, networks are uniquely suited to the development of learning communities that are both local and national.*

Similarly, the InterActive Education project was designed and analysed by Triggs and John (2004) as a 'layered' community in which professional development was undertaken across three nested levels: the *macro- community* (consisting of the whole project and its partners), *meso- communities* (consisting of teachers, researchers and teacher educators) and *micro-communities* (consisting of a single school-based teacher and researcher). This nested learning dynamic established a single learning network in which "…gradually the boundaries between the teachers and the researchers became permeable…so that [participants] could enter into each other's territory, literally and figuratively, as equal if different collaborators" (Triggs and John, 2004, p. 429).

This nested professional development strategy yielded positive learner outcomes as teachers moved away from being 'constrained deliverers' to 'enabled professionals' who actively generated knowledge within their practice (Triggs & John, 2004). Yet, researchers also noted the tension between the InterActive Education project and local school-based communities. Triggs and Johns (2004, p. 434) describe this dynamic:

> *The communities that we sought to build in the InterActive Project were nested inside already existing communities at the school, local, regional and national levels. [The project] often uncovered uncomfortable tensions between research project -- and school located communities' practice.*

Their experience highlights the challenge of enacting professional development within a complex and nested education system. Although Triggs and Johns (2004) sought to target specific 'layers' of this system (incorporating macro, meso and micro communities), their project outcomes still remain influenced by other parts of the nested, scale-free network.[6] In this regard, their findings highlight the intrinsic uncertainty for researchers dealing with complex, non-linear dynamics within authentic professional development contexts (Davis & Sumara, 2006). Yet despite this cause for uncertainty for research, the positive outcomes of the InterActive Education project support the potential of small world networks to enact participatory educational reform, even where Web-based technologies (as discussed in 1.1.1) are not central to the initiative.

Web-based technology may best be conceived then, as enhancing the field's capability for developing distributed, small world networks for professional learning (Dede, Breit, Ketelhut, McCloskey, and Whitehouse 2005). Teacher educators, researchers and governments have commonly sought to leverage the scale-free nature of online networks in order to establish small world contexts for professional learning that may, for example:

- Spread resources, such as expertise and archives, that do not exist locally (Glenn, 2001)
- Support collaborative teacher reflection that is hard to achieve face-to-face given the restrictions facing teachers on time and access to colleagues (Dede, et al, 2005);

[6] An explanation of scale free networks was provided in 1.1.1.

These small world networks, as novel contexts for teacher professional development, pose both opportunities and challenges for understanding the collective nature of professional learning (Stahl, 2006), justifying the work of the present study. The following two case studies prepare for the present study by making these opportunities and challenges clearer.

Tapped-In (Schlager, Fusco & Schank, 2002; Schlager & Fusco, 2004)

The Tapped-In initiative seeks to support systemic professional development by networking teachers, teacher educators, researchers and many other parties concerned with teacher renewal and education (Schlager, Fusco & Schank, 2002; Schlager & Fusco, 2004). The strategy adopts a Community of Practice orientation towards professional learning: one closely aligned with contemporary understandings of complex adaptive systems and networks.[7] Schlager & Fusco (2004, p. 122) write:

> *Communities of practice are viewed as emergent, self-reproducing, and evolving entities that are distinct from, and frequently extend beyond, formal organizational structures, with their own organizing structures, norms of behavior, communication channels, and history…*

As noted in the previous section, emergent and self-organising change within these communities of practice may be conceived as a type of collective learning within the professional network (Lieberman, 2000). This collective learning may take the form of shifts in the mini-culture (for example, norms, understandings and relationships) of *local* professional groups or *distributed* professional groups, as well as changes to the structure of the collective or network itself (Schlager and Fusco, 2004).

[7] The use of a Community of Practice theoretical orientation in networked professional development has been prevalent for many years. Dede et al's (2005) review of online professional development literature, spanning the last five years, established that over 60% of this research utilised a Community of Practice orientation. Less prevalent, but still common, were studies that included forms of mentoring and apprenticeship, both of which can be closely related to Community of Practice conceptions of teacher learning. Furthermore, nearly all the studies (90%) incorporated a social conception of learning. Dede et al's review thus highlights the dominance of sociocultural perspectives within the literature concerning online professional development in education.

Due to this emphasis on emergent, self-organising professional learning, the Tapped-In environment has been characterised by low levels of centralised intervention. Participants and groups can use the online network for their own professional learning purposes, an autonomy that allows them to utilise the online environment for initiatives that are aligned with local learning needs and communities of practice (Schlager, Fusco & Schank, 2002). This minimal intervention may be conceived as maintaining an online network characterised by weak links between semi-autonomous agents and their local professional collectives, a central characteristic for maintaining a learning dynamic within a scale free network (Csermely, 2006).[8] One consequence of this strategy has been the development of a nested structure within the Tapped-In site, a network dynamic best illustrated through an example of professional development from the Tapped-In site.

Schlager, Fusco and Schank (2002) report on a Tapped-In professional development initiative for supporting inquiry teaching in science. School-based teams of teachers undertook face-to-face professional development before returning to their local contexts to trial the approach in their own classrooms. In order to support this learning, and sustain the professional development initiative, online real-time meetings were then conducted in the Tapped-In environment. At least one member from each of the 14 teams was asked to participate in these online events, as a means of sharing their local progress, including any obstacles or questions that had arisen.

Schlager and Fusco's research provides a clear example of a professional network that incorporates the nested structure characteristic of complex learning systems (as discussed in 1.1.1). The 14 school-based groups (or local cells) were networked into a larger professional development group. This distributed professional network was itself nested within the wider Tapped-In environment. As in the Shell communities of practice, this nested structure offers the potential for learning, not only at the level of the individual teacher, but also at various collective levels. For instance, there was the potential for the

[8] The benefit of learner autonomy within web-based networks has been recognised elsewhere. For example, in discussing the successful Maths Forum network, Renninger & Shumar (2002, p. 62-63) assert that the provision of autonomy supports participants to align their intellectual and emotional needs as learners, with the appropriate resources and dialogue in The Maths Forum, maximising the affordances of the site's interactivity and multiple pathways for engagement and dialogue.

distributed group of teachers to develop a shared set of understandings through the project.

Schlager, Fusco and Schank (2002) sought to understand how the teachers' discourse evolved within, and was supported by, the online Tapped-In environment. To achieve this aim, they coded teachers' discourse into four categories: Business focus, meeting management, technology related and social. The researchers report on the success of the online environment for supporting online events, which they describe as becoming increasingly 'productive'. Their findings highlight the potential of online environments such as Tapped-In for real-time networking. Yet, in serving to understand teacher learning, and the manner it may have progressed at a collective level either locally or globally, such research may have less utility.

For instance, in the Tapped-In research, it is difficult to appreciate how the online network may have influenced the learning of local (that is, school-based) professional development groups, and subsequently, individual teachers. Furthermore, the manner in which shared understandings may have developed within the distributed collective also remains unknown. This appears to be a common deficit in the research reports of projects such as Tapped In.

According to Dede et al's (2005) review, the strong sociocultural orientation regarding teacher learning in this field has resulted in research being predominantly focused on understanding the interactions that take place between individuals, groups, and their technological environments.[9] Researchers have typically sought to understand how best to support the types of interactions that are believed to support teacher learning (for instance, through environmental design, task design and community-building).

Dede et al (2005) conclude that this has resulted in a knowledge base about online professional development that is rich in understanding about online interaction and design,

[9] Dede et al's (2006, p.48) review of research into online professional development found that only 7% of research methods focused on 'desired educational improvements' such as teacher change or student learning. In contrast, 39% of the studies focused on research methods often with the goal of "… creating better understanding [of] design, pedagogy and other factors …"

but still fairly poor in regards to our understanding of teacher learning and the manner in which student learning may be affected by this change. This summation reflects the findings of previous reviews of this field, spanning the last decade (Havelock, 2004; Zhao & Rop, 2001).

Thus, whilst research designs and their theoretical orientations may suggest the possibility of professional learning occurring in nested learning systems, typically research has failed to capture teacher learning, as it may have occurred within the various nested levels of such initiatives. More recently, modeling the nested structure of distributed communities of practice has become central to conceiving them as dynamic learning systems (Snyder & Wenger, 2004; Wenger, 2004). Nevertheless, this remains an agenda for future empirical research.

In the case of Tapped In, whilst Schlager, Fusco and Schank's (2002) research and e-learning design contributes strongly to the field's understanding regarding the potential of online environments for professional networking, there is a sense that the strength of the project for individual and collective professional learning may have remained unreported. This is despite the researchers' assertion of the networks potential in this respect. Schlager, Fusco and Schank (2002 p. 154) write:

> *…building the capacity to leverage the combined power of (a) policy initiatives now driving reform in many states, (b) schoolbased teacher networks, and (c) innovative content-based TPD [teacher professional development] projects requires building both human and technological infrastructures system wide to support sharing of information, communication, and collaboration across multiple stakeholder groups (e.g., policy-makers, TPD providers, and local teacher collaboratives)—in essence, a systemic education CoP.*

This vision alludes to the possibility of learning occurring at the level of the individual teacher, the school-based group, an online group, an overarching networked environment and the wider education system: that is, within a *nested* systemic education community of practice. Nevertheless, whilst the Tapped-In environment appears to represent an important technological and pragmatic enactment of this vision, research on web-based networks has yet to demonstrate how this learning may occur across these levels.

Furthermore, recent analysis of the decentralised Tapped-In strategy has prompted researchers to question the notion of Tapped-In as a single community of practice (Schlager & Fusco, 2004). The low levels of centralised intervention, combined with the diversity of the user population, have resulted in the Tapped-In environment supporting a range of diverse educational practices (Schlager & Fusco, 2004). The site has therefore been conceived, not as a community of practice, but as a *network of practice* (after Brown & Duguid, 2000).[10]

In response to this shift, a strategy of supporting *existing* professional networks has been recommended as a means of overcoming tensions between local cultures and imposed network strategies (Parr & Ward, 2006). Yet it is likely that existing professional networks will have well-established 'mini-cultures' (Wenger, McDermott & Snyder, 2002) including collective norms, understandings and values. The challenge remains then, how best to establish web-based networks that can drive *transformational* educational reform and professionalisation. According to Hargreaves (in Bentley, 2003) this amounts to a challenge for educators in particular but not exclusively, to overcome the fragmentation of knowledge that currently exists within education. He asks:

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[10] In keeping with this shift, Schlager and Fusco (2004) note that Tapped-In may be more appropriate for supporting *existing* communities in education: that is, professional networks or collectives that may operate as part of a nested *activity system* (after Engestrom, 1987). Schlager and Fusco (2004) describe this shift as putting the horse back in front of the cart within community-based strategies for teacher professional development. This perspective reflects an increasingly common view amongst researchers in the field (for example, Barab, MaKinster & Scheckler, 2004). Schlager & Fusco (2004) use the concept of an activity system (after Engestrom, 1987) to model the manner in which nested professional development initiatives may contribute to the wider educational system via communities of practice. The activity framework seeks to model how the various dimensions of a *complex system* influence the activity and learning that emerges, as a gestalt of the entire system. These dimensions include the subjects (which can include individuals and groups), their tools (eg. technological environments), objectives (such as a professional learning goal), rules (including norms in a community of practice) and divisions of labour (Engestrom, 1987). Whilst this theoretical perspective has yet to be tested empirically in the Tapped-In environment, it seeks to move the field closer towards an understanding of how nested professional development initiatives may contribute to learning and progression at a wider collective level in education.

Is it possible to conceive, deliver and legitimate large-scale programmes of change, reflecting collective goals, in societies where ideological prescription is weak and fuzzy and institutions seem beset by diversity, complexity and fragmentation?

Hargreaves asserts that distributed innovation networks, as dynamic and nested learning systems, have the potential to achieve this aim. This amounts to a vision of a single, but diverse and heterogenous learning system stretching across the many local sites where professional practice and learning are situated.[11]

The Tapped-In initiative provides then, an illustrative case study of the potential of web-based networks to support professional learning at nested, and thus, collective levels. The combination of face-to-face and web-based professional development expands this potential, by supporting collective learning both in local and distributed contexts. Nevertheless, it remains unclear how individual and collective learning at one level of a decentralised and self-organising network may contribute to collective learning in other levels: a genuine concern for enacting contemporary visions of teacher professionalisation. In this regard, technological systems may offer strategic and even conceptual support.

The following case study, the second dealing with distributed networks for professional development, illustrates an educational recommender system. As detailed in 1.1.1, the collective intelligence of diverse, heterogeneous populations outside education has been distilled through network technology (for example, the recommender systems of Amazon.com.) In education, similar systems are being tested for their ability to distil the collective intelligence of distributed populations of educators. Such initiatives may have the potential to reshape conceptions of collective learning in education, as they have in other parts of society.

[11] This parallels challenges in science and technology, where decentralised professional collectives must remain aligned with a wider collective. For example Broers (2005) noted of the nested collectivity in the contemporary fields of technology, whilst individuals and small groups may be responsible for creative innovation "…their ideas must fit into the matrix of creativity being generated by individuals and teams all over the world."

National Schools Network (NSN): (Ravitz & Hoadley, 2005)

In response to a need to identify quality resources on the Internet, the National Schools Network (NSN) project in the US sought to develop a large-scale distributed peer reviewing system focusing on educational Internet sites (Ravitz & Hoadley, 2005). The goal of this initiative was to leverage teacher knowledge for the wider profession, whilst seeking to use the reviewing process as the basis of professional development.

To achieve this aim, NSN utilised a recommender system, similar to Amazon.com as a means of distilling the collective intelligence of their distributed population of educators (Surowiecki, 2004). Through this system of rating, reviewing and evaluation, educators developed a decentralised and dynamic knowledge base concerning the educational value of Internet sites.

However, in contrast to the more common rating systems that produce user-generated metadata, the NSN reviewing process was undertaken as part of professional development initiatives and courses. This provided a supportive educational or learning context for the reviewing activity. The integration of rating with professional learning represents an important distinction between this learning-focused example and examples such as Amazon.com. Ravitz and Hoadley (2005) describe the integration of reviewing and teacher professional development as a 'catalysing mechanism' for generating a powerful knowledge base for all educators.[12]

Ravitz and Hoadley (2005) conceive progression, or learning, occurring simultaneously at two levels within the NSN network. At one level, individual teachers may learn from the

[12] Ravitz & Hoadley's (2005) notion of the generative capability of professional development *groups* for progressing the knowledge base of education extends the earlier conception of collective intelligence as distilled through *independent* ratings. Research on small groups has suggested that the collective intelligence of a population may be lessened as individuals diminish their 'independence' through communication (Surowiecki, 2004). This represents a potential point of tension for integrating recommender systems with group-based professional learning. Yet it also presents the possibility of the shared understandings of informed professional development *collectives* becoming the basis for ratings. This mechanism contrasts with Amazon.com, where the generative capability of collectives is not utilised.

process of reviewing educational sites. That is, the act of contributing to the knowledge base becomes a fundamental dimension of the teacher's own 'generative' learning process. They note:

> *The resulting evaluation and discussion [of educational resources] are noted as a strategy for generative learning (Allert, Richter & Nejdl, 2004). Applying a set of criteria may slow down a teacher initially as she reviews web resources, but there are likely benefits in the added thinking that is required…" (Ravitz & Hoadley, 2005, p. 965).*

At a second level, the knowledge base of the education profession expands and learns as increasing numbers of reviews are undertaken (Ravitz & Hoadley, 2005). Thus, as learners generate their own ideas, the wider system generates an increasingly sophisticated knowledge base. According to Ravitz & Hoadley (2005, p. 965), the quality of this knowledge base is regulated by the process of aggregation of peer reviews with "the results of multiple reviews [offering] a better indication of resource quality than a single review." The NSN distributed network can therefore be conceived as a learning system, self-organising on the basis of the learning and knowledge of multiple semi-autonomous professionals and collectives (that is, professional development groups.)

Teacher participants involved in the NSN initiative found the process beneficial as a professional development activity (Ravitz & Hoadley, 2005). Furthermore, beyond individual teacher professional development, the resulting evaluations were found to be useful for developing a collection of web-reviewed internet resources. This knowledge base provided a means of receiving feedback on the quality of educational websites, and as a tool for researchers and developers (Ravitz & Hoadley, 2005).

Extrapolating from these findings, Ravitz and Hoadley (2005) discuss the potential of the strategy as a decentralised network for professional knowledge, thus highlighting the political dimensions of the strategy. They write:

> *To a considerable extent, movement towards collaborative knowledge building among educational stakeholders requires a shift in culture and perspective...schooling often fails to emphasise how learners contribute to the community...However, co-construction is essential to group and organisational learning, and for the advancement of scholarship and the open source development model….The shift that has to occur is this: instead of only being accountable to the learning of individual educators who might use these resources, teachers and teacher educators should be enabled and encouraged to contribute to the larger enterprise....” (Ravitz & Hoadley, 2005, p. 967)*

This philosophical vision is being reflected in new technologies that aim to serve as a basis for enacting dynamic, systemic knowledge building. For example, Hiebert, Gallimore and Stigler (2002) advocate the development of a knowledge base for teachers that incorporates a dynamic mechanism for verification and improvement. This focus on cumulative professional knowledge that is both public and storable is evident in the development of these researchers’ Lessonlab software, an e-learning mediated professional development system that builds a database of video cases and associated material.

Similarly, Baraniuk (2006) has established a web-based network for supporting the distribution and peer-evaluation of educational resources that are contributed by its network population, most particularly, teachers. Such initiatives utilise open-source models of innovation for supporting professional learning and practice. The increasing propensity of such models, in both education and other fields, has situated users (in this case, teachers) as central to innovation (Leadbeater, 2007).

Such technology may support, whether deliberately or not, an expanded conception of professional development that is “…both personal and professional, both individual and collective, both inquiry-based and technical” (Lieberman, 1995). However, in order to harness and utilise the knowledge of teachers for collective and systemic purposes, there seems a need to understand more fully how such knowledge is being generated in these novel online contexts. In this regard, Butler, Lauscher, Jarvis-Selinger, and Beckingham

(2004, p. 436) emphasise the need to align learning theory with the nested and distributed nature of contemporary professional learning, stating:

> *…although there is a clear movement towards collaborative professional development, there exists disagreement about how to characterize the learning spurred in collaborative contexts. Conceptions range from psychological, ''in-the-head'' models… to situated or distributed models… In the face of these conflicting descriptions, what is clearly required is an analytic theory of learning that encompasses the social and the individual without oversimplifying the contribution of either, and that explains individual and collective development in the context of learning communities.*

Conceptions of collective intelligence within distributed professional populations provide one means of associating empirical accounts of networked collectivity with theoretical conceptions of *adaptive learning systems*. Furthermore, this strategy may have pragmatic strengths for systemic learning in education.

The NSN initiative described in this case study demonstrates that web-based networks can distil the collective intelligence of distributed populations. Furthermore, the NSN network illustrates that the knowledge generated from this front line of practitioners may be conceived as the generative product of a group or collective. This distinction demarcates the educational dimension of such a strategy as group-based professional development (in contrast to networks such as Amazon.com.) Accordingly, orienting analysis towards the locus of professional learning in such networked contexts may necessitate a focus on collective learning within the small group (Stahl, 2006).

In this regard, researchers, teacher educators and developers have sought to establish collaborative networks and distributed communities as a means of enculturing a population or collective, with a *specific* educational practice or orientation. This may be contrasted to initiatives such as the NSN network and Tapped-In that have adopted a more generic, pragmatic strategy. In the following section, two case-studies illustrate this more interventionist strategy for collaborative teacher professional development.

1.2.2 Inquiry-based Networks for Collaborative Professional Development

Dede et al's (2005) review of online professional development describes a range of initiatives that have sought to foster "teachers' abilities to use Inquiry-Based, constructivist pedagogies with students."[13] In many cases, collaborative networks have been established in order to allow teachers to experience inquiry learning in a manner that parallels, to some extent, the collaborative knowledge-building of professionals in science (Shulman, 1999; Harlen & Doubler, 2004, Loucks-Horsley et al, 2003).[14] These collaborative networks appear to be synergistic with the web-based *collaboratories* now common within science and technology (Kling & Courtright, 2004).

TryScience: Harlen and Doubler (2004)

As part of a Masters course entitled TryScience, Harlen and Doubler (2004) utilised an online network of educators, scientists and teacher educators in an effort to enculture teachers as inquiry-based scientists. The online strategy sought to address many dimensions of the science community, including its epistemology, practices, values, language and knowledge. In this regard, Harlen & Doubler (2004, p. 90) emphasise the strong collective learning dimension of the approach being tested through TryScience:

> *Science is also a social endeavour. Theories do not depend solely on one person's investigations, but on multiple investigations by many individuals over time. Ideas are revisited, modified, and extended by the science community…[science is] public*

[13] Within Dede et al's (2005) comprehensive review, the term 'constructivist' is used in a broad sense to assist with the task of grouping research for the review. Whilst this broad categorisation serves a pragmatic function within such a large review, it should be noted that some research under this category might have utilised other learning theory with different assumptions and understandings to constructivist theory (for example, Schaverien, 2003).

[14] The strategy builds on previous face-to-face professional development that has successfully established inquiry communities. For example, Palincsar, Magnusson, Marano, Ford and Brown (1998) established a face-to-face inquiry community of teachers that sought to incorporate the cultural and epistemological orientations of the scientific community. Participants, as a collective, began to "co-construct" or "generate tenets or principles" related to the shared, inquiry orientation to science education. For instance, the teachers collectively argued the importance of supporting students' conceptual understandings through carefully designed recursive investigations.

knowledge, as the collective understanding that results from everyone's experiments. Could this be mirrored in the online environment?

Teacher participants were therefore afforded the opportunity to engage with the ideas, strategies, explanations and perspectives of others in the group, in order to "negotiate their collective results" (Harlen & Doubler, 2004, p. 91).

Researchers of TryScience found that the online context supported teachers in gaining confidence for using inquiry approaches for science education (Harlen & Doubler, 2004). Furthermore, the online TryScience context was found to be particularly conducive to teacher reflection, which, in turn, produced strong educational outcomes.[15]

Yet whilst Harlen and Doubler (2004) acknowledge the centrality of collective knowledge building to their inquiry-based strategy, they do not appear to analyse how the teachers, and the group as a whole, progressed their collective understandings. Understanding this collective learning dynamic within the TryScience population (that is, across the entire population of teachers, teacher educators and scientists) may be particularly useful in gaining an insight into the manner in which the various sub-populations, such as teachers, teacher educators and scientists, negotiated each other's knowledge.

This is a concern that has pragmatic, theoretical and political dimensions. For instance, Harlen and Doubler's (2004) successful strategy utilised high levels of structure and intervention to guide teachers through the inquiry process. Yet without an analysis of the manner in which the teacher collective (and its individuals) negotiated this intervention as semi-autonomous learners and professionals, it is difficult to discern how the affordances of a nested, self-organising (and thus participatory) network may have contributed to this successful outcome.

[15] Whilst not yet confirmed by research, the parallels between the TryScience strategy and authentic web-based collaborations in science and technology may have enhanced these professional learning outcomes, providing teachers with an experience of the epistemological basis of much knowledge in these fields.

The TryScience case-study provides a promising network strategy for teacher learning in science education, using a heterogeneous group of professionals. Yet the research also raises questions about the nature of collective learning within such an initiative. If teachers are seeking to claim greater autonomy in their professional learning, including a greater propensity to contribute as knowledge workers, it seems wise for research findings to illustrate the nature of the intellectual interactions in these professional development collaborations. In other words, more needs to be known about how collective knowledge building occurs within these particular open systems (Gibbons, 1999), as discussed in 1.1.3. For instance, through the intellectual negotiations underpinning TryScience, teachers as educational professionals may have contributed to the knowledge of teacher educators and other professionals (for example, scientists). Yet due to Harlen and Doubler's quite legitimate focus on individual teacher learning, this remains unknown.

In contrast, other researchers have attempted to focus on understanding the network itself as an emergent, self-organising entity, underpinned by collaborative knowledge building. Their strategies echo knowledge-building communities in science and technology, including the manner in which these communities develop a collective knowledge base that represents a common ground for future knowledge building. The following case-study, again an inquiry-based initiative, illustrates such a strategy.

<u>Inquiry Learning Forum (ILF): (Barab, Mackinster & Scheckler, 2003) (Kling & Courtright, 2003)</u>

The Inquiry Learning Forum (ILF) is an online professional development context in which in-service teachers (and pre-service teachers) can view a suite of videos of other teachers engaging in inquiry-based learning. Community participants then have the opportunity to discuss these videos, and exchange ideas and understandings within a number of asynchronous online forums. The ILF thus combines online social networks with a web-based ecology of shared artefacts.[16]

[16] The use of shared web-based artifacts for establishing common ground in a population, is typical of many online network strategies for professional learning. For example, in discussing WISE, an online site for

As with Tapped-In, the ILF's design seeks to leverage the self-organizing, semi-autonomous nature of networked communities of practice (Barab, MaKinster, Moore, Cunningham, The ILF design team, 2001; Kling & Courtright, 2003). For instance, Barab, Mackinster and Scheckler (2003, p. 238) assert:

> *Much like a living organism, [communities of practice] are self-organizing, and cannot be designed prima facie. They grow, evolve, and change dynamically, transcending any particular member and outliving any particular task.*

Utilising this ecological network orientation, ILF researcher/designers sought to establish a decentralised, self-organising approach to professional development characterised by low levels of moderator intervention.[17]

ILF online moderators and designers therefore resisted defining what 'inquiry' education referred to (Barab, Mackinster & Scheckler, 2003). Furthermore, in contrast to the TryScience intervention, ILF moderators declined to prescribe what participants should be doing or discussing in the online forums (Kling & Courtright, 2003). Learners could individually, and collaboratively, develop their own conceptions of inquiry by engaging with the videos of classroom practice, all of which were designated as examples of this approach to science education. Thus, through collaborative yet autonomous, learner-centred inquiry, it was assumed, teachers would develop insights into inquiry-based learning and thus, inquiry-based education.

Kling & Courtright's (2003) analysis of the ILF focuses on the socio-technical nature of the site in order to assess how the ILF's design and operation affected participation and engagement. They report on the low participation rates of in-service teachers in the ILF.

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student and teacher learning, Cuthbert, Clark and Linn (2002, p. 216) state that learning communities are "…supporting networks of personal relationships that enable the exchange of resources and the development of a common framework for analysis of these resources. Members of the community jointly analyze resources and develop a common set of criteria for evaluating those resources."

[17] Whilst the ILF moderator strategy deliberately sought to allow participants to drive their own learning and inquiry, overall the ILF represents a more interventionist strategy than Tapped-In, due to its explicit focus on a particular practice (Dede et al, 2005).

Furthermore, whilst they provide some examples of 'supportive posts' and 'requests for information', Kling and Courtright describe the low level of critical engagement with the ideas and concerns of other members, including those teachers who had shared videos of their classroom practice.[18] In response to these findings, Kling and Courtright (2003, p. 231) question the self-organising rationale behind the ILF strategy, stating:

> *…we suspect that the development of CoPs [communities of practice] could require a much more interventionist strategy in which moderators try to encourage participants to get to know each other (for example, by posting some personal information as well as professional information in their online bios) and help to focus and deepen the online discussions.*

They note, however, that a more interventionist approach is likely to require even higher levels of social capital given that participants would be committed to higher levels of contribution. Furthermore, Kling and Courtright's recommendations for increased moderator intervention seem complicated by other findings in the ILF.

Barab, MaKinster & Scheckler (2003) report that emergent topics instigated by teacher participants within the ILF generated more dialogue than those instigated by moderators. This suggests teacher driven dialogue may have been more meaningful for the teacher population than topics generated by researcher/designers. Barab, MaKinster and Scheckler (2003) provide some explanation of these findings by describing an apparent divide between the 'local' needs of teachers and the 'global' agenda of the researchers and teacher educators (Barab, MaKinster & Scheckler, 2004).[19] Whilst time-stretched teachers generally seek activities and curricular resources in order to meet short-term teaching requirements (Gomez, Fishman, and Pea, 1998), the professional development underpinning the ILF sought transformative teacher change that required extended

[18] The challenge of sustaining intellectually rich collaborative dialogue within online professional development contexts has become increasingly well documented (for example, Suthers, Harada, Doane,Yukawa, Harris, & Lid, 2004; Parr & Ward, 2006).

[19] As noted previously in 1.1.2, these local and global dimensions are not conceived as separate domains, but instead are "… related levels of participation that always co-exist and shape each other" (Wenger, 1998, p. 131).

engagement and effort (Barab, MaKinster & Scheckler, 2003). This tension is well documented within science professional development in general (for example, Appleton, 2003).

Barab, MaKinster and Scheckler (2003) conclude that future efforts at developing online professional development should more adequately 'ground' systemic reform in the realities of the educational systems in which teachers practice, by affording teachers more ownership of the project, including a larger stake in the design of the environment (a finding supported by more recent research, Konings, Brand-Gruwel, van Merrienboer, 2007). They suggest this may more adequately address the teachers' own learning agendas: in part through "…an ongoing collaboration among designers, educators, and users" (Barab, MaKinster & Scheckler, 2003, p. 253).

These recommendations suggest that if networked and participatory professional learning is to be conceived as occurring in collaborative open systems (Gibbons, 1999), then teachers should be involved in designing these systems. The challenge remains however, to establish appropriate models of professional development that can recognise the self-organising, collaborative nature of professional learning (for example, the ILF model), whilst also addressing the systemic need to 'enculture' educators into the practice of, for example, inquiry-based learning and education (for example, the TryScience model). On the one hand, teacher collectives may be recognised as localized, generative knowledge builders and designers (that is, teacher educators in their own right), whilst on the other hand, the wider collective agenda of systemic reform seeks to effect collective, cultural change, the latter often characterised by a more prescriptive approach.[20]

Rather than addressing the local and global dimensions of collective professional learning in isolation, recognition of the nested quality of networked systems provides a means of

[20] In this regard, Loucks-Horsley et al (2003, p. 337) note that "the reform of … science education rests on a commitment to change the kind of teaching and learning that is currently the norm in our nation's classrooms." This emphasises the collective dimension of learning underpinning systemic reform in education. In science education reform, practising teachers have traditionally been involved to some extent in the development of innovation and curriculum (Anderson & Mitchener, 1994). In the majority of cases, however this input has amounted to testing and refining innovations that were developed centrally (Van Driel, Beijaard and Verloop, 2001).

viewing both as part of a single learning system (Holling, 2001). This may parallel, to some extent, knowledge building in science and technology, where local collective learning contributes to global knowledge, whilst global paradigms, technologies and agendas shape local efforts (for example, the collective SARS investigation detailed in Section 1.1.3) It may also address Hargreaves' (in Bentley, 2003) concern for overcoming the fragmentation of knowledge that currently exists in education systems. Importantly, this shift may be conceptual, rather than simply strategic.

Recognition of professional learning within nested learning systems allows systemic change itself to be viewed from a theoretical learning perspective (Papert, 2000). For instance, Cavallo (2004) and fellow MIT researchers have utilised ecological models for both design and analysis of systemic professional learning, in order to leverage emergent, self-organising professional learning at various nested levels. Regarding this strategy, Cavallo (2004, p.97) states:

> *We look to ecological and evolutionary models of change for ideas about how new educational patterns will emerge and how we can actively contribute to them… We study the fitness functions, the social niches, and the local ecologies of culture and thought. We study change itself as a process of learning…We bring in powerful ideas about learning and through our practice illustrate how to put them to work. The possibility for spread and growth is not through the exact replication of the actions since the context will be different and the culture is dynamic. Rather, the goal is for the appropriation of the principles and the development of models of thinking so that the agents can adapt and apply with the ability to continually develop through reflection on the feedback and changing environmental conditions.*

Ecological models, and the wider theoretical base of complexity thinking, provide a means of blurring the boundaries between, on the one hand, the design, intervention, and knowledge of teacher educators (and researchers), and on the other hand, the design, intervention and knowledge of the teaching population. In doing so, such theoretical orientations may more adequately recognise, interpret and explain collective learning, as it exists across a heterogeneous population and throughout a nested ecological context.

There is, however, a paucity of empirical accounts of network-based professional learning that utilise ecological and complexity orientations for this purpose. Establishing such accounts may contribute to the field's understanding of enacting networked participatory professional learning and educational reform (as discussed in 1.1) by foregrounding the ecological associations that may exist between local and global dimensions of professional development and learning. Such accounts may also serve an ethical and political purpose by more adequately reporting how knowledge was negotiated within novel collaborative forums for knowledge building.

The following section examines a case study that explores the potential of this orientation in more detail.

1.2.3 Collaborative Knowledge Building: establishing shared knowledge networks

The following case study from literature education illustrates how complexity and ecological forms of analysis may help recognise and interpret collective knowledge building within teacher professional development.

The Valley View Research Group: (Davis & Sumara, 2006)

Davis and Sumara (2006) use complexity thinking to interpret the collective dynamic increasingly evident in a school-based literature group consisting of researchers, teachers and parents. As the group engaged with its literature topic, significant changes occurred in the relationships and communications between members, to the extent that "…identity categories as "university researcher," "classroom teacher," and "parent" began to dissolve, allowing a community dedicated to collective sense-making to emerge" (Davis & Sumara, 2006, p. 87). The researchers note that the group's shared concern for education facilitated the emergence of a collective identity, an indicator that the group had become a learning *entity* (or agent) in its own right.[21]

Davis and Sumara (2006) use complexity thinking to interpret the group's knowledge as a nested, collective phenomenon: thus complementing the more typical analytical focus on social dynamics and patterns of interaction within research on collaborative teacher learning (Dede et al, 2005).[22] For example, the literature group's shared understandings and conclusions are interpreted as an *emergent* product of the collective rather than the result of any individual's contributions.[23] Davis and Sumara (2006, p. 98-99) write:

> *…it became clear that individual responses to passages were entangled in readers' conversations with one another, with their previous experiences in different settings, and with their students or children. Collected within the responses, then, were not only the markers of reading, but the traces of co-evolving identities and representations of complex, co-emergent patterns of thinking and responding.*

Furthermore, they distinguish these entangled knowledge webs from the social, community-based or organisational systems that produced them. In doing so, their analysis makes explicit a further level of nestedness that may exist within complex human learning systems: that of a particular domain's knowledge network, or 'structural complexity' (Davis & Sumara, 2006, p. 97). This represents a further level of collective learning,

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[21] The manner in which individual agents aggregate into *single entities* (or collective agents) has been theorised in numerous ways. For example, the 'coupling' of individual agents and systems to form increasingly (organizationally) complex systems, is recognised both in biology (Mayr, 1988) and dynamic systems theory (Waldrop, 1992). Maturana and Varela (1987, p. 193) contend that social collectives arise through 'structural coupling' as a function of maintaining or regulating autopoiesis (that is, their living organisation.) Benzon claims to "...treat the human group as a collection of coupled oscillators....Once a group has become coupled in oscillation, we can treat the group as a single entity" (cited in Rheingold, 2002, p. 178). Collective intentionality, or we-intentionality (after Searle, 1995) is commonly conceived as a fundamental basis for such social collectivity (Tomasello, Carpenter, Call, Behne, & Moll, 2005; Plotkin, 2003).

[22] The need for this shift has been recognised within the literature on online professional development. For example, Eraut (2002) advocates moving beyond overly 'social' units of analysis for understanding the learning that takes place within a teacher learning collective.

[23] Stahl (2006, p. 236) describes a similar collective process of knowledge building within a group of middle-school students where "meaning was a shared, collaborative, interactive achievement. It was an ephemeral, rapidly evolving group perspective."

existing as established and (in some cases) negotiated disciplinary knowledge, and reified within curricula.

The explicit recognition of knowledge networks as a dimension of collective professional learning, may distinguish this analytical approach from collective inquiry-based approaches that maintain an individualistic analysis of learning, or fail to analyse the emergence of knowledge networks as a collective phenomenon. Davis and Sumara (2006, p. 97-98) note that, in education, there exists:

> *…the conventional habit of defining, say, physics in terms of "what physicists study"- and, by correspondence, structuring physics classes around the sorts of things that physicists are imagined to do in their laboratories….[these 'driving definitions' do a] disservice to those interested in questions of education because they deflect attentions away from the particular structural complexities of a given domain- complexities that might inform if not enable efforts to teach if they were better understood.*

This concern may be of particular relevance to professional development in Science and Technology where unique challenges exist for supporting conceptual shifts in both students and teachers (for example, within our local research group and its pioneering antecedents, Osborne & Freyberg, 1985; Osborne & Cosgrove, 1983; Cosgrove, 1995).

For instance, contemporary approaches to inquiry-based science education emphasise the need to address the deep ideas underpinning science topics (Rennie, Goodrum & Hackling, 2001). Yet such teaching places complex demands on primary teachers who often lack adequate scientific understandings themselves (Rennie, Goodrum & Hackling, 2001; Smith & Neale, 1989). In order to acknowledge a student's existing views as a basis for conceptual development, primary teachers must be able to translate and interpret ideas during teaching, including understanding students' existing conceptions (Shulman, 1986; Appleton, 2003: Loucks-Horsley et al, 2003).

For teacher educators, this presents the challenging task of establishing professional development contexts that address the complexities of a domain's knowledge networks (in essence, the cultural heritage of that knowledge domain) whilst also ensuring that this knowledge is appropriately negotiated by professional collectives and their individuals, based on both individual and emergent understandings. In a pragmatic sense, this translates as a need to dynamically link the experience and knowledge of individual practitioners with collectively legitimated knowledge and evidence-based practice in school-based communities, district populations and beyond (Little, 2007; van Driel, Berijaard, Verloop, 2001).[24]

Networked knowledge building environments (after Scardamalia & Bereiter, 2003) may offer one means of achieving this aim given their focus on the continual collective refinement of knowledge. Yet, whilst these networked learning environments have been shown to support professional learning (for example, Renninger & Shumar, 2002) there are few descriptive accounts of the *emergence* of collective, self-organising understandings within such environments, or elsewhere in the educational literature (Davis & Sumara, 2006, p. 82). This apparent blind spot within the literature on networked professional learning means that claims of negotiated, professional knowledge building may be difficult to validate, given that, for instance, political constraints may be black-boxed in research accounts.

As Scardamalia and Bereiter (1994) note, the construction of collective knowledge is an inherently political endeavour (Latour & Woolgar, 1987; Latour, 2004). As such,

[24] Several educational researchers (for example, Little, 2007, Loucks-Horsley et al, 2003; McLaughlin & Talbert, 2001) indicate this aim is most effectively achieved in professional learning communities that incorporate, for instance, collective intentions, established patterns of interaction and shared intellectual principles. Describing one such community, Little (2007, p. 231) notes that teachers "…framing ideas and principles, together with the conversational routines and participation structures that the teachers employed, established in the Algebra Group what Horn (2004) calls a conceptual infrastructure that in turn enabled them to exploit classroom accounts of experience for purposes of professional learning and instructional decision making. The teachers' collective capacity for noticing, interpreting, and working on problems of practice, and for linking those problems to a broader set of learning goals and teaching principles, thus owed a large debt to the group's embrace of a broader set of goals, ideas, and commitments, the quality and continuity of its internal leadership, the particular routines by which they conducted their work together, and the kind of external ties the teachers maintained with reform-oriented mathematics networks, groups, and individual teachers."

maintaining an explicit and democratic epistemological basis for collective knowledge building (after Latour, 2004) may be seminal within professional development that aims to support learning at a range of nested levels, including the individual, the collective and the wider education system (Bentley, 2003). For researchers and teacher educators, this may entail attending to the evidential basis of professional dialogue and knowledge building within collective learning endeavours (Little, 2007, Nemirovsky and Galvis, 2004).[25]

In this respect, complexity accounts such as that of Davis and Sumara (2006) may serve to succinctly represent the ecological manner in which knowledge and learning *emerges* from a complex array of factors and associations within a collaborative professional learning environment (Clarke & Collins, 2007; Zellermayer & Margolin, 2005). Moreover, where these complex relationships can be made explicit, research accounts of collective learning may more adequately represent avenues of opportunity and constraint existing within these professional learning environments, or learning ecologies (Stahl, 2006). Looi (2001, p. 14) summarises the research potential for studying "learning ecologies":

> *Associations can be made between the ways that life forms coexist and coevolve in a biological ecology and the ways learning happens in the learning environment. In the biological ecology, life forms exist at different levels of organisational complexity. It is possible to study relationships between organisms and habitats of different sizes, from microscopic bacteria to the complex interactions between the myriad of species of plants, animals and other life forms found in a desert.*

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[25] Little (2002, emphasise in original) recognises this challenge in stating, "The contemporary policy press toward evidence-based decision making invites collective deliberations at the school and district levels in which educators examine and interpret aggregate data on student achievement and attainment or other kinds of evidence of student learning. As particular patterns compel attention, it seems likely that teachers and others will make assumptions and construct arguments about the origins of those patterns and about promising courses of action. Furthermore, it seems likely that they will animate those patterns and arguments with a human face and voice ("kids like that") and evaluate proposals for action by invoking the lessons of experience. That is, teachers will employ various stories and artifacts of their own professional experience as an interpretive filter in responding to other kinds of aggregate evidence. At issue is *whether* and *how* accounts of experience, and the representations of teaching and learning they encompass, further or impede the aims of evidence-based decision making."

> *Similarly, learning happens at a rich diversity of levels in the learning environment and can be seen from different perspectives. At the individual level, learning happens at the cognitive level. At the group level when the individual learns with peers, interactions take place at the species level as group, peer or social learning interactions. When different species or populations coexist, there is a thriving community. Different communities form a learning ecosystem in which there is interaction within and between each level giving ecosystems complex behaviour… An ecological perspective emphasises the relationships and dynamics between the various participants in the classroom or other learning situation.*

Looi (2001) emphasises that a *learning ecology* approach to research may contribute strongly to the field of educational research by capturing the complexity of ecological associations that exist across nested levels of learning, including collective and population levels. This learning ecology approach may be further supported by a growing body of work that has sought to establish the necessary, yet insufficient conditions for *occasioning* complex phenomena in educational contexts (Davis & Sumara, 2005, 2006).

Davis and Sumara (2005, p. 457) suggest that educational researchers seeking to establish and promote complex learning systems and emergent phenomena should ensure their research contexts include "…considerable redundancy among agents (to enable interactivity), some level of diversity (to enable novel responses), a means by which agents can affect one another and a distributed, decentralized control structure". By harnessing complexity sensibilities, such recommendations provide a pragmatic basis for designing educational research that hedges the likelihood of complex co-emergence, and thus collective learning, occurring.

So, in summary, many of the network strategies cited here in 1.2 successfully supported professional learning at various levels, including collective levels. Furthermore, they achieved these positive learning outcomes in a manner that harnessed the knowledge, learning, and subsequent contributions of teachers, thus paralleling to some extent the decentralised, participatory models of innovation and contribution discussed in 1.1. In this regards, findings appear to support the potential of web-based networks for enacting participatory professional learning and educational reform through the creation of nested small world organisations (Bentley, 2003).

Yet, in cases where novel professional development initiatives (and their technological learning environments) are based on participatory knowledge-building principles, it was considered both theoretically and ethically appropriate for research accounts to discern, analyse and report the ecological associations that are likely to exist between individual and collective dimensions of learning. In many of the studies cited above, addressing this challenge involved more adequately engaging with the nested quality of networked systems. This was achieved through novel methodology (for example, ecological methods, Cavallo, 2004), understandings of learning (for example, complexity thinking, Davis & Sumara, 2006) and technological strategies for establishing small world networks for collective knowledge building (for example, Tapped-In, NSN, ILF). These strategies appear to provide a fertile means of discerning, analysing and supporting both local and global dimensions of professional learning as part of a single learning system (Holling, 2001).

In many cases however, research accounts of novel networked environments for collaborative knowledge building did not represent in sufficient detail how the “structural complexities” (Davis & Sumara, 2006, p. 97) of content were negotiated between teachers and, for example, teacher educators and academics. This may have ethical implications, given the difficulty of discerning from such accounts the manner in which locally-situated knowledge of teachers contributed to authentic collaborative knowledge building, particularly in community-based models where teachers are conceived as important contributors of content and even environmental design. Theoretically on the other hand, this blind-spot may undermine the strength of such accounts for providing insight into how such networks may operate as nested adaptive learning systems (Laszlo, 2003; Banathy, 2000).

This concern was shown to be particularly pertinent to network strategies for professional development in Science and Technology education. This area of teacher development commonly seeks to reflect the inquiry-based epistemology of scientific *collaboratories*, where heterogeneous populations “negotiate their collective results” (Harlen & Doubler, 2004, p. 91). Yet if researchers are to incorporate this collaborative inquiry into their accounts of online networks for professional learning, there seems a need for stronger engagement with the *intellectual* terrain of Science and Technology education.[26] By incorporating how participants collaboratively negotiated the structural complexities of various content areas, such accounts may complement the field's strong focus on social dimensions of online communities (Dede et al, 2005; Eraut, 2002).

In this regard, ecological and complexity accounts of learning may help establish a more nuanced account of the epistemological dimensions of collaborative networks. By establishing an ontology based on learning ecologies, such models recognize the complex associations between the design of learning environments and interventions on the one hand, and the emergence of individual and collective knowledge on the other hand (Stahl, 2006).

In the following section, I outline the networked professional development project that formed the context for this study of collective learning. As will become clear, this project aligned with many of the contemporary visions of networked collaborative teacher professional development discussed previously.

1.3. DESCANT- SciTech: a professional development context for the study of collective learning

DESCANT - SciTech (Designing E-learning Systems to Celebrate And Nurture Teaching – in Science and Technology) sought to explore the worth of an innovative, e-learning

[26] Such accounts would complement those describing and analysing collective intellectual progression within face-to-face collaborative settings (for example, Grossman, Wineburg & Woolworth, 2001) and technological contexts for student learning (for example, Hewitt, 2004; Stahl, 2006).

strategy for scaling up teacher professional development in elementary Science and Technology education.[27]

Delivering and supporting quality teacher professional development is a salient and challenging issue for the New South Wales Department of Education and Training (NSW DET) given the geographical and logistical scope of the state's education system: the largest centralized education system in the southern hemisphere. DESCANT sought to address this concern through an online network-mediated strategy in a three-year research collaboration between the NSW DET and University of Technology, Sydney (UTS). DESCANT's research design was underpinned by a community-based and participatory conception of professional development in two phases.

In *Phase 1*, a small group of teachers, consultants, Departmental officers and University researchers was established. Teacher-participants were then supported within this group, *to conceive and prototype their own e-learning mediated environment* for teacher professional development in Kindergarten - Year 6 Science and Technology education. This participatory design process was simultaneously a Science and Technology professional development activity for the teachers: their professional learning formed one basis by which to *collectively* design their e-learning environment.

In *Phase 2*, the initial e-learning prototype was trialed, modified and evaluated, with a further two cohorts. Again teacher participants were expected to utilise their professional development in the project to contribute to the design of the e-learning environment.
Any primary (elementary) educator who had an interest in professional development in Science and Technology education was eligible to join the project, whether teaching full time, part time or casual. Through this loose criterion, the project sought a broad cross-section of teachers, with respect to years of teaching experience and confidence in Science and Technology and their teaching.

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[27] The acronym DESCANT was initially chosen to portray teacher learning metaphorically, as a decorative line in music, one that harmonises with and thereby embellishes the main melody of student learning. However, its meaning was to evolve throughout the project.

DESCANT-SciTech therefore represented a suitable context for this study of collective learning due to its participatory and nested approach to professional learning.

1.3.1 A Participatory and Nested Context for Collective Learning

The project's community-based learning orientation sought to leverage the knowledge of a heterogeneous population of professionals, deriving from a range of sub-populations, including teachers, Science and Technology consultants, academics and Department of Education and Training representatives. This presented the opportunity to investigate collective learning within a complex context that supported, in principle and design, the *collective* negotiation of knowledge and practice.

Furthermore, this project design incorporated a *nested structure* in which various agents, both individual and collective, would be operating. In both Phase 1 and Phase 2, individual teachers would form (where possible) learning partnerships with school-based colleagues, thus forming school-based collectives. These school-based groups would themselves be joined into online learning cohorts, thus forming cohort collectives. Finally, these online cohorts would themselves become sub-populations within the project population as a whole, thus forming a DESCANT collective that would include other professional groups such as the DET and UTS collectives.

This nested dynamic for professional learning has already been described within other professional development initiatives (both face-to-face and online), where it was conceived as particularly salient to collective learning in professional networks. Now, through DESCANT, there existed the possibility of investigating how collective learning may emerge within such a nested complex system, across various heterogeneous populations and over the lifespan of a novel e-learning strategy.

1.4 Chapter Summary: three challenges

In this chapter, I have justified the need for this study of collective learning and prepared conceptually for it, presenting evidence to suggest that learning is increasingly being conceived as a group or system level phenomenon: a network – or an ecology.

Three challenges may now be distilled if a context is to be created in which collective learning can occur – and hence be examined:

1. Affording appropriate levels of autonomy to professionals within their learning. This may be conceived as a democratically-principled *ethical challenge* relating to political and epistemological dimensions of teachers' professional learning and systemic reform in education.
2. Recognising and engaging with the phenomenon of collective learning, including the need to explain and understand its occurrence within complex nested systems. This may be conceived as a *theoretical challenge*.
3. Developing a pragmatic approach to the study and support of collective learning that, despite theoretical complexity and uncertainty, is aligned with and emerges from contemporary concerns in teacher professional development. This may be conceived as a *pragmatic challenge.*

In the following three chapters (Chapters 2, 3 & 4), I describe these challenges and my responses to them, including implications for the conduct of this study and, in anticipation, for the analysis of its findings. This conceptual preparation will allow me to describe the details of my research design and methodology in Chapter 5.

Chapter 2
An Ethical Challenge:
Democratic representation

In Chapter 1, case studies were used to illustrate the manner in which teacher professional development has been associated with participatory models of learning (Groundwater-Smith & Mockler, 2005; Loucks-Horsley et al, 2003; Van Driel, Beijaard & Verloop, 2001). I showed that collaborative, network approaches are increasingly used in an effort to afford practitioners a prominent role in generating and driving their learning and that of the wider profession. Such networks highlight the need to give teachers, teacher educators, domain experts and policy-makers a single learning system in which those local and global learning agendas crucial to systemic reform may be negotiated. In this chapter, I argue that this concern poses an *ethical* challenge for the present study with respect to both political and epistemological dimensions of teachers' professional learning in education.

2.1 Democracy: a guiding principle for knowledge building

As a principle, democracy represents a means by which a collective process may proceed on the basis of the voices of its many individuals. Dewey (1966, p. 86) noted:

> *A democracy is more than a form of government; it is primarily a mode of associated living, of conjoint communicated experience. The extension in space of the number of individuals who participate in an interest so that each has to refer his own action to that of others, and to consider the action of others to give point and direction to his own, is equivalent to the breaking down of those barriers [that keep people] from perceiving the full import of their activity*

So, a democratic ethic guarantees an arena, within which pragmatic and ontological matters may, in principle, be negotiated and resolved collectively (Latour, 2004). In research and system design, democratic considerations may precede all others, forming axiomatic guidelines that influence the process at fundamental levels. For example Banathy (1993, p. 9) concedes:

The basis for choosing a particular way of modeling or representing a problem is not governed merely by considerations of conventional logic and rationality. It may also involve considerations of justice and fairness as perceived by various social groups and by consideration of personal ethics or morality as perceived by distinct persons.

Democratic principle requires both democratic epistemology and representative assembly. It is now necessary to discuss how each of these principles might underlie collective learning or knowledge building.

2.1.1 Democratic Epistemology:

In Chapter 1, I identified participatory societal trends, particularly in teacher education, in which "…learning [is] increasingly organized as a horizontal process of mutual negotiation, as opposed to the more traditional view of a vertical relationship between a producer and a recipient of knowledge" (Wenger, 2004).

This shift is inherently political. Traditional epistemological rationales, and the political authority they yield, might undermine attempts to validate and engage in a democratic manner with the knowledge of the professional and civil population (Gibbons, 1999; Nowotny, 2003; Latour, 2004). Of course, learning collectively and systemically across disciplinary and sectoral boundaries is a contemporary imperative (Tapscott & Williams, 2006). However, such collectivity could be threatened by totalising scientific discourse on the one hand or relativistic pluralism on the other (Latour, 2004). The political implications of these two knowledge paradigms are made clear by May (2002, p. 2) in relation to theorising the social world:

While the idea that one can, without question, claim to speak in the name of a separate and unproblematic reality should be exposed to scrutiny, so too should the claim to speak in the name of different realities as mediated by alternative modes of *representation. We see the same tendencies in both claims: that is, to legislate over the constitution and nature of social reality.*

May alludes here to epistemological positions that may be associated with realism, or relativism. By 'legislating' over the ontological sphere of others, whilst simultaneously invalidating their epistemological grounds, both camps deny authentic representation within the collective process of establishing a common world (Latour, 2004: Farrell, 2003). Instead, a war footing is maintained between these two camps, eroding the potential of democratic knowledge building and collectivity (Latour, 2004).

A democratic epistemology does not mean feigning neutrality: all methodology is conceived as a political enactment (Eisner, 1998). Instead, it means seeking an explicit political orientation that stands down from a war footing, in favour of authentic democratic collectivity.

2.1.2 The Representative Assembly:

At the heart of democratic principle is the notion of representation and the representative assembly (Latour, 2004). In Chapter 1, I noted that participatory arenas or forums, often technologically based (within online networks), are increasingly being associated with the enactment of collective processes. These forums are often multidisciplinary or 'hybrid' in order to give representation to a heterogeneous mix of experts, practitioners, stakeholders and policy makers (Callon & Rip, cited in Latour, 2004). In each case, a defining quality of these learning forums is the representation they offer to disparate parties that are associated with, or affected by, the topic of concern. In this sense, they may be conceived as representative assemblies, formed for the process of collective or systemic learning, and knowledge building (Latour, 2004).

In Chapter 1, I also noted that, in education, participatory assemblies are increasingly being advocated as a means of professional development and knowledge building (Loucks-Horsley et al, 2003). Nevertheless, without research accounts that can adequately recognise and interpret how professional learning may *emerge* within these *collective forums*, the authenticity of the democratic participation underpinning many of these forums for collective learning remains uncertain.

In the face of this challenge, Latour's (2004) Political Ecology presents guiding axioms for conceiving a democratic process, and hence, enabling collectivity in learning. The following section discusses these axioms.

2.2 An Ethical Way Forward: the Political Ecology of Latour

Political Ecology[28] (after Latour, 2004) provides a means by which to engage with the ethical challenges associated with collective learning, in particular, by hedging the likelihood that both genuine collaboration and collective experimentation will occur. I now describe how.

2.2.1 Ensuring Genuine Collaboration

Political Ecology (Latour, 2004) aims to ensure genuine collaboration in the process of knowledge building. Collaboration, in this regard, is conceived as a process of *extending the representation* of entities in the process of *establishing a common world*.

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[28] All references to Political Ecology throughout this thesis are based solely on the approach developed by Latour (2004). In general terms, the wider field of Political Ecology contends with the complex interrelationships between environmental, political, cultural and social systems (for example, Petrina, 2000). There is also a concern in the wider field of Political Ecology for how the concept of nature has been established or constructed within cultural and historical contexts (for example, Escobar, Berglund, Brosius, Cleveland, Hill, Hodgson, Leff, Milton, Rocheleau & Stonich, 1999). Whilst these are important domains of concern to Latour's Political Ecology, they do not constitute its main focus. Instead, Latour's Political Ecology is a democratically-based *process* that seeks to gradually, and with due process, reconstitute the *common world* through a form of collective learning that transcends human and environmental (or non-human) realms. As such, Latour's Political Ecology offered an ideal means of establishing an ethical and democratic perspective on collective learning for this study.

Extending Representation:

Latour (2004) utilises a novel interpretation of ecology, as applied to systemic knowledge development, to radically expand the conception of representation and representative assembly. The democratic maxim underpinning Latour's Political Ecology is, in his own words, a 'risky' and 'ambitious' one:

> *"No reality without representation" (Latour, 2004, p. 127).*

On the basis of this simple maxim, Latour seeks to emphasise and institutionalise, the political dimensions underpinning the process of establishing a collective metaphysics or ontology. In this regard, political ecology (Latour, 2004) may be interpreted as a politically-based *participatory epistemology* "…that asserts that all aspects of the world, animate and inanimate, participate with humanity in the ongoing project of knowledge production" (Davis & Sumara, 2005, p. 457).[29]

According to Latour, two recalcitrant ideas must be reconceptualized if their divisive political implications are to be overcome: the *unity of 'nature'*, and the *unity of 'society'*.

Authentic representation is denied, according to Latour, through the conception of 'nature' as a *unity* that is *already established* prior to collective and democratically principled work. Latour asserts that conceiving 'nature' as a pre-existing unity contributes to the rationalisation of scientific methodologies in which a minority may inform a majority about how the 'world is', *prior* to authentic negotiation within some form of democratic assembly. This has resulted in the invalidation of, for instance, the world-views of many indigenous peoples. Whilst anthropologists may hold to pluralist conceptions of culture, an underlying conception of nature as a pre-existing unity still influences the relationships and

[29] Davis and Sumara (2005) assert that complexity science has provided researchers and educators with another *participatory epistemology* that recognises and foregrounds the ecological "web of relationships" (p. 458) underpinning meaning and knowledge production at any particular scale. In Chapter 4, the resonance between the epistemology of political ecology (Latour, 2004) and complexity sensibilities is used to establish a pragmatic basis for this research.

associations that are developed between these indigenous cultures and other cultures that claim to be ‘modern’ (Latour, 2004).

This conception of nature as a pre-existing unity diminishes the potential for a process of knowledge building within society that is truly representative in the sense of affording both a voice to civil population, and a means of authentic dialogue. Latour (2004, p. 14) notes:

> *The small number of handpicked [scientific] experts, for their part, presumably have the ability to speak.., the ability to tell the truth (since they escape the social world, thanks to the asceticism of knowledge), and finally, the ability to bring order to the assembly of humans by keeping its members quiet….*

Latour forms an explicit association here between the epistemology of science, based on a conception of an existing ‘nature’, and the political representation of a wider civil population, who may be silenced on the basis of the illegitimacy of their epistemology. Yet Latour is deeply respectful of the sciences and scientists. His goal is not to condemn either but rather to *expand* the representative assembly within which the sciences may be undertaken. In this sense, Latour’s aim aligns with a conception of scientific knowledge, as both reliable (after Ziman, 1978), and *socially robust* (after Nowotny, 2003), as discussed in Chapter 1. Latour writes (2004, p. 29):

> *...political ecology proposes to convoke a single collective whose role is precisely to debate the said hierarchy- and to arrive at an acceptable solution.*

For Latour, establishing this collectivity involves integrating diverse systems and epistemologies, without losing their distinguishing features.[30]

[30] In this sense, Latour’s conception of collectivity may be aligned to Levy’s notion of collective intelligence. Levy (1997, p. 17) writes: "Far from merging individual intelligence into some indistinguishable magma, collective intelligence is a process of growth, differentiation, and the mutual revival of singularities."

Latour also notes that authentic representation may be denied as a result of a conception of *society as a unity* wherein representations of the world are socially constructed. Latour (2005, pp. 129-130) asserts:

> *…everywhere, every day, people are fighting over the very question of the good common world in which everyone- human and nonhuman- wants to live. Nothing and no one must come in to simplify, shorten, limit, or reduce the scope of this debate in advance by calmly asserting that the argument bears only on "representations that humans make of the world" and not on the very essence of the phenomena in question.*

To Latour, postmodernist relativism diminishes authentic dialogue by invalidating the legitimacy of some proofs over others. Latour addresses this concern by expanding the notion of *representative assembly* in a radical way: assigning *representation* to those entities beyond the human sphere. This is an important move in separating Latour's political ecology, from postmodernist conceptions. For instance, Latour affords legitimate political *representation* to the realm of scientific *evidence*: the 'hard facts' established through scientific method. This provides a means of avoiding the radical subjectivism through which public discourse may "…lose any basis whatsoever for making rational choices" (Eisner, 1998, p. 47): a dilemma as salient to educational discourse as it is to scientific discourse.

Establishing the Common World

In some respects, Latour's conceptions are not new. His critique echoes others' ethical, epistemological and ontological dilemmas arising from dualist conceptions of the world (for example, Wynne, 1996; Pirsig, 1991; Maturana & Varela, 1987). Varela's (1999) conception of *ethical know-how* also seeks to avoid a dualist position by recognising the situated, embodied nature of cognition. According to this view, ethical action emerges not from deliberate reason, but rather from a dynamic and emergent response to an ecology of present factors, including immediate context, personal and cultural historicity and sensory-motor capacity (Varela, 1999) This embodied basis of ethical action explicitly challenges the traditional subjective/objective divide. Similarly, the notion of *embodied morality* (Lakoff & Johnson, 1999) recognises the complexity of contextual and experiential factors from which moral systems and, more specifically, moral metaphors emerge. Once again, dualist conceptions of morality, as deriving from an objective or subjective realm, become obsolete in this view.

Latour's concerns also parallel suggestions that positivist researchers may under-represent the political and moral dimensions of their work, a situation that may lead to political decisions being rationalized on the basis of supposedly 'objective' research findings (Clough, 1992).

Yet Latour departs from these commentaries in his solution to these dilemmas. Through political ecology, Latour (2004, p. 247) outlines a process he calls the "Progressive Composition of the Common World". In describing this process, Latour writes:

> *…the common world is not established at the outset (unlike nature and society) but must be collected little by little…to verify what the various propositions have in common."* [31]

In the modernist tradition this process has been conceived as one of detachment from archaic understandings, in which the scientific discovery of new distinctions is associated to the overarching unity of 'nature' (Latour, 2004). In contrast, Latour conceives the task of the sciences (in its expanded sense) as one of *attachment*, involving the ongoing development of complex *associations* between heterogeneous entities, both human and non-human, *thus forming an expanded collective* that achieves unity only through its political assembly. Latour contends (2004, p. 46):

> *Once we have exited from the great political diorama of "nature in general," we are left with only the banality of multiple associations of humans and nonhumans waiting for their unity to be provided by work carried out by the collective, which has to be*

[31] Latour's use of 'proposition' here is unconventional in that it refers, not to a 'statement' but rather to a phenomenon (including all its associations) that is yet to be (politically) incorporated into the knowledge of the collective. This important conceptual position will be discussed next.

> *specified through the use of the resources, concepts, and institutions of all peoples who may be called upon to live in common on an earth that might become, through a long work of collection, the same earth for all.*

Latour emphasises that the 'common world' that may be established is neither a totality nor a plurality, but a democratic political endeavour. Latour (2004, p. 227) asks:

> *What if freedom consists in finding oneself not free of a greater number of beings but attached to an ever-increasing number of contradictory propositions? What if fraternity resides not in a front of civilization that would send the others back to barbarity but in the obligation to work with all the others to build a single common world?*

The main aim of political ecology is therefore the *"progressive composition of the common world"* (p. 59): a feat that establishes the constituency of the *collective*, both human and non-human dimensions.[32] It is important to note that this is not an ontological position, but a pragmatic political one.

So, in summary, Political Ecology (Latour, 2004) seeks to ensure genuine collaboration in knowledge building in two ways: firstly, by overcoming the tendency to prematurely limit genuine representation through epistemological bias, and secondly by proposing that a *common world* be developed through a process of attachment rather than detachment, thus seeking to integrate diverse systems and epistemologies, without losing their distinguishing features.

This leaves the question of how to undertake such a process of genuine collaboration within knowledge building. Latour conceives the process that underpins Political Ecology as a form of *experimentation*: now expanded on the basis of democratic, representative principles. He notes:

[32] Latour does not conceive the collective as a unity: replacing that of nature or society. He writes: "By the word "collective" in the singular, I therefore mean...the reactivation of a problem of progressive composition of the common world..." (Latour, 2004, p. 59).

> *Let us retain from the sciences the word "experiment," to characterise the movement through which every collective passes in this way from a past state to a future state, from good sense to common sense…Why would not [civil discourse] try to imitate the sciences a bit by borrowing the experimentation that is incontestably their greatest invention? An experiment…consists in "passing through" a trial and "coming out of it" in order to draw its lessons. It thus offers an intermediary between knowledge and ignorance. It defines itself not by the knowledge that is available at the start, but by the quality of the learning curve that has made it possible to pass through a trial and to know a little more about it." (Latour, 2004, p. 195-196).*

I will now outline Latour's conception of experimentation as a means of democratically establishing the *common world*, so that implications for this study's research design and methodology can then be drawn.

2.2.2 Undertaking Collective Experimentation

Whilst Latour's Political Ecology may reject the epistemological politics underpinning many realist and postmodernist approaches, it does not reject the 'quest for certainty' (Dewey, 1929). For centuries, experimental methods for developing certainty through reliable and valid knowledge have been the domain of science (Ziman, 1978). The experimental method, which has precedence in some indigenous cultures, was refined by numerous cultures over hundreds of years, including the medieval Arab alchemists and philosophers (Dunbar, 1995, p. 41) Growing out of this tradition Latour describes a particular, democratically principled process of collective experimentation. I now briefly detail its key characteristics and the democratic work each characteristic does.

<u>Articulating a Proposition: sensitising to difference</u>

Latour uses the conception of a *proposition* to circumvent traditional epistemological dualism between objectivity and subjectivity, in the process of collective knowledge development. A *proposition* is not conceived by Latour as a 'statement' that *refers* to the world, but rather as a heterogeneous entity that is recognised by the collective in a provisional sense, as a “candidate entity” (Latour, 2004, p. 169) A proposition then, consists of a complex network of associations that bridge the human and non-human realms: developing associations between such things as empirical data, theory and human conjecture:

> *…[a proposition is] not a being of the world or a linguistic form but an association of humans and nonhumans before it becomes a full-fledged member of the collective…Rather than being true or false, a proposition in this sense may be well or badly articulated” (Latour, 2004, p. this 247).*

Latour’s final words here emphasise the methodological shift that this conception of a *proposition* allows. As propositions are not conceived as *references* to an objective world, the notion of judging their validity on a measure of ‘true’ and ‘false’ no longer applies. Instead, propositions are judged on their level of *articulation*.

> *…reality grows to precisely the same extent as the work done to become sensitive to differences. The more instruments proliferate, the more the arrangement is artificial, the more capable we become of registering worlds. Artifice and reality are in the same positive column whereas something entirely different from the work is inscribed on the debit side: what we have there now is insensitivity. Thus the dividing line does not pass between speech and reality through the fragile gulf of reference, as in the old polemical model of statements that are simply true or false, but between propositions capable of triggering arrangements that are sensitive to the smallest differences, and those that remain obtuse in the face of the greatest differences” (Latour, 2004, p. 86).*

The broader epistemological basis of this criterion expands representation by incorporating forms of understanding that have traditionally (in modernism) been conceived as non-propositional. Yet Latour also utilises the strength of the sciences for developing means, often technological, by which to appreciate increasingly subtle distinctions in the surrounding world (for example, through the use of sophisticated laboratory equipment.)

Again, this is not a novel conception for overcoming the subjective/objective dualism. For instance, both Eisner (1998) and Wenger (1998) use the example of wine connoisseurship as a means of emphasising the close relationships between subjective perception and distinctions in the world. Eisner (1998, p. 63) writes:

> *The ability to make fine-grained discriminations among complex and subtle qualities is an instance of what I have called connoisseurship.*

Eisner, like Latour, believes that this argues for an expansion of the role connoisseurs in any field or discipline play in articulating knowledge. In education, on this view, it is the education professionals who are in a strong position to perceive critical distinctions related to learning and teaching (Eisner, 1998).

Wenger emphasises the role of professional communities in this regard by asserting that both cultural knowledge and community dynamics serve to *focus experience* in order to appreciate the subtle distinctions that have been established (Wenger, 1998). At the boundaries of communities, negotiation as to which distinctions may be critical serves to produce novel interpretations and open new possibilities for exploration (Wenger, personal communication, July 18th, 2005).[33] This notion corresponds closely with the use of heterogenous groups for professional development and knowledge building in education (as discussed in Chapter 1).

Maintaining Rigour: Establishing Due Process

A hallmark of science has been the use of experimental protocol and collectivity by way of a scholarly community as a source of rigour and intense criticism (Ziman, 1978). Accordingly, Latour's expanded sense of experimentation requires a similar degree of sophistication in regards to the processes by which a collective may engage in the process

[33] This comment was made by Dr Wenger in a presentation entitled, *Building thriving learning communities*, at the Transforming Learning through ICT Series, Seminar 2 Education.au, Sydney, 18th July, 2005.

of criticism. Latour addresses this concern with a series of principles that ensure that *due process* has been followed in establishing the common world. The first two of these principles provide axioms to ensure the collective process of establishing the common world is not short-circuited on the basis of epistemological politics or prematurely completed on the basis of myopic certainty.[34]

<u>*The Power to Take into Account:*</u>

Latour (2004, p. 109) outlines two initial requirements for ensuring that the collective establishes the *common world* on the basis of *due process.* These two requirements are grouped, by Latour, under the 'Power to Take into Account'.

1. *Perplexity: You shall not simplify the number of propositions to be taken into account in the discussion.*

Latour (2004, p. 246) describes perplexity as one of the "…tasks through which the collective makes itself attentive and sensitive to the presence outside itself [its boundaries] of the multitude of propositions that may want to be part of the same common world." Enacting perplexity then, involves maintaining vigilance to the presence of new facts, matters of concern, or in the terminology of political ecology, *candidate propositions*. These must not be ignored *regardless of the risk they may present to the current state of the collective*.

2. *Consultation: You shall make sure that the number of voices that participate in the articulation of propositions is not arbitrarily short-circuited.*

Latour (2004, p. 239) states that consultation "…answers the question about what trials are appropriate to pass judgement on the existence, the importance, and the intention of a proposition…" This is an expanded conception of consultation that includes non-humans as

[34] Latour actually establishes four principles in all. The two not expanded in this research are 'Hierarchization' and 'Institution'. Both involve processes of systemic institutionalisation that are beyond the scope of this research.

well as humans. Consulting a piece of laboratory equipment may be as appropriate as consulting a panel of experts within this process. Latour borrows from law to conceive of a heterogeneous jury that must be formed on the basis of democratic principles: thus it cannot be stacked against or for the candidate. Latour (2005, p. 169) believes this has been a failing of democratic epistemology within modernist principles where:

> *The candidate entities…never had the right, within the narrow framework of modernism, to avail themselves of a council composed according to the specific problems that they raised for the collective.*

In political ecology, consultation ensures that candidate entities or propositions are permitted adequate representation by ensuring their case is framed in appropriate terms.

In summary, political ecology (Latour, 2004) conceives systemic knowledge building as a means of expanding the known world by simultaneously expanding its representatives (whether they are human or nonhuman) within a learning assembly that follows an experimental and epistemologically inclusive protocol. Adopting a political ecology framework, with its protocols for expanding representative assembly through collective learning, delivers key methodological tools of thought for this study.

2.2.3 Enacting Political Ecology: tools for thinking about this study's research design and methodology

Political Ecology (Latour, 2004) does not specify a precise methodology through which collective knowledge should be established. Instead, it provides a set of guiding principles (as summarised in 2.1 and 2.2) which act as boundaries for action. In this sense, Political Ecology (after Latour, 2004) is proscriptive rather than prescriptive with regards to particular forms of research design and methodology. Davis & Simmt (2003, p. 147) note, "The proscriptive attitude might be stated as "This is what's forbidden; everything else is allowed," which represents a much more open stance than the prescriptive, "This is what's allowed; everything else is forbidden." Accordingly, within the democratic principles of

Political Ecology (Latour, 2004), both quantitative and qualitative research methods are conceived as equally valid for providing distinct and often complementary means of articulating propositions.[35]

Political Ecology does however provide researchers with an overarching *goal* to develop increasing sensitivity to the presence of *distinctions* in the 'common world'. This involves developing sensitivity to individuals, cultures and ecologies as a *connoisseur* might develop appreciation for distinctions that others may not differentiate (Eisner, 1998). In qualitative research, anthropological approaches, incorporating naturalistic, ethnographic methodologies have commonly been used for this purpose (for example, Lincoln & Guba, 1985). Political Ecology (after Latour, 2004) may contribute to these approaches by providing three tools for thinking: the aim of establishing a common world, the process of democratic experimentation, and the conception of the educational researcher as a diplomat.

<u>Towards establishing a common world within this study</u>

Latour's conception of progressively *establishing the common world* emphasises the need for this study to develop knowledge within a system *common* to all parties: a system that develops, through the work of the collective, authentic associations and negotiations between the ontological claims of, for instance, teachers, academics and policy makers.

A genuine *representative assembly* in this sense must allow the voices of *all* parties to engage in authentic negotiation of that common world. This may cast as problematic the notion of naturalistic inquiry whereby educational researchers, often academics and teachers educators, enact anthropological methodologies to study events, people and artefacts in their 'natural' state (for example, Lincoln & Guba, 1985). Latour's (2004, pp. 47-48) caution regarding early anthropological tradition may provide insights in this regard:

[35] Like political ecology, all research, whether quantitative or qualitative, seeks to develop *associations* between claims and the research concern (Eisner, 1998, p. 39).

> *In order not to fall into a perverse fascination with differences, it is necessary to move quickly to create a common world that replaces surprise with the deep complicity of solutions…the anthropology of earlier times paid so much attention to the multiplicity of cultures…because it took the universal nature as a given. If it could collect so many diversities, it is because anthropology could grab hold of them by getting them to detach themselves from a common background [that is, nature] that had been unified in advance.*

Rather than undertaking naturalistic descriptions of ‘difference’ in educational contexts, this argues for the value of authentic representative assemblies for the negotiation of this common world. This is not conceived as a reversion to multiple and incommensurable cultures that may make claims solely on their own terms (Latour, 2004). Rather, it supports conceiving of (in this case) a professional development research context as a site of knowledge building in which negotiation, however arduous, develops authentic associations that form the basis of progression towards a common world.

> *From this point on [here, parties] can no longer be defined as different cultures having distinct points of view toward a single nature- to which "we" [here, researchers] alone would have access; it becomes impossible to define them as cultures among other cultures against a background of universal nature. They are… collectives that seek to know...what they may have in common" (Latour, 2004, p. 45)*

This ought not to mean that researchers must remain passive, as this could be interpreted as an unethical stance that sought to naturalise the context or reinforce the incommensurability of cultures. Instead, a recognition of *complicity* (Cohen & Stewart, 1994) between researchers, research participants and the complex research environment, becomes an ethical ground for justifying active participation by all involved in research and knowledge generation. As long as *due process* is observed, all voices and parties may “parley” (Latour, 2004, p. 213) in the process of establishing the common world. Furthermore, there seems no reason as to why this democratically principled process should not also involve the element of *design* as participants make conscious decisions about how the *common world* will be enacted.

Towards Democratic Experimentation

Establishing the common world without the security of *mononaturalism* or *multiculturalism* (in the relativistic sense) requires, according to Latour, a pragmatic process of experimentation. This is an experimental methodology that involves representative assemblies, thus making its political and ethical dimensions explicit. Again, this approach may be associated with an expanded conception of anthropological methodologies. Latour (2004, p. 47) states:

> *To participate in the development of political institutions adapted to the exploration of the common world and the "same earth", anthropology must become experimental.*

For the present study, this involves re-conceiving experimental methodology in educational research. Historically, experiments have contributed to the development of highly influential learning theories such as those of Piaget (1952) as well as serving as the basis of much knowledge concerning human cognitive ability. Experimental methods are commonly conceived as enhancing the rigour of research and thus the validity of its claims (Hoadley, 2004).

Yet, experimental methods are often disconnected from authentic learning contexts leading to a critique of their ecological (Sandoval & Bell, 2004) and systemic validity (Hoadley, 2004). Furthermore, translating theoretical knowledge derived from scientific disciplines into complex educational contexts has been problematic, thus drawing criticism for a lack of "usable knowledge" (Lagemann, 2002 cited in Sandoval & Bell, 2004, p. 1).

Having already associated anthropological methodologies with representative assemblies for the establishment of the common world, this process may also be conjoined to experimental approaches. Latour's political ecology is based on a conception of experimentation in which the integration of world-views and world-practices becomes a source of iterative negotiation.

> *We shall say, then, that the collective as a whole is defined from now on as collective experimentation. Experimentation on what? On the attachments and detachments that are going to allow it, at a given moment, to identify the candidates for common existence…The collective…has to experiment in such a way that it can learn in the course of the trial (Latour, 2004, p. 196).*

This argues for forms of educational research that allow *sustained* perplexity in the search for shared certainty, whilst also allowing for the emergence of novel solutions. There is synchrony here with other conceptions of educational research as supporting systemic novelty (for example, Cavallo, 2004). Davis & Sumara (2006, p. 136) note:

> *Education- and, by implication, educational research- conceived in terms of expanding the space of the possible rather than perpetuating entrenched habits of interpretation, then, must be principally concerned with ensuring the conditions for the emergence of the as-yet unimagined.*

This conception of educational research acknowledges the active role researchers may take in supporting systemic novelty in education. In essence, it re-conceives intervention. Whilst education is inherently interventionist (Bell, 2004), it is a notion often associated with authoritative dynamics.[36] In contrast, the use of representative assemblies may provide the appropriate conditions for supporting transformative agendas. As Dewey (1966) noted, the democratic principles underlying such representation seek to empower individuals in this process, whilst simultaneously supporting collective and systemic dimensions.

The notion of collective experimentation as a basis of collective learning and systemic design aligns well with design-based research (for example, Barab & Squire, 2004), and

[36] Bell (2004) asserts that contemporary research models in education often fail to contribute to educational innovation due to their non-interventionist stance (Bereiter, 2002).

ecological methodologies (for example, Cavallo, 2004). Through these methodologies, educational researchers have sought to enact participatory system design that is dynamically coupled to collective professional learning within hybrid communities (Design-Based Research Collective, 2003).

The Educational Researcher as Diplomat

Instead of undertaking the role of anthropologist, an educational researcher might be conceived as an *ecologist diplomat* (Latour, 2004): encountering educational culture in all its complexity. Latour notes the manner in which the diplomat may overcome both the unity of nature and society in its dealings with culture:

> *At no moment does the diplomat use the notion of a common world of reference [a unity of nature or society], since it is to construct that common world that he confronts all the dangers; at no moment, either, does he regard "simple formulations" with respectful contempt, since any one of them, however impalpable, may hold the key to the agreement that nothing has guaranteed in advance (Latour, 2004, pp. 212- 213).*

The notion of the diplomat implies an active participation in the negotiations, as well as emphasising that there is no course to neutrality in this process. In this regard, Latour (2004, p. 212) states:

> *…contrary to the arbiters who always rely on a superior and disinterested position, the diplomat always belongs to one of the parties...*

The educational researcher, as diplomat, may thus *articulate* their own position and its underlying values throughout the research process, whilst remaining attentively aware of the need to develop authentic associations between the languages, world-views and practices of those negotiating the common world. For the educational researcher as diplomat, this integration is always going to be experimental in itself, a way forward that is of the diplomat's own making.

The educational researcher may then, like the diplomat, be called to "articulate the collective" (Latour, 2004, p. 213): presenting a conception of the various camps as one system, conjoined by associations, commonalities and differences.

Summary

I have asserted here that Latour's political ecology can establish a democratic ethical orientation for this research and have described how this orientation aligns well with the participatory and community-based models of teacher professional development outlined in Chapter 1.

In particular, political ecology can support three methodological principles, each underpinned by a set of ethical requirements (as detailed throughout this chapter). A methodology based on political ecology should incorporate:

1. *Democratic Knowledge Building*: ensuring all parties' rights (including myself as researcher), to engage in a genuine negotiation of knowledge.
2. *Maintenance of sustained perplexity* (however uncomfortable): in preparation for the emergence of unforeseeable knowledge, design and structure in the collective through a process that is truly experimental.
3. *Diplomatic Intervention*: Re-conceiving the role of researcher, from that of a detached anthropologist, to that of an educational (and academic) diplomat who, in this case, is striving to articulate an interpretation of collective learning within an authentic knowledge building context.

Political Ecology provides then, a set of ethical principles for establishing a methodology to support – and hence to be able to study - collective professional learning in education. A methodology built on these foundations requires sensitivity to those participatory and democratic aspects of epistemology and pedagogy necessary for collective professional learning to occur, and educational researchers who are informed, yet ultimately conjoined, members of the research context and population.

Yet Political Ecology remains a political rather than ontological orientation (Latour, 2004). It remains necessary therefore to establish this study's *own* theoretical orientation: one that can remain aligned with its ethical, epistemological and political basis.

Chapter 3
A Theoretical Challenge:
Establishing an ecological complexity orientation

In the previous chapter, I introduced an ethical orientation for the study: one that aligns with the collaborative, participatory models of teacher professional development discussed in Chapter 1. In this chapter, I develop a theoretical orientation that may also be associated with these approaches to teacher professional development: in particular, the collective learning that may transpire there.

In this regard, three theoretical stances may be distilled from Chapter 1. They include:

- A conceptual shift in which learners are conceived as collective entities, rather than only individuals.
- A view of learning as an adaptive change within these collective entities, whether they are groups, networks, or systems.
- A similarity between the characteristics of networked / collaborative learning contexts and the characteristics of complex adaptive systems: in particular, their self-organising dynamics and nested structure.

Here in Chapter 3, I advance these conceptions as a basis for theorising collective learning and as a means of developing principles by which to establish this study's research approach.

3.1. Self-organisation: a basis for nested agency

As noted in Chapter 1, community-based and participatory models of teacher professional development seek greater levels of agency for teachers (Groundwater-Smith & Mockler, 2005; Groundwater-Smith & Sachs, 2002). Affording this agency to professionals can be justified on ethical and political grounds (after Latour, 2004). Yet this ideal is complicated where teachers learn in professional development groups, school-based populations and as part of systemic initiatives that have specific reform agendas. In such cases, conflicts may emerge between the learning agendas of individual teachers, school-based communities and the wider education system, often represented by teacher educators and academics (Barab, MaKinster & Scheckler, 2003; Loucks-Horsley et al, 2003).

Learner agency may best be conceived then, in relation to the nested agency of individuals *and* collectives (for example, groups or networks of teachers). Here it seems useful to invoke a conception of learning that can deal with these various levels of agency. In this section, it will be argued that the complexity concept of self-organisation fulfils this need.

3.1.1 Individual Learner Agency

Complex systems, whilst often appearing stable, maintain such form through a dynamic process that is continually making subtle adjustments in order to accommodate environmental and emergent internal change (Thelen & Smith, 1994, p. 68). This dynamic, commonly known as self-organisation, may occur through a decentralised process in which "… groups of agents seeking mutual accommodation and self consistency somehow manage to transcend themselves, acquiring collective properties such as life, thought, and purpose that they might never have possessed individually" (Waldrop, 1992, p. 11).

In living systems, this self-organisation commonly involves specialised parts of a network acting as a dynamic whole in order to maintain viability within changing environmental conditions (Maturana & Varela, 1987). These adaptive responses are cognitive in nature, resulting in structural changes that may be conceived as learning (Capra, 2002; Maturana & Varela, 1987). This conception coheres with Axelrod and Cohen's (2000) definition of agent *strategy*: one that underpins their model of learning within complex systems. Both conceptions relate to an agent or organism's *response* to the environment or other agents, whether in agent-based or ecological modelling.[37]

[37] Accordingly, in the analytical framework developed for this research, agent-based 'strategies' (Axelrod & Cohen) are conceived as forms of learning: a theoretical principle underpinned by this conception of ecological cognition (Capra, 2002; Maturana and Varela, 1987).

In simple organisms, cognitive structural change (that is, learning) may be very limited, occurring, for instance, within basic sensorimotor systems and leading to changes in direction. In highly complex organisms such as humans, these structural changes involve sophisticated nervous and sensorimotor systems, leading to changes, for instance, in the neural pathways in the brain (Maturana & Varela; 1987; Edelman, 1992).[38]

The greater an organism's flexibility for enacting self-organisation, the greater its potential for self-maintenance as a response to environmental changes (Maturana & Varela, 1987).[39] For this reason, the immense repertoire of responses available to humans through their sophisticated physiology provides a powerful basis for autonomous self-organisation: that is, for agency within their learning and behaviour.

3.1.2 Collective Learner Agency

Regardless of an organism's flexibility for self-organisation, their repertoire of adaptive responses remains 'coupled' to other parts of the (eco) system in which they exist (Waldrop, 1992). This adaptive coupling may occur between organisms over biological time as they "…constantly adapt to each other through evolution, thereby organising

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[38] Maturana & Varela (1987, p. 170) describe this process as one of selection, stating that "the functioning organism, including its nervous system, selects the structural changes that permit it to continue operating, or it disintegrates." Similarly, Edelman (1992) has developed a neural account of mind in which learning is conceived as an adaptive response by an organism to its surroundings. Like Maturana and Varela (1987), Edelman asserts that categories of experience (or meaning, in humans) develop through a dynamic process of self-organisation whereby bodily systems, particularly neural networks, undertake continual reorganization. At the heart of this explanation is a process of value-based selection across the neural structures of the brain. Edelman's selectionist account of learning acknowledges the importance of social exchange in developing meanings that have adaptive value (for example, within language and speech). Yet Edelman's neural account stops short of articulating a mechanism by which learning may occur at collective levels in groups or cultures.

[39] The environment is not considered here as a unified realm that exists separate to organisms. By determining *which* environmental triggers it responds to, the organism (or coupled collective entity) is partially responsible for "bringing forth its environment" (Maturana & Varela, 1987). Furthermore, this dynamic is bi-directional leading to a coevolution between organisms and environment: one specifying the other in a mutually enfolded dynamic (Maturana and Varela, 1987; Edelman, 1992). Perception and cognition are not therefore conceived as representing an external reality. Instead these processes specify an environmental context in the process of "structurally coupling" with environmental conditions (Maturana & Varela, 1987, p. 75). An interesting resonance exists here with Latour's (2004) political notion of '*progressively developing the common world'*. Through a process of rigorous self-examination and negotiation, the collective might be expected to establish their world, not as a separate pre-specified reality, but as an experimental integration of previously separated distinctions.

themselves into an exquisitely tuned ecosystem" (Waldrop, 1992, p. 11). Alternatively, coupling may take the form of social and cultural patterns of collective behaviour.[40]

Socially and culturally situated collectives of humans may therefore be ‘locked into a single system’ (Kelly, 1994) through what Plotkin (2003) describes as ‘collective intentionality’ (after the work of John Searle). According to Plotkin (2003, pp. 254-255) collective intentionality:

> *…is not the sum of individual intentionalities and is not reducible to them…This does not mean that [it]…hovers in the spaces between people or binds their minds through mysterious field forces. Each of us has a mind and mental life that are confined to our individual brains. But to quote Searle, ‘it does not follow from that that all my mental life must be expressed in the form of a singular noun phrase referring to me. The form that my collective intentionality can take is simply “we intend”, “we are doing so and so”, and the like. In such cases, I intend only as part of our intending. The intentionality that exists in each individual head has the form “we intend”.*

Groups and networks, underpinned by collective intentionality (and thus structural coupling), may be considered learning agents in their own right, harnessing not only the adaptive self-organisation of individuals, but also quite distinct patterns of adaptive self-organisation occurring at collective levels (Axelrod & Cohen, 2000). As with individual learners, self-organisation provides a degree of agency to these *collective* learning agents: an autonomy that is constrained by the need to couple to other levels of the complex system or network (Axelrod & Cohen, 2000).

[40] As in the case of social insects, structural coupling may involve the coordination of large numbers of autonomous agents: the phenomenon commonly represented in decentralised agent-based models of self-organisation. However, it is important to note that structural coupling may be conceived as taking place between pairs, small groups or even cultural groupings as meaning, behaviour and intention are regulated so as to operate as cohesive units for some adaptive purpose (Maturana & Varela, 1987).

3.1.3 Nested Agency and the Learning System

The concept of adaptive self-organisation provides then, a means of conceptualizing learner agency across nested levels in a complex system. Each coupled level of learning supports the maintenance of the system as a whole, providing the entire network with the capability to respond adaptively to environmental pressures. Yet for this to occur, a degree of transfer is required between levels of the system.[41] Holling (2001) describes this dynamic:

> *Each level communicates a small set of information or quantity of material to the next higher (slower and coarser) level... As long as the transfer from one level to the other is maintained, the interactions within the levels themselves can be transformed, or the variables changed, without the whole system losing its integrity. As a consequence, this structure allows wide latitude for experimentation within levels, thereby greatly increasing the speed of evolution.*

The recognition here of nested experimentation as a basis for macro-level evolution aligns well with community-based and network models of professional development in which wider systemic reform is sought through localised experimentation within school-based and district groups and networks (Bentley, 2003). Professional learning may be considered, in this view, an adaptive self-organising dynamic occurring across nested and coupled levels within a complex learning system.

In the following section, I outline a generative theory of learning that accommodates the ethical and theoretical ideas introduced thus far. This theory provides an initial basis by which to identify or describe collective learning if and when it occurs in this study.

[41] In ant colonies, this transfer may occur through a chemical flow (called trophallaxis) between individuals which results in hormone levels at a macro level across the population (Maturana & Varela, 1987). In humans, this transfer may occur as individuals share behaviours, ideas and understandings with others in their network, thus leading to emergent change across a population (Axelrod & Cohen, 2000).

3.2 A Generative Theory of Learning: a starting point for identifying and describing collective learning

Modeling complex systems (including human systems) as nested and coupled systems has brought with it the challenge of developing multi-level theories that attempt to develop bridging conditions between higher level and lower level phenomena (Markovsky & Borsch, 2002).[42] In essence, this often requires re-conceiving the *relationship* between entities that exist within complex systems. According to Minsky (1985, p.18), such multi-level theories, when seeking to model human learning should incorporate three scales of time:

> *Slow, for the billion years in which our brains have evolved; fast, for the fleeting weeks and months of infancy and childhood; and in between, the centuries of growth of our ideas through history.*

Plotkin (1994) provides such a multi-level theory by explaining learning across a three-tiered heuristic of generating, testing and regenerating. Schaverien & Cosgrove (1999, pp. 1227- 1228) describe this heuristic succinctly:

> *Animals have evolved this nested hierarchy of ways to learn in order to hedge their chances of survival. Their primary heuristic furnishes them with knowledge of their environment, which, by selection, becomes built into their genes and developmental pathways. However, this learning is slow, governed by reproductive frequency. Whilst organisms evolve slowly, organs like the brain and the immune system can adapt, within genetically constrained limits, to more rapid environmental change. However, whilst the brain, say, of one individual can generate, test and regenerate ideas effectively enough to track faster frequencies of environmental change than is*

[42] Theorising and modeling the relationships that may exist throughout hierarchically structured complex systems has long been the domain of biology and ecology (Grimm, Revilla, Berger, Jeltsch, Mooij, Railsback, Thulke, Weiner, Wiegand & DeAngelis, 2005). Eminent biologist, Mayr (1988, p. 14) describes the scope of this scientific enterprise in noting: "The complexity of living systems exists at every hierarchical level, from the nucleus, to the cell, to any organ system (kidney, liver, brain), to the individual, to the species, the ecosystem, the society..." Mayr's comment emphasises a strong overlap between the fields of complexity and those of biology and ecology.

possible by means of the primary heuristic alone, this secondary heuristic operates too slowly to enable that individual to track the fastest frequencies of environmental change. Hence, the evolution of a tertiary heuristic (consisting of the g-t-r mechanisms of culture), giving individual learners the benefit of knowledge that has been developed by cultures.

The biologically based generative theory of learning (Schaverien and Cosgrove, 1999, 2000) utilises this heuristic to offer a conception of learning that aligns with both complexity and ecological perspectives discussed above. In this view, learning is conceived as an adaptive behaviour that hedges our chances of survival. As Edelman (1993, p. 115) notes:

To survive in its econiche, an organism must either inherit or create criteria that enable it to partition the world into perceptual categories according to its adaptive needs.

According to generative theory this process is undertaken through iterative cycles in which learners generate and test ideas on their value, selecting those ideas that survive these tests (after Edelman, 1992; Plotkin, 1994; Schaverien and Cosgrove, 1999, 2000).

The *value-driven* selection that underpins this process operates through a generate-test-regenerate (g-t-r) heuristic that is identifiable at three *nested* levels (after Plotkin, 1994):

- At a primary level, in genes, by natural selection, as genetic knowledge-gaining;
- At a secondary level, in organ systems (immune systems and brains), as selection of ideas and behaviour on individuals' values (honed over evolutionary time and in life-experience); and
- At a tertiary level, in groups and cultures, again, as selection of ideas and behaviours, but this time tested, as well, against communal or cultural values.

In complexity terms, generative learning across each of these nested levels can be conceived as a self-organising shift from one dynamic state (or attractor) to another

(Waldrop, 1992). In this respect, the generative heuristic's tertiary level proposes a particular understanding of social and collective learning as a nested and coupled dynamic. It contends that the learning of each individual in a group is influenced, not only by their unique pattern of values at the primary and secondary level, but simultaneously by shared beliefs and values *on the collective level*, that is, within the group and culture in which they are operating. So, *diverse* individual ideas and behaviours in a group or culture may be tested (and thus either selected, modified or rejected) on the basis of these shared values in that group or culture. As suggested already, this collective level can, itself, be analysed for learning and progression.

This generative theory has proven useful for understanding the learning of individual students and teachers (for example, Hall and Schaverien, 2001; Schaverien and Cosgrove, 1997; Schaverien, 2003) and in re-conceiving e-learning design (Clendinning, Shepherd and Schaverien, 2002). By invoking this theory here, within an empirical study that focuses on the social, cultural and collective dimensions of learning, this research tests the theory for its utility in accommodating those political and ecological dimensions so far described as integral to understanding collective learning.

3.3 Theoretical Principles for Studying Collective Learning

In addressing the challenge of theorising learning across various levels of a participatory professional development context, I have utilized complexity thinking (Davis & Sumara, 2006) and biological models to establish an initial position. From this position, three principles for studying collective learning may be distilled: recognising complexity, continuity in time and dynamic stability (after Thelen, 2005).

3.3.1 Recognising Complexity

Learning at any level within a nested and coupled system is likely to be "... the product of many interacting parts that work together to produce a coherent pattern under particular task, social, and environmental constraints. Every [learning] behaviour is the condensation of these heterogeneous components" (Thelen, 2005, p. 261).

This principle serves as a reminder that single-cause explanations for learning may not be possible. Instead, it suggests that gaining insight into learning within a complex system may require the study of multiple, and often non-linear, interactions within and across parts of that system (Thelen, 2005).

3.3.2 Recognising Continuity in Time

Learning across a nested and coupled system is *dynamic* in that "…the state of the system at any time depends on its previous states and is the starting point for future states" (Thelen, 2005, p. 262).[43]

This principle serves as a reminder of the temporal nature of learning and the importance of experiential history to adaptive self-organisation. In this regard, Maturana & Varela (1987, p. 23) state "...when we examine more closely how we get to know this world, we invariably find that we cannot separate our history of actions- biological and social- from how this world appears to us."

3.3.3 Recognising Dynamic Stability

Learning involves a shift from one dynamic pattern (or attractor) of behaviour or understanding to another dynamic pattern, each having a different degree of stability and flexibility.[44]

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[43] This conception of complex systems as embodying a temporal dimension is characteristic of the fields of biology and ecology (Mayr, 2004). Darwin's (1859) famous case-study of finches on the Galapagos Islands helped him develop a theory of natural selection that positioned *historical antecedence* as a cause (Plotkin, 1996). This represented a significant shift from essentialist thinking whereby phenomena were conceived as embodiments of timeless essences or form (Plotkin, 1996).

[44] Thelen (2005, p. 264) emphasises the importance of this balance between stability and flexibility by noting: "It is a tenet of dynamic systems that they must lose stability to shift from one stable mode to another (attractor states). When patterns are very stable, there are no opportunities to explore and reassemble new solutions. Indeed, maladaptive behaviour is usually the result of excessive stability. People may move, or reason, or base their social interactions on rigid patterns: patterns that may have worked in the past but are

This principle represents a challenge to conceptions of development and learning that focus on stability and end-points: a conception underpinning influential developmental theorists such as Piaget (Thelen & Smith, 1994, p. 43). The principle suggests that recognising and gaining insight into these dynamic patterns (or attractors) cannot be achieved through static, or end-point depictions, but rather by *mapping* the "collective variable behaviour" over time (Thelen & Smith, 1994, p. 58). This approach allows research to characterize the stability of dynamic patterns within and across various levels of an adaptive complex system or network.[45]

In chapters 2 and 3, I have outlined an ethical and theoretical basis for this study, including a range of principles by which to proceed. I now integrate these perspectives into a pragmatic framework as a basis for designing a principled methodology.

now not appropriate for new situations. Problem solving is limited by the lack of new softly assembled possibilities."

[45] In dynamic systems terminology, the aim is to establish the *range* of these dynamic patterns (that is, their attractor basin). This goal has been achieved in narrowly defined biological systems such as heart rate rhythms (Goldberger and Rigney, 1988) and primitive neural activity (Mpitsos, Creech, Cohan, and Mendelson, 1988). In very complex social and cultural contexts, where the phenomenon under study is learning, this is far more challenging (Thelen & Smith, 1994). Nevertheless, complexity researchers have sought to address this challenge by utilizing insights into adaptive (and nested) self organisation in order to investigate *interrelated* attractor basins both *within* and *across* levels of a system or network (Waldrop, 1992).

Chapter 4
A Pragmatic Challenge:
An integrated framework for research design and analysis

In Chapters 2 and 3, ethical and theoretical principles were detailed for establishing and studying collective learning within a professional development context. In summary, Political Ecology (Latour, 2004) established an ethical need to ensure democratic knowledge building, maintenance of sustained perplexity and diplomatic intervention; and a complexity perspective (informed by a generative theory of learning) established the utility of recognising (nested) complexity, continuity in time, and dynamic stability.

Here in Chapter 4, these principles are utilised in order to address the pragmatic challenge of studying collective learning in a manner that, despite theoretical uncertainty, aligns with and emerges from contemporary concerns in teacher professional development.

4.1 A Case Study Approach: capturing the dynamic complexity of collective learning

The principles detailed above required that collective learning be studied in a manner that (amongst other things) recognised the complexity and dynamic nature of network-based professional learning contexts. A case study approach provided a pragmatic means of fulfilling this methodological requirement.

In educational research, case studies have proven useful for studying educational innovations undertaken in authentic, thus complex, learning environments (Jardine, 1992). The rich descriptions that can be developed through a detailed study of a single case are valuable for capturing the complexity of a single bounded system (Stake, 2005). For instance, a case study approach (Miles & Huberman, 1994) affords significance to ecological attachments and associations both within and across levels of a system. It therefore offers a means of mapping dynamic patterns, or “collective variable behaviour” (Thelen & Smith, 1994, p. 58) of professional learning across nested levels.

Case studies have also been recognised as particularly valuable for undertaking multiple levels of analysis within a single study (Yin, 2002). They allow detailed and complex accounts to be developed of various dimensions of a single research context, largely through an integrated combination of data collection methods (Eisenhardt & Howe, 1992). A case study approach thus provides a means of capturing and recognising the nested and coupled character of collective professional learning in an authentic network context.

As already noted, there are acknowledged uncertainties surrounding the phenomenon of collective learning (Plotkin, 2003; Stahl, 2006), and a paucity of empirical accounts of it (Davis & Sumara, 2006). Potentially, developing rich accounts of learning in an authentic professional development context could make an important contribution during the initial stages of developing scientific knowledge of this phenomenon (Dunbar, 1995). In particular, induction based on such rich empirical data sets may be used to develop tentative models, as well as to test the utility of existing theory (Dunbar, 1995, p. 25). Whilst a single case study cannot prove a theory, the single-case approach has been recognised for its propensity to contribute to novel explanatory frameworks (Eisenhardt, 1999).

In this regard, anthropological accounts offer a pragmatic means of establishing a case study account of collective learning (Latour, 2004). Diamond (1998) uses a combination of historical narrative and anthropological case study to explain the form of current cultures with respect to their experiential history and adaptive interaction with their ecological context (including other cultures). Diamond thus seeks historical causation in his account, establishing a dynamic, non-linear account of cultural progression.[46]

Although dealing with the subtle phenomenon of cultural learning, Diamond's account forms explicit associations to the ecological contexts (including cultural and historical) within which these changes occur. Furthermore, that account reflects complexity

[46] Diamond (1998, p. 16) utilises a historical and anthropological account to answer the question, "Why did human development proceed at such different rates on different continents?" His narrative establishes a web of dynamic and non-linear associations between cultures, technologies and environments in order to discern, what Diamonds interprets as, "history's broadest pattern."

approaches to the explanation of phenomena through its descriptions of branching, associations and attachments, all historically located, as a means of explaining current states of a complex system. This approach contrasts with explanations of cultural development and learning based on detached, essentialist conceptions.

A single case-study approach utilising ecological/ anthropological narratives thus offered a pragmatic means of studying the dynamic and temporal complexity of collective learning, if and when it occurred in an authentic professional development context.
The challenge remained however, to establish an ethical professional learning context in which collective learning, a phenomenon renowned for its subtlety and ambiguity (Stahl, 2006) could be elicited, recognised and analysed.

In this regard, a series of *design* principles were distilled from the ethical and theoretical principles already summarised. The case study should include:

1. Collective intentionality: whereby individual learners shared a purpose and thus formed collectives, with the possibility of those collectives also having a shared purpose.
2. Nested and Coupled Agency: incorporating a proscriptive strategy to professional learning that supported the transfer and democratically-principled negotiation of learning across various levels of a network and across various populations (including teacher educators and researchers).
3. Emergent System Development: whereby the professional network had the potential to shift its structure and organisation on the basis of emergent (and thus uncertain) strategies of its various agents, without overbearing constraint from external forces.

In the following section, design-based research will be presented as an appropriate means of achieving these requirements for a case study of collective learning.

4.2 Design-based Research as Principled Case Studies

Design-based research (after the ‘experimental design’ of Brown, 1992) integrates empirical investigation with experimental system design, thus combining theory development with pragmatic innovation in education (The Design-based Research Collective, 2003, p. 5). The Design-Based Research Collective (2003, p. 6) writes:

> *The intention of design based research in education is to inquire more broadly into the nature of learning in a complex system and to refine generative or predictive theories of learning. Models of successful innovation can be generated through such work -- models, rather than particular artefacts or programs, are the goal.*

So, design-based research provides a powerful strategy for enhancing our understanding of learning within complex educational systems (Linn & Hsi, 2000; Cobb, Confrey, diSessa, Lehrer and Schauble, 2003; Barab and Squire, 2004). In particular, it has proven effective for designing and researching complex online environments for learning and professional development (for example, Barab, MaKinster, Moore, Cunningham, & the ILF Design Team, 2001).

Importantly, design-based approaches permit the case study research of principled educational interventions that utilise multiple populations including teachers, teacher educators, academics, software designers and domain experts. Professional learning (across these populations) and system development (within the intention) requires successful interaction between these various participants, who are typically conceived as co-learning partners or collaborators in the research endeavour. The Design-Based Research Collective (2003, p. 6) state:

> *In design-based research, practitioners and researchers work together to produce meaningful change in contexts of practice (e.g., classrooms, after-school programs, teacher on-line communities). Such collaboration means that goals and design*

constraints are drawn from the local context as well as the researcher's agenda, addressing one concern of many reform efforts.

In effect, in recent years, this has meant that many design-based initiatives have deliberately foregrounded learner agency, emergence and self-organisation (The Design-Based Research Collective, 2003). So, whilst researchers (and teacher educators) may be centrally involved in initial system design, design-based approaches typically aim to establish a *participatory culture* (Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006) for learning or professional development.

Participatory culture, according to Jenkins et al (2006), has five main characteristics, including:

1. Adequate opportunities for expression and civic engagement;
2. High levels of support for creativity and for the sharing of creations with others;
3. Informal novice mentorship by experienced members;
4. Strong regard for the value of member contributions; and a
5. Strong sense of social connection between members, and/or a sense of pride in the creations that are being shared with other members.

Design-based research aims to harness the creativity and sharing that underpins participatory culture in order to design, establish and support innovative systems (The Design-based Research Collective, 2003). In doing so, design-based research extends the wider field of Participatory Design (Clement & Besselaar, 1993) in which innovation typically involves harnessing the knowledge and behaviour of those people who must operate a system, technology or product (for example, Ainsworth & Fleming, 2006; Bodker & Iversen, 2002; Kensing, Simonsen & Bodker; 1998). In design-based initiatives, this typically involves conceiving all participants (whether teachers, teacher educators or researchers) as existing within, and contributing to, a *single* complex system.

Clearly, in this regard, design-based research accommodates the aim of political ecology to establish a *common world* collectively and experimentally (after Latour, 2004). Within this research approach, learning and knowledge building are situated within a single, yet nested system that incorporates the perspectives of a heterogeneous population. Furthermore, collectives (here, teacher collectives) can be afforded a degree of autonomy and agency, in particular, by allowing such collectives to participate in emergent system design and knowledge building. For professional development, such agency presents the opportunity to enact a form of collective learning that incorporates self-organisation.

A design-based approach therefore provides an opportunity to combine a theoretical research agenda with a pragmatic agenda of developing technological environments that can support collective learning in a contemporary and ethical professional development context. In keeping with political ecology, these theoretical and pragmatic agendas need not be conceived as separate, but rather as part of a single agenda to establish collectively the common world.[47]

Moreover, within the heterogeneous population of a design-based research project, it is possible for various sub-groups, or collectives, to contribute to this collective learning. This provides a 'representative assembly' in which subgroups (or collectives) can pursue an experimental integration of their diverse understandings. That is, through a design-based research approach, they could collectively seek to "arrive at an acceptable solution" regarding matters of concern (Latour, 2004, p. 29).

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[47] The integration between pragmatic technological innovation and theoretical development has a long history in the sciences. For example, the fields of astronomy and molecular biology gained exponentially when explanatory frameworks were coupled with advances in technology that expanded the ability to research empirically in these fields, the benefits were exponential (Linn, 2003, Dunbar, 1995). Papert's (1980, p. 11) vision of technologically rich environments as supplying 'objects-to-think-with' made a similar vision explicit for education. In educational research, the explicit nature of communication over the Internet has proven valuable for studying many facets of social learning and community design. Nevertheless, within such online contexts, emergent phenomena such as collective learning remain implicit: something for researchers to carve out of the complex context based on their models or theoretical approaches. However, technologies that seek to capture, and more adequately represent, this collective level offer promise in this regard (Stahl, 2006).

4.3 DESCANT (SciTech): a design-based case study of collective learning

For this study, the DESCANT project (introduced in Chapter 1) provided a design-based case study which had the potential to fulfil the methodological requirements detailed above, as will be demonstrated in this section. In particular, DESCANT's participatory, community-based and experimental orientation provided opportunities to recognise nested agency across various populations of professionals, should collective professional learning occur.

DESCANT utilised a proscriptive professional development strategy for Science and Technology education. For instance, teacher participants would be afforded latitude in discerning their professional learning needs and how best to address these. Yet they would also be supported in this process through interactions with other teachers, consultants, academics, Departmental representatives and various e-learning environments. In such a context, learning outcomes are best conceived as emergent rather than predictable. Baym (1998, p. 49) contends that in such an online environment:

> *It may not be possible to specify the specific factors that will combine to affect [outcomes] in advance of actual interaction, let alone what the impact of those factors will be.*

Baym alludes here to the importance of endogenous system development in design-based professional learning: that is, the materials, practices and understandings "…devised by the local participants "in-action" as part of the enactment" (Tabak, 2004, p. 227). In the DESCANT context, with its participatory strategy, this relates most prominently to the teacher population. Yet, in distinguishing endogenous outcomes of an online community, there is the complementary requirement to recognize exogenous system development.

4.3.1 Recognising Exogenous and Endogenous System Design

Exogenous system design and development involve the perspectives of researchers or external partners, through "…instructional materials, activity structures, or instructional strategies that have been developed for the purposes of the research" (Tabak, 2004, p. 227). In DESCANT, this related to the various subgroups (or collectives) that worked to support the teacher population, including UTS researchers and DET partners and consultants.

Within participatory, design-based research there is typically a blurring of the boundaries between exogenous and endogenous system design, as various parties contribute to the collective's objectives and environmental design (Barab & Squire, 2004). This was particularly the case in DESCANT where the teacher population was afforded the *dominant* role in the e-learning environment, or system, design.[48]

To prepare for an analysis of collective professional learning, it was important to distinguish where exogenous design may have established significant system conditions (Tabak, 2004). Bell (2004) asserts that a failure in this regard represents a weakness of much educational research, stating:

> *Historically, educational anthropology research has produced rich descriptive accounts of everyday action in settings without foregrounding the designed nature of these contexts or activity structures (Bereiter, 2002; Pea, 1993).*

Bell's critique aligns with this study's political ecology and complexity orientation by

[48] It is recognised that this role did not extend to the systemic design of the wider educational system in which these teachers operated. Nevertheless, within the scope of the project, the teachers were afforded a very high degree of autonomy for the design of a professional development strategy and its complementary e-learning environmental context. When a Cohort 1 teacher questioned the extent of this agency at a face-to-face workshop, a senior DET officer responded: "But I'm saying you guys [the teachers] are the key authority that we're looking to for this. I mean if it's important to learning, to your learning and that's what you want other people to see then that's what we're interested in making sure they get access to, in the way YOU want them to get access to. Not necessarily the way we would want. But that's part of what we're trying to get to at this point."

suggesting the need for a more adequate representation of complex educational systems as contexts that are both emergent and designed. Such recognition foregrounds the interventionist agenda underpinning education and professional development. This corresponds to the ethics of political ecology where collective learning and knowledge building is considered a political process of negotiation and collective experimentation.

Accordingly, in preparation for investigating collective learning, the following section distinguishes prominent exogenous design features of Phase 1 DESCANT. This includes an overview of the various subgroups (or collectives) that were established through centralised research design. It also includes a detailed overview of the research timeline established centrally by UTS and DET researchers and partners.

These two overviews help establish the *patterns of interactions* (Axelrod & Cohen, 2000) between DESCANT participants (and with the research environment) that were centrally mandated (or at least strongly encouraged) through exogenous research and project design. Axelrod and Cohen (2000, p. 62) note that:

> *…the events of interest in a [complex] system arise from the interaction of agents with each other and with artifacts.*

Accordingly, identifying exogenous dimensions of DESCANT that may have influenced patterns of interaction between (collective) agents is conceived as an important preliminary strategy for understanding the more decentralised, endogenous patterns of interaction.[49]

4.3.2 Exogenous System Design in Phase 1 DESCANT

Two factors are used to discuss exogenous system design in DESCANT: Agent proximity and activation (after Axelrod & Cohen, 2000).

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[49] This strategy aligns with the previous discussion (see 4.1) of affording significance to ecological attachments and associations.

(Collective) Agent Proximity

DESCANT's research design in Phase 1 influenced the *proximity* (Axelrod & Cohen, 2000) and cohesion of participants by establishing, or utilising, a range of groups. Each of these groups was associated (through the research and project design) with various *collective* purposes and agendas.

The section below establishes some speculative so-called collectives, with minimal initial justification. In line with complexity sensibilities (as detailed in Section 2.2), each of these collectives can then be conceived as an agent in its own right: a potential learner. I therefore use exogenous system design in Phase 1, to recognise how the centralised design of researchers and partners established the collective agents that will be analysed for their learning behaviour and capability in subsequent chapters.[50]

Cohort Group

All Phase 1 teachers were grouped together as a single population of participants: Cohort 1. These teachers shared an online working environment, and met together at face-to-face workshops. The Cohort 1 population were thus afforded a close proximity as individual agents within the project. Their contributions, ideas and designs were accessible to each other, thus dynamically influencing the learning environment within which these participants were operating.

The group's cohesion as a participatory design group may also have established proximity between Cohort 1 participants. All Phase 1 teachers shared an identity as Cohort 1 members, and a purpose related to that identity: that is, to collectively design an e-learning environment based on what they considered, as a cohort, to be effective e-mediated professional learning. This *we-intentionality* (Searle, 1995; Plotkin, 2003) may have

[50] Given the participatory and emergent nature of the project, Phase 2 exogenous design is detailed in Chapter 4, thus allowing this report a chronological description.

influenced the level of cohesion within the group, and similarly, their patterns of engagement as a collective.[51]

The Phase 1 teacher population will therefore be referred to as the *Cohort collective*.

School-based groups

Where possible, pairs (or trios) of teacher participants were established in schools. This decision led to the formation of school-based teacher groups within Phase 1. Teachers within these school-based groups were afforded the opportunity of close proximity to at least one other DESCANT participant.

These localised professional development groups will therefore be referred to as *school-based collectives*.

Moderator group

A moderator group consisting of UTS and DET associates was conceived as providing the main support for Phase 1 teachers, especially during their online participation. Whilst membership of this group remained flexible, the use of moderators introduced a further subgroup into the DESCANT project. Given the need to develop collective strategies and plans for undertaking their moderating role, members of this subgroup required close proximity to each other throughout the project. Face-to-face meetings and online communications were the main vehicles for maintaining this proximity.

This subgroup will therefore be referred to as the *Moderator collective*.

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[51] Hoadley and Kilner (2005, p. 34) noted in relation to knowledge-building communities: "Shared purpose, indeed, is a defining factor in collaboration and community. It alone has the ability to relate everything that occurs within the community, and shared purpose is a giant step to generating trust and connections."

Partners/Steering Group

The design-based research partnership between the DET and UTS required an overarching strategic and managerial layer to the DESCANT project. This necessitated the creation of a Partners/Steering group. This organisational structure undoubtedly influenced the proximity between members of these two organizations. For example, throughout the DESCANT project, frequent dialogue was undertaken between DET and UTS participants.

The DET and UTS partnership group will therefore be referred to as the *Partners collective*.

Partners Subgroup Collectives

It is recognised that members of the Partners Collective had affiliations to other groups, or collectives, often related to their employment and research agendas. For example, UTS members of the Partners Collective were simultaneously identified with a research group with a history of research into Science and Technology education. This subgroup will therefore be described as the *UTS collective.* Similarly, executive employees of the DET can be considered as a subgroup, and will therefore be described as the *DET collective.*

(Collective) Agent Activation

During the recruitment sessions, and again in the Introductory Workshop, the goals of the DESCANT project were discussed with teacher participants. During this process, the expectations for participation in DESCANT were made clear to the prospective participating teachers. Expectations regarding the project timeframe were also made explicit to teacher participants, and represent an important mechanism through which the Partners collective sought to influence the timing of individual and collective activity.

In Phase 1, the timing of activities undertaken by collective agents in DESCANT was therefore governed to some extent by decisions made centrally by the Partners collective.

This timeline, although conceived as flexible, reified a number of expectations for teacher participation in the project. In doing so, this exogenous design undoubtedly influenced when (collective) agents undertook particular activities: that is, it influenced their patterns of activation (Axelrod & Cohen, 2000) throughout Phase 1.

The sequencing of events, or activation, in a complex system is conceived as an important feature of system development, given its temporal and dynamic nature (Thelen & Smith, 1994). Axelrod and Cohen (2000, p. 75) write:

> *"If [an interaction] takes place before events that it would otherwise have followed, it may change the character or likelihood of those events. The system can have an entirely different history as a result.*

Thus, whilst endogenous patterns of activation form an importance dimension of understanding self-organised and emergent collective learning in DESCANT, the exogenous sequencing of events that underpinned the research and project's design, is conceived as fundamental to the *dynamic*, and *nested* nature of that learning.[52]

The DESCANT timeline for Phase 1 below aims to makes explicit, to some extent, the influence of exogenous design (in particular project planning) on the temporal dimension of the professional behaviour and learning described in this study.

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[52] Thelen (2005, p. 262) articulates well the relevance of temporal ordering or activation to the dynamic nature of a complex system in stating: "… patterns that self-organize from multiple components can be complex, but they are always continuous in time. In the language of complexity theory, dynamic means that the state of the system at any time depends on its previous states and is the starting point for future states. Continuity of process applies to components at many different levels of organization…"

DESCANT Timeline: Phase 1.

Introductory Workshop: Cohort 1 (4th August 2003)

All Cohort 1 teachers met for the first time to attend a preliminary workshop at one of the district offices. The workshop was planned and facilitated by representatives of the UTS (Lyn and Lachlan) and DET (James and Louise, and Gill) collectives.[53] Following the workshop plan (Appendix 1.1), the group:

- Talked informally and then formally about learning and teaching generally and learning, teaching and professional development in science and technology in particular.
- Were acquainted with the DET Webboard, which was to be the mainstay of conversation and communication for the DESCANT community in planned conversations leading up to and beyond the conception of their e-learning environment.
- Were introduced to the Generative Virtual Classroom (GVC) – an e-learning environment that Lyn had developed and used in teacher education (see Appendix 2.1). The GVC was to occupy a central role in DESCANT's research design. Through their immersion in the GVC and Webboard, teachers gained their first "objects-to-think-with" (after Papert, 1980) about e-learning environments and their potential role in professional development.[54]

[53] With the exception of the Moderator collective (Lyn, Gill and myself), pseudonyms are used throughout this study, to protect the identity of members of the DESCANT Partners group (see Appendix 3.4). The study's ethical protocols and use of pseudonyms are detailed in 5.8 below.
[54] Subsequent e-learning 'objects-to-think-with' were available through a virtual excursion to other e-learning environments. These planned experiences deliberately addressed the risk that without clarity about new paradigms or educational media, teachers might design an e-learning environment that "[filled] in the grey areas based on their existing understandings and practices" (Stein, Smith and Silver, 1999, p. 950).

Online Immersion (August to October 2003)

Following the Introductory Workshop, Cohort 1 teachers were expected to engage online with DESCANT (and its population) as the main basis of their professional development and as a means of moving towards the collective design goals. DESCANT Partners, and associates (namely, the Science and Technology Consultant, Gill, and myself, as Doctoral researcher) developed a flexible timeline of topics for this purpose, thus representing an exogenous design within this online immersion (see Appendix 1.2). These targeted topics included:

- Student learning in Science and Technology;
- Professional development related to Science and Technology education;
- Technology; and
- Professional development in Science and Technology, using e-learning contexts.

Cohort 1 teachers were encouraged, through online prompts, to discuss these dimensions of professional learning. Furthermore, the various e-learning environments, particularly the GVC, provided a support and, in some cases, a medium for the teachers' learning surrounding these subjects, as well as a common point of reference.[55]

1st Design Workshop (15th October 2003)

A second face-to-face workshop, the 1st Design Workshop, was held to develop an initial design for an e-learning environment that could support professional development in Science and Technology education. Beyond the regular DET and UTS participants, two senior Information Technology (IT) Directorate officers from the DET attended the workshop in order to support the teachers in their e-learning design.

[55] A more specific description of these activities is provided in Chapter 5 as a means of contextualising transcripts and analysis. The overview here, however, provides contextual information for thinking about how the emergent outcomes of the project (discussed within analysis in Chapters 6, 7, 8, 9 and 10) may have been influenced by exogenous design.

Once again, the workshop was planned and facilitated by UTS and DET Partners, DESCANT's Science and Technology Consultant, and myself. Following the workshop plan (see Appendix 1.3), the group:

- Discussed the theoretical basis of the GVC and a companion e-learning environment, *Where does the cold come from?*
- Worked to distil their highest priority purposes for the e-learning environment they were to conceive and some indicators by which they could gauge whether these purposes had been achieved; and
- Conceived, in first draft, the design of their e-learning environment for teacher professional development in science and technology education.[56]

Online and School-based Design Period (16th October- 28th November 2003)

Subsequent to the Design Workshop, teachers returned to their schools to put together materials for their e-learning environment. This process was supported online within the Webboard. There, teachers posted and discussed their ideas and how they were enacting them in their school-based contexts. The teachers undertook to submit these materials to the UTS members of the DESCANT team by year's end. Meanwhile, software development began on the teachers' e-learning design.[57]

2nd Design Workshop (10th May 2004)

A second design workshop was held to firm up the group's e-learning design. In order to support their design process, a local primary teacher who was experienced in software design attended the workshop. Again, DESCANT Partners and associates developed a timetable for the workshop (see Appendix 1.5). Based on this plan, the group:

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[56] The day's work was supported by a folder of materials including summaries of the group's Webboard discussions (see Appendix 1.4). Participants also reviewed summaries of other e-learning environments being used for teacher and student learning elsewhere in the world. The group had already visited some of these environments during 'virtual excursions' held during the online immersion.

[57] The teachers' e-learning environment was developed by Janison, an Australian software development company. (See http://www.janison.com.au)

- Watched a documentary (*The Man Who Made Up His Mind*) related to scientific theories of learning, discussing how its insights might be used within their design;
- Shared the work they had completed and that would be contributed to the new e-learning environment, using this discussion to further the work of those who had yet to complete their contributions; and
- Further developed the structure and content of their e-learning design.

Final Design Workshop (14th March 2005)

On the completion of the first prototype of the e-learning environment, Cohort 1 participants attended a final workshop where they tested the prototype environment and discussed its strengths and weaknesses. This workshop led to minor changes in the design, in preparation for its use in Phase 2. Participants also utilised the workshop to complete their contributions to the environment, a process that was facilitated by their first-hand experience of the software.[58]

In this and previous sections I have identified where exogenous project and research design may have influenced the proximity and activation of DESCANT participants. In the following section, I offset this binary distinction by recognising my complicit role as both researcher and co-learner.

4.3.3 Researcher as Participant-Observer

Recognising and interpreting an uncertain and subtle phenomenon such as collective learning required an intimate familiarity with the educational dimensions of the case study. In education, anthropological approaches in which the researcher becomes both an observer and an active participant have proven particularly useful for gaining insight into online communities that are characterised by unpredictability, emergent behaviour and uncertainty

[58] Phase 2 of DESCANT began two weeks after this final design workshop. The timeline of this second stage of the project is provided in Chapter 7.

(for example, Kendall, 1999; Kolko & Reid, 1998).

By becoming immersed in the research context as a participant, researchers gain a privileged perspective on patterns of interaction (Axelrod & Cohen, 2000) and in particular, the meaning making that may underpin educational process and learning (Havelock, 2004). Moreover, by incorporating knowledge derived from other contexts and sources, the researcher may further enhance their emic perspective whilst ensuring a degree of criticality and reflection is maintained (Havelock, 2004).

For investigating collective learning within DESCANT (as a community-based model of professional development) it was necessary then to establish the complicit nature of my participation as a researcher and co-learner. As an authentic member of a professional development collective, my own knowledge and perspectives as an educator and researcher, became a resource for the collective learning of the entire population, rather than being simply a basis for my research objectives.

This distinguishes a community-based methodology from traditional anthropological strategies where a researcher's authentic beliefs and understandings may be largely withheld from discourse in the research context: at times, out of 'respectful contempt' for the understanding of a local population (Latour, 2004). Wolcott (1992, p. 20) notes:

> *…most so-called participant observer studies in education warrant the label only in the sense that the researcher was physically present. "Outside" researchers seldom become involved as genuine participants in educational settings, and they are inclined to express ambivalence as to whether or not their own involvement is desirable or even acceptable.*

Political ecology argues for a more democratic and authentic discourse between researchers and participants, where emic and etic distinctions may become blurred as a *common world* is developed (Latour, 2004). Accordingly, I sought to participate in the DESCANT context on the basis of my authentic understandings: as a diplomat for those perspectives, and the collective perspectives of my own UTS research group.

This perspective aligns with other ecological methodologies. For instance, Cavallo (2005, p. 98) and fellow MIT researchers utilised their exogenous position as researchers as an important source of novelty within a complex educational system, stating:

> *…we are not passive observers: we design and introduce new variants along certain principles and see how well they grow… Our role as the exogenous element in conducting the learning projects is to show the existence of a new way of instantiating dynamic learning environments. We bring in powerful ideas about learning and through our practice illustrate how to put them to work.*

This approach is typical of the researcher-intervention underpinning many design-based research initiatives. Aligning with complex systems sensibilities, researchers and participants alike are viewed in these approaches as complicit in the emergence of new system design, innovation and knowledge.[59]

For this study, recognising and leveraging my complicit involvement and that of all other DESCANT participants in any collective learning that was documented required a methodology of suitable scope and design.

Throughout 4.3, I have sought to make explicit the manner in which centrally planned project design may have influenced the interactions taking place within the DESCANT context. This exogenous design, however, is not conceived as determining patterns of interaction, but only influencing, or triggering, internally developed patterns. As will be shown in the following chapter, teacher participants and their cohort group, responded to these external design requirements with high levels of personal and collective agency. Thus, from the very beginning of Phase 1, the system was modified by internal, and emergent patterns of interaction and engagement.

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[59] In this sense, an interventionist and participatory strategy, based on complexity sensibilities, circumvents methodological concerns regarding the reactivity of participants to the research and the investigator(s), a problem that is described by Bryman (1999, p. 52) as “the most striking problem” to beset quantitative and qualitative researchers.

Here in Chapter 4, I have established a principled basis by which to develop this study's methodology. In the following chapter I provide details of my research design, as enactment of these principles.

Chapter 5
Research Methodology

In Chapters 2, 3 and 4, a learning ecology orientation towards the research design and methodology of this investigation was established, using political ecology and complexity sensibilities. A tentative theoretical orientation towards investigating collective learning was also established by way of a starting point: one that met those ethical and theoretical challenges identified. DESCANT (SciTech) was identified as an appropriate research context for studying collective learning within a democratic, theoretically principled and pragmatic professional learning context.

In Chapter 5, specific details of the research design that emerged will be described.

5.1 Research Questions: an emergent strategy

The development of a tentative research question served to progress early research design:

> *How does collective learning occur in a technologically rich teacher professional development context, focusing on Science and Technology education?*

Yet given the uncertainties surrounding collective learning in teacher professional development, research questions and constructs were developed cautiously, as an iterative and emergent process (Eisenhardt, 1999). This strategy was successfully utilised by Bettenhausen and Murnighan (1986 cited in Eisenhardt, 1999) within their study of group learning where unforeseen group behaviour suggested that a shift from theory-testing to theory-development was necessary.

A flexible approach to the generation of research questions may be particularly relevant to participatory case studies, where research questions may emerge in response to the interests and concerns of participants. Accordingly, this study poses a range of research questions, each associated with the core research question above. As these secondary research questions emerged largely through formative analysis they are documented, not here, but rather in Chapter 4 and following chapters, as part of the study's data analysis.

5.2 Participant Selection

Establishing a research population within design-based research need not involve targeted sampling beyond that which is appropriate for generating or supporting the particular system in question. The focus then, moves from restricting or limiting types of participants, to documenting and understanding the diversity of the population that exists in the system. In this regard, the approach adopts a form of population analysis common to biology and ecology (Cockburn, 1991). Eminent biologist, Mayr (1988, p. 15) noted of this shift:

> *For those who have accepted population thinking, the variation from individual to individual within the population is the reality of nature, whereas the mean value (the "type") is only a statistical abstraction.*

Accordingly, within DESCANT's recruitment process, a loose criterion for participation was applied.

<u>Phase 1</u>

In Phase 1 of DESCANT, two rural NSW school districts were selected to initiate the DESCANT project, in recognition of DET's strong interests in remote and rural education and to test the project approach's potential in this context. Gill, the Science and Technology consultant in these two districts, called for expressions of interest from schools known to her, thus leveraging existing networks.[60] The aim was to establish a network of about five participant schools, with two self-nominated teachers in each school.

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[60] It is recognised that this pragmatic strategy may have influenced the outcomes in Phase 1. For instance, all Cohort 1 teachers came into the project having previously worked with Gill (as regional Science and Technology consultant). Given the teachers' obvious appreciation of Gill's consultancy in the past, this is likely to have provided teachers with a degree of confidence in the DESCANT project.

Information and recruitment sessions were held in the targeted districts. Researchers explained that participation in DESCANT would engage teachers with activities (mainly by immersion in a range of e-learning environments and through web-mediated discussion in the DESCANT community) designed to support their conception and subsequent prototyping of an e-learning environment for teacher professional development in K-6 science and technology education.

Eleven teachers volunteered to participate, in six schools – one deputy principal considered the project so interesting that he asked to participate without funding, alongside two funded members of his staff. In all schools, except two, there were at least two participant teachers – and in the remaining two schools, small country schools relatively close together, two teachers agreed to work collaboratively.

As expected, preliminary conversations with new participants revealed a broad cross-section of attitudes, capabilities and experiences with regards to Science and Technology education.[61] The majority of participants expressed a lack of confidence in teaching Science and Technology. Only one teacher, Sally, had taught the subject frequently, yet she too expressed a willingness to improve her capabilities in this regard.

Phase 2

In Phase 2, the aim was to establish two simultaneous cohorts of teachers, thus providing a means of engaging multiple populations with the newly developed e-learning environment. It was expected that each cohort would range from between 10 to 20 teachers. Whilst representing a scaling-up of the project, this relatively small Phase 2 strategy supported, once again, a resource intensive research trial.[62]

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[61] As part of the wider DESCANT research agenda, preliminary conversations were undertaken with all participants in their own school contexts. These conversations contributed to a general understanding of the teachers' learning objectives and attitudes to Science and Technology. Yet, whilst they became data for the wider DESCANT project, they are not used explicitly within this study. Instead, this study focuses on data gathered from the *collective* engagement of participants with their cohort. It is recognised however, that this wider corpus of data provided useful referential possibilities for the analysis contained in this study.

[62] Papert (1973) recommends that innovative educational interventions be undertaken in a resource-intensive manner so as to establish an adequate test of the strategy. He notes that, if the educational strategy succeeds

Three new NSW school districts were targeted for Phase 2 recruitment: two rural and one metropolitan. Again DET consultants in these districts assisted in informing potential participants of the project, with the same criteria being applied for eligibility. To expand this process, DESCANT Partners also utilised other DET networks and known contacts to inform potential participants. Project and research information was posted to interested parties who could contact DESCANT Partners or their district consultants for more details.[63] Interested teachers then attended a face-to-face Introductory Workshop in their school district, where recruitment procedures were formalised.[64]

Again preliminary discussions with the Phase 2 participants indicated they came to the project with a wide range of competencies regarding Science and Technology education.

5.3 Data Gathering within Professional Development: an integrated knowledge-building context

Harlen and Doubler (2004) describe how data gathering requirements may be integrated with professional development dimensions of a project. In their study of online teacher professional development (detailed in Chapter 1), participant reflections served both as a basis for professional dialogue and a source of data for research purposes. This reflects a community-based orientation to professional learning, in which various parties (for example, researchers and teachers) work together to pursue collective goals, whilst simultaneously pursuing learning goals related to their particular domain.

Similarly, data gathering processes in this study sought to align, where possible, with the professional development processes of DESCANT. There existed therefore a strong

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then iterative trials may determine which resources are essential. However if the initial well-resourced trial fails then, according to Papert, it is almost certain that a vastly different approach is necessary.

[63] The face-to-face information and recruitment strategy of Phase 1 was not possible in Phase 2 due to logistic and time constraints.

[64] The first of these Introductory Workshops was held on the 29th March. Due to logistical delays the second and third workshops were not held until June (1st and 6th). Nevertheless, the flexibility of the DESCANT timeline meant that all participants finished their participation at the same time, thus allowing the earlier recruits some extra time for online immersion in the new prototype environment.

symbiosis between the DESCANT project's professional development dimensions and its research base. At times, various learning activities undertaken by teacher participants had a clear research orientation. At other times, activities that were chiefly designed for research purposes emerged as professional development activities, as participants and other DESCANT participants pursued their learning objectives together.

5.3.1 Sources of Data

Eisner (1998, p. 39) notes that "…qualitative studies typically employ multiple forms of evidence, and they persuade by reason." This strategy aligns closely with political ecology (after Latour, 2004) where collective knowledge is developed through increasingly *articulated* propositions. Accordingly, in this study, multiple forms of data were deemed necessary in order to capture the intricacies and multifaceted dynamics of collective learning within the DESCANT context. Similarly, by combining various methods of data gathering, I sought to achieve an *articulation* of professional collective learning that achieved 'ecological validity' (Cicourel, 1982).

<u>Online contributions:</u>

Utilising text-based online communication as data has become a central strategy for analysing and understanding online professional development (Dede et al, 2005). The strategy is, however, a problematic one given the question of authenticity that surrounds disembodied research environments. For instance, Markham (2005, p. 805) asks: "How much does text represent the reality of the person?" A related concern in this respect is the manner in which online text may represent the *embodied* learning of a person, or collective. As Markham (2005) asserts, the manner in which researchers address this methodological dilemma depends on the research focus, and the *conceptual* underpinnings of their research question(s).

Stahl (2006) notes that, in studying computer-based *collaborative* learning, a significant methodological advantage is derived from the *visibility* of collective exchange and knowledge building. Similarly, researchers have recognised online contributions as a central source of data for describing and understanding the *interactions* that form the basis of collaborative online education and learning (Dede et al, 2005). This corresponds well with a complexity orientation, where *patterns of interaction* between agents and their environment, may be conceived as the source of emergent collectivity (Axelrod & Cohen, 2000). In this regard, the patterns of engagement and communication visible through online contributions may be conceived as adequately representing the embodied reality of collective learning.

In DESCANT, online contributions represented the main exchange between cohort members and other DESCANT participants (that is moderators, researchers and partners) outside the face-to-face workshops.[65] These contributions thus constituted specimens or artefacts of the topic of research: that is, they were instances of collective patterns of interaction, as they occurred within the DESCANT context. Through the use of such artefacts "the researcher is in more direct touch with the very object that he or she is investigating" (Perakyla, 2005, p. 869).

In Phase 1 of DESCANT, all online contributions within the GVC and the Webboard were electronically archived for analysis. This represented many months of online dialogue, consisting of hundreds of posts. In Phase 2, all online contributions within the newly developed DESCANT Colony e-learning environment were archived.

Through this data I sought to capture one level of the educational context, collective participation, with ecological validity. It is recognised however, that focusing on online contributions involved black boxing, to a large extent, data related to other nested levels within the complex system of DESCANT, such as individual learning. This is a practical necessity within the study of learning in complex systems where it has been noted, "…an

[65] Occasionally, researchers used emails to communicate privately with individual participants. However these exchanges were, on the whole, logistical and managerial. To the best of my knowledge, participant teachers did not use other means, such as private emails or telephones, to correspond with DESCANT colleagues in other schools.

educational researcher could not possibly account simultaneously for several levels of dynamic activity" (Davis & Sumara, 2006, p. 29).[66]

This is not to imply that individual learning was not represented within online contributions. For instance, many online activities throughout DESCANT encouraged individual participants to articulate (through text or video) their personal views, and understandings as well as their perceived learning throughout DESCANT. In this sense, the online activities generated data similar to that gleaned through informal interviews in which "the researcher can reach areas of reality that would otherwise remain inaccessible such as people's subjective experiences and attitudes (Perakyla, 2005, p. 869)

School-based Conversations:

By Phase 2 of DESCANT, new research concerns had become salient for understanding collective learning in the DESCANT context. Whilst I continued to focus on cohort-based processes and their relationship to wider patterns of collective learning, I increasingly sought to understand how school-based investigations concerning Science and Technology education might be associated with this collective learning. This new concern required an expansion of data sources from those used in Phase 1. Within a case study approach, adjusting data collection based on formative analysis is a recognised means of "prob[ing] particular themes which emerge" (Eisenhardt, 1999, p. 144).

Final conversational interviews with Cohort 2 and Cohort 3 participants were undertaken towards the completion of the project. In most cases, group conversations were conducted in participant schools, in conjunction with research colleagues. In a few cases, where logistics prevented visits, final conversations were undertaken by phone.

[66] In focusing on collective representations (that is, online interactions) rather than the more personal thoughts of individuals, I recognise that what is expressed in these contributions may represent partially formed thoughts (Stahl, 2006) or ideas that have been modified for public consumption. Furthermore, technological mediation is also recognised as influencing the manner in which interactions, including ideas, are represented to the group (Cole, 2007; Stahl, 2006; Hutchins 1996; Vygotsky, 1986). Nevertheless, these factors do not negate the collectivity that emerges on the basis of these communications and interactions.

Where school-based groups had participated in the project, participants were interviewed together. Semi-structured group interviews are recognised as a useful means of producing rich data on participants' perspectives, due to their cumulative and elaborative nature (Fontana & Frey, 2000). Whilst group dynamics (and politics) may influence individual contributions, this study's focus on collective and group dynamics and understandings meant that such a strategy was deemed appropriate.

Both audio and video recording were made of all final conversations. This new source of data in Phase 2 was deemed beneficial given an increasing recognition of the importance of localised, school-based professional development to the DESCANT project.[67] Of course, the data generated within conversations and interviews is the creation of a "collaborative effort" of all participants, including the researcher (Fontana & Frey, 2005, p. 696).

In this study, this recognition is further informed by a political ecology orientation (after Latour, 2004) that situates the educational researcher as a political actor who attempts to *articulate the collective*. Accordingly, the 'collaborative effort' of school-based interviews is ultimately *translated* through the (political, theoretical and pragmatic) position I took as a researcher.

<u>Participant Designs and Designed Artefacts:</u>

Design-based methodologies typically conceive "…learning environments as embodying conjectures about learning" (Sandoval, 2004, p. 2). Accordingly, there is recognition that such learning environments, and the artifacts that are contained within them, may be indicators of theoretical or conceptual positioning. Within participatory approaches such as DESCANT, where participants design environments and artifacts, such designs may therefore serve as indicators of learning, or when developed collaboratively, of collective learning.

[67] Real-time transcripts of the conversations were also developed. Beyond their utility for researchers, these transcripts were given to each school-based group to serve as a first draft for a 'learning journey' document they would contribute to their online cohort. In this way, the final conversations served a number of purposes within DESCANT, both research and project based.

This orientation was particularly relevant within DESCANT where teachers would design an e-learning environment based on their collective understandings and needs as professionals. Furthermore, as an educational environment, the prototype e-learning design would serve to shape the learning of future collectives. This interventionist agenda is often explicit within design-based research methods. For example, Tabak (2004, p. 226) writes:

> *The design aspect involves designing an intervention that reifies a new form of learning to articulate and advance a particular position on learning.*

In seeking to understand collective learning in DESCANT, the teachers' e-learning design thus became another source of data: a reification of any collective position they may have developed. This included any designed artefacts that were developed for the environment, once again conceived as indicators of learning. These participant artefacts were developed both by individuals and groups, and in all cases served a professional development purpose as well as a research purpose.

<u>Face-to-Face Workshops:</u>

Both the Introductory Workshops and the Design Workshops provided rich sources of data for confirming or confounding many emerging insights, or analytical findings. All workshops were recorded by audio and videotape.

5.4 Data Analysis

In this study, a dynamic and emergent analytical framework was developed consisting of two interrelated methodological pillars:

1. Core principles and terminology relating to political ecology and

2. Core principles and terminology related to complex, ecological systems.

The following sections outline how these two pillars became a pragmatic analytical tool.

5.4.1 A Pragmatic Political Ecological Framework:

Latour (2004) does not outline any specific method for enacting political ecology beyond the ‘requirements’ detailed in previous sections. Instead, he leaves the pragmatics of implementation as a matter to be resolved on the basis of the various democratic axioms. Political Ecology provided, however, a conceptual framework through which to interpret data from the DESCANT context. In order to do this, key components of Latour’s framework were used as the basis for interpretation. This led to an analytical approach in which the data set was interrogated for its resonance with the framework of political ecology already described.[68]

5.4.2 A Pragmatic Complexity Framework:

Whilst the scientific status of knowledge emerging from the field of complexity remains contested (Daneke, 2005), complexity is nevertheless increasingly being used to provide a metaphor for interpreting empirical data (Thelen, 2005), providing ‘conceptual tools for qualitative reasoning’ (Jacobson & Wilensky, 2006) and as a mode of thinking. The utility of this field for researchers is emphasised by Davis and Sumara (2006, p. 130) who assert that:

> *…complexity thinking has evolved into a pragmatics of transformation- that is, a framework that offers explicit advice on how to work with, occasion, and effect complexity unities.*

These ‘pragmatics of transformation’ are not associated with authoritarian or centralised control (both of which are conceived as problematic in complex systems) but rather as a

[68] Key terms related to political ecology (after Latour, 2004) are italicised at seminal points through the analysis, in order to emphasise their technical usage.

process of harnessing the dynamics of complexity as a means of achieving systemic goals (Axelrod & Cohen, 2000) and enriching education (Davis & Sumara, 2006).

The Complex Adaptive System framework of Axelrod and Cohen (2000) provided a starting point in this regard. This framework recognises three salient qualities of complex learning systems:

1. *Patterns of interactions* (between agents and with the environment);
2. *Variation* (between agents and populations of agents); and
3. *Processes of selection* (that effect changes in the complex system).

This framework provided a set of initial categories by which to interrogate the emerging data set, over time, for qualities related to nested levels of learning (thus collective learning) within DESCANT.

By itself, the Complex Adaptive System Framework is not explanatory, but rather was developed by Axelrod and Cohen (2000) as a means of discussing, engaging with, and improving, complex adaptive systems. The framework thus provided a coherent, utilitarian set of concepts and terminology that capture ‘a way of looking at the world’ (Axelrod & Cohen, 2000, p. xvi) based on extensive research into complex adaptive systems (for example, Holland, 1975; March, 1976). Moreover, through the generative design-based methodology, this initial framework could then be refined in response to empirical findings, thus supporting iterative theory-development regarding collective learning in the DESCANT system or network.

Over the course of the project, other salient qualities of complex learning systems and networks became incorporated into the study’s analytical framework by drawing from an increasingly diverse set of models (for example, Davis & Sumara, 2006; Csemely, 2006; Wright, 1931; Kauffman & Weinberger, 1989). Also utilised in this respect were biological and ecological conceptions of learning (for example, Maturana & Varela, 1987; Plotkin, 1994; Schaverien & Cosgrove, 1999, 2000).

As noted in Section 3.1, there exists strong correspondence between the complexity notion of self-organisation and widely held conceptions of learner autonomy and agency. In the view adopted in this thesis, learning occurs as an adaptive response that changes the relationship between the (collective) agent's structure and the environment in some way (Maturana & Varela, 1987). For instance, if learning occurs in the small cohesive groups within the present study (here, collective entities or agents) then changes can be expected, say, in the form of development of useful understandings, or more efficient means of social communication or knowledge building.

Evidence of collective learning was sought in the form of changed configurations, through *experimental* process. This aligns with political ecology (Latour, 2004) which interprets collective learning as an iterative and experimental process.[69] Such evidence might variously be termed adaptive selection (at various nested levels), or pragmatic experimentation (within a collective forum, or representative assembly), consistently with the theoretical positions adopted here.

Over the course of the study, this emergent analytical framework afforded a dynamic means by which to interrogate the data within formative analysis.[70]

5.4.3 A Learning Ecology: an emergent analytical framework

Initially the political ecology and complexity dimensions of the framework were used separately for purposes of analysis, thus establishing their utility as analytical systems in their own right. An integrated approach was then developed that combined the two approaches into a unified framework, referred to as the *Learning Ecology* framework. This

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[69] Similarly, Cocks (2003, p. 236) contends that, within a social learning system, "changes in social organisation are essentially empirical experiments on a dissipative complex system…Any worthwhile social learning system will be continuously experimenting to improve itself."

[70] In one sense, this strategy reflects aspects of grounded theory (after Glaser & Strauss, 1967) where the use of formative empirical analysis is used to build theory, a strategy which encourages "…researchers to remain close to their studied world and to develop an integrated set of theoretical concepts from their empirical materials…" (Charmaz, 2005, p. 508). However, the strong use of complexity and ecological theoretical frameworks distinguishes this study's emergent analysis from many grounded-theory approaches.

is typical of Design-based research, where *emergent* analytical frameworks commonly form the basis of theory development (The Design-based Research Collective, 2003). At each stage of this process, the analytical framework is tested for its worth in helping understand the phenomenon under investigation.[71] Theory development is thus coupled, in design-based research, to an experimental process, a conception that aligns well with the experimental basis of political ecology.

Accordingly, in this study, the *Learning Ecology* framework was used to formatively interrogate the data set for evidence of collectivity associated with ethical and theoretical dimensions of collective learning. This analysis established, over time, *associations* between the data set and the various qualities of nested (collective) learning in a complex system. These associations became, in essence, the foundation of the study's emergent *articulation* of collective learning in the DESCANT system (after Latour, 2004).

This strategy provided a pragmatic way forward for modelling the DESCANT context as a complex system, with the aim of distinguishing patterns associated with collectivity and learning within that system. In a sense, this is typical of scientific exploration, whereby initial assumptions are made as a means of engaging theoretically within a particular case (Eisenhardt, 1999).[72]

5.5 Strategies for Ensuring Rigour and Ethical Compliance

Whilst all research aims to produce valid and reliable knowledge, any criterion for discerning research quality and credibility is underpinned by theoretical, philosophical, ethical and political positioning (Patton, 2002; Eisner, 1998). Without recourse to a single (positivist or post-modernist) touchstone for establishing research credibility and

[71] Importantly, this phenomenon is not addressed in *isolation* from the ecology of the entire system, but rather as an emergent phenomenon of the entire research-design. In this sense, the experimental approach of design-based research may be distinguished from more traditional experimental approaches.

[72] An example of this strategy is evident in 4.3.2. There, a set of assumptions regarding the existence of collective agents was articulated as a means of testing an agent-based conception of collective learning within the DESCANT system.

legitimacy, it becomes necessary for criteria to be explicitly associated with specific theoretical and epistemological orientations (Patton, 2002).

In the following sections, a range of strategies for ensuring validity and reliability is detailed. Whilst each strategy is associated with this study's orientation, the account includes a summation of how these align with other conceptions of rigour within qualitative research.

5.5.1 Establishing Validity within a Political Ecology

Eisenhart and Howe (1992) present a conception of research validity that relies, not on correspondence to an external, objective reality, but instead, on the persuasion of an argument. Furthermore, they define a valid argument as "…one that is credible in a general as well as a design specific way (Eisenhart & Howe, 1992, p. 655). On this account, the validity of research, or its 'trustworthiness' (Lincoln & Guba, 1985) may be judged by the weight of the argument, and the coherence of the case (Eisner, 1998).[73]

Eisner (1998) notes that the validity of a well argued case and the credibility of persuasion is central to the field of law. Given that our justice system claims to take into account more than the subjectivity of people, the field of law presents a useful metaphor for educational research that seeks to move away from objective claims to truth, yet also values evidence-based perspectives (Eisner, 1998).

This is a conception that corresponds well with Latour's (2004) political ecology. In Political Ecology, evidence to the 'jury' is derived from a range of entities, both human and non-human. Thus claims of validity straddle the objective and subjective realms. As in a courtroom, 'certainty' within political ecology is arrived at through due process: a collective endeavor that always recognises perplexity and ambiguity (Eisner, 1998).

[73] In keeping with this conception, Cronbach (1982) suggests "plausibility" as a measure of validity, thus emphasising the subjectivity of any such measure. Yet, in doing so, Cronbach may understate the rigour of validity in this respect.

Further refining this comparison, Nemirovsky and Alvaro (2004, p. 69) assert that both education and law make strong use of *situated generalisations*, in contrast to the formal generalizations commonly utilized in mathematics and computer programming. The strength, or validity of a situated generalization depends on a *balance* between theory (or interpretation) and evidence: thus corresponding to Latour's assertion that knowledge claims, including theoretical claims, should *remain attached* to the evidence on which they were developed.[74]

The validity of any *articulation* of a proposition (in the expanded Political Ecology sense) may therefore be judged *on its coherence and persuasive power*. One means of establishing this coherence is by incorporating multiple perspectives into the account, a process that may be interpreted as enhancing the ecological validity of the proposition.

5.5.2 Ecological Validity: articulating a proposition through multiple perspectives

Stake (2005) notes that qualitative case studies have typically sought to gain validity by developing coherence between multiple data sources and multiple perspectives, a process known as triangulation (Denzin, 1978).[75] In this view, the validity of a research account may be strengthened through the "structural corroboration" of multiple sources of data or evidence (Eisner, 1998, p. 53), used to develop a particular interpretation or theoretical claim.

In this study, a similar basis for validity is sought through the requirements of *political ecology*. This orientation conceives that increasing articulation is gained through the incorporation of a range of *voices*: some human (for example, participants and researchers) and some non-human (for example, primary data derived through technological means).

[74] For political reasons, Latour also advocates a similar process for formal generalisations. By keeping the evidence for these generalisations associated with the theory, the collective can recognise the 'ecology' that has given them articulation.

[75] Seeking a more adequate metaphor in this regard, Janesick (2000, p. 392) notes that contemporary qualitative research often seek to "move on from plane geometry [that is, triangulation] to the new physics" by utilising the metaphor of a crystal (after Richardson, 1994).

Thus, Latour (2004) uses the concept of 'reliable witness' to transcend the more conventional distinction between empirical data and those who 'translate' that data into evidence, in support of, or opposition to, specific propositions. The concept of 'reliable witness' thus:

> *…designates situations capable of testing the faithfulness of representations, in the knowledge that the distribution between what speaks and what does not speak is no longer definitive and that there are just spokespersons whom one doubts… (Latour, 2004, p. 248).*

Accordingly, this study incorporated a range of 'voices', both human and non-human through both its design and dissemination. In doing so, it sought to develop an articulation of collective learning that incorporated *collaborative, and evidence-based analysis over time*. Each facet of this strategy assisted in promoting validity within the study's findings. For instance:

- *Sustained collaboration with all research participants, including other researchers* allowed for synergistic insight to be developed and utilised within formative analysis. [76] In this respect, the emerging insights into collective and community-based learning in DESCANT were regularly discussed with the research population, in the course of online discussions. This reflects a conception of 'researcher as diplomat': whereby there is *sincere* communication with research participants.[77] In design-based research this participatory strategy is recognised as a means of developing "validity of findings [through]…partnerships and iterations…which result in increasing alignment of theory, design, practice, practice and measurement

[76] Rather than attempt to develop uniformity between researchers' observations and interpretations, these idiosyncrasies were utilized as a means of harnessing a range of perspectives emerging from experienced colleagues. Of this strategy Eisner (1998, p. 34-35) notes: "Rather than regarding uniformity and standardization as the summum bonum, educational criticism views unique insight as the higher good." This recognises that consensus within participatory analysis need not mean objectivity. Eisner (1998, p. 47) notes that "…consensus provides no purchase on reality, it merely demonstrates that people can agree." Instead then, validity is gained through persuasion within a democratic arena that affords due process (after Latour, 2004).

[77] Thus individual perspective was offset by use of empirical evidence and detailed reason (Eisner, 1998).

over time.” (The Design-Based Collective, 2003, p. 7).

- *Formative analysis over many years* supported a gradual shift from “primary epistemic seeing”, where the focus is on developing awareness *of particulars* in the data, to “secondary epistemic seeing”, where these particulars are increasingly conceived as members of a larger set (Eisner, 1998, p. 68). This iterative strategy that has been noted as a strength in ethnographical traditions by supporting strong internal validity within research findings (Bryman, 1999). From a political ecology perspective, this represented a process by which certain *associations* between data and theory became strengthened whilst others weakened.[78] Moreover, it supported the political ecology requirement to *maintain perplexity* (Latour, 2004). An effort was made therefore, to maintain a critical stance towards any research findings, a process that required the continual search for discrepant data that suggested analytical modifications may be necessary.[79]

- *Incorporating multiple sources and types of data* allowed for a triangulation of evidence that could (in keeping with design-based methods) “connect intended and unintended outcomes to processes of enactment.” (The Design-based Collective, 2003). This strategy helps to strengthen the ecological validity of research findings by incorporating data that may reside outside “researchers’ tacitly held assumptions” (The Design-based Collective, 2003). In conjunction with collaborative data analysis, this helps ensure that new insights may be derived from complications to existing understandings or interpretations.[80]

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[78] This is a conception of formative analysis that deliberately parallels conceptions of learning in complex systems at various levels, for instance, in neuronal dynamics in the brain (Edelman, 1992, 1993) and in scientific knowledge building (Popper, 1968, 1970). As such, the analysis aligns with the generative theory of learning (after Schaverien & Cosgrove, 1999, 2000), as detailed in 3.2

[79] Once again, this conception aligns with a complexity orientation of a learning system where it is commonly conceived that an open system must remain off-balance.

[80] In this regard, Eisenhardt (1999, p. 154) contends that, within case studies “…creative insight often arises from the juxtaposition of contradictory or paradoxical evidence…[forcing] individuals to reframe perceptions into a new gestalt. Building theory from case studies centres directly on this kind of juxtaposition. That is, attempts to reconcile evidence across cases, types of data, and different investigators, and between cases and literature increase the likelihood of creative reframing into a new theoretical vision.”

- *Associating first hand evidence with theoretical reasoning* offset the idiosyncratic, or "individual" nature of the study's findings (Eisner, 1998, p. 35). For instance, the incorporation of primary data such as transcripts, video excerpts and designed artefacts provides an articulation of collective learning that may be interrogated more adequately by others, both within and outside the project.[81] This supports others in assessing whether evidence adequately supports interpretation.[82]

5.6 Data Selection and Dissemination

Data excerpts were chosen to correspond with the study's aim of gaining insight into *professional learning* at a collective level. A series of data excerpts was therefore chosen that would allow detailed examination of the collective professional learning that occurred, as it related to *science and technology professional development.*

Targeting professional learning that related *specifically* to a subject domain (that is Science and Technology education) was deemed an important dimension of this research strategy. Whilst many researchers have addressed the social and cultural dimensions of online collaborative learning (Dede et al, 2005), there remains a paucity of empirical accounts relating to the intellectual dimensions of collective learning: that is, how the intellectual shifts and conceptual developments may have developed within a particular domain.[83]

Whilst the learning of *teacher* participants was the main focus in this regard, there was a deliberate blurring of the boundaries with regard to the professional learning in DESCANT. Tabak (2004, p. 231) writes:

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[81] It is recognised that artefacts such as transcripts are themselves constructions, thus are not objective representations of an event or phenomenon (Stahl, 2006).

[82] This is a central threat to validity as a researcher's conceptual positions may lead them to misconstrue, for instance, "key aspects of the complexity of action or of meaning perspectives held by actors in the setting" (Erickson, 1986, p. 140).

[83] This remains the case even where complexity approaches are adopted. For instance, Davis & Sumara (2006, p. 82) state "…although the number of complexity-informed reports appear to be increasing exponentially within the educational research literature, very few of these writings have taken on the actual phenomenon of emergence, opting most often to examine already-emergent understandings, classrooms, schools, and other systems." In response to this challenge, these researchers focus on the "the generation of knowledge and understandings of the subject matter at hand" (Davis & Sumara, 2006, p. 104), a strategy also adopted in this study of professional collective learning in science and technology education.

In the design-based research literature, there are emerging calls to focus on constructing narratives of change as the products of our field work …it will [therefore] be important to consider who should be the "protagonist" of the narrative…. [rather than focusing on exogenous design] a more profitable approach might attempt to construct multiple intersecting narratives with different local participants, such as students and teachers, as the main characters of the story."

Accordingly, within this study, data vignettes were developed in order to construct 'multiple intersecting narratives' in which *various* collective agents were involved in professional learning surrounding science and technology education, including DET and UTS partners, moderators and researchers.[84]

Ultimately, however, the selection of data and the construction of vignettes is recognised as a means of developing my *own* account of collective learning: as an educational *diplomat* (after Latour, 2004). Through a mix of empirical data and interpretation I sought to *articulate the collective* (after Latour, 2004).

Whilst the analytical framework (discussed in the previous section) offered salient conceptual pillars for the analysis, no rigid template for discussing these concepts is used for dissemination. Instead a discursive approach allows a more flexible (and perhaps ecological) illustration of how conceptual pillars, empirical data and analytical interpretation may help articulate collective learning in this professional development context.[85]

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[84] This corresponds with a complexity orientation to learning, where it is deemed problematic to analyse the learning of a single (collective) agent without recognising the ecological associations with other (collective) agents within the system. Brown (1992, p. 166) emphasises this complexity in discussing the dilemmas of methodological design within research on teacher professional development, stating "Components are rarely isolatable, the whole really is more than the sum of its parts. The learning effects are not even simple interactions, but highly interdependent outcomes of a complex social and cognitive intervention."

[85] The *ecological associations* developed between these heterogenous entities parallel those that are discussed as part of the analysis itself, thus developing a dissemination that has fractal qualities. This emphasises the participatory and democratic underpinnings of the study that situates itself as one of many articulations of learning undertaken within the DESCANT context.

5.7 Possible Weaknesses of this Methodology

Design-based research inherently bears a tension between the *complexity* of the research context and the ability to generate research claims within this context. The Design-based Research Collective (2003, p. 7) notes:

> *[Methodological*] *complications arise from sustained intervention in messy settings. A single, complex intervention (e.g., a 4-week curriculum sequence) might involve hundreds, if not thousands, of discrete designer, researcher, and teacher decisions-hopefully working in concert in an attempt to promote innovative practice. In these situations, causality can be difficult to decipher and disambiguate; all possible factors cannot logistically be equally pursued; precise replication of an intervention is largely impossible; and emergent phenomena regularly lead to new lines of inquiry informed by current theories or models of the phenomena.*

Similarly, for this study, the complexity of the DESCANT context, as a professional development intervention over many years, posed many challenges for developing rigour within research findings. The already documented strategies for enhancing validity and rigour (for instance, using multiple data types and sources, collaboration, and iterative analysis over time) sought to address this challenge. Nevertheless, the complexity of such a context always incorporates a degree of uncertainty.[86]

Furthermore, data selection and dissemination were ultimately *value-based* processes, influenced by my own bias as an individual and researcher. Instead of attempting to minimise this value-basis, an effort was made to *articulate* it as fully as possible. In doing so, I hope that readers can appreciate the bias behind methodological and analytical decisions. Nevertheless, this strategy is limited given that, by definition, a researcher's bias incorporates their blind spots. In this regard, the collaborative and participatory dimensions

[86] This aligns both with a complexity orientation, where the fractal nature of a nested system incorporates a degree of uncertainty, and political ecology, where a recognition of uncertainty is an initial requirement of engaging with the collective.

of the research design, including collaborative analysis with other researchers and participants, provided a means of gaining complementary perspectives.

5.8 Ethical Protocols

Four central procedures, emanating from successful formal applications by the DESCANT project team for approval from the university's Human Research Ethics Committee and the NSW DET's Ethics Procedure, were undertaken to ensure that ethical protocols were maintained at all times:

1. Participants engaged with the research as volunteers and were made aware that they were free to leave the study at any time without consequence.
2. Recruitment procedures involved a detailed information session that sought to inform teachers of the research objectives. This included detailed information sheets that allowed teachers to read about the project and its requirements, in their own time.
3. Upon recruitment, participants were asked to fill out consent forms in accordance with ethical requirements (see Appendix 3.1). All participants agreed to fill out these forms. Parental information sheets (see Appendix 3.2) and consent forms (see Appendix 3.3) were also used where teachers involved students in the project.
4. Participants and schools were ensured of confidentiality where research details and findings are disseminated. Pseudonyms have been used in all such dissemination, including this document (see Appendix 3.4). Whilst this confidentiality was afforded to all participants, some gave consent to disclose their first names in disseminations. Pseudonyms were not used for these participants however surnames have been withheld, as requested.
5. Data from the research will be kept securely in line with agreed ethical protocols.

Here in Chapter 5, I have outlined a principled research design and methodology aimed at describing collective learning and assessing the worth of understanding and theorising that learning in ecological and complexity terms. In the following five chapters I undertake this analysis of collective learning in the DESCANT context.

Chapter 6
Describing and Analysing Learning in Groups I
Exploration in Phase 1 of the DESCANT project

In Chapter 5, I described a Learning Ecology framework as a possible way of meeting some ethical, theoretical and pragmatic challenges of both supporting and then potentially explaining collectivity in the learning of K-6 Science and Technology teachers in the present study. I now consider the worth of this framework as a means of analysing the online investigations of teachers and moderators during Phase 1 of the DESCANT Project. I thus seek to answer the research question:

Can groups of teachers' initial investigation of Science and Technology learning (as a precursor to their e-learning design) be understood as a Learning Ecology?

I undertake this task by analysing data obtained in the initial stages of DESCANT, as Cohort 1 undertook an online immersion. Figure 6.1 shows where this immersion was situated on the DESCANT Project Phase 1 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 1</th></tr>
<tr><td rowspan="2">Introductory workshop</td><td rowspan="2">Online Immersion: GVC & Webboard</td><td rowspan="2">1st Design Workshop & School-based Design Period</td><td>2nd Design Workshop</td><td>Final Design 2nd Design Workshop</td></tr>
<tr><td colspan="2">Participants Upload & Rate Culminating Tasks</td></tr>
<tr><td>4th Aug</td><td>Aug- Oct</td><td>15th Oct- 28th Nov</td><td>10th May</td><td>14th Mar</td></tr>
<tr><td colspan="3">2003</td><td>2004</td><td>2005</td></tr>
</table>

Figure 6.1 Online Immersion: GVC & Webboard (shaded) within the DESCANT Phase 1 Timeline

During their online immersion, Cohort 1 teachers investigated and discussed various aspects of Science and Technology learning and teaching. They did so within two e-learning environments - the Generative Virtual Classroom or GVC, and the Webboard or WB. This process of group investigation was supported and expanded by online moderators.

Their investigation was governed to some extent by a flexible program developed by the moderator group, in conjunction with the DESCANT Partners and Steering Committee

(See Appendix 1.2). Week to week, loose focus topics provided an initial basis for collective engagement. It was the cohort of teachers however, that ultimately decided if, when and how these topics would be addressed.

The data set in this chapter illustrates how a collective dynamic emerged. Each of the five excerpts exemplifies a stage of Cohort 1's collective investigation of learning, an exploration that spanned much of the online immersion period (Figure 6.2).

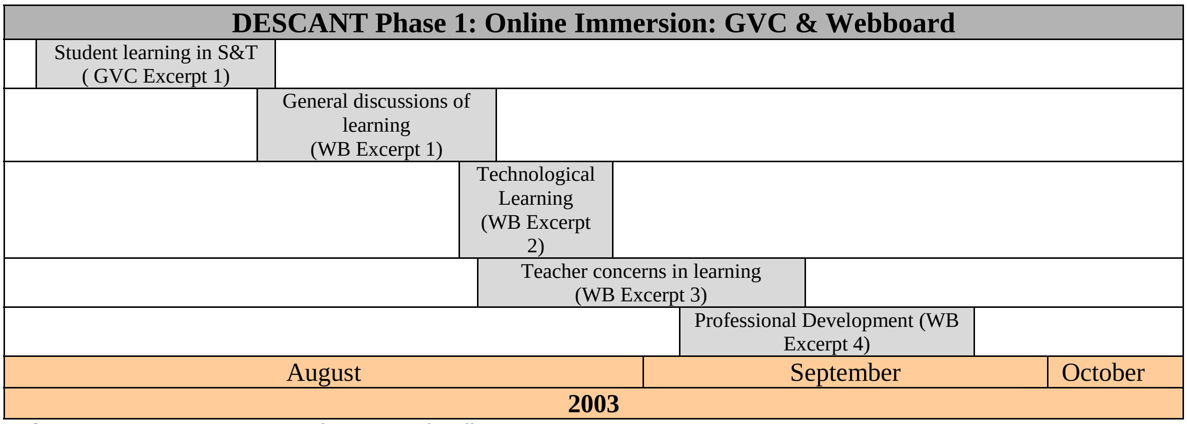

Figure 6.2 Data Excerpts: Chapter 6 Timeline

Initially participants were encouraged by moderators to explore and discuss their understandings of learning in the GVC (GVC Excerpt 1). In this initial period, the group also investigated and discussed learning in a more general sense in the WB environment (WB Excerpt 1). This prepared for a more specific focus, in Week 3, on technological learning (WB Excerpt 2). The teachers were also encouraged to identify and discuss other topics of concern that, as classroom practitioners, they considered of particular importance to their professional learning. Again these discussions often centred on conceptions of learning and their influence on teaching (WB Excerpts 3 & 4).[87]

[87] This online immersion period also included a significant amount of discussion related to matters of design within e-learning environments and professional development. Through this online discussion Cohort 1 teachers prepared for their task of designing an e- learning environment for professional learning. This design dimension of the Phase 1 online e- learning immersion is the subject of analysis in Chapter 7.

Whilst many other subjects and concerns were discussed throughout the immersion period, Cohort 1's investigation of student and teacher learning was to become their priority concern for professional development, hence the selection of these five excerpts.

This data set was also considered an appropriate test of the Learning Ecology framework's response to ethical, theoretical, and pragmatic challenges. During the initial online exploration, DESCANT gave teachers and moderators opportunities to express and discuss their own ideas, understandings and experiences of Science and Technology learning and teaching. This e- learning immersion thus enabled my study of learning in collectives in a technologically rich context that was also democratically principled (Latour, 2004).

Furthermore, a generative theory of learning (Schaverien & Cosgrove 1999; 2000), informed by complexity and ecological sensibilities, predicted that collective learning was likely to occur in situations where individuals, groups and cultures had the opportunity to explore, share and test a range of ideas and behaviours. Finally, data captured from online actions and communications (both here and in subsequent chapters) provides a pragmatic means of *accessing empirical evidence of* collective learning, if or when it occurs (Stahl, 2006).

6.1 Teachers enter the Generative Virtual Classroom

Very early in the DESCANT project, we provided the teachers with the Generative Virtual Classroom (GVC) as an "object-to-think-with" (after Papert, 1980, p. 11) about e-learning mediated Science and Technology professional development.[88] So, teachers' contributions within the GVC enable a first test of the Learning Ecology framework (as detailed in Chapter 5). In testing this framework, I work from first principles, examining whether what occurred can be understood first of all as a political ecology and then as a complex dynamic system.

[88] Appendix 2.1 gives an overview of this e-learning environment.

6.1.1 Can teachers' initial contributions to the Generative Virtual Classroom be understood as contributions within a political ecology?

To address this question, I describe and analyse a short excerpt (GVC Excerpt 1) from the initial stage of the Phase 1 online immersion period.[89] Figure 6.3 locates GVC Excerpt 1 (shaded) in time in DESCANT's Phase 1 Online Immersion.

DESCANT Phase 1 Online Immersion: GVC & Webboard		
Student learning in S&T (GVC Excerpt 1)		
General discussions of learning (WB Except 1)		
Technological Learning (WB Excerpt 2)		
Teacher concerns in learning (WB Excerpt 3)	Teacher concerns in learning (WB Excerpt 3)	
	Professional Development (WB Excerpt 4)	
August	September	October
2003		

Figure 6.3 Locating GVC Excerpt 1 (shaded) in the Timeline of DESCANT's Phase 1 Online Immersion.

This excerpt illustrates the manner in which Cohort 1 teachers contributed to the GVC. As will become clear, only a few teachers engaged significantly online in the GVC. The excerpt therefore provides a comparatively simple data set in which to examine whether their engagement might be understood first as a political ecology, and then as a complex system. As well, as a deliberate plan to engage teachers with a theoretically-principled environment, it allows me to describe ways in which the initial systems design in DESCANT (SciTech) began to mediate teachers' learning.

<u>Excerpt 1: Participants engage with the GVC video 'Alicia and Batteries'</u>

During the initial period of online e-learning immersion, all Cohort 1 participants were expected to engage with the GVC online, contributing their thoughts to its Community Views section. The design of the GVC encourages participants to share observations

[89] In order to distinguish data excerpts from the main body of analysis, each is situated below in a shaded box, with transcripts shown in blue italics.

related to a range of video excerpts, each involving an example of student learning in Science and Technology. I have selected teachers' contributions to one such excerpt, 'Alicia and Batteries', for scrutiny here, though other choices would have sufficed. The selection is representative of the parsimonious yet insightful nature of teacher contributions throughout the GVC.

During the designated period, only four Cohort 1 teachers made public contributions in the GVC: Vaughan, Rob, Sally and Cathie.

Rob was the first to share his observations about how Alicia may be *generating* ideas related to electricity and batteries.[90] He used Alicia's own terms to specify these ideas:

Rob 09/08/2003

Alicia has an idea of "loss" as far as electricity is concerned. This is evident in her observation during the "eternal circuit" discussion. "I think some of it would get burnt off"...

"If there was any (electricity) left over, it would go into the minus [end of the battery].."

The notion that electricity flows back and forth (through the cord of the Mixmaster).[91]

But she states that the circuit she has built is not a representation of this.

Sally then used a list to identify a range of conceptions generated by Alicia in the short video excerpt.

[90] The design of the GVC, encourages participants to interpret student learning through the generative heuristic (generate - test- regenerate). In particular, observations of student learning are recorded within dedicated sections, each corresponding to a stage of generative learning- 'Generating', 'Testing' or 'Regenerating' (see Appendix 2.1). In each of the examples below, participants are making observations they believe to be associated with one of these three stages of generative learning.

[91] 'Mixmaster' is the brand name for a type of food processor or blender.

Sally 10/08/2003

Idea of a circuit.

Expiry date

Electricity in wires and batteries

Using up all electricity

Regenerating electricity -going round and round and not being used

Lights use up electricity

The teachers then shared their conceptions of the *ways children tested their ideas* in the short videos. Rob began by noting that Alicia's investigation of electricity had been influenced by a discussion with her father:

Rob 09/08/2003

Alicia wasn't sure about her Dad's explanation (that there's current in everything) with regard to the Mixmaster.

Playing with her "circuit" is an attempt to make better sense of it.

She states that the circuit she has built is not a representation of her idea that electricity flows back and forth through an appliance cord.

Rob contributed two novel ideas here. Firstly, he emphasised that Alicia was testing an idea that had originated elsewhere: that is, through a conversation with her father. This was an important insight into generative theory, given the common confusion of generative learning with learning by discovery. (It is not the case in generative theory that learners must generate every idea themselves.) Rob's second point was also novel in interpreting Alicia's play with the circuit as a form of testing.[92] This alluded to a *technological* form of

[92] Rob records 'playing with her circuit', as an example of 'testing' (see previous footnote on GVC design).

testing. The other teachers did not conceive Alicia's actions during the excerpt as a form of testing, as is clear from Sally's contribution:

Sally 10/08/2003

No actual tests made, but proposition is there to perhaps test these at a later date.

Vaughan noted the influence of sustained conversation and investigation on the progression of Alicia's ideas.

Vaughan 12/08/2003

It was good to hear Alicia suggest a 'test over time'.
The prospect of varying the investigation by adding more batteries and checking using the light was impressive.
The time provided for deep conversation allowed a thoughtful exploration or investigation of ideas resulting in an idea being discarded such as the determining that it could not go on "for ever and ever". She then recalled her knowledge of the expiry date.

The three teachers then shared their ideas about where there was evidence of progression, or *regeneration* in Alicia's conceptions regarding electricity.

Rob 09/08/2003

The "eternal" circuit - first the electricity would flow forever - then the notion of "loss", followed by consideration of the implications of an expiry date!

Sally 10/08/2003

Talking through ideas, linking this circuit with mixmaster.
You have the feeling that Alicia will continue to ponder the questions she has raised in her own mind.

Vaughan 12/08/2003

The final comment of "worth trying that out too" was a clever link to Alicia choosing the next step for her investigations.

Again there was some diversity evident in the contributions. Whereas Rob identified a progression of Alicia's conception of electricity, Vaughan did return to this as an example of regeneration, even though he alluded to this progression when he wrote about the ways she tested her idea.

Here, Sally, Vaughan and Rob developed a range of ideas and observations related to Alicia's investigation into electricity. In particular, they noted two important conceptual positions on electricity: one related to loss and the other, conservation (or in Sally's words, 'going round and round and not being used'.) In doing so, they had begun to explore, as cohort participants, some of the important conceptual positions students may hold when thinking about electricity. The teachers were supported by the GVC to explore how these conceptual positions may be generated (or formulated), tested and progressed by the students. That is, they were supported in exploring how Alicia's learning may be generative (after Edelman, 1992 and Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000).

However, learning was also occurring for these teachers, not only as individuals, but also collectively. To understand to what extent collective learning might have been occurring, with the help of my Learning Ecology framework, is my first concern. Rob's contributions within this data set will be taken as a case in point, but a similar analysis might have been conducted for Sally's or Vaughan's.

Through his numerous posts in the GVC, Rob contributed strongly to the group's investigation of student learning in Science and Technology. Through his contributions to the 'Alicia and Batteries' section of the GVC, Rob formed associations (in Latour's, 2004 terms) between a range of heterogeneous entities including:

- A *specific instance* of student learning (for example, Alicia playing with a circuit),
- A specific artefact (that is, the 'Alicia and Batteries' video)
- The student's *own* conceptions of these concepts in Science and Technology (for example, Alicia's doubt of her father's scientific understandings),
- Specific language used to express domain ideas about electricity (for example, "loss")
- The generating and testing phases of student learning (as conceived in generative learning theory),

The associations that Rob formed publicly between these entities contributed to the cohort's *articulation* of the phenomenon of student learning in Science and Technology. In particular, they became one basis by which generative student learning in Science and Technology, as a *proposition*, was conceived and described in the DESCANT context.[93]

In order to establish more adequately the basis of this crucial analytical position, each of Rob's associations will now be discussed in some detail.

Alicia plays with a circuit in the GVC video (A specific instance of student learning in a specific artefact)

Through his contribution to the GVC, Rob formed an association between his ideas, and a *specific instance of student learning*, as captured in a *specific artefact* (that is, the GVC video). Here, he discerns within the classroom video, a salient moment regarding Alicia's engagement with electrical circuits:

> *[Alicia] states that the circuit she has built is not a representation of her idea that electricity flows back and forth through an appliance cord.*

[93] Once again, a *proposition* is not conceived by Latour as a 'statement' "that may be true or false: it is used here in a metaphysical sense to designate not a being of the world [that is, a 'fact'] or a linguistic form [that is, a 'representation'] but an association of humans and nonhumans before it becomes a full-fledged member of the collective, an instituted essence" (Latour, 2004, p. 247).

In developing this association, Rob may be conceived as a *spokesperson* that is operating the GVC in order to *articulate* certain distinctions about learning in Science and Technology. Through his interpretation, Rob works to give the video excerpt (an entity), and a specific instance of student learning (an entity) *representation* within the collective process being undertaken in the GVC. Through this representation, these entities become tangibly associated with the cohort's developing conception of student learning in Science and Technology: in particular, generative student learning. Other teachers may not agree with Rob that Alicia's comment above was salient for discussing Science and Technology learning. Nevertheless, this association existed now, however speculative, as a part of the GVC's Community Views.

Alicia's doubt of her father's scientific understandings (The student's own conceptions and descriptions of these concepts in Science and Technology)

Rob's contribution to the GVC also formed an association to the student's own conceptions regarding electricity. For example Rob noted:

> *Alicia has an idea of "loss" as far as electricity is concerned. This is evident in her observation during the "eternal circuit" discussion. "I think some of it would get burnt off...*

Through this contribution, the student's own conceptions in Science and Technology (conceived here as entities) were given *representation*. Furthermore, Rob incorporated the student's own domain related language. For instance he refers to the student's conception of 'loss'. The association between Rob's ideas and domain language (whether developed by the student or the wider scientific community) gave representation to yet another entity as a means of further articulating the *proposition* of (generative) student learning in Science and Technology.

Rob's theoretical interpretation of Alicia's learning of electricity (A specific instance of student learning and the generative theory)

Rob also formed an association between his observations and the generative heuristic *(generate-test-regenerate.)* This association is developed through his willingness to interpret the video excerpts from a generative perspective. For instance, Rob shared his observations relating to the 'tests' Alicia used in qualifying her ideas about electricity and batteries. He articulated a conception of learning that incorporated a technological test of the student's ideas (as she "played with her circuits"), and in doing so, formed a novel association between a specific instance of student learning and a learning theory.

So, viewing this data set in this way highlights both the ecological and political nature of this event. Rob's contributions, as they enter the collective realm, need not be conceived only as a subjective statement made by a participant. Nor need they be conceived as referring to an objective reality that is established prior to political representation. Analysed in this way this event may be conceived more as an ecology that incorporates, or gives representation to, the voices of many heterogeneous entities. This is not a totalising conception of ecology, based on a pre-established unity of nature, but rather a political ecology. It is not meant as an ontological claim, but rather as a means of establishing a process by which to develop knowledge within a collective: to *establish the common world* (Latour, 2004, p. 239.) In Latour's (2005, p. 86) words:

> *Who assembles, who speaks, who decides in political ecology? We now know the answer: neither nature nor humans, but well-articulated…associations of humans and nonhumans, well-formed propositions.*

Thus, teachers' initial immersion as described in this event can be understood as a political ecology. In particular, their contributions may be understood as articulating a proposition (in this case, related to generative student learning) in a probationary sense: that is, as a "candidate entity" (Latour, 2004 p. 169) for collective investigation in DESCANT.

6.1.2. Can teachers' initial contributions to the Generative Virtual Classroom be understood as a learning ecology?

Making explicit the political ecology of this event has demonstrated a method for associating individual contributions with collective processes. Now these collective processes can be interrogated more closely for evidence of a conception of learning that transcends individuals as units of analysis.

By contributing publicly to the GVC, Vaughan, Sally, and Rob used the e-learning environment to generate a pool of ideas regarding student learning in Science and Technology. Through these contributions the teachers offered their cohort (through the Community Views' section) a range of interpretations as to what was salient within the video excerpts. For instance, all three teachers gave salience to Alicia's conceptions of conservation and loss within electrical circuits. This represented an important starting point for the cohort and their collective exploration of student learning in Science and Technology. These three teachers (and Cathie, elsewhere in the GVC) had initiated the beginnings of a collective *articulation* of student learning within the DESCANT context.

This initial conception of student learning had gained *articulation* through the ideas and observations of the teachers, as well as through the associations that were formed to other entities in the DESCANT context (in similar ways to those detailed in the previous section). In this respect, Rob's contributions to the GVC were typical of those by other teachers during the initial online e-learning immersion period of the DESCANT project. Constrained by the design of the GVC, each of these cohort members articulated their ideas using similar associations. These patterns of association prove useful for identifying *collective strategies* that may have been shaping the cohort's collective exploration of student learning in Science and Technology.[94]

[94] As detailed in 3.1, a *collective strategy* is a means by which an agent (in this case a collective agent) responds to its environment based on its goals and intentions. Where DESCANT participants seemed to be responding based on their collective intentionality as a cohort, they may be conceived as exhibiting collective strategies.

For instance, the teachers contributed to their cohort's process of knowledge building by engaging with a collective strategy of *specifying an instance of student learning*. For example, Sally specified how Alicia discussed whether her conceptions of electricity were compatible with her observations of a Mixmaster. Similarly, Vaughan noted that Alicia appeared to move beyond a conception of the electricity "going on for ever and ever." This degree of specificity within the teachers' contributions gave other teachers the *opportunity* to think about how they would interpret this same instance of student learning: that is, what meaning they might associate with this example of student behaviour. It thus provided a common node within the learning ecology: a point of common ground for professional discussion.[95]

The GVC subgroup of teachers (that is, those teachers contributing publicly in this environment) also adopted a collective strategy of focusing on the student's own conceptions in Science and Technology. That is, they discussed Alicia's learning on the basis of the student's own ideas about electrical circuits. Sally noted that Alicia initially adopted a conservation conception of electricity, whilst Vaughan noted that Alicia then appeared to move away from this conception later in the excerpt. The degree of specificity here provided the opportunity for other teachers to engage with the domain ideas related to electricity. Again this provided a common node in the ecology: a point of intersection between the student's own ideas about electricity, the science of electricity, and the teachers' interpretations of student learning as captured in the GVC videos.

As was demonstrated in the previous section, the GVC's structured design provided a degree of support for some of these strategies, whether undertaken collectively or individually. In a sense then, it became a niche within which particular strategies were supported.[96] For instance, it encouraged the teachers to focus on the learners' *ideas*, whilst

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[95] Nemirovsky and Alvaro (2004) conceive of this as a 'grounding' of participant contributions. It is important to note however that this does not mean to imply that there needs to be a commonality of opinion. Quite the opposite. Nemirovsky and Alvaro (2004) emphasise that grounded contributions are powerful because they force participants to adopt new connections.

[96] These strategies were closely associated with the UTS collective, and its academic research perspective (for example, Schaverien, 2003). Thus the GVC may be considered as a niche that supported professional strategies that were associated with a 'global' professional development agenda: that is, an agenda that sought

also encouraging them to utilise a generative interpretation of student learning. Vaughan, Sally and Rob all demonstrated a willingness to adopt these positions, at least temporarily. In doing so, they assigned meaning to Alicia's behaviour, on the basis of both the generative theory and their own interpretations as educators: beginning the process of forming connections between the concepts and values at the heart of a generative approach (as reified within the GVC), and their own understandings and values as experienced teachers.[97] They had, in a sense, begun the process of *establishing a common world* (Latour, 2004) within the DESCANT context.

Yet this was a difficult challenge for the cohort teachers.[98] As already noted, public contributions in the GVC required collective strategies that involved particular ways of interpreting (or articulating) learning. They also encouraged high levels of specificity that made it necessary for participants to engage with the scientific or technological ideas involved. The difficulties teachers faced in the GVC may indicate that these collective strategies may have represented a major shift from those familiar to these teachers.

It is likely that the subgroup of teachers who contributed in the GVC had to temporarily suspend other interpretations of Alicia's learning, so as to trial the utility of a generative perspective: to consider it in a probational sense as a candidate entity. The GVC may then have influenced the cohort's collective exploration by encouraging a 'displacement of point of view' (Latour, 2004).

In this analysis I have demonstrated how the subgroup of teachers in this excerpt *collectively operated* the GVC as a technology for group exploration into student learning. Moreover, this pattern of operation within the GVC initiated the cohort's *collective* exploration into generative student learning in Science and Technology. This pattern of engagement, underpinned as it was by the collective strategies discussed above, generated

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to support professional renewal across in education system, rather than within a particular local context (see 1.2.2).

[97] In a political ecology sense, these understandings and values may be united within the concept of "matters of concern" (Latour, 2004, p. 244) as a means of moving away from the separation between facts (concerning a unified nature) and values (as a measure that is applied *after* facts are established).

[98] Most cohort 1 teachers were later to express their trepidation at contributing publicly to the GVC.

an initial conception of generative student learning, one that was articulated through an ecological association of ideas, interpretations and meanings. It remained, however, an ecology that was not associated explicitly with the majority of the cohort collective at that time. Most teachers had chosen not to respond in this environment, preferring to articulate student learning elsewhere and in association to different meanings, values and collective strategies. These teachers operated the GVC individually or in school-based collectives.

So within this relatively simple excerpt so early in the project, there are emerging signs of a learning system dynamic. The contributing teachers (the GVC subgroup) appeared to be organising around a common conception of student learning in Science and Technology. Given the strong influence of external system factors (that is, project timeline expectations and GVC structure) this is likely to have been an experimental conception for these teachers, an endeavour to collectively test the value of a new theoretical interpretation of student learning. Yet the ecology of ideas and associations that had been generated by these teachers represented a first tentative step towards an interpretation of student learning that incorporated their own perspectives and values as educators, and the new perspectives and values that were now available within the DESCANT context.

It remained to be seen whether this conception of student learning would stand in other learning contexts, such as the Webboard. Furthermore, it is important to emphasise that the ecology detailed above was influenced by the lack of public participation of other cohort members within the GVC context. In this regard, the cohort had responded to the GVC in a way that provided an early indication of its collective autonomy and perhaps also its collective capability within this particular context. Nevertheless, overall the collective process had harnessed an ecological assortment of understandings and values to initiate a subtle shift, or development, in the DESCANT professional development system: a ‘displacement’ (Latour, 2004) relating to the actions of its participants (in particular their collective strategies) and their understandings.

In this sense, the teachers’ initial immersion in the Generative Virtual Classroom might be understood therefore as an embryonic learning ecology.

6.2. Teachers’ Webboard discussions

The Webboard provided teachers with a less structured forum for working online as a professional development group than did the GVC.[99] I describe and analyse here the Webboard contributions of the Phase 1 population, including those of teachers and moderators. Once again, I examine these contributions for evidence of a Learning Ecology.

6.2.1 Can online investigation in the Webboard be understood as a learning ecology?

To address this question, I have selected four data excerpts, each depicting an example of online discussion within the Webboard during the Phase 1 online immersion period (Figure 6.4).

DESCANT Phase 1 Online Immersion		
Student learning in S&T (GVC Excerpt 1)		
General discussions of learning (WB Except 1)		
Technological Learning (WB Excerpt 2)		
Teacher concerns in learning (WB Excerpt 3)		
	Professional Development (WB Excerpt 4)	
August	September	October
2003		

Figure 6.4 Locating WB Excerpts 1 to 4 (shaded) in the Timeline of DESCANT’s Phase 1 Online Immersion

During the online immersion period, moderators worked to provide some structure to the group's investigation. They did so by using thematic questions that encouraged the group (amongst other things) to discuss student learning in Science and Technology, with reference to the GVC videos.

I have selected Webboard (WB) Excerpts 1 and 2 to illustrate the manner in which Cohort 1 teachers responded to these moderator prompts. Webboard Excerpt 1 provides an example of a typical collective response to these moderator prompts, Webboard Excerpt 2 provides an example of a response that was a-typical for this Phase 1 population. Taken as

[99] Webboard is a collaborative message-board environment that offers threaded discussion and real-time chat.

a pair, these excerpts provide a means of describing and analysing Webboard contributions that were closely associated with structured investigation. Whilst the focus for this analysis was on endogenous patterns of learning that may emerge from collectivity within the DESCANT network, I considered it appropriate and necessary to represent the influence of exogenous learning agendas to this investigation.[100]

By contrast, Webboard Excerpts 3 and 4 show how Webboard investigation became increasingly driven by an endogenous dynamic, as teachers and moderators reflected upon and shared perspectives that perhaps only came to light as the online immersion period progressed. In this regard, Webboard Excerpt 3 provides a typical example of the increasingly self-perpetuating Webboard investigation, within which teachers and moderators alike reflected on professional beliefs and concerns about student and teacher learning in Science and Technology education. Webboard Excerpt 4 provides yet another extension of this endogenous investigation, illustrating how the boundary between teacher and moderator became increasingly blurred.

Taken together then, these four excerpts illustrate a gradual shift towards a more participatory or community-driven investigation in the Webboard. By representing the various forms this collective investigation took, the excerpts became an appropriate means by which to test whether Webboard contributions can be understood as part of a learning ecology in DESCANT.

<u>Webboard Excerpt 1: Asking teachers to identify a 'Good Example of Learning,' discussing it on the Webboard</u>

In the first month of Phase 1, the Moderator collective encouraged Cohort 1 teachers to use the Webboard environment to discuss their understandings of student learning in Science

[100] In Section 4.3, I defined exogenous dimensions of DESCANT as those system conditions arising directly from the project's design and timetable (Tabak, 2004). Endogenous dimensions of the project, on the other hand, were defined as the materials, practices and understandings "…devised by the local participants "in-action" as part of the enactment" (Tabak, 2004, p. 227). In making this distinction, it was recognized that both dimensions become increasingly blended within participatory design-based research (Barab & Squire, 2004).

and Technology. The Moderator collective posed a strategic question to encourage teachers to use specific instances of video (from the GVC) as the basis of their discussions.

"Choose a classroom [video] from the GVC you think is a very good example of learning. What do you think learning is and why is this such a good example of it?"

In responding to this question, the cohort developed a range of ideas, most of which related to forms of *teaching* that teachers perceived as facilitating strong learning. For example:

"A good example of learning is a situation that has an end objective in mind with no formal structure as to how that objective will be achieved." (Angela 13/8/2003)

"I've enjoyed watching the GVC videos and they've reinforced one important point for me - children need to be able to freely talk through their ideas, thoughts and feelings on a given topic…How do you manage this in a class of 30 children though??" (Ingrid 19/8/2003)

"To get students able to talk their thoughts through with each other do we need to immerse them early into small group activities?" (Kerrie 20/8/2003)

"We are engaged in good examples of learning when we skill the students in processes that enable them to question effectively, and work cooperatively and collaboratively… All the models on the videos demonstrate: student direction, teachers valuing the efforts and celebrating the progress…" (Vaughan 20/8/2003)

"I think that, at times we need to come in to the children's conversations and make a suggestion, in a round-about way perhaps, for a next step, to avoid frustration level being reached." (Sally 25/8/2003)

As a group, the teachers had generated a pool of ideas and suggestions about student learning. Whilst there was variation within their posts, there was also a degree of commonality. For instance, most agreed that student conversations were important for learning. The teachers suggested various ways to facilitate this type of student engagement. Overall, there was a strong incorporation of classroom dynamics in their posts, mainly in the form of teacher strategies and management.

By incorporating the realities of their day-to-day educational contexts, the teachers were expanding the scope by which learning was described in the DESCANT context. The degree of commonality in this account (and others during this period) seemed to indicate that these teachers were utilising shared understandings and values as educators. That is, they may have been generating a range of responses to the moderator question that were underpinned by shared cultural values.

Certainly, these teachers used concepts and terminology common to school-based professional dialogue, such as objectives, management and cooperative activities. The description of learning that was emerging here may therefore have had a degree of familiarity to these teachers. This familiarity may account for the willingness of some cohort members to contribute in this Webboard forum, whilst remaining silent within the GVC environment where the description of learning represented a 'displacement of point of view' (Latour, 2004).

By this account, the cohort collective seemed to have expanded their collective exploration into student learning, generating responses on the basis of shared values and understandings as professional educators. The dynamics underpinning this process will now be examined more closely for evidence of characteristics of a Learning Ecology.

The DESCANT moderators, through their initial online question, encouraged teachers to describe student learning, by making explicit connections (or associations) to two types of entities: *specific GVC video artefacts* and *specific instances of student learning* as contained in these videos. Despite this encouragement, the teachers largely circumvented this request in their contributions to the Webboard.

In response to the moderator question, the cohort developed their own associations between student learning and a range of classroom-related entities including:

- Learning objectives
- Classroom management
- Small-group activities
- Teacher values regarding student effort
- Teacher suggestions

Although Ingrid and Vaughan loosely associated their contributions with the GVC videos, they immediately associated their descriptions of student behaviour with teaching behaviours, thus moving away from the learning-centred perspective of the GVC. None of the group associated their comments with *specific instances of student learning* that incorporated the student's own conceptual engagement with Science and Technology ideas (the collective strategies prominent within the GVC environment).

Taken together, in the context of this online professional dialogue, the posts may be conceived as contributing to their own heterogenous ecology of associations, ideas and meanings. The resulting ecology was, in some respects, quite different to the one anticipated by the moderators, who had envisaged teachers forming explicit connections to the various GVC entities (for example, *specific instances of student learning*, *specific video artefacts*, and perhaps even generative theory). The teachers had instead articulated explicit associations between student learning and a range of classroom-based entities. In doing so, they had *attached* (in a political ecology sense) the day-to-day pragmatics of being a primary teacher to the investigation and discussion of student learning in DESCANT.

The teachers, as a group, exhibited a *collective strategy* of associating learning with classroom realities, thus expanding the scope of their investigation into student learning. In the GVC (as detailed in Section 6.1.1), a small group of teachers had described student learning in Science and Technology by forming associations to generative theory, specific instances of learning and classroom videos. In contrast, these participants in Webboard discussions described student learning in relation to the values, constraints and affordances (that is, the ecology) of their own school environments. In doing so, the group was articulating learning as if it were teaching, perhaps lacking the language to adequately articulate learning without using the teaching terminology that was so dominant in their school environments and culture.[101]

The teachers contributed to a conception of student learning that reflected their own experiential histories and values as teachers, rather than simply adopting those of the Moderator collective. At this early stage of the project, through their collective strategy (that is, their collective *response* to the moderator question) the group exhibited a degree of autonomy regarding what was and was not afforded salience. In other words, in the circumstances in which it found itself, the cohort already seemed to be self-organising around their own attachments to ideas. In this case, as already noted, they self-organised principally around their attachments to specific teacher behaviours related to their ideas about student learning.

Many of the teachers who had been unwilling or unable to contribute publicly within the GVC environment, had now contributed to a description of student learning that was, perhaps, more in tune with their usual collective strategies as professionals. The cohort's articulation of student learning had shifted as new voices were heard, new values (or *matters of concern*) were incorporated and new associations sought to *account* more adequately *for* the entities that deserved *representation*. In the words of Latour:

> *We shall say, then, that the collective as a whole is defined from now on as collective experimentation. Experimentation on what? On the attachments and detachments that are going to allow it, at a given moment, to identify the candidates for common existence…The collective…has to experiment in such a way that it can learn in the course of the trial" (Latour, 2004, p. 196).*

[101] Papert (1980) has suggested that we lack words for discussing and thinking about learning. He suggested the term 'mathetics' as a means of moving towards a more sophisticated engagement with the phenomenon of learning, though this term has not embedded itself successfully in educational discourse. Perhaps this lack of success corroborates the existence, at a global level, of the phenomenon (of not being able to articulate those specific concerns related to student learning) observed locally here in the DESCANT project.

It is possible, therefore, to conceive the Cohort collective's response to the moderator question as a form of self-organisation within a Learning Ecology. The Webboard excerpt indicated a teacher-centric *collective strategy* as a pattern (dynamic stability) within the posts of this collective agent (the teacher participant group). This expanded the cohort's collective exploration during this initial DESCANT period, as ideas and suggestions were developed, apparently on the basis of shared cultural values. Yet there were also exceptions to this collective strategy. The following excerpt outlines one of these variants.

<u>Webboard Excerpt 2: Focusing teachers' Webboard discussion on Marissa's technological learning</u>

During the initial period online, moderators encouraged teachers to discuss their conceptions of technological learning in the Webboard. Contributions concerning this theme occurred within two Webboard threads. In one thread, the majority of cohort members posted long, detailed posts concerning technological education. However, as discussed in the previous section these posts were, without exception, highly teacher-centric, discussing such things as skills tests, school logistics and departmental policy and funding. Whilst the moderator collective supported and contributed to this dialogue, they simultaneously sought to encourage a discussion of technological learning that focused more specifically on the learner.

As in the previous example, the Moderator collective posted the following strategic question to encourage teachers to use a specific video excerpt from the GVC as a basis for discussing their conceptions of technological learning,

"Our discussion focus this week is "technology." If we look at Marissa with her burglar alarm, many of us would identify some of the things she DOES as technological acts or behaviours. What ARE some of the things that Marissa does that we recognise as technological?"

Describing technological learning in this way proved to be a difficult task for the teacher population. Even Gill, the Science and Technology consultant, expressed difficulty with the challenge. Vaughan was the only participant to attempt the task. He began by describing the excerpt.

Vaughan

Subject: Understandings of technology

Posted: 28 Aug 2003 09:33 PM

When observing and appreciating the video of Marissa and the burglar alarm, I found it fascinating that she had (and the teacher must also have) a sound understanding of technologies such as light meters and the logo, I believe, computer language. However the thing that demonstrated the greatest creativity to me was the problem solving that she used to direct the beam to serve its purpose [of signalling the presence of a burglar] rather than spreading everywhere. She secreted it in full knowledge of the purpose of the instrument.

He then associated the student's technological engagement with DET syllabus outcomes, and the generative (generate-test-regenerate) heuristic.

She also demonstrated that she was able to achieve [syllabus outcome] UTS3.9 (...meet the requirements and constraints of investigation and design tasks.)[102]

She could only have achieved this outcome if she had developed a design, being aware of the task, tested it and re-designed the task to achieve the end she required.(gen / test / re-gen)

Gill acknowledged the value of Vaughan's contribution.

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[102] NSW DET Syllabus Outcomes are defined as "specific, observable indications of learning to be expected of students at the end of a particular stage of the course" (Board of Studies NSW, 1991, p. 9). Vaughan refers here to a Science and Technology Outcome related to 'Using Technology': "Evaluates, selects and uses a range of equipment, computer-based technology, materials and other resources to meet the requirements and constraints of investigation and design tasks."

Gill

Subject: *Understandings of technology*

Posted: 29 Aug 2003 01:02 PM

AHA!!! (for which many thanks)

Authentic D&M [Design & Make] is in its essential nature generative!

Here, Vaughan had developed a detailed interpretation of Marissa's technological learning. He began by discussing Marissa's technical capability with light meters and logo. Yet for Vaughan, the real substance of technological learning in this video involved Marissa's creative, problem solving ability. He noted how Marissa used this capability to harness the affordances of each technology in order to design and make her burglar alarm. For Vaughan, this was sufficient evidence that Marissa had achieved the syllabus outcome associated with technological learning. Furthermore, he perceived a generative pattern within her 'Design and Make' process.

As noted above, the majority of Vaughan's cohort had chosen to discuss technology education from a logistical and teacher-centric perspective, remaining silent within this Webboard thread. In contrast, Vaughan chose not to contribute to the other Webboard thread, instead discussing technological learning here, from the perspective of the learner.

Vaughan's contribution thus introduced an important variant to the group's pool of ideas and contributions concerning technological learning and education. He appeared to be utilising a different set of values or more specifically matters of concern, for discussing technological education to those of his colleagues. He was not interested, it seems, in discussing the (quite legitimate) logistical concerns surrounding technological education, such as equipping schools and skills-based tests. Instead Vaughan appeared interested in exploring the subject from a student perspective. Yet Vaughan did not neglect these other logistical concerns. He wove these into his contribution in the form of syllabus perspectives.

Vaughan's values in this regard led to an expansion of the way in which technological learning was being discussed, or articulated, in his cohort, thus expanding their collective exploration. Vaughan's contribution deserves examining from an ecological perspective, too. It represented a recombination of the dominant collective strategy exhibited in the GVC immersion (of theoretical, student-centred perspectives and artefactual common ground) with the dominant collective strategy exhibited in the Webboard (of pragmatic classroom-centred perspectives and experiential common ground).

Vaughan describes explicit connections and relationships between a range of entities, including:

- A *specific instance* of student learning (as captured on the GVC videos);
- The student's *own* technological understanding of light meters and the computer programming language, Logo;
- The student's creativity in working with these technologies to achieve a desired function;
- The DET Syllabus Outcome UTS3.9.
- The generative heuristic (generate-test-regenerate);
- The Webboard forum (as a basis for discussing technological learning with the group).

In doing so, Vaughan used many of the collective strategies already demonstrated by the subgroup of teachers in the GVC (detailed in Section 4.1), in order to describe technological student learning. That is, he formed associations between the concept of technological learning and a range of entities that were directly available to the group, either through the DESCANT environment, the GVC or through shared syllabus documents.

Yet Vaughan also utilized his connoisseurship as an experienced educator to perceive salient dimensions of Marissa's technological engagement, as captured in the GVC video.

For example, he focused on the way the student's technological intention mediated her problem solving:

> *…the thing that demonstrated the greatest creativity to me was the problem solving that she used to direct the beam to serve its purpose rather than spreading everywhere. She secreted it in full knowledge of the purpose of the instrument.*

He also alluded to an association between the 'Design and Make' process (a central dimension of technology education in the DET syllabus), and the generative heuristic (generate-test-regenerate), stating:

> *She could only have achieved this outcome if she had developed a design, being aware of the task, tested it and re-designed the task to achieve the end she required. (gen / test / re-gen)*

For Gill, a regional Science and Technology consultant for the DET, this association was a particularly powerful one.

Vaughan's evidence-based contribution was therefore underpinned by his professional assessment of the video's salient moments. It was also characterized by explicit associations between the student's learning and Vaughan's contemporary school culture. The contribution is likely then to have established common ground in two related ways: firstly, through shared physical resources such as the GVC and DET artifacts, and secondly, through the shared connoisseurship of being a professional educator working in contemporary school culture and environment. In a political ecology domain, neither is more relevant in *establishing the common world* collectively.[103]

Vaughan's contribution may therefore be conceived as a population variant, perhaps partly emerging as a result of his experiential history in the two e-learning environments or

[103] The measure of value in this respect is whether the articulation helps the collective become "sensitised to difference" (Latour, 2004), as discussed in Section 2.2.2.

cultures, each with its own affordances and constraints. Having participated strongly in the GVC environment, Vaughan may have developed new values regarding the benefits of a learner-centred investigation into learning. Given the difficulty of undertaking this task for the teachers generally, it may be that this was less familiar to them than discussing logistical, teaching-related dimensions of technology education. Vaughan may therefore have been generating ideas based on a different set of values to those dominant within his professional context.

So, the cohort's treatment (in all their diversity and commonality) of the moderator questions suggests that self-organisation was occurring within the DESCANT professional development environment. The dominant collective strategies underpinning these contributions were not deliberate undertakings of the cohort, but seemed to result naturally as the teachers introduced and reacted to dimensions of learning and teaching that were salient to them as professional educators. This was not a static pattern, but a dynamic one that included variants, perhaps themselves a result of differing experiential histories in the population of teachers. The resulting ecology of ideas and associations existed as an experimental collective conception of student learning in Science and Technology.

So, both these vignettes, early in Phase 1 of the project, can be understood as the beginnings of a Learning Ecology, self-organising even in circumstances where the Moderator Collective was deliberately attempting to mark out some quite specific structural constraints for teachers' conceptual work. The following vignettes, a little later in Phase 1 in circumstances when the role of the Moderator Collective was not quite as prominent, show more of how this learning ecology began to develop.

Most Webboard discussions however were not instigated through strategic Moderator questions. Increasingly, Webboard discussion was characterised by spontaneous professional dialogue, as the entire group (including moderators) worked to develop their professional understandings of Science and Technology education. The following excerpt provides an example of this community-driven investigation.

Webboard Excerpt 3) Discussing learning in even finer grain: 'How do we choose [the new ideas and concepts we learn]?'

By Week 3, many of the teachers participating in the Webboard thread at the core of this vignette had not contributed to the GVC. Nevertheless, in the Webboard they increasingly demonstrated their willingness to discuss learning within free ranging professional dialogue

During Week 3, Gill used a teacher's contribution to discuss her (Gill's) own developing conceptions of learning. Gill used this contribution as a means of encouraging the group's online dialogue. Whereas moderators had asked about others' learning to encourage such discussion elsewhere, this post focused on a genuine instance of a moderator's own learning process.

Gill

Subject: *How do we choose?*

Posted: 23 Aug 2003 07:55 PM

In the Meaning of Technology thread up in the CR [Common Room], Kerrie said "...technology changes all the time and that it is changing at an ever faster pace. We adapt to the changes by absorbing them into our personal knowledge base."

I've brought that over here because it seemed to me that that last bit "adapt to ..changes by absorbing them into our personal knowledge base" is so close to what I'm getting from the GVC about learning. In the original context it referred to changes in technology, but I think it's even more apt if one applies it to changes in - how can I put this? - available ideas and concepts?

What do you think? And if it is what's going on, what determines which new "bits" make the cut and get absorbed and which don't? (whether we're talking about bits of new technology or of new understandings, for children or for ourselves as learners)

Gill addressed the group from the perspective of a co-learner, sharing her genuine insights from the GVC. She reworked Kerrie's absorption metaphor of learning by alluding to a process of selection underpinning this process. Kerrie responded by stressing the selective agency of the cohort.

Kerrie

Subject: How do we choose?

Posted: 24 Aug 2003 09:21 PM

Gill i guess it's up to us, the members of this group to decide what gets absorbed and what doesn't. I found a site I'd like to share with you all, so I'll attempt a link.

http://members.aol.com/_ht_a/il2teach/right.html

The above is a link to Jenna's website… Could our final result [e-learning design] have something like this, where teachers share the good things they have done or are going to do?...

Kerrie weaves together the group's discussion of learning, with their endeavour to design an e-learning environment for professional development. At times, it becomes difficult to distinguish the two. For instance, Kerrie responds to Gill's notion of selectivity, by conceiving the cohort as a selective force in deciding what 'makes the cut' in the DESCANT environment. The group's agency in the DESCANT environment, including their autonomy as designers, becomes closely associated to the notion of learning as a selective process.

Sally used her recent experiences in the GVC to reflect on the process of selection.

Sally

Subject: How do we choose?

Posted: 25 Aug 2003 11:09 AM

Gill I would agree with you that this applies to what I'm getting out of the gvc. I think that we are all probably testing the ideas against our background, and, if the timing is right, and these ideas make sense, we take them on board. The key thing is probably to have time to think deeply about an issue. I find that I wake up in the middle of the night and think things through.

Sally's notion of testing ideas against one's background reflected a developing generative orientation. Her final comment about the time necessary for learning reminded me of another post from Kerrie, one in which she had offered her thoughts about these reflective moments. I responded to Sally (and others) by initially quoting Kerry's previous contribution. This provided a basis for discerning a connection between these teacher contributions, related to value-based selection.

Lachlan

Subject: How do we choose?

Posted: 25 Aug 2003 02:07 PM

Kerrie wrote:

"I guess that is what I processed this morning. I suppose that is what the scientists I read about this morning did too: thought about how it affects them; how likely it is to become reality; how it can be used for personal growth; how it can be used more widely; who can I share this with.."

I see these as all related to value. So is this another criterion for 'testing the ideas' that we select or choose to keep. Sally stated that we test ideas "against our backgrounds." Perhaps these two criteria go together. Any thoughts?

Rather than picking up on my focus on values and selection, Kathryn seemed to relate more strongly to the processing dimension of Kerrie's conception of learning.

Kathryn
Subject: How do we choose?
Posted: 25 Aug 2003 10:33 PM

I agree with the time needed for processing, both for children and us. The time for processing will vary according to the background knowledge and interest in the topic… Some children need a lot of processing time as they struggle to assimilate all facts in a new environment or theme. (I actually feel I am doing the same with science and technology as I have not taught science for many years!)
The value we place on the time for processing will depend on the relevance to us at the time.

In contrast, Vaughan used the notion of e-learning threads as a dominant metaphor.

Vaughan
Subject: How do we choose?
Posted: 27 Aug 2003 09:27 PM

What you're all saying makes sense:
the time to reflect and accept or seek a thread elsewhere and
the 'dip-in' where it is appropriate for us.
Different things strike the chord for each of us, don't they. Sometimes it's the appropriate level of understanding, sometimes it's the appropriate type of intelligence we favour and sometimes it's the 'truth' of the analogy as related to our experience.

That's why opportunities for many to input to a thread broadens the rate of involvement and acceptance by reader.

Vaughan emphasised the importance of flexibility and diversity within the learning process. Vaughan's use of an e-learning term seemed to indicate he was referring to, or at least drawing from, the DESCANT population's own learning process in the Webboard.

Katrina then responded to Kerrie's earlier website link and associated design recommendations.

Katrina

Subject: How do we choose?

Posted: 28 Aug 2003 09:42 PM

Kerrie,

I agree that the site is a wonderful way to share what we do in a non-threatening way. Many people can take many different things away from that site and use them in their own way, adapt the ideas to suit their own particular circumstances…We all have wonderful ideas that can be beneficial to others, but we very rarely get the chance to see inside someone else's classroom and be inspired and vice versa…

Katrina seemed to incorporate some of the dialogue regarding learning into her reply to Kerrie. She noted how teachers could select valuable sections of the resource, adapting them for their own use. After replying to Katrina regarding the e-learning environment, Kerrie expanded her absorption metaphor for learning.

Kerrie

Subject: How do we choose?

Posted: 09 Sep 2003 03:27 PM

…Don't we sometimes just absorb the key idea and forget how it came?

I'll illustrate with this: Have you ever avoided one shop and frequented another?... One day lunch shop A is closed for some reason and you are disappointed as you cannot buy lunch. The person with you says "Why don't you go to lunch shop B?".

Your reply is something like "I never go there"…you almost can't remember why you have this aversion to B until you search your mind and remember that you got food poisoning from that shop the first time you went there, several years ago.

Do we have some inbuilt mechanism that helps us remember the important bit and forget the rest?...The child who has touched the heater won't touch it again and will try to stop another small child from doing it. What stays in the memory? The pain - not really - just an instinctive urge to avoid it, that doesn't even need explaining unless somebody pushes the issue.

Kerrie was now suggesting a more detailed process of learning that included unconscious values. Lyn responded with her own thoughts on the issue.

Lyn

Subject: How do we choose?

Posted: 09 Sep 2003 04:05 PM

Kerrie

I think there are good neuroscientific reasons (dare I say it?!!) for how we remember and for the habits we establish. Certain neural pathways get strengthened - making it more likely that they will be used again; others atrophy - making it much more unlikely that they will carry traffic again.

As well, we obviously have "value systems" - ways of recognising the value of what we do. Pain helps us sense that a particular behaviour is NOT one we necessarily want to indulge in again…

So we can think of value as a DRIVER for learning - in ways that people have already acknowledged previously. Some learning theories carve valuing off from learning totally - put it to the side. That's affective, not cognitive, these learning theories say.

Hmmm...I think it actually DETERMINES whether a thing is learned or not - it is fundamentally cognitive. Cognition IS affective, if you ask me - and I think your examples here say exactly that, Kerrie.

The challenge is how to build this realisation into formal classroom learning. What are people's thoughts?

In her response, Lyn positions 'values' at the heart of her conception of learning. The post drew another long post from Kerrie in which she once again used anecdotes to discuss the question of values in the learning process. Angela then contributed to the dialogue, introducing a very different perspective.

Angela

Subject: How do we choose?

Posted: 18 Sep 2003 08:36 AM

Hi all,

…This is a frightening thought as educators, does it mean that negative experiences we have, will prevent us from taking this journey again? If so, perhaps we should be specialist teachers so that the clients will not suffer from the effects of being placed under the care of a person who does not share the same interests as the learner. I know that from personal experience, that even though I am very well aware of multiple intelligences, and De Bono's

Hats, I will always return to what I know best. Does this mean that I am effectively impeding the journey of a nuclear physicist because of my dislike for physics? Another huge factor here is also that, when time is limited you once again rely on your areas of skill and preference rather than undertaking a new and lengthy journey in an effort to stimulate the student in the 2nd row that is usually non-responsive to most classroom activities. (Oh no, a career crisis!!)
Ange.

The contributions to this Webboard thread expanded yet again the cohort's description of learning. In earlier discussions of learning in the Webboard, the cohort had focused heavily on classroom strategies and management. Now their contributions increasingly focused on the process of learning itself. They discussed various mechanisms and drivers that may underpin this learning, both in students and teachers. For instance, in discussing selectionist perspectives, Kerrie noted the possibility of this selection being done unconsciously. Vaughan noted the importance of diversity for enriching the pool of choices within selection. Sally, still maintaining a selectionist perspective, noted the importance of time, a dimension that Kathryn also believed to be salient.

The teachers' contributions did not neglect their professional contexts, but instead, incorporated these into their investigation of learning theory. For the most part, they achieved this by grounding their assertions in personal and professional experience, thus integrating both individual and shared professional insights and values. For example, they associated their ideas with their own e-learning experiences in the GVC (Sally) and Webboard (Vaughan), their design task (Sally and Katrina), their classroom experiences (Kathryn and Angela) and their own learning experiences (Kerrie). In developing this variation, and incorporating the values that underpinned each of these contexts, their collective exploration of learning was expanded and strengthened.

Now that a freer-flowing conversation was beginning to develop, it is important to try to understand how the Cohort collective and the Moderator collective were operating as subgroups.

The Cohort Collective

Through the Webboard exchange captured in this excerpt, the cohort developed a range of suggestions as to why an idea may be accepted or rejected by a learner. The teachers supported their assertions by associating them with particular *experiences*. For instance:

- Sally used her *experience in the GVC* to propose that learners test their ideas based on their background;
- Kathryn seemed to draw implicitly from *professional experience*. She proposed that the idea's relevance would lead to extended processing time, thus contributing to its assimilation from the environment.
- Vaughan seemed to utilise the *cohort's experience* using Webboard threads as a metaphor for learning. For him, learners might accept ideas, when they are appropriate for their current understanding or type of intelligence. Vaughan also recognised the importance of a learner's experience in determining which ideas were accepted.

In forming such associations, the teachers engaged with learning theory from their own perspectives, experiences and values. They asserted the relevance of particular distinctions such as 'multiple intelligences' and 'time', which then became (candidate) entities that could be *taken into account* (in a political ecology sense) in developing a collective conception of learning.

Teachers appeared to be exhibiting a different collective strategy to that demonstrated in response to thematic moderator questions (as discussed in regards to Webboard Excerpts 1 and 2 above) Whereas the former pattern was focused on teacher-centred aspects, the collective strategy exhibited here was focused on the learner and the learning process itself.

Other collective strategies were also evident. For instance, the teachers formed associations to a range of professional concerns, or (in political ecology terms) *matters of concern*.[104] For example, Kerrie used a hypothetical anecdote in order to suggest the importance of the unconscious mind.

> *I'll illustrate with this: Have you ever avoided one shop and frequented another?... One day lunch shop A is closed for some reason and you are disappointed as you cannot buy lunch. …Do we have some inbuilt mechanism that helps us remember the important bit and forget the rest? …Don't we sometimes just absorb the key idea and forget how it came?*

Kerrie thus developed a number of questions for the group, questions that appeared to be significant for her. In doing so, she linked the cohort's investigation into learning, with an area of professional uncertainty pertinent to her own understanding of the topic.

Cohort 1 teachers commonly expressed professional uncertainty throughout Phase 1. This pattern of exchange (or collective strategy) is likely to have allowed for the articulation of professional concerns and understandings that remained unsure or problematic. This strategy may therefore have influenced the pooling of ideas within the DESCANT context, teacher-driven uncertainties generating a ripple effect, as other teachers noted their own lack of certainty.

For instance, Kerrie's assertion concerning the importance of the unconscious mind on learning seemed to pose a serious professional dilemma for Angela. Angela used a personal anecdote to articulate her own uncertainty:

> *I know that from personal experience, that even though I am very well aware of multiple intelligences, and De Bono's Hats, I will always return to what I know best. Does this*

[104] The use of the term 'matters of concern' becomes a means of moving from a conception of 'matters of fact' (derived from a unified nature) to a more (political) ecological conception in which propositions (or candidate entities, see 2.2.2) are not prematurely judged as being epistemologically invalid but rather may argue their case in a representative assembly on the basis of their articulation (Latour, 2004).

mean that I am effectively impeding the journey of a nuclear physicist because of my dislike for physics?

Like Kerrie, Angela expressed uncertainty as a professional, not from a position of ignorance, but rather from the position of an experienced educator. Her contribution emphasised that if they, as a cohort, were to conceive learning as a largely unconscious processes of selection, they may need to *take into account* (Latour, 2004) the implications this had for them as teachers. Angela asks how they, as teachers, can prevent their own value-based selections prematurely limiting the learning opportunities afforded to their students.

From a political ecology perspective, Angela is *maintaining perplexity* (see 2.2.2) within the collective's process of *establishing the world*, by confounding it with yet another distinction that must be *taken into account*, and balanced with the emerging *proposition* of learning in Science and Technology.[105] Kerrie had done a similar thing in introducing the unconscious mind as an entity that may need accounting for, even though her own understanding of its relevance was not yet well formed.

These examples emphasise the experimental nature of the *proposition* of learning emerging within Phase 1 of DESCANT. The teachers were contributing towards a conception of learning that incorporated a web or ecology of associations. Yet it was a tentative ecology that was, in a sense, bootstrapping itself into existence through the ongoing DESCANT process. By developing explicit connections (or associations) between their ideas and a range of experiences and professional concerns, the cohort widened the scope, or reach, of this ecology, and thus the scope of their collective exploration.

[105] Within the early stages of collective learning in a political ecology "propositions do no more, as it were, than propose their *candidacy* for common existence and subject themselves to trials whose outcome is still uncertain ….[So] new entities appear in the form of that which leaves those who are discussing them *perplexed*…. [in doing so] we are trying to make sure that our interlocutors, by limiting in advance the list of states of the world…"*shalt not simplify the number of propositions to be taken into account in the discussion*" (Latour, 2004, pp. 103- 104, emphases in original).

The Moderator Collective:

In this 3rd Webboard excerpt, the DESCANT moderators also formed associations between a range of heterogeneous entities, including experiences and theories.

For example, Gill connected her experience in the GVC with a developing conception of learning as an adaptive process of selection. Lyn on the other hand gave representation (in a Latourian sense) to neural pathways by associating them with habit formation, thus encouraging the group to 'take into account' the insights of neuroscience in establishing a conception of learning as a proposition in the common world. Lyn not only introduces *perplexity* here by confounding the collective with another entity that must be accounted for; in doing so, she increases the scope of *consultation*, by incorporating the field of neuroscience.[106]

So, the moderator collective expanded the scope of the discussion in two ways here. Firstly, they formed associations between their own professional insights, the teachers' insights, and the entities available to the entire group (for example, the GVC videos). This may be conceived as forming internal associations, from the perspective of the DESCANT system. Secondly they formed associations between these internal entities and other entities, such as the research findings of other fields (for example, neuroscience.) In one sense, this latter process parallels the teachers' tendency to incorporate their school contexts, thus widening the scope of the discussion. Likewise, the moderators widened the scope of the process by incorporating other contexts that are closely associated with their areas of interest or expertise.

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[106] In political ecology, 'consultation' is considered one of the "essential functions of the power to take into account: it answers the question about what trials are appropriate to pass judgment on the existence, the importance, and the intention of a proposition; it applies, of course, to nonhumans as well as humans; it does not have the ordinary meaning of an answer to an already-formulated question; instead, it implies participation in the re-formulation of the problem through a search for reliable [human or nonhuman] witnesses" (Latour, 2004, p. 239).

In many cases, the moderators' posts represented *recombinations* of teacher contributions. For instance, Gill's initial post represents a clear recombination of Kerrie's contribution from elsewhere in the Webboard:

> *I've brought that over here because it seemed to me that that last bit "adapt to ….changes by absorbing them into our personal knowledge base" is so close to what I'm getting from the GVC about learning. In the original context it referred to changes in technology, but I think it's even more apt if one applies it to changes in - how can I put this? - available ideas and concepts?*

Gill used Kerrie's association between technology and adaptation as a means of expressing a novel description of learning. Similarly I formed a new association between the contributions of Kerrie and Sally:

> *Kerrie wrote: "I guess that is what I processed this morning. I suppose that is what the scientists I read about this morning did too.." I see these as all related to value…Sally stated that we test ideas "against our backgrounds." Perhaps these two criteria go together.*

Lyn, on the other hand demonstrated a different type of recombination. As already noted, she addressed Kerrie's contribution regarding the unconscious mind, by forming an association between habit formation and the strengthening of neural pathways, an association already articulated within the field of neuroscience.

Through these recombinations, the moderator collective contributed to the diversity of ideas, understandings and associations being pooled by the entire Phase 1 population developing new variants within the emerging ecology. Yet whilst there was internal diversity within the contributions of the moderator collective, there was also a degree of uniformity. Gill, Lyn and I all alluded to a conception of learning that was underpinned by a process of selection. Driven by the shift in her own beliefs about learning that had occurred with her recent introduction to generative learning theory, Gill asked the group:

…what determines which new "bits" make the cut and get absorbed and which don't?

Lyn and I also assert a selectionist perspective whilst expressing a further shared position by associating this process with values:

> *I see these as all related to value. So is this another criterion for 'testing the ideas' that we select or choose to keep. (Lachlan)*

> *So we can think of value as a DRIVER for learning - in ways that people have already acknowledged previously. (Lyn)*

Lyn and I (another loose subgroup, the UTS collective) shared such values and understandings. Often we expressed understandings that reflected those dominant theoretical positions of our research group. In this case, we refer to value-based selection, a conception central to generative theory.

It is possible then to distinguish cohesion both within the moderator collective and also within subgroups of this collective. The shared values and understandings held in these loose groupings seemed to influence the nature of the emerging learning ecology by shaping the types of entities that were given salience in the process.

Whilst the moderators undertook deliberate strategies for achieving professional development and research objectives, at no time did they collude to present a cohesive intellectual response within the Webboard immersion period, or any other time during the DESCANT process. The teachers' professional development was not sought through the transmission of a single intellectual viewpoint or even a consolidated position on Science and Technology education. Instead, commonalities that can be perceived in the moderators' contributions were emergent patterns, perhaps resulting partially from the shared values and understandings of this subgroup, as well as their collective intention (or 'we-intentionality' after Searle, 1995) to widen the intellectual scope of the DESCANT process.

So, both the cohort collective and the moderator collective appeared to exhibit some forms of self-organisation at a collective level. New collective strategies began to emerge, including a sharpening focus on learning rather than only teaching, and a willingness to express uncertainty, thus eliciting teachers' own professional concerns.

The complexity of this educational context prevents any definitive explanation for the patterns of collective response, the collective strategies, described here. A range of factors is likely to have been influential, including the complex historicity that resulted from the online population's idiosyncratic engagement with the project, its timeline and its various e-learning environments. Yet a description of these collective (dynamic) patterns, as strategic responses within the learning context of DESCANT, provides a means of discerning movement or progression at a group and population level. They demonstrate an increasing depth of engagement with learning, as a phenomenon that could be discussed separately to teaching.

Perhaps, as freer collective professional dialogue arose, what might be called new dynamic stabilities (or attractors) were developing in the online population perhaps reflecting collective values that were closely aligned with the population of teachers' deeper learning needs for developing as Science and Technology educators. Similarly, the Moderator collective also enabled the expression of core beliefs and interests, for example, revealing a level of intellectual cohesion (or dynamic stability) regarding a conception of learning as selection.

So, this excerpt demonstrates the continuing subtle collective self-organisation occurring within this first phase, as diverse and commonly shared ideas, values and understandings are pooled. Participants from a range of collectives including the cohort collective, the moderator collective and UTS collective, developed a complex ecology of ideas and contextual associations relating to learning as a phenomenon in its own right.

The following excerpt enables consideration of the extent to which as the professional dialogue continued, certain *collective strategies* became common to all collective agents, thereby approaching a common culture within the DESCANT context.

Webboard Excerpt 4) What are our Professional Development Needs? A Webboard discussion

With the Moderator collective undertaking an active role within the group's discussions, the possibility existed for participants to assign higher value to the contributions of members perceived as being of high status.[107] The copying of high status individuals is recognised as a legitimate strategy within social learning contexts (Bloom, 2000). However, the intelligence of a group may be limited if individuals choose to copy or accept the ideas of others, rather than express their own ideas (Surowiecki, 2004).[108] Throughout the DESCANT project, moderators sought to position themselves as co-learners, and to elevate the status of teacher participants. Similarly, the teachers seemed to position themselves and their peers as important contributors to the DESCANT process. The collective strategies that were exhibited formed an overarching intellectual culture within Phase 1.

The online dialogue in this Webboard thread occurred in Week 4 of the initial immersion period. The teachers had been discussing various needs in professional development as a precursor to their development of a top priority purpose for their e-learning environment. The dialogue gradually became concerned with theories of learning, reflecting the group's continued interest in learning as a phenomenon in its own right. Elsewhere in the

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[107] Whilst high status is conceived here as relating to moderators, I acknowledge that this may not apply to a particular situation. For instance, high status may be assigned to teachers with very lengthy professional experience as was the case with at least one member of the teacher cohort. Similarly high status may be defined by current classroom practice, thus delegating academics, researchers or consultants to a lower status than classroom teacher participants (Gore & Gitlin, 2004).

[108] Surowiecki (2004) identifies the level of independence or autonomy in a group as an important measure of its collective capability. This relates to the independence or autonomy the group displays in generating and valuing solutions or ideas. Surowiecki distinguishes large distributed collectives (such as networked recommender systems) from smaller cohesive groups (such as the bounded cohort group) maintaining that the latter are more susceptible to the paralysing effects of low autonomy in the group. He states: "One of the real problems small groups face is emphasizing consensus over dissent" (Surowiecki, 2004, p. 178).

Webboard the group had discussed the 4Mat concept of teaching and learning.[109] Here, Ingrid again raised the topic as a means of discussing how teaching approaches may be tuned to an underlying conception of how students learn.

Ingrid

Subject: our prof devel needs

Posted: 03 Sep 2003 06:09 PM

I know I keep harping on the 4Mat concept of teaching but to me it makes complete sense to structure teaching style around the four basic - yet vastly different - ways in which children learn. If we don't cater for different learning styles within our rooms we will only ever be connecting with 1 out of 4 children (assuming an even spread of learning styles within the class.) Rather than academic streaming, maybe schools could look at grouping according to these learning styles - if you had a class that consisted solely of kinaesthetic learners, for example, imagine what you could do with them!! That may be an over-simplistic way of looking at things but you must be able to initiate that very first, basic 'connection' with a student to ensure they become active participants in the learning process!!!

Whilst Gill had often advocated the value of the 4Mat approach, she remained cautious about the ways it could be used in the classroom.

Gill

Subject: I'm ranting again, sorry

Posted: 04 Sep 2003 05:12 PM

I'm glad you did, I've been meaning to get back to the 4MAT stuff all week and I promise I'll pick up on it again later. One quick point for now: I agree very much about the

[109] According to the 4Mat model (McCarthy & McCarthy, 2005) learners typically have a preference for one of four learning styles that involve experiential, abstract, applied or creative strategies for learning. By distinguishing between these learning preferences, the 4Mat model aims to support teachers and instructors to more adequately address the different ways people learn.

desirability of catering for the full range of learning styles but the thought of grouping children on that basis... well to be honest it gives me the screaming abadabs.

*Two basic reasons: firstly I don't believe the "styles" are immutable, but rather that we all use all of them at different times and for different purposes, we just have *preferences*. To me the trick is to cater for each preference within our teaching so each student is in their "comfort zone" for some of the time but equally, is encouraged [to] extend their capabilities in their "non-preferred" modes.*

Secondly, I'm by NO means convinced the validity of the models or the test instruments are anywhere near well-enough established to be a basis for differentiating the ways children are taught or grouped..

I apologise if I'm over-reacting on this one, it's a bit of a hot button thing for me. Back in the dawn of time I did a two (3?) day neurolinguistic programming (VAK) course with Michael Grinder. It was barely into the first afternoon when I overheard somebody smugly (and it was, truly) comment that "yes, such-and-such a kid's your typical kino, can't do a thing with him, fidgets round like he needs worming..."

I was more than a little unimpressed, and it's stayed with me ever since as a cautionary tale

Ingrid's discussion of the 4Mat approach encouraged Vaughan to undertake some research into the subject.

Vaughan
Subject: I'm ranting again, sorry
Posted: 04 Sep 2003 06:09 PM

I'll start by clearly stating that the following is a "through-your-hat" comment because I've not done the 4mat training you refer to.

Since you mentioned it I've searched the web and found some information. Reading as much as I was able to without being a subscriber led me to believe that it was a similar awareness-raising to the multiple intelligence sort of stuff. While I know it's more complicated than that, it's really puts us on notice that we must provide for the favoured perspectives of learning / preferred learning styles of the individuals in our care.
I too believe that categorising ones so young to the virtual exclusion of their less preferred styles is masking whole quadrants of their educational opportunities; opportunities which would otherwise develop to support more rounded understandings.
Vaughan

Vaughan's description of the 4Mat approach as contributing to the awareness of teachers, regarding their students, consolidated much of what had been written previously. Like Gill, he remained cautious about the use of such an approach. Lyn was even more sceptical.

Lyn
Subject: I'm ranting again, sorry
Posted: 05 Sep 2003 06:38 PM

I would want to go even further than these comments made so far in this discussion of 4Mat…

Neuroscience tells us that many many capabilities rely on the activation of a very broadly distributed range of neuronal groups - yes, we can see clusters of activation that can sometimes lead people to say that such-and-such is predominantly associated with right brain or left brain activation. However, there is activation in many areas in most complex everyday tasks - AND right and left brain are connected through the corpus callosum - a huge, richly supplied part of the brain so messages flow both ways!!!

I think in education that we fall prey to FAR TOO MANY sales pitches - that SOUND fine - and superficially match some of the things we see…. I would want people in education to be MUCH more sceptical about them - asking such questions as:

** how real are the so-called DIFFERENCES we are talking about (what does it mean, for example, to be an active vs a reflective processor?)*

** what are the influences of circumstances/context/content on the ways that people learn? …*

I think that many of these things have appeal simply because they say, at their core, that learning is complex, multi-faceted, dynamic, unpredictable - and that therefore we need to be clever about designing learning environments that are rich and provide many opportunities - sure, I'd never argue against that.

However, I do not believe it is honest to represent one's model as deriving from neurosciences on the flimsiest passing reference to right and left brain dominances -or to make observations that extend findings about core verbal/image-processing capabilities far beyond the mappings of these capabilities that have been made on isolated tasks conducted in laboratory settings.

In a separate post, Lyn responded directly to Vaughan.

Lyn

Subject: our prof devel needs

Posted: 05 Sep 2003 06:46 PM

…One small but key point for me: I often hear people say we need to teach kids/adults how to learn. I don't think we do. I think they already know how to do that - but sometimes it can be a matter of "waking up" the successful learning strategies, though, I think…I find that the easiest thing to do is to underestimate what our students are capable of - by setting the bar too low...

So, I would want to orient the prof devel need just slightly differently - that what we need are some good, subtle ways of finding out what students ALREADY know and what they can ALREADY do. What do people think?

Within half an hour Ingrid had responded to Lyn’s long and detailed critique of the 4Mat approach.

Ingrid

Subject: our prof devel needs

Posted: 05 Sep 2003 07:11 PM

Lyn, I can see your comment about '"waking up" the successful learning strategies' as relating directly to 4Mat and left/right brain hemisphericity. I really do believe that children learn in a number of ways and that these differences have to be addressed. I don't have anywhere near your knowledge on this subject and having only completed the first - and basic - level of 4Mat training that knowledge is undoubtedly still sketchy as well. But its key premise - that; "Human beings perceive experience and information in different ways. Human beings process experience and information in different ways. The combinations formed by our own perceiving and processing techniques form our unique learning styles." to me, seems entirely valid. 4Mat also states that it's lesson sequence is a natural learning progression. Don't get me wrong, I haven't been paid by the 4Mat people to be their advocate here but, after 14 years of teaching an incredibly diverse range of children, there's something about this philosophy that just rings true….

Your other point Lyn, that we often set the bar too low is particularly valid!!! I have a little knowledge of both the British and German education systems and it seems that we are certainly the 'poor relation' in terms of where we expect our children to be at comparable stages of maturity. We spoon feed them and coax them along and, in some ways, perhaps even cultivate a sense of 'fear of failure' precisely because we don't challenge them to take risks, secure in the knowledge that it's okay to not be 100% right all the time. While children should never be made to doubt their own abilities they also have to be made aware *of the enormous potential each and every one of them possesses. I've probably gone way off the topic here but it is Friday night after all and it's been another huge week! :-)*

Rather than contributing more ideas to the dialogue, I chose to acknowledge the strength of this particular discussion:

Lachlan

Subject: our prof devel needs

Posted: 06 Sep 2003 10:32 AM

Thanks Ingrid, for elaborating some more on the 4Mat model for those who have not encountered it, and in particular, thanks for elaborating on your personal convictions regarding this model. I think it's incredibly valuable for the community, in this early stage especially, to share these (personal) convictions so that we really understand the diversity of beliefs/ ideas within the community as a whole…So this is a very important dialogue, whether it is about 4Mat or any other model of learning…

Like Vaughan, Sally was unfamiliar with the 4Mat model. Nevertheless, she contributed her thoughts about learning styles whilst also sharing her own theories on learning.

Sally

Subject: our prof devel needs

Posted: 06 Sep 2003 03:42 PM

Ive read, with interest, the discussions about learning styles and right and left brain functioning etc.
I haven't done any 4Mat training or had any formal experience with today's theories of learning, so I'm coming from a completely "naive" position.
I'm inclined to think that we learn different things in different ways and that maybe each of us is completely unique in how we learn a particular thing at a particular time.

I wonder how well we can tell whether children have learned something. Perhaps we can tell by their changed behaviour, or by what they're saying, but this won't necessarily be evident, will it?

When I think about how, and what I learn, what immediately comes to mind is the need for me to actively want to find something out or to upgrade my skills. It's the reaching into some inner depth, or new level in my brain, so that I can mull over and process the information that's available.

I often think I've got to click into another gear. Often there are distractions and I can't do it.

I think I used to be better at it than I am now. I don't think its necessarily to do with my age, more likely the lack of practice.

Whilst Sally had acknowledged her lack of formal study in learning theory, it was clear her experience as an educator, and reflective learner, had stood her in good stead to contribute strongly to the dialogue.

Ingrid concluded her discussion of 4Mat in this thread by affording her DESCANT colleagues a source of more information on the topic.

Ingrid

Subject: *our prof devel needs*

Posted: 07 Sep 2003 01:38 PM

In case anyone would like more information on 4Mat then here is the website:

http://www.aboutlearning.com/

It's an interesting read!

Another great thing about it is that it's a 'philosophy' not confined to young learners but includes those at university and management levels, adult learners etc.

Gill however was keen to continue to discuss the value and credibility of models of learning such as 4Mat. It was clear Gill was seeking to address Lyn's critique of the model.

Gill

Subject: Credibility of models

Posted: 07 Sep 2003 09:26 PM

I've had substantial exposure to 3 of what might be loosely categorized as models of learning that reference neuroscience; the NPL/VAK stuff I mentioned earlier, a composite presented by Julia Atkins and drawing heavily on the Hermann Brain Dominance model, and most recently 4MAT.

Thinking about it I realize practically nothing of VAK has stayed with me but the other two have become very much part of the language with which I think about teaching and learning. What I'm trying to sort out now is why. (Warning, this may get long)

*First up, do I accept any of them as solving the mind/body riddle to yield a valid and reliable mapping of thought processes to the physiology of the brain? Nope, not even remotely (studies of persons with corpus callosum divided not withstanding.) I get *almost* as niggly when they're presented as Literal Truth as I do when the models are used either to label people or as an excuse ("I'm a 4, I don't do paperwork" is tempting but alas, fundamentally flawed ;)*

But you see I've always regarded them as metaphors more than anything and evaluated them as such (which is why I happily draw on both 4MAT & HBD)

VAK didn't "take" with me for several reasons, including the way it was presented. But really all those reasons come down to a failure to capture the richness of my own experience as both learner and teacher. The model seemed mechanistic and impoverished compared with what I saw children doing and with the way I learn myself.

By the same token I value the Hermann & 4MAT models primarily because I can recognize myself and my students in the descriptions they generate. It's not so much that they said something radically new but rather that they gave me a coherent structure within which to analyze and build on what I already experienced.

It probably helped that both were presented with an emphasis on honoring diverse preferences while encouraging all learners to use the full range, and that the focus was more on the models as descriptive and as an approach to instructional design rather than dwelling at length on claims about neurophysiology.

*What has ensured their survival as part of my thinking is simply that they seem to me to work. If I apply the 4MAT cycle when I design a lesson or workshop it seems to go better, most particularly in terms of engagement and sustained focus. (I say seems because this is light years away from rigorously controlled testing. If you ask can I *prove* there was greater learning the answer's no, yet these repeated impressions are evidence of a sort)*

So really, I agree what you said Lyn about claims to a neurophysiological basis but in a sense that doesn't matter to me very much; it's not what I'm looking to the models to provide.

Whilst acknowledging the weakness of their scientific claims, Gill used a pragmatic test to discern the validity of the Hermann and 4Mat models of learning. She reinforced this pragmatic position minutes later by responding directly to Ingrid.

Gill

Subject: our prof devel needs

Posted: 07 Sep 2003 09:31 PM

::nods:: I often use 4MAT when designing workshops for teachers.

Thanks for posting the link, I'd been meaning to dig it out myself :)

In taking this pragmatic stance, Gill had adopted a different position to her fellow moderator, Lyn, who had questioned the validity of the 4Mat model on scientific grounds. Lyn responded firstly to Ingrid, supporting her in her strong contributions to the forum yet continuing to challenge the validity of 4Mat.

Lyn

Subject: our prof devel needs

Posted: 09 Sep 2003 12:09 PM

It's great to hear you pick up two particular points, Ingrid, on which to focus your thinking. As Lachlan says, it is SO important for our little community to have these conversations - we will each see things differently - and trying to understand these differences and come to some agreement about what we think is vital if we are to design an e-learning environment that is soundly based on common values and theories…

I'd like to respond to the points you make - and I don't feel that I am expert in this - I am NOT a neuroscientist - not even a biologist - I have had to teach myself what knowledge I have in these fields - and it is still sketchy compared with people who have worked their whole lives in these disciplines. So, we are ALL feeling our way - and using things that look as though they will be helpful in our own practice.

…I agree that each individual is unique - we are working in education with a population of quite different individuals - in many many ways. I have a bit of a problem, though, when it comes to lumping these unique individuals into a set of four "stylised" approaches to learning...I think what the 4MAT people are doing here is taking their view of learning (their natural learning cycle) and chopping it into parts (almost) and making sure that we teach so as to encourage people to strengthen each PART of what constitutes learning (for them)…

…I am hoping that others will pull out some more features of the 4MAT stuff, as Ingrid has done here - there is much more food for thought in all this - many other issues that we could discuss - and I am grateful to Ingrid for putting these two on the table. What about other parts of the package that we can chew over together?...

Lyn then responded to Gill's pragmatic test for the validity of models of learning.

Lyn

Subject: Credibility of models

Posted: 09 Sep 2003 01:53 PM

I want to spend a bit of time thinking about this significant post of Gill's about "credibility of models" - I think it ties in with Ingrid's comment about the "philosophy of 4MAT ringing true."

Of course, we are going to have many different kinds of benchmarks in judging the worth of these different approaches - and obviously, it is going to be important for us as teachers to gauge whether something "works" or "rings true" with our experience or not. If it does, it is more likely we will run with it.

I do think, though, that we MUST question WHY a thing works. It is an important part of progressing a discipline by generating new knowledge in it. The builders of the European cathedrals only made REAL progress once they analysed exactly WHY particular cathedrals stood up….

Lyn detailed response (only a small part of which is transcribed here) advocated the need for more adequate theoretical bases for models used in education. Cathie, however, seemed to adopt the pragmatic view described by Gill.

Cathie

Subject: our prof devel needs

Posted: 10 Sep 2003 06:23 PM

I have completed the first two session of 4Mat and like Ingrid was impressed with the ideas presented, but I think I am a bit like Gill I tend to draw on many experiences to "piece meal" these ideas. I have tended to "evolve" with each of these experiences but adapt them, to suit myself, rather than take one method on as a whole. I am also more aware of different learning styles after 4 Mat and will cater for these in my lessons.

Following two posts by Ingrid and Lachlan regarding the value of authentic learning contexts, Gill once again challenged Lyn's position.

Gill

Subject: Credibility of models

Posted: 14 Sep 2003 12:17 AM

Lyn, you said "I do think, though, that we MUST question WHY a thing works."

I find myself oddly undecided about this. I'm very fond of delving into the whys and wherefores myself, there's much satisfaction to be had there and I'm wanting to agree enthusiastically. Certainly asking why "is an important part of progressing a discipline by generating new knowledge in it."

But...Can we extend the cathedral-building analogy a bit further?

Sure, until they understood how they worked the designers and master builders couldn't reliably build cathedrals that stayed built, so the "why" was essential. But I suspect your average cathedral chapter choosing an architect didn't ask him to trot out his theory of stress distribution - they wouldn't have understood it anyway - they asked what he'd done *before and whether it was still standing. If so, and his drawings matched their expectations of how a cathedral should be, he probably got the job.*

It seems to me I'm in rather that position with theories of learning. I don't have the expertise to evaluate generative vs constructivist vs neurophysiologically-based models of learning at that deep theoretical level…

As a classroom teacher I'm going to look at the "proposed cathedral" - the kind of classroom practice being suggested - and see whether it matches up with my expectations of how a lesson should be; is it internally consistent, does it make sense?...

Gill

This led to a range of responses that moved the dialogue towards a shared focus on valuing individuals' knowledge.

Cathie

Subject: our prof devel needs

Posted: 16 Sep 2003 11:03 AM

Lyn after reading your post I feel that one of the biggest challenges is to "value" not only what kids know and what they can do, but to provide tasks which allow them to bring this knowledge to bear on the task. I have found with my own class that it takes a while for kids to "unlearn" their reliance on their teacher to provide a learning track, and value their own knowledge and ability to attack a problem and really look at what they know in order to solve the problem.

Lachlan

Subject: Valuing one's own knowledge

Posted: 16 Sep 2003 09:34 PM

Cathie, I think this is a challenge that sits at the heart of the shift from more 'authoritarian' forms of social order AND THINKING, to more 'organic' models that function increasingly like 'eco-systems' or networks… When students (and adults) begin to really feel their 'voice' is being heard (ie. what they believe is validated and built upon) I believe that is a great start, not only for strong learning, but strong identity and sense of place within a community….

Ingrid

Subject: Valuing one's own knowledge

Posted: 17 Sep 2003 09:48 AM

...Once you lose that simple, open way of looking at the world you lose a great 'unstructured' and perfectly 'natural' way of learning. Children do it all the time - that lovely free-thinking spontaneity that we should all try and preserve throughout our lives…

Sally

Subject: Valuing one's own knowledge

Posted: 17 Sep 2003 10:54 AM

This does make you think, doesn't it?.. When do we get time to be completely self-absorbed and ponder deeply on life's great wonders? This project has forced (enabled?) me to do just that. I'm still not very good at it, but I'm trying to get to that deep-thinking level necessary.

Vaughan

Subject: our prof devel needs

Posted: 22 Sep 2003 9:00 PM

It's wonderful to read that people are talking about 'honouring' our individuals, 'valuing' them and recognising that we owe it to our students to observe their ways so closely we are

prepared to help them 'unlearn' some of the 'stuff' we've thrust upon them because it was prudent, or convenient, or easy, or obviously within our control.
[It is a concern that the institutions people are prepared to pay the most for, seem to provide the least of what we are stating is of the highest order.]

Through this informal, yet far-ranging collective exploration of learning theory, the group gradually developed a shared focus related to the need to value what students know and how they learn. Whilst this was not a novel conception by the standards of educational discourse, it represented the emergence of a priority professional need within this DESCANT group: one of highest order. It was clear that the group, as a whole did not conceive this as an entirely theoretical concern, nor an entirely pragmatic one, but rather a concern that spanned these realms. As Cathie noted, just recognising that a student's knowledge is important doesn't mean that it is easy "…to provide tasks which allow them to bring this knowledge to bear on the task."

This online dialogue (and others like it) provided a means to recognise collective values that were emerging within the cohort, as they prepared for their design task (of an e-learning environment for the professional development of K-6 Science and Technology teachers). These shared values were not imposed authoritatively on the teachers, but rather emerged within the dynamic of the Learning Ecology. Discerning its dynamics showed just how.

The Cohort 1 Collective

Ingrid's contributions provide an interesting example of how teachers asserted their agency on the Webboard.

Ingrid began by asserting (as she had elsewhere) that the 4Mat model was valuable for addressing students' learning needs. Both Gill and Lyn were quick to critique a number of her associations. For instance, they questioned the validity of the 4Mat model and learning styles as propositions in their own right. This critique, coming as it did from members of the Moderator collective, risked prematurely concluding the professional dialogue.

Yet, Ingrid showed no indication of being deterred. In response to the challenge by the moderators, she stated:

> *Human beings process experience and information in different ways. The combinations formed by our own perceiving and processing techniques form our unique learning styles…after 14 years of teaching an incredibly diverse range of children, there's something about this philosophy that just rings true…*

Ingrid thus formed an explicit association between her own professional experiences and fundamental tenets of the 4Mat model. She further articulated her point by developing an association between a comment by Lyn, the 4Mat model, and a model of the brain:

> *Lyn, I can see your comment about '"waking up" the successful learning strategies' as relating directly to 4Mat and left/right brain hemisphericity.*

Furthermore, she suggested her position was compatible with other dimensions of Lyn’s views by noting:

> *Your other point Lyn, that we often set the bar too low is particularly valid!!!*

Ingrid also used an internet link to create a tangible association between her convictions and the 4Mat theory, as it is described by the developers of the model:

> *In case anyone would like more information on 4Mat then here is the website: http://www.aboutlearning.com/*

In presenting her case in this manner, Ingrid articulated an argument for the validity of the 4Mat model and its underlying theory of learning. Her resilience in the face of critique is a clear example of the teachers' intellectual agency. Despite the moderators' concerns, Ingrid continued to give representation to the 4Mat model within the DESCANT context. Her convictions were based on her years of teaching experience, a basis for knowledge that she explicitly validated as a means of discerning the relevance of theories and models.

Yet, it is also clear that Ingrid did not require certainty before contributing to the online dialogue. In response to Lyn's reference to current understandings in neuroscience, Ingrid noted:

> *I don't have anywhere near your knowledge on this subject and having only completed the first - and basic - level of 4Mat training that knowledge is undoubtedly still sketchy as well.*

Yet her perception that she lacked knowledge, her uncertainty, did not prevent Ingrid from continuing to articulate her ideas regarding learning. In the previous section, I identified teachers' admission of uncertainty as provoking questions, dilemmas and concerns. Here despite her uncertainty, Ingrid strongly defends her position. This may be conceived as a strategy of *sharing emerging ideas*, that is, the sharing of partially formed ideas, not based on certainty.

Just as expressions of uncertainty, in the form of questions and concerns, seemed to have a ripple effect in the dialogue, so may the *sharing of emerging ideas*. For instance, Ingrid's articulation of learning through the 4Mat model prompted Vaughan to research the model as the basis for his own contribution to the group. Similarly, Vaughan acknowledged the limitation of his knowledge of 4Mat, before expressing his thoughts to the group:

> *I'll start by clearly stating that the following is a "through-your-hat" comment because I've not done the 4mat training you refer to... it really puts us on notice that we must provide for the favoured perspectives of learning / preferred learning styles of the individuals in our care.*

Sally also acknowledged her limited knowledge of the 4Mat model. Again, this did not prevent her contributing to her collective's dialogue:

> *I haven't done any 4Mat training or had any formal experience with today's theories of learning, so I'm coming from a completely "naive" position. I'm inclined to think that we learn different things in different ways and that maybe each of us is completely unique in how we learn a particular thing at a particular time.*

Whilst Vaughan and Sally were not familiar with the 4Mat model, they both contributed *emerging ideas* to their cohort's professional conversation. Again, this may be conceived as a *collective strategy*, a dynamic pattern (or stability) of exchange within the cohort. The collective strategy of sharing emerging ideas appeared to play a role in encouraging other participants to contribute regardless of whether they felt expert. As is evident in this excerpt, this increased the pool of ideas and understandings being articulated, increasing the variation within these contributions.

This excerpt demonstrates the intellectual agency that members of the cohort collective exhibited within the Webboard. In articulating positions that clearly were not supported by moderators, the teachers introduced their own "displacement of point of view" (Latour, 2004) into the professional development process. Shared values of the moderators, for instance, were challenged by cohort conceptions that were often supported by insights, models and theories that had proven useful over years of classroom experience. The cohort collective were clearly ensuring that any conception of learning that was developed in the DESCANT context, would *take into account* entities they knew to be salient, regardless of what any expert might say to the contrary. Maintaining *perplexity* then, was a task for both the cohort collective and the moderator collective.

Moderator Collective:

There are few grounds in this vignette upon which to divide contributions of the Cohort 1 collective and those of the moderator collective. Ingrid, for instance, exhibits patterns of exchange more commonly associated with a moderator role: introducing theory, recombining the ideas of others and providing resources for further research. Furthermore, the moderators exhibit many of the collective strategies detailed previously in relation to teacher participants. For example, Lyn acknowledged sincere professional uncertainty, stating:

> *I'd like to respond to the points you make - and I don't feel that I am expert in this - I am NOT a neuroscientist - not even a biologist - I have had to teach myself what knowledge I have in these fields - and it is still sketchy compared with people who have worked their whole lives in these disciplines. So, we are ALL feeling our way - and using things that look as though they will be helpful in our own practice.*

In doing so, Lyn, like the other moderators, exhibited the collective strategy of expressing professional uncertainty. The authenticity of this uncertainty within the moderator collective was reinforced by the genuine intellectual debates that are evident within this excerpt. For instance, Gill and Lyn debate the utility of pragmatic tests for discerning the validity of models of learning and teaching. The ongoing debate made it clear to all DESCANT participants that the Moderator collective did not possess total certainty or even unanimity on the topics being discussed. In keeping with political ecology, no member of DESCANT whether moderator or teacher, was afforded the intellectual authority that could 'short-circuit' (Latour, 2004) the dialogue. Furthermore, intellectual boundaries in DESCANT were clearly not governed by associations or allegiances.

However such equity did not preclude the influence of the moderators' expertise, nor the refined values and understandings of their wider professional contexts. For instance, Lyn's scientific and theoretical position appeared to reflect her own interest in the learning sciences, as well as the values of her academic position as a researcher. Similarly Gill's defence of practice-based forms of validity resonated with her professional approach as Science and Technology Regional Consultant with the DET. Whilst these are only speculative indications of the influence of wider values and cultures, they act as an acknowledgment of the nested structure of the systems within which these events took place. In various ways, DESCANT gave *representation* to the values, insights and epistemologies of a range of educational contexts, including university, Departmental and school contexts.

It is possible then to understand the intellectual positions in this excerpt as deriving, at least in part, from a range of wider cultures (or collectives), self-organising within the DESCANT arena for the purposes of professional dialogue and learning. Clearly, individual agency was still important within this process, but so was the nested structure within which these individuals were operating. The excerpt highlights a range of values that are both implicitly and explicitly associated with wider contexts, including classrooms and other professional developments contexts.[110]

Through this self-organising dynamic, a central professional concern was emerging within the group. Whilst their ideas, theories and epistemologies remained diverse, there was an emerging recognition of the need to tune teaching practice on the basis of a deep valuing of students' knowledge and ways of learning. This was to become a central dimension of the group's e-learning design for professional development.

I now summarise how this Learning Ecology analysis has proven useful for understanding the collective dimensions of GVC and Webboard contributions in Phase 1 of the DESCANT Project, thereby answering the research question that is at the core of this chapter, Can teachers' initial collective investigation of Science and Technology learning (as a precursor to their e-learning design) be understood as part of a Learning Ecology?

6.3 Answering Chapter 6's Research Question: an analytical summary

A Learning Ecology analysis has proven useful for understanding the collective dimensions of GVC and Webboard contributions in Phase 1 of DESCANT. In particular, the analysis highlights how the actions, strategies and contributions of DESCANT participants may be

[110] From a complexity perspective, each of these wider environments or systems may be characterised as a nested ecology shaped by dynamic stability and value-laden attractors, incorporating environmental values, biological values and social or cultural values (Davis & Sumara, 2006; Capra; 1996; Pirsig, 1991).

associated to a diverse range of collectives, some developed for the project, and others associated with wider professional contexts. Furthermore this analysis has assisted in understanding how these collective contributions and strategies may be associated with a complex yet increasingly patterned collective learning dynamic.

This analysis presumed that a learning ecology might initially be characterised by some form of collective exploring whereby new, potentially valuable, patterns are generated. The patterns that were identified here related to *collective strategies*: that is, collective *responses* to the environment based on the collective agent's purposes and intentions (Axelrod and Cohen, 2000).

Initially, two collective patterns were identified, each contributing to the group's exploration into learning. The first involved a subgroup of teachers who operated the GVC collectively to develop an experimental conception of student learning, one based on generative theory and learner-centred values. The second collective pattern was exhibited by a larger population of cohort members, in response to strategic moderator questions in the Webboard. This collective pattern was characterised by a teacher-centred conception of learning: that is a description of learning that was closely associated with teaching strategies, school cultures and classroom logistics.

In one sense, the learner-centred pattern (or attractor) represented a 'displacement of point of view' from the, apparently more familiar, teacher-centred pattern (or attractor). Yet from another perspective, teachers' classroom-based values challenged the relevance of a learner-centred interpretation. Each position thus expanded the ecology of associations, values and interpretations generated during this initial collective exploration. That is, they ensured that a diverse set of entities would be *taken into account* in establishing a collective conception of learning in DESCANT.

From a Learning Ecology perspective these two collective patterns, or attractors, may be associated with exogenous system design: the former with the highly structured GVC environment, and the latter with the centralised structure of the thematic moderator questions. This does not imply that this structured centralised design determined teachers' strategies. However, these exogenous system elements may have shaped (at least to some extent) the value-laden terrain of DESCANT through their ecological "affordances" and "constraints" (after Gibson, 1979).

In this view, these structured elements may have influenced the (collective) strategies employed by agents as they negotiated through the DESCANT ecology. This is, of course, their central purpose as structured learning elements in DESCANT. For instance the GVC sought to provide a structured environment through which to support individuals and groups in progressing their understandings (that is, strategies) with respect to learning. It may be that Vaughan's experiential history within the highly structured and value-laden terrain of the GVC (for example) placed him in a good position to formulate, on the Webboard, a *recombination* of the two collective perspectives centred on learners and teachers.

Within the Webboard's less structured online immersion, characterised by free-flowing professional dialogue, these patterns (or attractors) began to shift, recombine and be replaced by new collective patterns. For instance, the teachers became increasingly interested in discussing learning as a phenomenon in its own right. Furthermore, a range of common collective strategies was identified that stretched across the cohort and moderator collectives. These formed a sort of proto-culture that may have helped to expand the variation within the group's exploration by validating professional uncertainty, and encouraging the expression of emerging, tentative ideas.

Gradually, as the exploration continued, the subtlety of individuals' positions (both teachers and moderators) began to emerge. These were associated with a range of professional contexts, thus further expanding the reach of the ecology being articulated. Still, there were strong indications that these individual conceptions remained closely associated with the shared values of collectives and subgroups, both in the teacher population and moderator collective. This was an indication of the nested structure of the learning ecology existing within the DESCANT context. It is possible to discern simultaneously the variation inherent within individual contributions, and the cohesion that results from identification with various collectives and cultures.

So, a Learning Ecology analysis helped map the strategies that were evident within the teachers' collective exploration of Science and Technology education, including their intellectual orientations, patterns of interaction and patterns of operation. Together these constituted a developing ecological terrain, shifting dynamically with the values of individuals, collectives and the environmental contexts in which they were operating.

However, such a picture was not confined to the earliest exploratory phase of the DESCANT project. In Chapter 7, I examine the subsequent designing phase of the DESCANT project for evidence of features of a learning ecology.

Chapter 7
Describing and Analysing Learning in Groups II
Designing in Phase 1 of the DESCANT project

In Chapter 6, I described and analysed the learning, in groups, of teachers and moderators as they investigated student and teacher learning in Science and Technology, within Phase 1 of DESCANT. However, the design-based nature of the DESCANT project meant that investigation was fundamentally underpinned by the intention to design an e-learning environment for professional development, one that could be used in Phase 2 of the project. So, it is crucial that I examine whether a Learning Ecology framework can make sense of groups' designing as well as of their exploration. In particular, if a collective intention can be identified, then I will have gone some way towards affirming that collective learning has occurred. Furthermore, I will have significantly progressed my inquiry if I can then make sense of this development of we-intentionality in terms of a Learning Ecology framework.

Here in Chapter 7, I seek to understand whether the group's design contributions may be interpreted through a learning ecology framework, asking:

How might a learning ecology analysis make sense of teachers' collective design of an e-learning environment?

I address this question by examining the various design events that took place in Phase 1 of the DESCANT Project as shown in Figure 7.1.

<table>
<tr><th colspan="5">DESCANT Phase 1</th></tr>
<tr><td rowspan="2">Introductory workshop</td><td rowspan="2">Online immersion: GVC & Webboard</td><td rowspan="2">1^{st} Design Workshop & School-based Design Period</td><td>2^{nd} Design Workshop</td><td>Final Design Workshop</td></tr>
<tr><td colspan="2">Participants Upload & Rate Culminating Tasks</td></tr>
<tr><td>4^{th} Aug</td><td>Aug- Oct</td><td>15^{th} Oct- 28^{th} Nov</td><td>10^{th} May</td><td>14^{th} Mar</td></tr>
<tr><td colspan="3">2003</td><td>2004</td><td>2005</td></tr>
</table>

Figure 7.1 Various design events (shaded) within the DESCANT Phase 1 Timeline.

In 7.1, I begin this analysis by describing and analysing how teachers and moderators used the Webboard environment to work towards a collective e-learning design. Excerpt 1 exemplifies this online design dynamic. In particular, it is representative of how teachers and moderators connected their parallel online investigations (as described in Chapter 6) with their sharing, discussing and critiquing of design solutions. For this reason, Excerpt 1 was considered an appropriate test of the Learning Ecology framework.

In 7.2, I extend this analysis by describing and analysing the end product of this collective design process, the prototype DESCANT Colony. For this purpose I examine three central design decisions underpinning the e-learning design, as proposed by Cohort 1 teacher-designers. These design decisions were made by Cohort 1 teachers, with the support of the wider DESCANT population, over the 1st, 2nd and Final Design Workshops (as shown in Figure 7.1).

Describing and analysing these design principles, as part of the wider study of collective learning in the DESCANT network served two purposes. Firstly, this approach provided a means of recognizing where the collective learning of Cohort 1 (as discussed in Chapter 6 and in 7.1) may have been articulated through their e-learning design. This is typical of a design-based research approach, which conceives learning environments as reifying positions and conjectures on learning (Sandoval, 2004). Secondly, those central learning principles underpinning the e-learning design were a likely arena in which collective learning would occur, if it did occur. Thirdly, I considered such examination of the foundations of the e-learning design essential as a preparation for describing and analysing learning in Phase 2. There, I would be seeking evidence for collective learning and testing the worth of a learning ecology framework to make sense of it, if it occurred, when teachers in Cohorts 2 and 3 were immersed in the DESCANT Colony.

In 7.3, I then describe and analyse how Cohort 1 teachers contributed classroom videos and accompanying texts to be used for professional learning within the DESCANT Colony. Whilst these Culminating Tasks represented individual design contributions, they were to become the central means by which Phase 2 participants would engage with the intellectual terrain of the DESCANT Colony. I therefore describe and analyse the ways one Cohort 1 teacher's classroom videos and accompanying texts articulated her learning. This scrutiny formed essential preparation for analysing groups' learning within Phase 2, where participants would be engaging with these Culminating Tasks as a central basis for their professional development.

In 7.4, I conclude with an analytical summary, thereby answering the central question of Chapter 7: whether a Learning Ecology analysis makes sense of teachers' collective design of an e-learning environment.

7.1 Working up a Design Orientation

Cohort 1's design task required that they negotiate a shared perspective regarding the value of different e-learning designs for professional development in Science and Technology education. The DESCANT Project encouraged the development of a shared intention. It was this shared intention (both to design and to design on a negotiated set of shared values) that ought implicitly to have underpinned the group's investigation (as discussed in Chapter 6). To judge that there was collectivity in design, it is therefore crucial to examine the extent to which such intentionality is empirically present. In this section, I address the overarching question: Can teachers' initial design contributions be understood as a learning ecology? Consideration of the extent of we-intentionality will necessarily be a key part of this analysis.

7.1.1 Can teachers' initial design contributions be understood as a learning ecology?

As already noted, I describe and analyse those initial design contributions occurring in the Phase 1 online immersion period (as shown in Figure 7.2), and in particular, during a specific Webboard discussion.

<table>
<tr><th colspan="5">DESCANT Phase 1</th></tr>
<tr><td rowspan="2">Introductory workshop</td><td rowspan="2">Online immersion: GVC & Webboard</td><td rowspan="2">1st Design Workshop & School-based Design Period</td><td>2nd Design Workshop</td><td>Final Design Design Workshop</td></tr>
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</table>

Figure 7.2 Locating Design Excerpt 1 (shaded) in the Timeline of DESCANT's Phase 1 Online Immersion

Prior to this online immersion period, during the Introductory Workshop, teachers had been encouraged to discuss their professional development needs in Science and Technology. Essentially, this conversation had marked out the beginning of their shared task of designing an e-learning mediated professional development environment. In conversation, the teachers discussed a range of professional learning needs that included:

- Identifying how to remain in control of Science and Technology lessons, whilst ‘letting go’ of the need to overly direct the lesson.
- Gaining the appropriate knowledge for supporting learners’ questions and experiments, including domain and process knowledge.
- Accessing ideas for making and/or gaining resources for Science and Technology education.

During this conversation, and throughout the remainder of the Introductory Workshop, none of the Cohort 1 teachers had expressed a need, or desire, to better understand student learning in Science and Technology as a means of addressing these learning needs. Furthermore, whilst the teachers had expressed their need for more extensive domain knowledge in science, they had not expressed any interest in gaining a more intimate perspective on the students’ conceptions within these domains.

Nevertheless, only a few weeks later, there were signs of a new perspective emerging within the group, concerning their professional learning needs and the means by which they might be met through their design task.

<u>Design Excerpt 1: Establishing the value of video clips to teacher learning</u>

In the Webboard, Gill initiated a discussion by noting that the GVC did not ‘approximate the experience’ of watching a colleague teach:

Gill

Subject: Value of Videos

Posted: 11th August 2003

*…Because [in the GVC videos] we get to see one or two children, not what's going on in the rest of the room and especially not the teacher in action, it doesn't seem to me like watching a colleague at work. What it does do [is] it lets me watch *kids* in a way I can't in my own classes…What do people think are the pros and cons of using video clips?*

The discussion of the GVC videos that was to follow allowed the group to develop a pool of ideas and a range of values, by which to make design decisions related to the e-learning environment they would build.

Rob then framed the issue in terms of functionality, with some key insights about the selectivity of focus (and perhaps perception):

Rob

Subject: Value of Videos

Posted: 11th August 2003

Videos can be valuable for specific purposes- such as the GVC. They can never be a substitute for actually being present in a teaching space. The clinical view of the camera lens screens us from the larger view- that's appropriate for a focused task. A group of observers present in teaching space will observe a huge variety of interactions, even when instructed to focus narrowly. Insights gained can be unexpected and unintended. Significance can be given to these insights by attempting to apply them to a meaningful framework…

As one of the teachers who had contributed strongly to the GVC environment, Rob seemed to be alluding to the benefit of interpreting student learning through a specified, and 'meaningful' framework, such as the generative framework. For him, a focused approach was useful for such a purpose. In contrast, Ingrid advocated a less finely resolved picture, one that incorporated the entire classroom system.

Ingrid

Subject: Value of Videos

Posted: 12th August 2003

…Using video clips to gain an overall impression of class interaction is brilliant though - that appeals a lot and would really let you sit back and see all the little 'incidents' that happen and that you just physically can't take in when you're teaching. Yes Gill, seeing one or two kids is great but that overall classroom atmosphere is lacking and how children mesh and integrate in that setting is crucial.

It is unclear what ‘incidents’ Ingrid thought valuable to teacher observation. It is clear, however, that she had a preference for videos that represented classroom ‘interactions’, rather than the small group dialogue offered through the GVC videos. Cathie saw the value in both points being raised:

Cathie

Subject: Value of Videos

Posted: 12th August 2003

Hi Ingrid, I think you and Rob have both hit on valuable points. Watching others in action is a very powerful training tool. I can always remember a colleague of mine complaining that many of the T&D [training and development] clips were false and not realistic as they concentrated on a very small group with “perfect” children, which as we all know is not how it really is. We need to show the macro as well as the micro.

Vaughan then made explicit for the group his view that fine grain might be helpful early and coarser grain later:

Vaughan

Subject: Value of Videos

Posted: 12th August 2003

At this stage the videos serve their purpose well as we are focusing on the intricacies of how individuals are thinking, and generating ideas. As these are just examples of what we hope is occurring simultaneously in many young minds in our class during a stimulating lesson, they're very useful. We could spend a very long time watching 'more realistic' videos with less focus for the same result. The 'more realistic' videos may be of use later when we are better skilled at selecting the trees in the forest…

Like Rob, Vaughan appeared to recognise the value of interpreting the video content through a particular framework, relating it again to a generative orientation. Angela had sympathy for Vaughan's position but, like Ingrid, felt 'realism' was important.

Angela

Subject: Value of Videos

Posted: 13th August 2003

…I agree with Vaughan (move slowly so we can pick the trees in the forest), but the realism factor of large classrooms, sets in again and challenges how the outcomes of the single child have been achieved in the 30+ classroom. Would the response of a single child be seen as misleading the public?

Kerrie discussed the use of exemplary teaching video, and her comment echoed the cohort's focus, in the Webboard discussions, on teaching-centred rather than learning-centred dimensions of classroom practice:

Kerrie

Subject: Value of Videos

Posted: 13th August 2003

Earlier this year I attended a teacher development day at Ashille with many other teachers in the Hillsland district. It was about advanced pedagogy.
We were shown a film and asked to evaluate the pedagogy techniques in it. The teacher was (at the time of filming) regarded as the "bees' knees" and the film was used as an example of good teaching. That day, it was an example of finding the things he didn't do. I can't verbalise what I thought at the time. It was as if I was prying.

Whilst acknowledging that the GVC videos did not approximate classroom experience, Sally emphasised the value of its more focused approach. Like Vaughan and Rob, her position may have derived from her strong usage of that environment.

Sally

Subject: Value of Videos

Posted: 18th August 2003

… I also think it's different from being actually physically present in a classroom, but it is extremely valuable to have these insights into thought processes of these children. Would it be possible to create a split-screen situation?

Here, the teachers expressed a range of positions regarding the value of narrowly focused classroom videos for teacher learning. Whereas some asserted the benefit of focused videos for specific learning purposes, others stressed the need to maintain classroom realism – by which they seemed to mean, a sense of what was happening at scale over the whole classroom - in these videos. Through this Webboard discussion, the cohort collective was beginning to develop a shared, yet still diverse, perspective regarding what would be of importance to their e-learning design.

As with the Cohort's collective exploration (discussed in Chapter 6), in discussing the value of the GVC videos for professional learning, two main design positions may be distinguished: one in which 'micro' videos were valuable, the other in which 'macro' videos were valuable.

Collective Value: The 'micro' position

Whilst all teachers were sympathetic to calls for 'classroom realism,' Vaughan, Sally and Cathie all expressed a belief that there is value in gaining access to a more intimate perspective on students, as they engage with Science and Technology:

> *At this stage the videos serve their purpose well as we are focusing on the intricacies of how individuals are thinking, and generating ideas. (Vaughan)*

> *…it is extremely valuable to have these insights into thought processes of these children. (Sally)*

> *We need to show the macro as well as the micro. (Cathie.)*

Rob also acknowledged the value of a narrowed focus for videos, presumably referring to the group's use of the GVC videos in order to better understanding student learning in Science and Technology:

> *The clinical view of the camera lens screens us from the larger view- that's appropriate for a focused task. (Rob)*

These teachers appear to be acknowledging the value of gaining a more intimate, 'micro' perspective on students as they engage with Science and Technology topics. For them, such focused videos would offer insights into the intricacies of the students' thought processes in Science and Technology. Their insistence on the value of these insights for professional learning was a shift from their perspectives during the Introductory Workshop only a few weeks earlier. It seemed that a new professional learning need was becoming salient for some in the group.

Vaughan, perhaps fulfilling the role of a professional elder in the group, was explicit in asserting that the cohort, as a whole, had things to learn from the intricacies of student thinking, noting:

> *The 'more realistic' videos may be of use later when we are better skilled at selecting the trees in the forest… (Vaughan)*

As teacher designers, this subgroup was expressing shared values as to the types of videos that could meet their professional needs for Science and Technology education. These shared values seemed underpinned by a 'student dominance' assumption (Osborne and Freyberg, 1985): that is, an assumption of the importance of understanding students' *existing* ideas and conceptions as a basis for teaching Science and Technology. This collective understanding was becoming increasingly evident in this subgroup.

Why this subgroup of teachers began to articulate this collective understanding, both here, and elsewhere, is a subject for speculation. It is possible this shared understanding may have developed naturally as a result of the teachers' engagement with generative theory.[111] As well, the collective strategies they used for engaging with the generative theory in the first few weeks of the project may themselves have been influential. Vaughan, Sally, Rob and Cathie, were the only cohort members to have contributed *publicly* within the GVC environment during this early online immersion period: that is, they operated the GVC collectively. Furthermore, the collective strategies of this subgroup in the GVC (as detailed in 6.1) demonstrated they had engaged strongly with the conceptual understandings of the students in the GVC videos.

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[111] Osborne and Freyberg (1985, p. 86) note, "If one adopts a generative view of learning…the importance for science teachers of understanding children's science becomes very clear….children's science must necessarily play a dominant part in science learning."

These collective strategies may have afforded these teachers a shared insight into the potential of narrowly focused (micro) videos for teacher learning. In the excerpt, the subgroup appeared to be using this shared understanding as a value by which to judge the merit of particular design options (something they continued to do throughout Phase 1).
This analysis corresponds with a generative model of learning, which holds that an important dimension of (collective) design is the establishment of values by which to test the merit of available ideas, variants or options (Schaverien & Cosgrove, 1999; 2000). It seemed that this subgroup was now testing the value of 'micro' videos on the basis of a collective understanding, one that may have developed through these teachers' shared experiential history in the GVC.

From the perspective of political ecology, these teachers seemed to be asserting that students' thinking, rather than simply classroom dynamics, should be *represented* within their e-learning design for professional learning. That is, they sought a design that incorporated the intricacies of student thinking. For these teachers, such a design would provide solid ground for teacher learning. Yet others in their cohort were less convinced of the relevance of this dimension for their e-learning design.

Collective Value: the 'macro' position

In contrast to this subgroup (or GVC subgroup), Ingrid, Angela and Kerrie's strategies remained private. During the early stage of the project, these teachers were unwilling, or unable to share their observations in the GVC with their cohort colleagues. This pattern of operation may have resulted in a different experiential history for this subgroup. For instance, in utilizing a private pattern of operation these teachers may not have committed, even temporarily, to using the generative heuristic (generate-test-regenerate) as a means of interpreting student learning in Science and Technology.

These teachers were still able to utilize (in private) the generative framework as the basis for watching the student videos. Nevertheless, as already noted above, the act of making specific observations based on this theoretical framework may have encouraged strong engagement with the students' conceptual understandings in Science and Technology. Perhaps, without fully operating the GVC, these teachers, as a subgroup, developed different associations to the GVC videos.

Of the teachers who had not contributed to the GVC during the designated period, only Angela expressed support for the micro view.

> *I agree with Vaughan (move slowly so we can pick the trees in the forest)…*

Yet, Angela questioned the validity or relevance of a design that failed to incorporate the realism of the classroom.

> *…but the realism factor of large classrooms, sets in again.. Would the response of a single child be seen as misleading the public?*

In doing so, Angela seemed to indicate a different appreciation of the value afforded by accessing the intricacies of student thinking and conceptual understanding. Other teachers alluded to a more teaching-centered rationale for a wide, or 'macro' focus. Ingrid stated:

> *…an overall impression of class interaction is brilliant though - that appeals a lot and would really let you sit back and see all the little 'incidents' that happen…*

Ingrid remained vague as to what 'incidents' she was referring to. However, it is doubtful that Ingrid conceived the wide classroom focus as capable of capturing the individual conceptions of students, regarding the Science and Technology topics being investigated.

Kerrie's comment was the most ambiguous regarding the issue of 'micro' and 'macro' videos. She noted how readily practising teachers might critique videos that claim to be exemplary in some respect. Yet it is unclear whether this is a rejection of unrealistic videos, or a critique of using videos to demonstrate exemplary practice. In either case, Kerrie gave no indication of valuing a learner-focused video.

The comments of Angela, Ingrid (and to some extent Kerrie) seem to suggest these teachers did not, at this early stage of the project, share the other teachers' conviction regarding the *relevance* of focused videos for professional development in Science and Technology. These teachers seemed to place less value on accessing the ideas and conceptual understanding of individual students, or small groups of students, as a basis on which to develop insights into Science and Technology education.

The contributions of this second subgroup may therefore be conceived as a critique of the 'micro' GVC videos regarding their value for professional development. From a political ecology perspective, this was a critique of their capability of being 'reliable witnesses' or "situations capable of testing the faithfulness of representations…" (Latour, 2004, p. 248). In a sense, these teachers were suggesting an expansion of video content in order to more adequately *articulate* student learning in Science and Technology. Ingrid, for instance, was resolute on the importance of capturing the classroom dynamics of 30 students. For her, this would increase the worth of the videos for professional development. It seemed for these teachers, the 'micro' focus of videos prematurely constrained the boundaries in which Science and Technology education could be investigated and understood. For them, this risked the charge of, in Angela's words, "misleading the public."

This classroom or teacher-focused orientation reflected the values and understandings expressed by the entire cohort during the Introductory Workshop. Now, however, this orientation was being challenged by a subgroup of teachers who appeared to have developed a learner-focused orientation, perhaps due to their experiential history in the GVC. These two collective orientations were noted in 6.2.1 in regards to the cohort's exploration of topics related to Science and Technology education. Now, they have been shown to be equally apparent within the cohort's design process.

These two subgroups appeared to be establishing two different values by which to test design ideas: one in tune with the values of the GVC (as discussed in Chapter 6), the second in tune with the values of the classroom and school cultures in which these teachers operated. Again this resonates with generative theory, which holds that ideas are tested, not just on individual values, but also on the shared values of groups and cultures (Schaverien & Cosgrove 1999; 2000). This analysis reveals how newly developed collective values in a group, may represent a challenge to more established collective values within a culture.

From a political ecology perspective, both subgroups were asserting the relevance of particular design choices for helping others understand student learning in Science and Technology. For one group, it was necessary to give representation to the intricacies of students' own thinking. For the other group, the realities of classrooms required representation. Their process of collective design can therefore be associated with Latour's (2004, p. 109) second requirement of political ecology: *Consultation*.

> *You shall make sure that the number of voices that participate in the articulation of propositions is not arbitrarily short circuited.*

Latour describes the requirement of consultation as one that seeks relevance within the process of establishing the common world (see 2.2.2). This analysis has demonstrated that the cohort teachers actively organised around the ideas, values and understandings that they believed relevant for their e-learning design.

So, in this way, a Learning Ecology analysis has proved useful for making sense not only of the cohort's process of collective exploration, but also of its collective design in this initial period of DESCANT. In particular, such an approach is sensitive to both experiential history (derived from complexity thinking) and collective values (derived from generative learning and political ecology). Such sensitivity has helped expose the relationship between the group's prior collective exploration (described in Chapter 6) and the design contributions they had begun to make.

Next, it is necessary to discuss how the group's understandings and values were reified in their e-learning design.

7.2. A Prototype Environment

As was noted in 4.2, design-based methodologies typically conceive learning environments as reifying positions and conjectures on learning (Sandoval, 2004). As Tabak (2004, p. 226) noted, “The design aspect involves designing an intervention that reifies a new form of learning to articulate and advance a particular position on learning.”

The cohort’s prototype design became a means of developing an *articulation* of learning and teaching in Science and Technology, an articulation that would become the basis of the Phase 2 professional development intervention. In this sense, their environment, and the artifacts it contained, became a means of passing on their own knowledge, understandings and values, a form of cultural transmission within professional learning.

Here in Section 7.2, I examine the Cohort’s prototype environment for evidence that this occurred. My analysis in this chapter deliberately focuses on the design, rather than the enactment of the design which will be detailed subsequently in Chapters 8 and 9. This approach allows for an analysis of the prototype design as an *articulation* (Latour, 2004) of the cohort’s collective learning (as detailed previously in Chapter 6 and in the previous section, 7.1). I thus seek to answer the question: *What implications might the e-learning design itself have for understanding collective learning?*

7.2.1 What implications might the e-learning design itself have for understanding collective learning?

To address this question, I examine a short vignette that describes the DESCANT Colony with regard to three central design decisions. The Cohort 1 teacher designers established these central dimensions of the DESCANT Colony over the course of three Design Workshops, with the support of the wider DESCANT population. Figure 7.3 shows where this vignette was located in the DESCANT Phase 1 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 1</th></tr>
<tr><td rowspan="2">Introductory workshop</td><td rowspan="2">Online immersion: GVC & Webboard</td><td rowspan="2">1st Design Workshop & School-based Design Period</td><td>2nd Design Workshop</td><td>Final Design Workshop</td></tr>
<tr><td colspan="2">Participants Upload & Rate Culminating Tasks</td></tr>
<tr><td>4th Aug</td><td>Aug- Oct</td><td>15th Oct- 28th Nov</td><td>10th May</td><td>14th Mar</td></tr>
<tr><td colspan="3">2003</td><td>2004</td><td>2005</td></tr>
</table>

Figure 7.3 Locating a Design Vignette (shaded) in the Timeline of DESCANT's Phase 1 Online Immersion

The DESCANT Colony: A Design Vignette

Cohort 1 teachers influenced the learning orientation of their e-learning environment for professional development, through three fundamental design decisions:

1. The choice of a (generative) *learning* focus as the environment's 'priority purpose'.
2. The use of *teacher-generated Culminating Tasks*, in combination with a recommender system, as the intergenerational source of *content* in the site.
3. The use of a *bounded group structure* for professional development.

I now outline the nature of these design decisions, in preparation for an analysis of their implications for understanding collective learning.

Collective Design Decision 1: Focusing on understanding (generative) learning

During the morning session of the 1st Design Workshop the teachers worked to develop a priority purpose for their e-learning environment. Prior to the design workshop, the teachers had discussed a range of professional development needs and concerns that could potentially serve as the main focus of their e- learning environment. These were summarized in a support document for the Design workshop (see Appendix 1.4).

From this wide ranging discussion of purposes and needs, it was necessary for the group to prioritise a select set of purposes for professional learning in their prototype environment. Following discussion within subgroups and as a whole, the following priority purpose was developed:

> *To understand better how we (students and teachers) learn, initially by consideration of a generative model of learning, specifically in the context of designing and making and investigating in order to improve student learning in K-6 Science and Technology.*

The teacher group unanimously agreed that future participants should investigate the *generative* orientation as a starting point for their investigation into the learning of students and teachers. There was a strong sense that the group felt this represented a common ground of understanding for them as a group. Vaughan articulated this in the 1st Design Workshop by stating:

> *What we're saying is we have, I believe, developed a commitment to the value of this particular [generative] learning model. And we would like to expose and convince other people that this is a worthwhile way of going about teaching, which is quite a change for many people…. this is our baby.*

Yet, they also expressed the importance of other perspectives on learning being validated within the DESCANT environment. Gill summarized the group's discussion of this point: "We had some possible problems with being too prescriptive about saying 'thou shall be generative', to the point of saying 'thou shall at least *consider* being generative'. And if after all of that, you actually decide, after you've considered and tested it, you actually rejected it, then so be it."

The consensus to focus on student and teacher learning represented a major shift from the professional needs that had been expressed by the cohort during their Introductory Workshop. They had, at that time, given no indication of any interest in gaining new insights into the way students and teachers learnt, instead focusing on gaining access to new teaching strategies for Science and Technology education.

Indications of the emergence of this learner-centred collective position were discussed in Chapter 6 and here in Chapter 7, particularly in regard to the GVC subgroup of teachers who were early adopters of this position (see 7.1.1). Now this perspective had been incorporated into the main learning purpose for their prototype environment.

Having established this priority purpose, the teachers used the design workshops to develop an e-learning design that would best fulfill this aim. During this process, they commonly referred back to their DESCANT experiences as a source of newly acquired insights into student and teacher learning in Science and Technology, utilizing these insights as the basis of design decisions. Furthermore, on numerous occasions, they challenged the intellectual and design perspectives of members of the wider DESCANT design team who had not shared their experiential history in the DESCANT project, such as senior IT representatives from the DET.

For example, in the 1st Design Workshop, the teacher-designers collectively argued against DET executives and Senior IT Representatives who believed (following conventional IT logic) that users should be allowed to edit their private journal entries. The teacher-designers drew on their DESCANT experience to argue that the journal would represent a learning journey that should be preserved. Rob noted “It’s like dragging a brush behind to erase your footprints. You don’t do it.” During the 2nd Design Workshop, the teachers pushed for the use of a technological rating system as a means of establishing valuable teacher contributions. This was despite an IT consultant recommending that a central body or a particular person undertake this process of evaluation. Again the designer-teachers appeared to draw upon their experiences in DESCANT to argue the learning benefits of a decentralised rating system. Their collective agency as a cohort of teacher designers was therefore often evident.

Over the course of the three design workshops, an initial design for a prototype e-learning environment emerged (see Appendix 2.2). During the 1st Design Workshop the teachers decided that each DESCANT participant would be invited to author a short classroom video that captured a pertinent incident of student learning in Science and Technology. These videos would be uploaded to the prototype environment in conjunction with an accompanying text that aimed to help viewers understand the excerpt’s context and focus.

This set of materials (their own video together with their explanatory text) became known as the Culminating Task.

Collective Design Decision 2: Utilising teacher-generated Culminating Tasks and a recommender system

Initially, the teacher designers conceived this Culminating Task as a means for DESCANT participants to demonstrate their learning at the end of the DESCANT process. However, by the end of the 2nd Design Workshop, the Culminating Task took on a more central role in the e-learning design. The teacher designers decided that the prototype environment should be continually furnished with the Culminating Tasks of previous cohorts. Each of these Culminating Tasks would be developed as a means of supporting teachers to develop their understandings of student and teacher learning in Science and Technology (in line with their priority purpose). It soon became clear that the group was conceiving the Culminating Tasks of DESCANT participants as the main content for their professional development environment.

Cohort 1 teachers volunteered to develop their own Culminating Tasks. Through these classroom videos they aimed to contribute to the learning of future teacher participants, supporting them towards better understandings of student learning in Science and Technology. The group did not conceive their classroom videos as being exemplary of teaching practice, but rather as a means of enhancing teacher learning. In this regard, Angela noted, “I am comfortable with showing my mistakes…”

The cohort aimed to develop Culminating Tasks that were exemplary for helping teachers learn, rather than exemplary for demonstrating teaching practice. When questioned directly by DET executives on how teachers would be able to extrapolate teaching practice from their learning about learning, the teachers were confident that this was possible, just as they themselves had managed it in their own DESCANT experience.

The cohort's community-based or bottom-up conception of professional development raised considerable challenges regarding quality control and site management. The teachers addressed both of these concerns during the Design Workshops, with the support of the wider design team. During the Second Design Workshop, Vaughan and Kerrie suggested that a rating system be used to manage the content of the site in a decentralised manner.[112] The rating system would also inform future DESCANT participants as to which of the Culminating Tasks had been of value to previous cohorts.

The implications of integrating the Culminating Tasks with a rating system were summarised by the group in one short exchange:

> *Katrina: It's like passing on knowledge.*
>
> *Vaughan: like a search engine throwing to the top.*
>
> *Gill: So the culminating tasks actually become a modification to the environment and get added to it as initial furnishings…*
>
> *Katrina: it makes the design forever changing doesn't it [tracing a circle with hand], it's not just [tracing a straight line]"*
>
> *Vaughan: it can be done technically can't it, rather than manually?*

In this short excerpt, both Katrina and Gill make explicit the implications of the emerging design: as each cohort authored a further collection of Culminating Tasks, their own learning within DESCANT had the potential to change the environment in a substantive manner, thus continually *establishing* (or re-establishing) *the common world* (after Latour, 2004).

[112] These teachers may well have developed this idea based on their experience with online search engines and recommender systems outside education, although this is not altogether clear.

An important consequence of this design decision was that future teachers would also be given the opportunity to contribute to the emerging design of the e-learning environment, through their Culminating Tasks. So, the DESCANT professional development process would remain underpinned by an intention to contribute to "the commons" (Bowers, 2005).

In this respect, choosing an appropriate rating criterion became an important task for the first cohort. Whilst it was recognised that these criteria may change in the future (as Phase 2 teachers critiqued the initial design), the decision represented a significant means of implementing a particular educational focus in the environment. After a long and vigorous group discussion, it was decided that the rating system should, at least initially, utilise categories related to the generative learning theory. In this way, the collective maintained correspondence with the priority purpose they had established for the environment (See Appendix 2.2 for final rating categories).

The group's design thus remained closely associated to their increasingly explicit generative orientation to professional learning. This orientation was at times used to conceive of the entire environment as a type of generative learning system. For instance, Vaughan articulated an association between the cultural learning dimension of their design and generative theory:

> *"I find it interesting that a Generative approach would allow us to put something out there and allow people to test it and modify it, and so it could wander off. If this, the whole [e-learning environment] was a generative learning model then it would gradually evolve as it went on wouldn't it."*

There is an explicit recognition here that the environment, as a generative and cultural mechanism for professional learning, could proceed by way of iterative experimental trials. In some ways, Vaughan's comment captures the iterative cycling typical of design-based research and professional development. Yet by positing that this system development would proceed through a process of generating and testing, Vaughan was associating this process with the generative learning theory.[113]

Vaughan's comments theorise DESCANT as a site for intergenerational, or cultural, collective learning. The comment reflects a growing sense in the group, including, the wider DESCANT population, that the e-learning design could become a type of *learning ecology* in its own right, 'forever changing' (using Katrina's words) through the modifications that would be made by subsequent generations of DESCANT participants.[114]

Collective Design Decision 3: The Bounded Group as a structure for professional development

Whilst the Cohort 1 teachers advocated a decentralised design for content generation in the DESCANT environment, they were also aware of the risks this design entailed for quality control. During a design workshop, Vaughan articulated this tension in discussing the emergent, intergenerational dimension of the design:

> *But I'm sitting here thinking, I'm not sure I want these other people to get hold of it, maybe, sully it. [Laughter in group] And I think, hang-on, I'm talking about a generative model. So I'm having a few problems between control and allowing it to evolve, which is what we're really talking about.*

Vaughan's concerns sparked a discussion relating to how the environment may be regulated. Cathie began by noting the benefit of maintaining a cohort structure.

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[113] As detailed in 3.2, the generative theory (after Schaverien & Cosgrove, 1999; 2000) contends that learning occurs through a process of generating, testing and regenerating.

[114] There were early indications of this view in the wider DESCANT population during the online immersion period where Gill (as DET Science and Technology Consultant) discussed "…the survival of *ideas* within the collective understanding. Some become established and generate a whole line of descendants that come to occupy an important and lasting place in "the way we see things around here" (is it stretching the metaphor too far to suggest an ecology of ideas?) others sink into extinction." (Webboard 9/9/2003)

Cathie:…The next people that are going to look at it, we're not actually talking about the next step as opening it up to the [gestures wide expanse with hands]. We're only talking the next cohort so they will be a little more protected as a group won't they?

Gill (or Kerrie?): They'll also be…

Sally: More controlled too

Cathie: Yes so…

Vaughan: I'm Sorry , who are 'they'?

Lyn: We don't know who they are.

Vaughan: I thought I'd missed something.

Cathie: I was just thinking about your comment Vaughan about what are they going to do with our videos. But if they're like us, if they're the next cohort that's sort of, you know like controlled and if a group all know one another, you know it's not quite so, I suppose, fearful letting your work go, is it?

Ingrid: [nodding]

Cathie: It's not open to Joe Blog down the street, it's only going to be open to another group such as ourselves.[115]

Throughout the workshop, the group often expressed the value of their cohesive group for learning. This was well articulated by Vaughan, in stating:

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[115] Cathie's position here reflected ideas she had expressed previously in the Webboard discussion (3/11/2003), where she also argued for a bounded group structure: "Our site needs structure and I like the idea of a private space where different groups can comment without the whole participating, but several groups using the same materials. I think that this type of structure would lead to valuable comments, learning and support for invited/committed members of like thinking people."

> *The video is a powerful source and it can be very credible. But…it has a lot of value when you have an opportunity to discuss it and see that what you thought you heard and understood.*

Vaughan emphasised his point by referring to the positive feedback he was getting, at that very moment, from his cohort colleagues:

> *You get other people- [refers to a colleague at the table] like Angela was just going [nods] like that then. I'm being validated in what I'm saying by her saying, 'Yes that's right.' We [as a cohort] discussed it and we felt much better about it. So, the interconnection of individuals is really important as well, rather than just being information in front of a screen and taking it in [traces outline of individual figure with hands] in isolation.*

It is clear from Vaughan's comment that he perceived the learning in the group as being influenced by continual feedback from within its ranks. Whereas the inter-generational dimension of their design allowed cohorts to access videos, and *pass* knowledge on to future participants, they recognised that it was through the forums and chat rooms, that knowledge was developed, or generated, in conjunction with the wider DESCANT collective, that is, their bounded group.[116]

<u>*Implications for Understanding Collective Learning in DESCANT*</u>

The three design elements appear to support a conception of collective learning that extends beyond that of a single, cohesive cohort. The incorporation of a decentralised, intergenerational and generative form of learning in the design, suggested that the evolving environment, and the network of professionals it supported, might also need to be

[116] This reflects the principles underpinning the Shell Community of Practice detailed in 1.1.2. In that online community, the knowledge that was generated within local cohesive groups was shared with the wider community. Similarly, in the NSN initiative (detailed in 1.2.1) the bounded group was conceived as the most effective site for the generation of new knowledge in professional development.

represented as an overarching form of context for collective learning in the DESCANT project.

In many ways the prototype environment did possess the characteristics of an *adaptive learning system* or network (see 3.1). For instance, its community-based strategy for content generation reflected a self-organising, bottom-up dynamic that would rely on the local, or short-range, relationships of teacher participants contributing to the DESCANT environment. This suggested that emergent collective patterns of learning could be supported through the environment.[117]

For instance, through its decentralised design, the ('forever changing') DESCANT environment could restructure itself over time based on the understandings (or learning) of new agents, or in response to the shifting priorities or needs of agents in a changing (and dynamic) education system. The design thus supported the DESCANT system in dynamically embodying its history. That is, it supported the system to *learn* (Davis & Sumara, 2006).

Furthermore, as Vaughan and others were aware, this network learning could be associated with a sophisticated learning theory. For instance, through the priority purpose and rating criteria, a value system had been established in the environment, based on the dominant values and understandings of the initial cohort. In particular, the value system afforded high priority to a learner-focused approach to Science and Technology education, as well as a generative orientation (both for student and teacher learning). Thus, whilst the system was highly decentralised, it also incorporated a degree of structure in order to ensure that self-organisation remained focused on priority educational values.

This corresponds to the conception of adaptive learning systems developed in 3.2. There, it was asserted that learning involves a value system, one that may develop increasing

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[117] Davis and Sumara (2006, p. 105) write, "If agents are able to affect and be affected by their nearest neighbours- as is the case for neurons, ants, species in ecosystems, and so on- then the grander unity has complex, transcendent possibilities. If, however, information is controlled through a central hub- that is, if the architecture of the system is Euclidean- then emergent possibility is unlikely."

sophistication as agents engage with each other and the environment.[118] In particular, generative learning theory (Schaverien & Cosgrove, 1999; 2000) contends that ideas or behaviours may be tested against these values which occur at three nested levels: the values associated with genes, those associated within individual learning (for instance, in the brain and immune system) and those associated with social and cultural forms.[119]

The DESCANT recommender system, as a mechanism for learning at an overarching network level, had the potential to represent both individual and collective values and understandings in this respect.[120] For instance, although the recommender system allows individuals and cohorts to pass on knowledge to future participants, it does not require them to reach a *consensus* regarding the value of particular teacher videos. Instead individuals undertake private ratings, which are then aggregated by the system into a mean rating. A video that is rated most highly (on a particular criterion) may be thought of as the current best guess of the entire DESCANT collective (or a particular cohort, depending on which is population is reviewing). DESCANT participants could then access this best guess video through the recommender system for viewing.

Surowiecki (2004) identifies diversity (both in generating and in testing or valuing) as a fundamental property if a group or collective is to operate or learn effectively or intelligently; and this perspective is shared by Bloom (2000). The rating system used to generate each collective best guess here fulfils this requirement, since it is based on aggregating many different individual perspectives.

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[118] For example, newborn infants will track faces and certain patterns over others (Thelen & Smith, 1994). In early agent-based computer modeling, this value bias was often implicit, yet it always existed in some primitive form (Waldrop, 1992). This is not to imply however, that more sophisticated value systems are not developed on top of these initial biases.

[119] In DESCANT, there was evidence of *cultural* values playing a role in the development of the value system that would underpin the environment. For instance, the initial criteria developed by the Cohort collective have since been revised (in a decision made by the DESCANT Partner Collective), to include other criteria expressed in the language of Departmental Science and Technology syllabuses. This change may highlight the need for the DESCANT community and environment, as a professional development learning system, to have an adaptive *fit* (in a biological sense) with the wider systems within which it is situated. Whilst it seems that the teachers have largely self-regulated this fit with their school environments, the extension to the rating criteria may represent the wider DESCANT collective (which includes Departmental and university representatives) assuming a measure of regulatory control.

[120] Users of the recommender system can view the ratings of specific cohorts. Thus, they are afforded insights into the values of that collective (See Learning Landscape description in Appendix 2.2.)

The use of rating and aggregation is increasingly common in online technologies. End-user ratings seek to capture the collective wisdom of distributed groups, or ‘smart mobs’ (Rheingold, 2002). Surowiecki (2004, p. xix) states:

> *An intelligent group, especially when confronted with cognition problems, does not ask its members to modify their positions in order to let the group reach a decision everyone is happy with. Instead, it figures out how to use mechanisms- like market prices, or intelligent voting systems- to aggregate and produce collective judgments that represent not what any one person in the group thinks but rather, in some sense, what they all think.*

For almost a century now, this aggregated form of collective intelligence has proven of interest to researchers dealing with groups of people who have particular cohesion as a social or cultural group (Surowiecki, 2004). Findings indicate that the aggregation of individual ratings (or opinions), especially where there is an independence or autonomy between agents (that is, they are not influencing each other’s ratings) will often produce results that are superior to that of individuals, even experts in the domain (Surowiecki, 2004).

Such findings seem to suggest that the collective intelligence of the DESCANT network may be undermined by the cohesive nature of its bounded professional development groups. It should be noted however, that these findings are usually based on research involving economic models and game theory. Within such frameworks, judgements of collective intelligence are able to be ranked, as markets or financial or other gains can provide frames of reference. In a professional development context however, the educational significance of a particular judgment might be much more challenging to determine.

Moreover it may be asked, how much diversity is healthy within a professional development context, or any educational context for that matter? For instance, certain understandings may afford such reliable explanations of the world, that, as a collective, we no longer value any significant diversity in appreciating them. Furthermore, in professional contexts where individuals are (legally) responsible for upholding certain standards and behaviours, certain forms of diversity may not be appreciated or even tolerated at a systemic level.

In DESCANT, the Cohort 1 teachers did not shy away from developing a cohesive intellectual culture. On the contrary, they sought to protect their shared intellectual tradition in DESCANT, at least until such time as it could be genuinely appreciated and evaluated by other teachers.[121] Moreover, they believed the use of a bounded group structure, with its cohesive feedback of 'like thinking people' (as described by Cathie), introduced a measure of control into the DESCANT learning system. It provided a means of ensuring that the decentralised and self organising nature of the system was not detrimental to its development.[122] This was perhaps an insightful collective approach. The decentralised, self-organising nature of an adaptive learning system has been recognised as being intrinsically hard to control (Kelly, 1994).

From a political ecology perspective this desire for control can be reinterpreted as the Cohort 1 designers striving for an appropriate way forward for collective knowledge building in the DESCANT context. The teachers seemed to recognize the need to establish an *initial* shared intellectual position (on learning in Science and Technology education) in order to begin a wider process of collective knowledge building. Yet, they envisaged future cohorts testing the *relevance* of the shared (or collective) understandings that had been developed and *articulated* by Cohort 1.

This conception is in tune with political ecology which conceives the process of negotiating a *common world* as an endless process of refinement (Latour, 2004). Collective learning in

[121] As noted previously, the group was careful to define a priority purpose for the environment that was *initially* focused on a generative orientation, but that could be expanded at a later date.

[122] This is in keeping with a generative orientation, which contends that the cohesion of social and cultural dimensions develop shared values that then offer a mechanism for testing the value of new ideas and behaviours in a group of culture. This association to generative learning theory was explicit as Vaughan noted the tension between 'control' and 'evolution' within their 'generative model' for professional development.

this view is an increasingly cohesive intellectual culture, rather than a disconnected mass of intellectual positions and worldviews. It thus strives for collective intellectual cohesion based on *differentiation and attachment*: that is, increasing sensitivity to difference and diversity.

The cohort designers sought to ensure this dynamic through their priority purpose. As the intellectual tradition of Cohort 1 had coalesced around a generative orientation, they challenged future cohorts in DESCANT to engage with this orientation in order to develop a *common world* in DESCANT.

So, on the basis of this brief analysis, the prototype design (or DESCANT Colony) does appear to support a conception of network learning akin to an overarching form of collective learning. The design elements discussed above ensured that this collective learning need not be characterised by uniformity but rather by differentiation and diversity. As cohesive bounded groups (and their individuals) dynamically evaluated the relevance of each other's collective understandings, a common yet highly differentiated articulation of Science and Technology learning and teaching could, potentially, be progressively developed.

From a research perspective, this offered the possibility of investigating whether the collective values and understandings of Cohort 1 influenced, and progressed, the collective values and understandings of the DESCANT population in Phase 2. In preparation for undertaking this analysis, it was necessary to understand how Cohort 1 teachers had passed on their learning through Culminating Tasks. This analytical requirement is undertaken in the following section.

7.3 Passing on Learnings: representing learning across project phases in DESCANT

Given the potential for intergenerational professional learning in the DESCANT Colony (as discussed in 7.2), I considered it necessary to establish how Cohort 1 teachers *represented* their learning and understandings to Phase 2 teachers. That is, I needed to examine representations that transcended the e-learning design itself, hence my decision to consider teachers' Culminating Tasks themselves.

7.3.1 Can Culminating Tasks be understood as (part of) a learning ecology?

In this section, I therefore provide an illustration of Cohort 1's contributions to the newly developed DESCANT environment. These contributions were undertaken over a significant period of time, in conjunction with the software development of the prototype e-learning environment that had been designed by the teacher designers. Figure 7.4 shows where this occurred in the DESCANT Phase 1 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 1</th></tr>
<tr><td rowspan="2">Introductory workshop</td><td rowspan="2">Online immersion: GVC & Webboard</td><td rowspan="2">1st Design Workshop & School-based Design Period</td><td>2nd Design Workshop</td><td>Final Design Workshop</td></tr>
<tr><td colspan="2">Participants Upload & Rate Culminating Tasks</td></tr>
<tr><td>4th Aug</td><td>Aug- Oct</td><td>15th Oct- 28th Nov</td><td>10th May</td><td>14th Mar</td></tr>
<tr><td colspan="3">2003</td><td>2004</td><td>2005</td></tr>
</table>

Figure 7.4 Locating the design of Culminating Tasks in the DESCANT Phase 1 timeline.

I begin this section with a brief description of the Culminating Tasks that were uploaded into the DESCANT Colony in Phase 1. This provides a contextual overview for the subsequent analysis of one Culminating Task.[123] Taken together, this brief description and analysis provides an indication of how Cohort 1 participants may have 'passed on' (in Katrina's words) their learning and understandings to Phase 2 participants. This supports the study's investigation of how this *intergenerational* dimension may have influenced professional learning in Phase 2, and thus the collective learning evident in the DESCANT environment in the later parts of the project (as detailed in Chapter 8).

[123] After careful deliberation, the decision was made to focus here on one Culminating Task in detail, rather than discuss, in a more general sense, the commonalities and differences of Cohort 1's Culminating Tasks as a group. Focusing on a single Culminating task allowed for a more detailed analysis of how the cohort teachers shared their learning with Phase 2 teachers. Given the importance of this cultural learning dynamic to a conception of collective learning in an adaptive learning system, I deemed this approach more appropriate than a (perhaps more conventional) summary of collective understandings, as exhibited through their Culminating Tasks. A summary of the group's shared understandings is captured, to some extent, in the group's Learning Legacy (See Appendix 4.1). All Culminating Tasks may be viewed online in the DESCANT Colony.

A Cohort Level Collection of Culminating Tasks: The Learning Landscape

Cohort 1 teachers generated a total of seven videos and accompanying texts.[124] Whilst, they undertook these Culminating Tasks individually, where possible teachers sought their school-based colleagues or other school staff's assistance in videoing and other technical matters.[125]

As already noted, the aim of each Culminating Task was to help other teachers develop their understandings (at least initially) of (generative) student and teacher learning in Science and Technology. Beyond this collective aim, there were no constraints imposed on what teachers should include in their videos. This flexibility may have helped promote diversity within the Culminating Tasks developed by Cohort 1 teachers. For example, whilst most teachers used narrowly focused, 'micro' videos of student conversation, Angela adopted a 'macro' approach to videoing that included her entire class engaging with a unit on birds.[126] This represented an interesting solution to the micro versus macro Webboard discussion (See 7.1.1). Whilst all teachers used their videos to focus on student learning, Angela included what teachers had termed the 'realism' of her classroom context.

Each of the Cohort 1 videos and accompanying texts was uploaded into the DESCANT Colony.[127] The task, then, was to rate these Culminating Tasks. As other cohort members began rating their colleagues' work (based on their established criteria) the Culminating

[124] Whilst all Cohort 1 teachers expressed their desire to undertake a Culminating Task, some failed to complete a video and accompanying text. In most cases this appeared to be the result of shifting responsibilities in their school context, a change of personal circumstances, or a mix of factors. Whilst this represents an important factor for any systemic implementation of the DESCANT model in the future, I did not deem it important for this study to pursue the reason for teachers' failure to complete a Culminating Task. Nevertheless, as a result, the learning and understandings of some Cohort 1 participants were better represented than others in Phase 2 based on their contributions to the Culminating Task.

[125] The wider DESCANT community also supported technical logistics remotely.

[126] In Appendix 4.2, I reproduce Angela's Accompanying Text in full. Her video (titled Birdhouses) can be viewed online in the DESCANT Colony.

[127] Whilst it was intended that teachers would be able to upload the videos themselves, logistics and time constraints prevented this occurring during this initial period. In Phase 2, a more sophisticated back-end to the environment allowed teachers to upload their own classroom videos, thus enacting a more decentralised mode of operation.

Tasks were dynamically plotted on the environment's Learning Landscape, the visual representation used for the recommender system (Figure 7.5).[128]

Figure 7.5: Cohort 1's Learning Landscape. As users roll their mouse over a dot (or 'trace'), the details of that video become visible. In this example, Sally's video title and rating details are visible. When clicked, each trace brings up a pop-up video box related to that video (see Appendix 2.2).

Taken individually, each video *trace* (that is, each dot) on the Learning Landscape represented a single Culminating Task: each one was made public by an individual teacher as a representation of their learning and understandings. Thus, at a *cohort level*, the collection of video traces (that is, their collection of Culminating Tasks on the Learning Landscape) *represented* the learning of a bounded population of teachers, as generated by that population.[129]

As a representation of their learning, this cohort-level visualisation had no fidelity with, or correspondence to, any external measure of their learning. Instead, their Learning Landscape was shaped by their collective capability to pass on their learning through the medium of the Culminating Task. To do so with integrity regarding what they had learned had become part of their collective challenge as teacher designer learners.

[128] For a more detailed explanation of the Learning Landscape, see Appendix 2.2.
[129] The design allowed users to specify whether the Learning Landscape was viewed at a cohort level, or as an aggregation of the entire DESCANT population. Of course, during Phase 1 of DESCANT, when only one Cohort had participated, these two views were identical.

The Cohort 1 teachers collectively established what textual information would best accompany their classroom videos. The resulting Accompanying Texts included background or contextual information about each classroom video. This included a description of the unit of work being addressed and, in some cases, relevant Syllabus Outcomes. Cohort 1 teachers also documented “things [they] were happy about” with regards to student and/or teacher learning. They also shared “things to develop”: that is, continuing areas of concern for them, as teachers of Science and Technology. For example, Angela and Sally both noted their tendency to hinder student-led conversation and investigation:

> *The power of conversation has certainly impacted on my delivery in the classroom. Even though I considered myself to be a listener of the student, the video proved that I did prevent directions of the conversation, because I had my idea of the finished product. (Angela)*

> *I should have seized upon their ideas and given them the opportunity to test individual components of their model before getting it all together in their final investigative tool eg. a series of simple evaporation experiments.(Sally)*

It was clear that the Culminating Tasks of Cohort 1 exhibited other commonalities relating to their intellectual orientation and values concerning Science and Technology education. For instance, all accompanying texts interpreted student learning (as exhibited in the classroom videos) through a generative orientation. For example:

> *They use existing or background knowledge about the way plants work as a starting point and add their results from their experiments to generate ideas about why and how plants grow. Some of these ideas are not exact, some are completely wild, but the clips demonstrate the way the child has come up with an idea, or generated a thought rather than merely stated textbook knowledge. (Cathie)*

The students display excellent indications that they were learning generatively. They generated an idea, tested it, came to some conclusions, changed their original thinking and came up with another idea to test. (Kerrie)

When questioned about the materials to be used, the child appears to be regenerating ideas about how she will actually build her birdhouse. She seems to be clarifying her thoughts as we watch. (Angela)

In one sense this was unsurprising given their inclusion of this theory in the priority purpose. Nevertheless, it demonstrated a degree of sophistication in their theorising of Science and Technology education in their classroom practice. This common concern for generative learning did not however prevent individual teachers from sharing diverse observations relating to their classroom videos. For example, Kerrie focused viewers' attention on the cautious manner in which a student was testing ideas, whilst Angela focused on the influence of social dynamics on student learning:

…the child has already realised that he has to think for himself and he needs to check it out to be sure of it. He knows he can ask others, but he's not prepared to let it sit there. He's not willing to let someone else tell him something is so unless he's checked it out for himself. To me that is utter delight because he's on his way to so much learning. (Kerrie)

One of the most impressive aspects of this video is the sense that it gives of a group concern and a group response to that concern. These children are obviously comfortable with each other and with their teacher and this provides the environment so necessary for learning to take place. (Angela)

Across all of the Cohort 1 accompanying texts, there were also clear commonalities in the teachers' concern for allowing students to drive their investigations and discussions. Again this collective concern was expressed by Cohort 1 teachers in varying ways within their Accompanying Texts, for example:

There were many opportunities for cross-curricula activities, e.g writing and talking in front of the class; i/e the children became the teacher as they gave information which had to be backed up by their scientific experiment. (Ingrid)

Where could these boys go from here? What could generate from here? Is this the same question as the previous one or are we looking at two different things– where the teacher might send them and where the kids would like to go? (Kerrie)

These personal thoughts, then, are evidence of my generative learning. I had an idea for a science unit, but what actually eventuated was very different from that original thought. The fact that I could "let go" and follow the children's direction is further evidence of my generative learning. (Sally)

This is a good example of the strategic question helping to clarify an idea. It's not necessarily the teacher who asks these pertinent questions. The idea generated about the soap on the pole is a further example of some knowledge from the past being regenerated and briefly tested in the present situation. (Angela)

Perhaps one of the other big changes has been letting go, allowing the children to have a more direct input into the general direction that our learning might take us. For example in this unit I let the children design their own experiments. Previously I would have set it up, provided all the necessary equipment, instructions and directions to have "a proper" science experiment that produced the proper results. (Cathie)

It seemed, then, that Cohort 1 teachers had incorporated into their Culminating Tasks, their initial concern regarding how to remain in control of Science and Technology lessons, whilst 'letting go' of the need to overly direct the lesson (see 7.1.1). Furthermore, this professional concern had been addressed, at least partially, through their growing understanding of how generative learning may be occurring in specific instances of Science and Technology education in their classes. They were now 'passing on' this professional learning (and the professional concerns that underpinned it) to Phase 2 DESCANT teachers.

In the following section, I provide a more detailed analysis of a single Culminating Task, as a means of making further sense of this *intergenerational* aspect of the DESCANT process.

One Culminating Task

By using Sally's Culminating Task as a case study, I can examine its features so as to understand to what extent the intellectual common ground of the group may have been *represented* within such Culminating Tasks. Even if it is, it is also necessary to understand how that collective learning of Cohort 1 might be preserved for and conveyed to teachers in the cohorts to follow.

As did all Culminating Tasks, Sally's consisted of a video of her students learning and an accompanying test which she wrote to explain it. I reproduce Sally's Accompanying Text here in full and her video (titled Water) can be viewed online in the DESCANT Colony.

Water: Sally's Accompanying Text:

Context

This unit of work was set in the International Year of Freshwater.

Discussion had taken place about the small amount of available freshwater in our environment, as opposed to the vast quantity of saltwater.

The investigation as proposed was "How could we conduct an experiment to find a way to extract the salt from saltwater to obtain freshwater?"

The accompanying video was taken on the day following the initial discussion. I believe it is a good example of children generating ideas in an introductory stage of a science unit involving investigation. It's interesting to note the fact that, following my "Generative

Learning Journey", my choice of video clips to include is probably very different to that which I might have chosen prior to it.

In the past I would most likely have been dismissive of the children's evolving and partially formulated thoughts and ideas and more interested in getting the "correct" answer to a direct question, which would have proved that I had correctly "taught" the concept in question.

Added to this is the fact that a discussion like this would not be conceivable in a teacher directed, controlled science lesson, where pre-determined concepts were "taught" through a series of sequential steps.

Instead I have chosen a clip that shows two children discussing their ideas of ways to come up with an answer to a puzzling question, which they have actually been involved in formulating.

Discussion about the video

Positives / Things I'm happy about

Jason generates the idea of a "sieve". Kirallee thinks about it, tests the idea using her prior understandings and rejects it because she believes that the salt would still be dissolved in the water and would pass through the sieve.

She says "But , then, would.….", and you can actually "see" her thinking. She then goes on… "I was gonna say that then, wouldn't it be still dissolved, so it wouldn't… wouldn't it just go through as water?"

They then move on to jointly regenerate ideas. They explore the concept of the water cycle and explain what they know. In explaining the idea of the water cycle, Jason says, " The *water evaporates and the salt stays in the ocean and the… it evaporates and goes up into the clouds and then the clouds rain it down again”*

Their generative thinking is hung upon this existing knowledge. They appear to understand that the water going up into the clouds is fresh. They explain their thoughts about evaporation.

Jason says “The sun shines on it and it gets hot”. At the same time Kirralee is saying “It heats up.”

When suggestions are invited about designing an experiment to simulate the water cycle, Jason generates the idea of a “sun lamp”. He says “Get a sun lamp or something and put it on the top” Kirralee adds “Like a really good…. like bright light”

They explore this idea and move into a regeneration of ideas in designing apparatus to test their theory. They generate idea upon idea.

Jason says “ We could get a little container with salt in it and put a light that gets really hot over it and if it works, the top of the light should get moist from the water going up.” Kirralee says “ Yeah and like, after a little while, we should be able to see the steam sort of.”

It's interesting to watch their hand-movements and gesticulations as they search for a means of explaining their ideas and a way to create a simile from their existing knowledge.

You can see their ideas formulating as they talk through their emerging thoughts. They are actually visualizing their ideas and appear to be mentally testing these thoughts.

I believe that this section of the video captures the excitement and enthusiasm that these two are feeling at the prospect of carrying out this investigation.

Off camera, they make a model (a metaphor?) to further explain their ideas. I had suggested they draw a diagram to explain these ideas, but they came up with the model instead. This, for them, had developed into a design and make situation, obviously their preferred mode of learning.

Kirralee explains the operation of their model demonstrating the functioning of the various parts to achieve their aim. This provides evidence of their testing of their initial thoughts to develop a concrete representation of these thoughts.

Negatives / Things to develop

Deeper thinking probably takes place at a more advanced stage of an investigation, but I believe this early groundbreaking thinking is also valuable.

I think I need to improve my questioning technique to elicit more profound thoughts from children and I also think that I need to try to find more opportunities to have these "intimate" discussions with them. I believe this would allow the generation of children's individual ideas.

Several content areas emerged which could be explored more fully, among them Jason's comment, that "black attracts heat" and the method they were going to use to set up the battery-operated "rocker" for their still.

They also had made no allowance for an enclosed environment for their apparatus and when they built a more substantial version of their model, (without the battery operated rocker) they actually trapped very little water and had to regenerate ideas to modify their equipment.

I should have seized upon their ideas and given them the opportunity to test individual components of their model before getting it all together in their final investigative tool eg a series of simple evaporation experiments. In hindsight, I think that I was probably too *interested in keeping to my plan of developing a solar still, rather than the "Big Picture" of expanding the children's understanding of their environment through their exploration of the water cycle. I had in mind a simple set-up using two plastic bottles, but nothing even remotely resembling this emerged.*

In my pre-generative era, I would probably have built this equipment myself, demonstrated it and given the children step by step instructions on making it and they would have "learnt" about evaporation and condensation. It's embarrassing to contemplate.

These personal thoughts, then, are evidence of my generative learning. I had an idea for a science unit, but what actually eventuated was very different from that original thought. The fact that I could "let go" and follow the children's direction is further evidence of my generative learning.

What I found interesting in this Unit was that, while most children seemed to know about the water cycle, I'm not sure that they understand what actually happens in evaporation and condensation. It's a difficult concept and, after reading a paper Children's Conceptions of the Changes of State of Water (Osborne & Cosgrove, 1983), I'm not sure that I do either. I can say, as they do that "water changes from a liquid into a gas and back again", but my metaphor for molecules moving around at various speeds is a bit hazy.

I guess though, that if children can discuss and think about this type of concept, that they will develop an age-appropriate (?) understanding of it. Interestingly, also, none of the children in this class had any prior knowledge of a solar still.

Also, coincidentally, at the time, I was reading "The Life of Pi" by Yani Mantel (I think) and came across a detailed description of a solar still in it, the hand of fate?

References:

Osborne, R. & Cosgrove, M. (1983). Children's conceptions of the changes of state of water. Journal of Research in Science Teaching, 20 (9): 825-838.

Sally's Culminating Task, in many respects, offered a *coherent* perspective on learning and teaching in Science and Technology education. At first glance, it was clearly influenced by generative theory and methods of teaching associated with this understanding of learning. Yet Sally's Culminating Task was also evidence of a deep level of personal and professional engagement with this generative perspective. She shared, not only a video excerpt of its enactment within her teaching practice, but also many personal insights in her text that could help other teachers learn. For example, she focused viewers' attention on specific details of her video:

> *It's interesting to watch their hand-movements and gesticulations as they search for a means of explaining their ideas and a way to create a simile from their existing knowledge.*

Just how, through her Culminating Task, Sally was able to pass on to future DESCANT participants many of the shared intellectual positions increasingly evident within Cohort 1, as well as many of the ways learning was articulated within the DESCANT context, is the concern of the next section. Once this is clear, it will be possible to describe and analyse the collective learning that occurred in Phase 2.

Through her own creative and technological process of designing and making, Sally had *articulated* a personal, yet highly generative perspective on Science and Technology education. She did this through an ecological association of entities that included:

- A specific instance of student learning
- Specific student conceptions (including those that held promise for progressing learning, for example, Jason's comment that "*black attracts heat*")
- A specific video artefact

- The generative theory
- An academic text related to children's conceptions of water.
- A student-centred approach to Science and Technology education

For instance, Sally's Culminating Task gave salience to students' *own* conceptions of Science. It did this, perhaps most significantly, through its use of a narrowly focused (or 'micro') video excerpt. Rather than striving for what her cohort had termed classroom realism, Sally's video focuses on the ideas and uncertainties that two students express regarding the phenomena of evaporation and distillation.[130]

This design decision, although undertaken individually by Sally, was underpinned by a *shared* set of intellectual perspectives or strategies regarding Science and Technology education. Most prominently, there was an assumption regarding the importance of students' current scientific and technological conceptions: that is, a student dominance assumption (Osborne & Freyberg, 1985). Sally made this association explicit in her accompanying text:

> *…following my "Generative Learning Journey", my choice of video clips to include is probably very different to that which I might have chosen prior to it. In the past I would most likely have been dismissive of the children's evolving and partially formulated thoughts and ideas and more interested in getting the "correct" answer to a direct question …*

For Sally, understanding the conceptions that her students currently held had become central to the conversational strategy that she was utilising in order to support their generative learning. This was an orientation that has already been discussed as a collective *intellectual* strategy within the GVC subgroup. Now it was being represented within the Culminating Tasks of the cohort population.

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[130] This is not to imply that the teaching strategies used by Sally in her excerpt were not relevant to the students' learning, only that Sally did not choose to represent her entire classroom context within the videos.

Yet Sally's Culminating Task also utilised collective strategies of *exchange* that were evident within Cohort 1's DESCANT process. For instance, the ecological association of entities that she had developed parallelled to a large extent the GVC subgroup's articulation of student learning in the GVC during the initial stages of the project (as reported in 6.1.1). Sally's contribution thus afforded the possibility of *common ground* being established through the use of entities that could be shared by future DESCANT participants. Yet, just as Vaughan had expanded this form of articulation when contributing in the Webboard (Section 6.2.1), Sally too had used her significant experience as a teacher (her educational connoisseurship) to develop, amongst other things, an insightful commentary on the students' learning in her video excerpt.

In this commentary Sally utilised the generative theory of learning as a basis for interpreting the students' behaviour and conceptual development. In doing so, Sally may be conceived as modelling a particular type of observational and interpretative framework, one that articulated very precisely how *specific* instances of student behaviour and dialogue relate to these students' learning in Science and Technology. Again, there appears strong commonality between Sally's video commentary and the contributions of the GVC subgroup of which Sally was a part.

Yet Sally did not only utilise the *collective strategies* common to the GVC subgroup. She had also developed an accompanying text that embodied the collective strategies that were common within the wider cohort collective. For instance, she utilised her own professional "mistakes" (in Angela's words) as a source of professional learning by noting:

> *In hindsight, I think that I was probably too interested in keeping to my plan of developing a solar still, rather than the "Big Picture" of expanding the children's understanding of their environment through their exploration of the water cycle.*

In sharing these *emerging ideas*, Sally was exhibiting a collective *strategy of exchange* that was common to online dialogue within Phase 1. Yet Sally was also exhibiting here an *intellectual* strategy that had become common to the cohort of teachers. This was a belief in the value of a flexible student-centred approach to teaching Science and Technology. This was a common intellectual position within the Culminating Tasks of Cohort 1. It became then, an intellectual collective strategy within Cohort 1, one closely attuned to the generative orientation that these teachers had adopted.

Sally also acknowledged a lack of certainty regarding her own scientific knowledge.

> *I'm not sure that [the students] understand what actually happens in evaporation and condensation. It's a difficult concept and, after reading a paper Children's Conceptions of the Changes of State of Water (Osborne & Cosgrove, 1983), I'm not sure that I do either. I can say, as they do that "water changes from a liquid into a gas and back again", but my metaphor for molecules moving around at various speeds is a bit hazy.*

In acknowledging her own uncertainties in this way, Sally was exhibiting the collective strategy of *expressing professional uncertainty*. Again, this was a collective strategy of exchange that was common to the group's online dialogue.

So, Sally's Water Culminating Task provides an example of the manner in which Cohort 1 teachers incorporated two types of collective strategy into their Culminating Tasks: strategies of exchange and intellectual strategies. Taken together, these collective strategies represented the underpinning of the culture that had existed within Phase 1 of DESCANT. Thus by reifying these strategies within their Culminating Tasks, Cohort 1 teachers were essentially passing this culture on to Phase 2 DESCANT participants.[131]

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[131] The cohort also passed on their collective strategies (both intellectual strategies and strategies of exchange) through another component of the environment: the Learning Legacy. This was a shared text developed by the cohort at the completion of their journey in order to give future DESCANT participants a brief overview of their DESCANT experience. Whilst the cohort's Learning Legacy provided indications of shared intellectual positions, it also made explicit (to future participants) the learning *culture* that had developed in the bounded group. The teachers describe, for instance, a 'supportive, nurturing environment' in which they could make intellectual contributions "without the arrogance of ridicule". This supports the analysis detailed in 6.2, where it was illustrated that Cohort 1 teachers exhibited a willingness to contribute intellectual perspectives that were distinctive, and even at odds with members of the DESCANT collective that may have been perceived as having high status (including, for instance, the Chief Investigator). It is

From a political ecology perspective, Sally's Culminating Task may be conceived as a *candidate proposition* for helping *establish a common world* within the DESCANT context. It sought to offer future DESCANT teachers a new perspective on learning and teaching in Science and Technology, whilst simultaneously changing the DESCANT environment itself. As such the Culminating Task may be conceived as "…a new and unforeseen association…" (Latour, 2004, p.83). In this sense, the Culminating Task was neither an artefact (subjective) nor a fact (objective), but an ecology that straddled these realms.

Accordingly, this Culminating Task could be judged, not simply on the truth of its assertions, but on its articulation. As discussed in 2.2.2, Latour (2004, p. 247) contends:

> *…[a proposition is] not a being of the world or a linguistic form but an association of humans and nonhumans before it becomes a full-fledged member of the collective…Rather than being true or false, a proposition in this sense may be well or badly articulated.*

So, Sally's Culminating Task can, in this view, be understood as an ecological entity, one that could be situated within a larger knowledge building ecology (that is, the DESCANT context). Furthermore, based on this analysis, it could be expected that the novel associations articulated in Sally's contribution, and those of other Cohort 1 teachers, would serve to transplant their collective culture into Phase 2 of the project. This could include both their intellectual strategies and their strategies of exchange (or collective patterns of interaction) for learning about Science and Technology education.

The Cohort 1 teachers recognised however, that for these collective strategies to have the appropriate conditions for success in Phase 2 of DESCANT, they would

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included here as Appendix 4.1 as a complementary indicator of the way in which Cohort 1 passed on collective intellectual strategies and strategies of exchange.

have to be supported by the cohesive structures (for example, bounded groups) they had experienced within Phase 1.

I have now analysed the manner in which Cohort 1 utilised and *articulated* their professional learning within various dimensions of their collective design, including within online collaboration (7.1), the DESCANT Colony (7.2) and Culminating Tasks (7.3). In the following section, I bring together these analyses in order to answer the central research question of Chapter 7: Can teachers' collective design of an e-learning environment be understood as a part of a Learning Ecology?

7.4. Answering Chapter 7's Research Question: an analytical summary

As is now clear, the cohort's prototype design incorporated a range of features that have implications for understanding collective learning. In particular, the design had features of a generative learning system, one with potential to develop and transform on the basis of the collective intelligence, or more specifically, the collective *articulation,* of generations of DESCANT participants.

This design analysis foregrounded the possibility of studying intergenerational collective learning in DESCANT within the context of an adaptive learning system. Already it has been established that Cohort 1 had developed a cohesive collective position on Science and Technology education, one consisting of a learner focused, generative orientation. For Cohort 1, the development of this collective position consisted of collective exploration, collective operation (for instance, of the GVC and Webboard) and collective design (as discussed here in Chapter 7). Now, through their e-learning prototype they were affording Phase 2 teachers the same opportunities.

Yet instead of collectively operating the GVC and the Webboard, Phase 2 cohorts would collectively operate the Descant Colony for their professional learning. In particular, they would engage with the Culminating Tasks of Cohort 1. As is clear from the analysis above, these Culminating Tasks were themselves a complex articulation of Cohort 1's professional learning. They were capable of forming associations to such entities (in Latour's words) as theoretical positions, teaching approaches, strategies of professional interaction (in DESCANT) and specific evidentiary artefacts. It remained to be seen then, whether Phase 2 participants would seek to develop their own professional associations to these nested learning ecologies: and in doing so, design their own articulations of teaching and learning in Science and Technology.

For this study of collective professional learning, this amounted to questioning how Phase 2 participants would engage with, and then progress the embodied learning of the DESCANT system. Within DESCANT (interpreted here as a decentralised and self organising learning system) there was value in both diversity and cohesion: the former to generate new possibilities in order to evolve, and the latter to maintain stability in the system (Bloom, 2000). As designers of the next generation of Culminating Tasks (the main content of the DESCANT environment), Phase 2 participants would be in the position to re-establish, not just the intellectual terrain of the DESCANT Colony, but also the *values* that underpinned this tradition.[132] This was in keeping with the conception of DESCANT as a learning system. Yet, from a professional development perspective, maintaining an appropriate balance between individual teacher diversity, and collective cohesion (as may be required by the mandates of the education system) through decentralised, self organisation brought with it ethical considerations.

For instance, the 'learning systems' described by Bloom (2000) efficiently cull those parts of the system (for instance, individual views) that are not proving successful. In the case of complex human systems, this may represent the removal of individuals or populations of individuals from the system (Axelrod & Cohen, 2000).[133] Yet in education such a strategy must be balanced by the needs and rights of the individual. This relates to the ongoing tension in contemporary models of teacher professional development in maintaining a balance between systemic intervention and teacher autonomy (as discussed in 1.2.2). There

[132] Once again, the generative theory of learning (Schaverien & Cosgrove, 1999; 2000), conceives designing as a process in which even the values on which ideas and behaviours are tested can evolve, at varying rates.

[133] Bloom (2000) theorises that individuals may instinctually remove *themselves* from a system if there is not a successful coordination with the collective processes of that network, that is, if they feel they are not contributing successfully to the system.

is an explicit agenda in professional development, to assist individuals to develop (amongst other things) powerful conceptual frameworks that benefit their engagement with the systems within which they exist (Loucks-Horsley et al, 2003).

In professional development contexts then, the process of judging the worth of various ideas or solutions becomes an *educational* process for both the individual *and* the collective. As discussed already, the fact that certain explanations become firmly established in a learning system (based on various collective or cultural value biases) need not affect the diversity of solutions that are being generated (by individuals, based on their value biases). In some ways, this was demonstrated through Cohort 1's prototype design. Whilst the group developed a cohesive generative orientation, throughout the design process (as well as the exploration process detailed in Chapter 6) there was evidence of great diversity in the group. In this respect, perhaps the collective design process described in this chapter may be best understood through the words of Levy (1997, p. 17, emphasis in original), as cited previously:

> *Far from merging individual intelligence into some indistinguishable magma, collective intelligence [here, collective design] is a process of growth,* ***differentiation****, and the mutual revival of singularities.*

Similarly, the DESCANT Colony design appeared to have the capability to represent the learning of its population with varying degrees of differentiation, preserving both individual and collective values within its embodied history. The prototype was designed to 'generate' and evolve on the basis of individual and collective engagement, yet it also incorporated a value system (in its priority purpose, and ratings) and bounded structure that could potentially control the development of the network, thus regulating its collective learning. This was, in one sense, a homeostatic mechanism.

From a complexity perspective, the regulatory design dimension was interpreted as a means of ensuring that professional development in the DESCANT context would progressively and appropriately incorporate the experiential history of the network. That is, it could support participants (whether they were teachers, teacher educators, domain experts or DET executives) to articulate propositions that engaged with (and formed associations to) the propositions of others in the network.[134] In political ecology terms, such engagement had the potential to generate a collective articulation of learning in Science and Technology education that *established a common world* based on an (experimental) process of differentiation and attachment (Latour, 2004).

So, a learning ecology analysis has helped make sense of the teachers' collective design by foregrounding its potential as a dynamic learning system, one with coupled mechanisms for evolution and homeostasis, exploration and exploitation (of learning gains).

Having now analysed collective learning within Phase 1 of DESCANT, I now turn my attention to Phase 2 of the project. As in the first phase of DESCANT, Phase 2 included a degree of centralised (or exogenous) system design undertaken by the DESCANT Steering Committee and the various subgroups associated with this collective. In the following section, I prepare for an analysis of collective learning in Phase 2 by detailing this exogenous system design.

7.5. Exogenous System Design in Phase 2 DESCANT

Two factors are again used here to discuss exogenous system design: agent proximity and activation (after Axelrod & Cohen, 2000).

7.5.1. (Collective) Agent Proximity

DESCANT's research design in Phase 2 influenced the 'proximity' (Axelrod & Cohen, 2000) and cohesion of participants *by establishing or utilising a range of groups.* Again,

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[134] In this regard, there could be no guarantee that future participants wouldn't simply ignore the Colony's priority purpose to engage (experimentally) with generative learning. Similarly, nothing could guarantee that future participants wouldn't simply reject the Culminating Tasks of past participants, without *engaging* with their (intellectual) substance in any depth. This serves to act as a reminder of the unpredictable nature of complex (learning) systems, even where regulatory mechanisms are in place (Kelly, 1994).

each of these groups, or agents, was associated (through the research and project design) with various *collective* purposes and agendas.

Cohort groups

In line with Cohort 1's recommendation for bounded groups, the Steering Committee established two teacher cohorts within Phase 2 of DESCANT. Teacher volunteers were recruited across three districts with the help of DET Science and Technology Consultants based in these areas. This recruitment process was largely informal with District Consultants distributing information about the project, and supporting teachers who wished to attend the introductory sessions in order to learn more.

Following the introductory workshops in each district, the teachers still interested in participating were assigned to a particular cohort. In each district, there were a small number of withdrawals, leaving Cohort 2 with 15 teachers, and Cohort 3 with 10 teachers.

Each Phase 2 cohort operated in a separate learning area within the DESCANT Colony. This use of bounded groups lessened the proximity of participating teachers within different cohorts. This had not been the case in Phase 1, where only one cohort was established.

In order to again conceptualise cohorts as collective agents in their own right (as detailed in 4.3.2), each of these teacher groups is referred to as a *cohort collective*.

School-based groups

Phase 2 participants included teachers from 11 schools located both in metropolitan and rural regions. Where possible, multiple participants were located at each school as a means of providing school-based learning companions. [135] This led to the formation of 4 school-based teacher groups in each Phase 2 cohort. In one school with five DESCANT participants (Pattonsvale), a decision was made to separate the group by assigning them to different cohorts. This afforded the School-based group access to both cohorts, but had the potential to lessen their proximity to each other as DESCANT participants. This is a clear example of complex system design in which "barriers and boundaries are deliberately introduced into systems (physical and social) with the aim of altering the rates of interaction among types." (Axelrod & Cohen, 2000, p. 69)

Once again, in Phase 2 these local groups are referred to as *school-based collectives*.

Moderator group

As in Phase 1, a moderator group consisting of UTS and DET members provided the main support for Phase 2 teachers. Once again, the DET was represented by two executive officers, Grant and Louise, representing science and technology respectively.[136] Three regional consultants (including Gill from Phase 1) were also active in the recruitment and introductory workshops in Phase 2. Of these consultants, only Gill maintained an active involvement as a moderator after the initial Phase 2 period.

Representing UTS, Lyn once again acted as Chief Investigator in Phase 2 of DESCANT, whilst I continued as doctoral researcher. We were joined in the latter stages of Phase 2 by a research assistant, Rebecca.

This group is again referred to as the *Moderator collective*.

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[135] Cohort 1 teachers had vouched for the value of school-based learning companions as a complement to the distributed Web-based network. This is in keeping with research findings that have demonstrated the benefit of local pairs of teachers (Worthington, 2005).

[136] In Phase 2, Grant replaced James as the DET executive associated with Science education.

Mentor group

Cohort 1 teachers were invited to participate in Phase 2 as mentors. On request, these teachers were given access to the online workspaces of Cohort 2 and Cohort 3. By the time Phase 2 began, Cohort 1 teachers were no longer active participants in DESCANT, though most were keen to know how others would experience the DESCANT environment.

This Cohort 1 subgroup is referred to in Phase 2 as the *Mentor collective*.

7.5.2 (Collective) Agent Activation

Introductory Workshops were held to explain the goals of the project, as well to clarify the expectations for contributing to the DESCANT Colony (as envisaged by the Cohort 1 teacher designers). Once again, the Partners Collective reified these expectations within a timeline that was discussed with teachers at the introductory workshop. As in Phase 1, this represented an important mechanism through which the Partners collective sought to influence the timing of individual and collective activity.

Timeline, Goals and Expectations

As in Phase 1, the timetable for teacher participation in Phase 2 presents another form of external system design. It instituted once again, research and professional development goals. Due to logistical challenges and changing circumstances, this timetable was reformulated on a number of occasions. The timeline below provides a general guide to the activities and goals that were imposed as external or exogenous project milestones.

DESCANT Timeline: Phase 2.

1st Regional Introductory Workshop (29th March 2005)

An initial group of five Cohort 2 teachers is introduced to the project in a face-to-face workshop. Once again, the workshop was planned and facilitated by representatives of the UTS and DET collectives. Following the general plan for Phase 2 Introductory workshops (see Appendix 1.6 for example), the group:

- Introduced each other and discussed why they had joined the project. This also allowed DET and UTS representatives to discuss their conceptions of the project.
- Undertook a walk-through tour of the DESCANT Colony, the prototype e- learning environment which would be central to their professional development in DESCANT.
- Explored the DESCANT Colony as individuals and pairs, with a particular emphasis on investigating the culminating tasks of Cohort 1.
- Discussed the value of these culminating tasks for professional learning using one as a shared example.
- Discussed the aims and expectations of the project. In particular, the UTS and DET collectives stressed that participation required a commitment to contributing to online discussions.

Online Immersion begins for (part of) Cohort 2 (April to July 2005)

Following the Introductory Workshop, this first group of Cohort 2 teachers began their online immersion in the DESCANT Colony. Initially, no moderator prompts were used to elicit responses to particular topics. Cohort 2 teachers were encouraged instead, to engage with the learning environment in a collaborative manner.

Sydney introductory workshop (1st June 2005)

A second introductory workshop was held in Sydney. This followed the format of the first regional workshop (see Appendix 1.6). Of the 17 teachers who attended this workshop, and agreed to continue in the project, seven were assigned to Cohort 2, the rest becoming the bulk of Cohort 3.[137]

2nd Regional Workshop (6th June 2005)

A small second regional workshop was conducted in order to include a third district in Phase 2. Whilst the format of this introductory workshop was the same as previous ones, it was partially conducted by video conference. Three regional teachers joined Cohort 2 following this workshop.

Online Immersion begins for Cohort 3 and remainder of Cohort 2 (June to July 2005)

Cohort 3 and second intake of Cohort 2 teachers begin their online immersion. Once again, participants were not required to undertake any particular task or discussion other than what was expected through the design of the learning environment itself. For instance, participants were expected to engage with Cohort 1's Culminating Tasks (videos and texts) and to discuss, with their online cohort, how these may relate to their understandings of (generative) student learning in Science and Technology.

Towards the end of this period, participants began to design and make their own Culminating Tasks. I supported teachers in this challenging technical task by on-line moderation, providing advice on filming, editing and uploading video.

[137] Two colleagues who attended this workshop decided that the project would not be appropriate for their professional learning given that they worked in a school with students with severe disabilities. Whilst DESCANT partners would have been keen for them to participate, their choice not to volunteer was respected.

Participants upload and rate Culminating Tasks (August and September 2005)

Cohort 2 and Cohort 3 teachers uploaded their culminating tasks into the DESCANT Colony. Teachers then rated these new videos on the criteria that have been developed by Cohort 1.

Final school-based Conversations (September 2005)

The UTS collective undertook final face-to-face discussions with Phase 2 participants in their school locations. A loose protocol was established for these conversations by the UTS collective, in collaboration with the DESCANT Partners (see Appendix 3.5).

Through the use of a timetable complete with specified activities (for example, rating videos) and deadlines, the Partners Collective encouraged all teachers and collectives, to engage with the various environmental artefacts, such as videos, texts and readings. There is little doubt that this external design had important influences on the sequencing of activities in the environment. Nevertheless, it is also important to note that the teachers and teacher collectives regulated their activities largely based on their own internal patterns of activation. As in Phase 1, specified focuses and deadlines were often adjusted or changed by the Phase 2 teacher population.

Here in Section 7.5, I have provided an indication of exogenous system design in Phase 2 by detailing external patterns of proximity and activation. These patterns had an important influence on the dynamic structure of the DESCANT project in its second phase. Yet, much of DESCANT’s structure remained flexible and emergent, in tune with both the research design and the design specifications of Cohort 1. As such, the expectation was that, in Phase 2, internal factors of proximity and activation would again influence the structure to a large extent.

Now that the plan for Phase 2 of DESCANT is clear, it now remains to examine, in Chapter 8, the nature of the learning that occurred for the participating cohorts of teachers.

Chapter 8
Describing and Analysing Learning in Groups III
New cohorts explore the DESCANT Colony in Phase 2

In Chapters 6 and 7, I described and analysed Cohort 1's exploration and design during DESCANT's Phase 1, demonstrating that a Learning Ecology framework could make significant sense of the collective learning that occurred. This first stage of the project culminated in the design and development of a prototype e-learning environment, the DESCANT Colony. Here in Chapter 8, I describe and analyse the online investigations that took place within the DESCANT Colony in Phase 2 of DESCANT. In doing so I address the question:

Can the investigation of Science and Technology learning of a second DESCANT generation be understood as a Learning Ecology?

I address this question by describing and analysing cohort-based investigation in Phase 2 of DESCANT. To a large extent, as will become clear below, this investigation was characterised by collective exploration of the Culminating Tasks which had been developed by Cohort 1 teachers (see 7.3).

8.1 The Phase 2 Population Investigates the Culminating Tasks of Cohort 1

The DESCANT Colony supported Phase 2 participants to engage with the Culminating Tasks of previous DESCANT participants. These Culminating Tasks were, in a political ecology sense, complex propositions that articulated the individual and collective learning of Cohort 1 teachers (see 8.3.1). In the following section, I therefore seek to understand how online contributions in Phase 2, could be associated with the collective learning of the Phase 1 population (as described in Chapters 6 and 7).

8.1.1 Can teachers' contributions to the DESCANT Colony in Phase 2 be understood as a learning ecology, and if so, as one that transcends the boundaries between Phases 1 and 2?

To address this question, I have selected a data excerpt from the initial stage of the Phase 2 online immersion period. Figure 8.1 locates this excerpt in the DESCANT's Phase 2 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 2</th></tr>
<tr><td>Intro. workshop: Cohort 2 (1st intake)</td><td>Intro. Workshops: Cohort 2 (2nd intake) & Cohort 3</td><td rowspan="2">Online immersion: DESCANT Colony (Full Cohort 2 & Cohort 3)</td><td>Participants Upload & Rate Culminating Tasks</td><td></td></tr>
<tr><td colspan="2">Online immersion: DESCANT Colony (Cohort 2: 1st Intake)</td><td></td><td>Final School-based Conversations</td></tr>
<tr><td>29th Mar +</td><td>1st – 6th June</td><td>June- July</td><td>Aug-Sept</td><td>Oct</td></tr>
<tr><td colspan="5">2005</td></tr>
</table>

Figure 8.1 Locating Excerpt 1 in the DESCANT Phase 2 timeline.

Within this excerpt, Cohort 2 teachers discuss Angela's Culminating Task in which she sought to represent the investigations and designs of her entire class.[138] This excerpt provided a valuable means by which to describe and analyse how Phase 2 participants engaged with a Culminating Task that, in political ecology terms, articulated a unique blend of teacher orientated and learner orientated perspectives on Science and Technology education.

<u>Excerpt 1) An Online Discussion of Angela's Culminating Task</u>

Relatively early in Cohort 2's online immersion period, Jack discussed Angela's Birdhouse video and accompanying text on one of the Colony's discussion forums (the Birdhouse Video Ant-e-chamber).

[138] In Appendix 4.2, I reproduce Angela's Accompanying Text in full. Her video (titled Birdhouses) can be viewed online in the DESCANT Colony.

Jack

Conversational Directions

Wed, 11 May 2005, 15:04

I was really impressed with the personal reflection at the end of this by the teacher in regard to their impact on conversational direction and to a larger extent how we unknowingly influence the students' work.

The majority of these students were able to justify their choices and reasons, doing this clearly and quite maturely. They were sticking to their guns so to speak. As teachers we can sometimes direct students away from their own ideas through our direction of the conversation, we could hear this in some of the questioning by the teacher. This is so hard not to do! We have a preconception about what the finished product will look like, and kids being kids will adapt their ideas to match what they think we want. The kids obviously have a great relationship with their teacher so will do their best to please them. not unnatural and certainly clear expectations are important, particularly for students still developing their skills.

I find that it becomes more problematic to allow students in stage 3 to follow an idea or concept that I might not think is the optimum one. Finding a balance between direction and free exploration can be difficult.

Jack had picked up on Angela's own concern about unintentionally directing conversation away from the students' own ideas in an investigation. Furthermore, he could see this happening in the excerpt. The issues raised by Jack also rang a chord with Sandy, an infrequent contributor to the online forums:

Sandy
Re: Conversational Directions
Tue, 13 May 2005, 10:51

Great points Jack. I agree with what you have said whole heartedly. It can be difficult at times not to put the answers in the students' mouths. It can challenge your teaching style and it takes time to make changes to your teaching style. It won't happen overnight!

Sandy does not specify any particular example of student learning from the Birdhouse video. His remarks remain generalised, as do Samantha's in a separate reply to Jack;

Samantha
Re: Conversational Directions
Sat, 21 May 2005, 16:36

I agree Jack. I do tell my students that if they would like to take a different direction to my suggestions then they can.
The thing that bothers me with this project is what happens if birds do not use the birdhouses? I can see scientific conversations taking place, but if the birdhouses sit out unused in the playground what lesson have the students learnt? After a great deal of effort would they want to rebuild/modify their birdhouses and where would we find time in the curriculum anyway?

Whilst Samantha advocated student-driven investigations, she also alluded to the time restrictions for enacting such an approach. Jack's response to Samantha did not address this concern. Instead he focused on the value of design failure for student learning.

Jack
Re: Conversational Directions
Sat, 21 May 2005, 17:21

I think they could learn a lot still even if it went unoccupied; investigate why, hole too small, painted - does it smell, too cold, wrong spot lots of others. Was there a specific type of bird identified originally i wonder? Each species has distinct needs and even in my garden i have had to modify what i thought was a good design because it didn't suit the needs of the species i was trying to attract. Experimentation is all about failure, just ask Young Einstein!

This prompted Lyn to draw out the educational implications of Jack’s comments for teaching Science and Technology.

Lyn
Re: Conversational Directions
Sun, 5 Jun 2005, 23:41

Jack,
Thanks for this lovely post - pointing out the importance of failure in Science and Technology is of enormous significance here! Yet it conflicts starkly with how we work in education - we try to eliminate failures altogether - but then if we get successes one after the other, we sometimes have a very limited understanding of why things succeed. Almost a catch 22 here, really.

If we can avoid short-circuiting students' experience, and actually LET them fail, safely and in supported ways now and then, there can be some very powerful learning experiences - not that we want to engender failure after failure - not great for self-esteem...

It would be lovely to hear more of your adventures with birdhouses, Jack - you seem to be very experienced with them - what are some of the successes and failures you have had?

How do they fit with what was being suggested in this video? You say that needs of particular species need to be taken into account - do you have some specific examples of this from your own adventures?? It would be just lovely to hear some more detail of these things - it would help us understand a lot more about the learning involved in this video event - both prior and post...

Anyone else have any experience with birdhouses in their gardens??? ...

Lyn's invitation for Jack to share his experiences in birdhouse design led to a more explicit articulation of his domain knowledge concerning ecological niches:

Jack
Re: Conversational Directions
Tue, 7 Jun 2005, 12:50

Probably batting 50% success rate at first attempt. no species really likes treated pine, so this should be avoided, it does leach and will put most birds off using the house, same with paint, the smell, or it might be fumes in such a confined internal space, but some paints, can't mention brands for legal reasons. The hole size should be just larger than the adult bird, trick is some species bring in their own nesting materials so if the hole isnt big enough they cant get the material through. placement is vital, i was putting houses up high in trees and wandering why the smaller birds weren't using them, ornithologist mate explained relationship between height of box and physical ability to fly that high…

Lyn used the opportunity to discuss the role of conversation, and diverse perspectives, in Science and Technology education, whilst also introducing some formal terminology into the discussion.

Lyn

Re: Conversational Directions

Wed, 8 Jun 2005, 18:51

Thanks so much for these detailed perspectives on your experience building birdhouses, Jack.

I think this video is a lovely example of a "coffee table conversation" - for those of you who have read the children's conversations paper in the library - and I could really see the value of bringing in a "consultant" at a particular stage of the building project - not so much to shortcircuit the process of testing the children's ideas - but as a way of enriching the generation step - if you are thinking about this as generative - increasing the pool of things the children might consider in their building.

In Jack's set of ideas, are ideas to do with niche - a species' fit with its environment - and what might hedge the chances of such fit - trying to build habitat - and it is so necessary that the children look at species' characteristics of those birds they mentioned (Jack mentioned height of birdhouse and ability to fly that high, size of hole and nesting habits). Careful observation of birds in the playground will fill in some of their knowledge to help with design parameters for the birdhouses, obviously - and help them build the birdhouse that will appeal to the particular birds. Empathy with living things - substantively and as a moral principle is clearly growing here...

Any other experienced birdhouse builders out there? City people who can give insights into the challenges of urban birdhouse building? Differences in species across NSW - Malleeville/Hillsland/Koppi [pseudonyms] and different parts of Sydney - north, southwest, east? What are the environmental issues you are confronting where you live? What are the differences in the kinds of ideas the students are showing us in this domain - and how they might wish to test them? Over to you...

Samantha accepted Lyn's invitation for others to share their experiences. She began by noting the value of the domain knowledge being shared in the Birdhouse Ant-e-chamber.

Samantha

Re: Birdhouses

Thu, 9 Jun 2005, 17:37

Yes we built bird houses and they remained empty, I now have some inkling why this might be. It goes to show that the general level of information given to children is aimed low. Any tv program for kids, or kids environmental book about building them would probably only deal with construction and not getting birds to use them.

I agree that it is important to let kids fail in a safe environment, but I think that means that they then have a chance to regenerate their ideas and try again. In my case it was time consuming, costly and huge effort to get them made, only to have them sitting up in our trees unoccupied.

Once again I think teachers do need to increase their level of expertise but not necessarily force all the information onto children. Just be able to lend support when needed.

In light of Jack's recommendations, Samantha advocated the importance of teachers having adequate domain knowledge for undertaking Science and Technology design tasks with their students. She supported her opinions with a blend of (generative) learning theory and classroom experience.

Through this online dialogue Jack, Samantha and Sandy began to express the difficulties of enacting a flexible, student-driven process within Science and Technology. They clearly empathised, as professional educators, with Angela's difficulty in this regard. Angela's willingness to acknowledge professional uncertainty (as discussed previously) through her Culminating Task may have encouraged these teachers to share their own difficulties, understandings, and experiences in enacting such an approach.

In the following analysis I sought to understand how these Cohort 2 contributions may be associated with the intellectual and social terrain that might have been ‘passed on’ (in the words of Katrina) through Cohort 1’s Culminating Tasks. This relates then, to the inter-generational learning dynamic that may have been operating within the DESCANT system, conceived here as a *generative* learning environment (as discussed in Chapter 5).

I now examine these excerpts for features of a Learning Ecology. In essence, at issue here is the extent of cultural learning across the phases of the DESCANT project. Once again it is useful to focus specifically on the various collectives involved.

<u>The Cohort 2 Collective</u>

The small minority of Cohort 2 teachers participating in this online forum was typical of patterns of engagement during this initial immersion period. Despite encouragement from moderators and Cohort 1 mentors, only small numbers of Cohort 2 teachers participated frequently in online dialogue. Whilst online participation did vary dramatically, this pattern did not change substantially throughout Phase 2. Yet, whilst this represented a significant challenge for developing professional dialogue at a *cohort level*, informal communication with participants suggested that the majority of teachers was still engaging with the project, both individually and collectively, with their school-based colleagues.

In contrast, Jack, Samantha, and Sandy were engaging in the Birdhouses Antechamber at a cohort level. That is, they were exhibiting a *cohort-based* pattern of operation. These Cohort 2 participants responded to each other as co-learners. They were expressing agreement, asking questions, providing information and sharing ideas over time. In doing so a range of ideas was pooled at the cohort level, regarding this important professional concern.

The central professional concerns being discussed here by Jack, Samantha and Sandy relate to the value and difficulties of student-driven investigations and design. Whilst Jack is the

Cohort 2 teacher who initiated this online dialogue, it was Cohort 1 participant Angela who initially generated this concern, leading to its expression within her Culminating Task. As such, the pool of ideas developed within this Phase 2 discussion may be conceived as an extension of an ongoing process of collective exploration. These Cohort 2 teachers expanded the range of ideas being associated (in the Political Ecology sense) with this professional concern in the Birdhouses Ant-e-chamber by discussing such things as classroom constraints and ecological constraints.

Angela's accompanying text *articulated* a flexible, student-driven approach to Science and Technology education (see Appendix 4.2). This reflected the dominant intellectual position of the Cohort 1 collective: that is, their shared *proposition* regarding Science and Technology education. Yet, as Angela noted in her text, her video excerpt did not entirely reflect this position.

> *I did prevent directions of the conversation, because I had my idea of the finished product.*

So, in one sense Angela's video excerpt expanded her articulation of Science and Technology education by incorporating authentic classroom practice in a way that introduced perplexity and uncertainty to the overall proposition.

Jack was quick to use this discrepancy as a means of discussing his own difficulties of enacting student-driven approaches. In doing so he recognised the importance of Angela's concern to his own practice:

> *…we have a preconception about what the finished product will look like, and kids being kids will adapt their ideas to match what they think we want.*

Jack's use of Angela's Culminating Task demonstrates how the intergenerational dimension of the DESCANT Colony was now allowing a degree of continuity in the discussions of Science and Technology education both across cohort boundaries and across phases of the project. A common professional concern was emerging as a salient issue for DESCANT's population of teachers. This related to the manner in which teacher preconceptions can get in the way of student-centred investigations. It was a concern that had never been raised by moderators, but rather had been developed in the DESCANT teacher population.

From a Political Ecology perspective, this represented a challenge to the dominant proposition regarding Science and Technology education that had been established in Phase 1 of the project. Whereas Cohort 1 teachers had focused largely on student learning to articulate this proposition, Cohort 2 teachers were now seeking to articulate a more adequate teaching perspective that could be associated with this proposition. Cohort 1 teachers had opened the way for this task by incorporating perplexity, inconsistency and uncertainty into their own proposition. Now Cohort 2 was addressing the challenge, through the development of new associations based on their own experiences and concerns. Beyond the focus on students, salient entities now included:

- An instance of teacher learning (Angela's professional concern);
- A specific artefact (Angela's Culminating Task);
- A professional concern (expressing professional uncertainty or weakness concerning student centred approaches);
- The constraints imposed by school culture and organisation (for example, the limitation of time to enact a student-driven approach);
- Domain knowledge (for example, ecological niches).

By incorporating these entities into the ecology of associations in the DESCANT Colony, the Cohort 2 teachers expanded the discussion of Science and Technology education.

The entities being afforded salience by Cohort 2 teachers provided an indication of *their underlying values* at the time of this discussion. Unlike Cohort 1 teachers, these Cohort 2 participants did not form explicit associations to specific instances of student learning. Instead, they formed associations to teacher learning, the day-to-day realities of the current educational system, and their own professional experience. Angela's strong representation of classroom practice proved salient to this group of Cohort 2 teachers, thus resulting in the selection of these entities as common ground on which to develop new associations.[139] The ecology of associations developed by Cohort 2 teachers stood, in some ways, as a *witness* to the *relevance* of the Birdhouse Culminating Task.

The Moderator Collective

In supporting Cohort 2's discussion in the Birdhouse Ant-e-chamber, Lyn was also active in forming associations that gave salience to particular entities (in the Political Ecology sense). For example, Lyn expanded the ecology by associating Angela's Culminating Task with:

- A particular kind of knowledge-building dialogue ('coffee table conversations');
- An academic paper in the Colony Library (The 'children's conversations' paper[140]);
- A theoretical heuristic for learning (generate-test-regenerate);
- A teaching approach for supporting student learning (bringing in a 'consultant'); and
- Scientific terminology related to the discussion of bird environments (for example, "niche", "fit", "habitat").

Each contribution here expanded the means by which Cohort 2 teachers might articulate Science and Technology education in their cohort collective. The entities given salience in this respect indicate underlying values and understandings. Lyn utilises entities closely associated with her research group. For instance, she frames her comments through the lens of the generative theory, and interprets Angela's video in relation to 'coffee table conversations': another conception deriving from her own research and academic writing.

[139] As detailed in 7.1, Angela, like others in Cohort 1, had argued that teacher videos should include a macro classroom focus so as to not 'mislead the public' by showing just a few students. Furthermore she had argued strongly for Culminating Tasks to incorporate the difficulties of enacting exemplary practice in Science and Technology education. She was therefore "comfortable showing [her] mistakes" in her Birdhouse Culminating Task. Now, Cohort 2 participants seemed to be selecting these values as salient.

[140] 'Children's Conversations and Learning Science and Technology' (Cosgrove & Schaverien, 1996).

This excerpt demonstrates the manner in which, in Phase 2, moderators contributed, introducing their own ideas and theories on the basis of teachers' interests and concerns. In Phase 1, the GVC had represented a strong (value-laden) theoretical imposition on the teachers' collective investigation, designed as it was by the Chief Investigator. In Phase 2, the ideas and theories of the moderators were still available, but now they were introduced as a means of enhancing the *internal diversity* of the DESCANT system. In a sense, the moderators were parallelling what Lyn had suggested for student learning, that is "…bringing in a "consultant" at a particular stage- not so much to short-circuit the process of testing…ideas - but as a way of enriching the generation step."

So, there is evidence in this excerpt of a type of progressive, intergenerational knowledge-building occurring within the DESCANT Colony. This occurred through a process of self-organisation as Phase 2 participants *selected* salient components of the DESCANT environment, engaging with them as the basis of their discussions. In doing so, these participants were carrying forward professional concerns as well as collective patterns of interaction (for example, expressing uncertainty) that had taken root within Phase 1 of the project. By then *associating* these with their own professional concerns, experiences and values, these teachers were expanding the *collective exploration* of Science and Technology education in DESCANT, articulating a wide ecology of entities that would need to be *taken into account* (in the Political Ecology sense).

Once again, the Moderator collective, as Lyn exemplified in this case, was also active in this process. Lyn utilised her own professional values and knowledge to expand the pool of entities that were given salience in the Colony's discussions.

Nevertheless, this collective exploration was represented by only a small number of teachers from Cohort 2. Cohort-based dialogue (in both Phase 2 groups) was very sporadic throughout the online immersion period. Instead, new patterns of collective interaction seemed to be occurring, particularly localised *school-based* engagement.

Through the following analysis, I sought to understand how the varying ways that Phase 2 collectives were engaging with the project may be influencing their learning. Once again, I was particularly interested in how these varying patterns of operation may be influencing the selection, rejection and modification of the intellectual and social terrain ‘passed on’ from Phase 1.

8.1.2 Can school-based contributions to online investigations be understood as a part of a learning ecology?

Through a second excerpt, I now seek to more adequately understand the relationship between these school-based contributions and the collective investigation of Science and Technology learning taking place in Phase 2. This second excerpt is taken from a later stage of the online immersion period of Phase 2. Figure 8.2 locates it there.

<table>
<tr><th colspan="5">DESCANT Phase 2</th></tr>
<tr><td>Intro. workshop: Cohort 2 (1st intake)</td><td>Intro. Workshops: Cohort 2 (2nd intake) & Cohort 3</td><td rowspan="2">Online immersion: DESCANT Colony (Full Cohort 2 & Cohort 3)</td><td>Participants Upload & Rate Culminating Tasks</td><td></td></tr>
<tr><td colspan="2">Online immersion: DESCANT Colony (Cohort 2: 1st Intake)</td><td></td><td>Final School-based Conversations</td></tr>
<tr><td>29th Mar +</td><td>1st – 6th June</td><td>June- July</td><td>Aug-Sept</td><td>Oct</td></tr>
<tr><td colspan="5">2005</td></tr>
</table>

Figure 8.2 Locating Excerpt 2 in the DESCANT Phase 2 timeline.

By this stage (over a month after the Excerpt 1), a second intake of Cohort 2 teachers had joined the project, bringing new perspectives and patterns of interaction into the online investigation.

Within this second excerpt, Cohort 2 teachers discuss Cathie's Culminating Task.[141]
This online discussion shows newly emerging patterns of online interaction that were increasingly influenced by school-based collectives.

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[141] In Appendix 4.3, I reproduce Cathie's Accompanying Text in full. Her videos (titled Plant food, and Thomas and Caterpillar) can be viewed online in the DESCANT Colony.

Excerpt 2) An Online Discussion of Cathie's Culminating Tasks

During the second week of their online immersion, Pattonsvale teachers Caitlyn, Casey and Tom simultaneously began three separate threads in the Plantfood Ant-e-chamber (discussion forum). The similarity of their posts indicated the ideas being expressed had originated from a shared perspective developed by the three work colleagues in their local school context.

Casey discussed the teaching possibilities for moving Thomas towards a more scientifically sound understanding of plants.

Casey

Pattonsvale Thoughts on Thomas and plant food.

Fri, 17 Jun 2005, 13:19

Thomas has some interesting ideas. It would seem that further experimentation and time spent in this area would be beneficial in testing his hypotheses. This would also prevent him from taking on board ideas that are not scientifically sound.

This lesson seems to be a good starting point for their investigations and should be built upon.

It's great how the children were given the opportunity to come up with their own theories on how plants grow and to test them. However a control plant is needed to compare their finding with. This would allow them to see if their theories were correct.

To conclude, it would be beneficial to the students to be able to see visual representation of how plants draw in their nutrients eg through a web site, video or experiment (using coloured dye and celery to show how the nutrients are drawn through the cells).

Casey's post did not receive any replies. However, Caitlyn's near-identical post prompted a range of responses from Cohort 2 participants, who were likely to have recognised that the trio had posted almost identical contributions.

Caitlyn
Pattonsvale Thoughts Thomas and Plant Food
Fri, 17 Jun 2005, 13:19

Thomas had some interesting ideas. He needs to explore and conduct further experiments to get a further understanding of how plants work.

It seems that this was a good starting point for their investigations, and should be built upon.

It's great how the children were given the opportunity to come up with their ideas and test how plants grow. However a control plant is needed to compare their findings with. It would give them a connection with the real world of living things and see whether their ideas were correct.

It would be good for the children to have access to an actual visual representation of how living things draw in their nutrients, eg a web site, video or experiment (using coloured dye and celery, to show how the nutrients are drawn through the cell system).

Cohort 1 teacher (and now DESCANT mentor) Sally replied to Caitlyn by suggesting that Thomas's conceptual understanding was appropriate for his age.

Sally

Re: Pattonsvale Thoughts Thomas and Plant Food

Sat, 18 Jun 2005, 14:38

Did you notice that, in the accompanying text, Cathie mentions the follow-up as being similar to what you are suggesting?

Thomas is actually quite young and does appear to have a very basic understanding of how plants obtain nutrients.

He is thinking and considering things and this is a start, isn't it?

Sally’s defence of Cathie, her school-based colleague, alluded to some important differences of opinion between the Pattonsvale school-based group, and the Cumbly school-based group of which Sally and Cathie were members. Gill mediated these perspectives by framing the teachers’ dialogue in professional development terms.

Gillian

Re: Pattonsvale Thoughts Thomas and Plant Food

Tue, 21 Jun 2005, 15:24

Like you, I found myself responding to some of the videos with that same wish to follow up in this way or that (and of course, as Sally says, so did their teachers :) What interests me about it is how readily we can see, from even such short glimpses as these, where the students need to head next if they're to achieve the sorts of outcomes we'd want in SciTech; and how quickly we're moved to come up with our own ideas about how to facilitate that.

I find myself relating this to both the teaching-learning cycle and the generative model. What are the implications for how we plan and structure our lessons, do you think?

As moderator, Gill had skilfully integrated two frames of reference, a pedagogical one and a theoretical one. However in a direct reply to Caitlyn, Samantha had already extended the critique of the Pattonsvale perspective.

Samantha

Re: Pattonsvale Thoughts Thomas and Plant Food

Tue, 21 Jun 2005, 15:19

I'm not sure that I think his work is not scientifically sound. Certainly his ideas may be 'different.' He has worked in a very scientific way using a controlled experiment, and showed his knowledge of HOW plants take up food. Although not the correct foods this is certainly how plants grow.

I think the idea of generative learning is to listen very carefully to what the students are saying and use this as a basis for exploring the ideas they generate, rather than our ideas.

According to Samantha, Cathie's generative teaching approach had allowed Thomas to demonstrate his understanding of plants, noting her view that his position was not necessarily unscientific. Once again, Gill mediated between the various perspectives.

Gillian

Re: Pattonsvale Thoughts Thomas and Plant Food

Tue, 21 Jun 2005, 15:34 Reply to message

Is it the case that a "scientifically sound" understanding is an incremental thing, that is arrived at through an ongoing process of evolution, rather than somehow absorbed all of a piece? I can see aspects of his method and explanation that do reflect accepted scientific models but he's only part way there at this stage (as Caitlyn points out, the concept of a control isn't part of his investigative approach at this stage)

Gill had combined Samantha's focus on *incremental* (yet not linear) *conceptual development*, with an acknowledgement of the importance of scientific conventions of investigation, as focused on by the Pattonsvale group. The dialogue prompted Camilla to enter the debate with further concerns about a student driven approach to Science and Technology education.

Camilla

Re: Pattonsvale Thoughts Thomas and Plant Food

Thu, 30 Jun 2005, 12:52

Do you allow children to experiment and create "theories" no matter how wild they may be before they are given correct information, or is it better to allow the children to gather information and then design their tasks to "prove" their theories?

With Thomas, I would have expected that he would have had a better understanding of how a plant reproduces and the life cycle of the plant and so had been able to give a better explanation of how the plant absorbs the food. As this clip was at the conclusion of the unit I wonder if Thomas was given this information earlier in the unit.

Like the Pattonsvale teachers, Camilla appears to be unimpressed by Thomas' current level of conceptual understanding.

Tom also appeared uncommitted to the approach taken by Cathie. Like his school-based colleagues at Pattonsvale, Tom did not share Sally and Samantha's more tolerant view of Thomas' current level of understandings.

Tom

Pattonsvale thoughts on Thomas & plant food

Fri, 17 Jun 2005, 13:19

I found it difficult to see the basis of his thinking and actualisation. He needs to conduct further experiments that lead him to better understanding of how the plant system works. What do others feel about our ideas on his studies? This lesson appears to be a good springboard for their next series of understandings about the plant food system. I found it difficult to see how they came up with some of their ideas. It would be good to give them a chance to have a proper scientific test with a control plant to compare their findings with. It would then give them a real connection with the real world of living things and show *whether their findings are correct or just ideas. This gives them a chance to draw comparisons and create generalisations. It would benefit the children by accessing a site that demonstrates the capillary action of plants. It is a good experiment that can be conducted by children with celery sticks and coloured dye. It develops a clear knowledge especially if you cut the stick in half and see the dye travelling up the stem cells. At the moment the children are only guessing as they have no actual knowledge of how the system works.*

Like Caitlyn, Casey and Camilla, Tom focused on developing Thomas' understandings towards more acceptable scientific understandings. Grant, the CEO of Science for the DET, was the first to respond to Tom (and his school-based colleagues).

Grant
Re: Pattonsvale thoughts on Thomas & plant food
Sun, 19 Jun 2005, 17:04

Grant here from [DET Office]. I like the suggestions from Caitlyn, Casey and Tom from Pattonsvale. While I was listening to Thomas, I was drawing a plant with flower and roots and wondering if he had done that at some time. My drawing prompted me to consider if Thomas would benefit from cutting a plant from the flower down through a stem to the roots to see if there is a way for the flour and water to travel. This approach might also allow him to test the idea that the flower comes from the roots.

The celery experiments are great for investigating the structure of plants and it would be good to compare with other plants too.

Grant gave support to the Pattonsvale teachers by discussing possibilities for extending Thomas' understanding of plant structure. However he went on to qualify this perspective.

[little pause to consult the SciTech Syllabus outcomes and Big ideas]

I've just discovered that the "structure and function of living things" is part of the Stage 2 Living things outcome - Thomas is in Year 2 so it is getting very close - does anyone feel it would be a problem to set Thomas on this course??

Grant thus made explicit for the group the fact that these understandings were a part of the curriculum for Thomas in his very next school year. He then addressed the perspectives being developed by other teachers in this conversation thread.

In relation to other areas of discussion, I have conflict with my ideas about teaching and learning when I listen to this video. On one hand, I can see the critical importance of providing opportunities for students to generate and regenerate their ideas, but there is a strong tendency to want to intervene so they get to the point quicker. Good teaching might be about getting the balance right!

This prompted Samantha to articulate once again the professional concern she had raised in the Birdhouses thread.

Samantha
Re: Pattonsvale thoughts on Thomas & plant food
Sun, 26 Jun 2005, 13:22

The more I teach the more I see children being rushed through a crowded curriculum with very shallow thinking required. I think it would stop the class from going onto other scitech topics if they all had to do much more testing and work in this one. How would the teacher cover all the areas required by her school's scope and sequence? If some areas of the scitech curriculum are left out what will the next teacher have to build on?

However if Thomas is really keen and ready to absorb more complicated concepts then we need to find a way for him to work on this himself. I think I would allow some 'free' time during the week when individual interests can be followed.

Gill responded to Samantha's concern based on her years of experience as regional Science and Technology consultant. She began by discussing school level scope and sequence plans:

Gillian

Re: Pattonsvale thoughts on Thomas & plant food

Mon, 27 Jun 2005, 10:37

I agree with you about children "being rushed through a crowded curriculum with very shallow thinking required".

As for the problem of addressing this while covering all the areas required by the school's scope and sequence, which has been raised in several threads now, my first reaction is to ask what the scope and sequence is requiring? (general question, not yours particularly Samantha)

I say this because I've found there is so often a great deal mandated by scope and sequence statements that is not actually required by any syllabus. If only the syllabus outcomes are treated as mandatory within the school, there is far more flexibility for the sorts of things a generative approach suggests we do. (Or for that matter a Quality Teaching approach - consider the Intellectual Quality dimension just for starters, very much what you're saying here Samantha.)[142]

Gill then problematised the teacher orientated notion of 'covering' a topic, using the generative theory to propose a more learning centred vision of this classroom dynamic.

[142] Gill refers here to a 'model of pedagogy' associated with the discussion paper, 'Quality Teaching in NSW public schools' (NSW DET Professional Support and Curriculum Directorate, 2003). This model has three dimensions related to quality pedagogy: intellectual quality, quality learning environment, and significance. In particular, Gill refers to the first of these dimensions, intellectual quality. This dimension "refers to pedagogy focused on producing deep understanding of important, substantive concepts, skills and ideas. Such pedagogy treats knowledge as something that requires active construction and requires students to engage in higher-order thinking and to communicate substantively about what they are learning" (NSW DET Professional Support and Curriculum Directorate, 2003, p. 9).

*Secondly, what does it mean to "cover" something? For me the bottom line is that **if** children really can learn well when the content is delivered by traditional methods of direct instruction, wouldn't that be the way to go? I could certainly cover a lot of territory in a short time that way.*

*But my experience is that it flat-out doesn't work. Much of what I've "covered" won't be understood or retained by many (most??) students, much less lastingly incorporated in their understanding of Life, The Universe and Everything. So I question, very much, the value of being able to say *I've* covered whatever in my class if in reality my students haven't had adequate opportunities to take it in. Might it be that by requiring deeper* thinking and making opportunites for g-t-r we do less but children learn more?

On the same day as their contributions in the Plant Food discussion forum, the Pattonsvale teachers posted separate, but again similar posts, in the 'Thomas and the Caterpillar' Video Ant-e-chamber.

Again, the comments of the Pattonsvale teachers suggest a lack of enthusiasm for the Science and Technology teaching approach shown in the Caterpillar excerpt.

Casey
Tasting leaves
Fri, 17 Jun 2005, 14:31

This clip left me somewhat confused. The task being set (to take on the role of a caterpillar) seems to be a bit ambiguous. It would be difficult to test the children's theories.

The questions posed allowed the children to use their imagination, however do not seem to allow for scientific experimentation.

Caitlyn

Tasting leaves

Fri, 17 Jun 2005, 14:34

This video was somewhat confusing. I am confused with the scientific aspect of the children's thinking. The teacher asks the children to take on the role of the caterpillar and what the plant tastes like. This questioning allows the children to use their imagination and therefore it would be difficult to test their theories.

Tom

The taste of tasting leaves or you be a caterpillar

Fri, 17 Jun 2005, 14:34

I was confused with the science aspect of this study. It didn't give me any ideas as to the purpose of the study. I am not sure if a caterpillar actually thinks like a human and uses colour as a taste base. Did the children know if the caterpillar is born on a particular plant then it is the only plant it can live on? They are programmed to survive not select by interests using complex sight/colour variants.

I would like to have seen the children testing if the animal would actually have eaten other types of plants or rejected them due to its taste/plant base.

Please add any points or criticisms. I am seriously fishing for ideas here.

Did this video lead the children to study any further and in what new direction were they looking to extend their knowledge?

I opened out the teaching dimension of Tom's post, focusing specifically on the value of understanding students' current conceptions of a phenomenon.

Lachlan

The taste of tasting leaves, or you be a caterpillar

Mon, 20 Jun 2005, 17:00

…is there value in encouraging students to discuss their current conceptions about scientific phenomena, as Cathie has done here? There is a paper now available for download in the Colony Library that deals with this issue in regards to children's' conceptions of water. (See Waterviews_OsbCosg file) This may be a useful shared resource for discussing the issues that Tom, Caitlyn and Casey have raised in regards to this video.

PS: Personally I am still fascinated with the way our human bodies (including our brains and nervous system) mediate experience in the same way the caterpillar's body mediates its experience. I think this line of inquiry may be incredibly fundamental to understanding our place in the world, and the status and limitations of human knowledge (generated from experience.) But that's another post...:)

My postscript sought to encourage the group to take a fresh look at the biological concepts being discussed in these teacher videos. Responding directly to Tom's post, Gill stressed the difficulty of some of the biological concepts for students.

Gillian

Re: The taste of tasting leaves or you be a caterpillar

Tue, 21 Jun 2005, 16:49

What I think we are seeing in these videos is a set of ideas children very often hold but rarely express as clearly as this, namely that plants obtain nutrients and energy in somewhat the same way as we eat food. The understanding that plants mostly absorb very simple substances such as carbon dioxide and water then synthesise the complex molecules they need while obtaining their energy directly from the sun seems to take a lot of developing. It's been my experience that students right through to Stage 6 are confused about this.

Yet these same students have been given the scientifically accepted information, often at several points. Often they can trot out the correct formula or diagram in answer to a test question, so the "disconnect" goes undetected by the teacher, whereas it is clearly evident in this footage.

What implications does this have for the way children develop understanding and how we go about guiding that process?

Gill had emphasised the importance of hearing students' *existing* conceptions of phenomena. Responding to Caitlyn, Samantha also articulated an alternative perspective on the video, one that cast Thomas's ideas as important to his developing scientific understandings.

Samantha
Re: Tasting leaves
Wed, 22 Jun 2005, 13:05

I think this conversation is in the context of what plants take up, how they obtain their food, how they grow. Plants do actually taste different depending on what they take up, although the students are extrapolating this from their own experience of food I think.

Samantha went on to defend the authoring teacher's approach, drawing explicit connections to the theoretical readings available to the cohort.

If the teacher had not started this conversation when Thomas noticed the caterpillar she would never have known what the children were thinking. She may also have tried to impose her own ideas of what they needed to learn which may have been in opposition to the ideas the children already held. If you read the material on generative learning it discusses how these ideas may be discarded or ignored, rather than teaching the children what is 'true,' because the children can not make them fit with their own ideas.

I have been listening to my students a lot more since I began this journey, and I have been surprised by what I have learnt.

I think if you asked the children to test their theories they would be able to have a pretty good attempt, because the teacher has given them the freedom from being 'wrong.'

The shared perspective expressed by the Pattonsvale group across these online threads represented, it seems, an explicit challenge to the generative, learner-centred orientation underpinning Cathie's plant food video and text. Through her Culminating Task, Cathie had articulated a conception of Science education that gave salience to the *existing* conceptions held by students. In this view, students' current understandings are conceived as adaptive strategies that remain within a dynamic state, thus being replaced by more powerful (that is, more adaptive) strategies on the basis of new experiences and tests (Edelman, 1992, Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000).

Cathie had represented (in the political ecology sense) this orientation in her Culminating Task by supporting Thomas to reflect upon, articulate and test the ideas that were currently salient *for him* as a learner. Furthermore this approach provided Cathie with a means of accessing Thomas' idiosyncratic values and understandings, thus supporting her endeavours to align her teaching with his learning needs in the future.

Nevertheless, the Pattonsvale teachers (as a school-based collective) were largely unconvinced of the appropriateness of Thomas' investigation and reasoning. Instead they recommended activities that would give Thomas a more 'scientific' understanding of plants. In the Plant Food forum, their position appeared to gain support from Camilla, another Cohort 2 participant.

Yet their perspective drew a prompt and direct response from other DESCANT teachers who sought to defend Cathie's generative, learner-centred approach. In the Plant Food Ant-e-chamber, Sally (from Cohort 1), and Samantha (from Cohort 2) presented a very different interpretation of the Plant Food video. In the Caterpillar thread Samantha developed her response still further, going as far as suggesting the Pattonsvale group investigate the generative approach in more detail.

The contributions to this discussion fuelled the exploration of Cathie’s Culminating Tasks at a collective level, increasing the *variation* in ideas and values being pooled in the online forum. Yet throughout these excerpts, this collective exploration was characterised as much by commonality as variation. Initially, two loose subgroups of teachers appear to exist within the Plant Food excerpt. Expressing a shared set of perspectives was the Pattonsvale school-based collective, and Camilla. This sub-group focused on what they saw as a worrying gap between Thomas’ current conceptions of plants and more scientific explanations. For example:

> *With Thomas, I would have expected that he would have had a better understanding of how a plant reproduces and the life cycle of the plant and so had been able to give a better explanation of how the plant absorbs the food. (Camilla)*

> *I found it difficult to see the basis of his thinking and actualisation. He needs to conduct further experiments that lead him to better understanding of how the plant system works. (Tom)*

In response to this concern the Pattonsvale collective focused on the means by which Thomas could be supported towards a more ‘scientific’ understanding of plants. For instance, the school-based group provided helpful suggestions of activities that might assist in this regard. In a political ecology sense, they developed ecological associations between (amongst other things):

- the Plant Food video excerpt;
- Thomas’ existing conceptions of plants (as captured in the video);
- a collective professional interpretation of the deficiency of Thomas’ current understandings.
- a range of teacher-derived activities for progressing Thomas’ understandings.

Thus, on the basis of their shared understandings, perspectives and values, this group had developed a complex proposition on student learning in Science, a proposition that was articulated through this ecology of associations.

In contrast, a second subgroup was evident within the Plant Food excerpt. Sally and Samantha, although from different cohorts, expressed a unified position that was clearly different to the views expressed by the other subgroup. Sally formed an association between (amongst other things):

- the Plant Food video excerpt;
- Thomas' existing conceptions of plants (as captured in the video);
- a professional interpretation of the appropriateness of his understanding as a 'starting point', considering his age.

Samantha adopted a similar position, challenging the other subgroup's perspective directly. She formed an association between Thomas' discussion of plants, as captured in the video excerpt, and the very notion of a scientific understanding:

> *I'm not sure that I think his work is not scientifically sound. Certainly his ideas may be 'different.' He has worked in a very scientific way using a controlled experiment, and showed his knowledge of HOW plants take up food. Although not the correct foods this is certainly how plants grow.*

Samantha appeared to be making a distinction between how Thomas was *learning* how plants grow, and the existing body of knowledge concerning biology. In doing so, Samantha made the perspective that was being articulated by this subgroup increasingly explicit. She noted that a generative perspective on learning implied a need to listen closely to students' existing ideas:

I think the idea of generative learning is to listen very carefully to what the students are saying and use this as a basis for exploring the ideas they generate, rather than our ideas.

In this respect, Samantha's position corresponded closely with the dominant intellectual position that had been adopted by the Cohort 1 collective. It was an orientation that Sally, as a member of Cohort 1, was now actively defending as a mentor. The similarity between these two teachers' perspectives was thus an early indicator that this small subgroup may be part of a larger collective, coupled, not by their identity with a cohort, but on the basis of a shared intellectual and professional orientation to Science and Technology education. Furthermore, the orientation they were articulating seemed to correspond to the dominant intellectual culture in the DESCANT Colony. It appeared that this intellectual culture was now actively challenging positions that did not correspond with its own values and understandings.

The online dialogue within the Caterpillar Video forum was further indication of this wider intellectual collective or culture. In response to the Pattonsvale group, Samantha once again articulated a highly generative orientation, thus validating Cathie's approach as a valuable means of understanding the student's current conceptions. Here Samantha seemed increasingly comfortable in using the generative orientation to mount an explicit challenge to the perspectives of the Pattonsvale group:

If you read the material on generative learning it discusses how [conventional scientific] ideas may be discarded or ignored [by learners], rather than teaching the children what is 'true,' because the children can not make them fit with their own ideas.

Samantha thus strengthened her position by associating it to the generative readings in the Colony library. Her post seemed to imply that the Pattonsvale collective might not be engaging adequately with the dominant theoretical position of the DESCANT environment. Whilst in some ways provocative, Samantha's comment here was in line with the purpose of the DESCANT Colony, which articulated that participants should *engage* with the generative perspective as an initial (or experimental) means of thinking about learning in Science and Technology education. Participants were expected then to associate their ideas (at least initially) with the generative perspective, even if that meant doing so as a critique of this orientation. Samantha appeared to believe that the Pattonsvale collective was critiquing the approach *without making this association*. In a political ecology sense, they were not seeking a *common world*.

Yet the Caterpillar forum dialogue also provides an indication of a wider cohesion regarding this intellectual orientation. For instance, Gill took here a more decisive stance on the issue than she did in the Plant Food thread. She asserted the importance of hearing students' existing conceptions regarding scientific phenomena, strengthening the point by associating it with her extensive consultancy experience across many school contexts.

> *It's been my experience that students right through to Stage 6 are confused about this.*

Her post thus became an indirect challenge to the Pattonsvale collective through its description of the failure of approaches that focus on simply providing scientific facts without engaging with students' current thinking.

> *Yet these same students have been given the scientifically accepted information, often at several points. Often they can trot out the correct formula or diagram in answer to a test question, so the "disconnect" goes undetected by the teacher, whereas it is clearly evident in this footage.*

Furthermore, my own post alluded to a generative orientation by associating the discussion to the 'Children's views of water' paper in the Colony library.[143] The postscript was a deliberate attempt to express my own uncertainties regarding the larger domain issues surrounding physiology and the way it mediates experience and perception. Whilst this went well beyond the scope of the discussion, it acknowledged the complexity of the

[143] 'Children's Conceptions of the Changes of State of Water' (Osborne & Cosgrove, 1983).

science being discussed, taking a position that, in one sense, paralleled Thomas' own uncertainty.[144]

So, there were clear indications in this excerpt of the operation of a cohesive intellectual culture within the DESCANT Colony. This culture did not exist within cohort or moderator boundaries but rather as an overarching cohesion of values and perspectives on Science and Technology education. The culture incorporated a wide range of entities including the generative theory, academic papers, Culminating Tasks (including classroom videos and texts), as well as the experience of teachers and consultants. The (political) ecology that was formed by these associations represented a complex orientation towards Science and Technology education, one that included diversity, professional uncertainty and continuing perplexity.

The Pattonsvale perspective represented an important challenge to this dominant orientation. Yet this school-based collective were not outsiders but fellow teachers, dealing with a common school culture. For the dominant intellectual culture, integrating the perspective this small group had articulated represented, perhaps the most significant professional concern for Phase 2 teachers, and moderators. The same issue was paralleled in Cohort 3 discussion, despite the two cohorts having little interaction.[145] In both cohorts, there was evidence of teachers actively seeking to integrate these two perspectives through their own classroom practices and Culminating Tasks.

The excerpt above also demonstrates how the Moderator collective supported the teachers in this task, often on the basis of their own sincere desire to integrate these perspectives. The Moderator collective played an active role in supporting the teachers' discussion of both the Plant Food and Caterpillar videos and texts. Through their contributions, the moderators acknowledged the legitimacy of the various perspectives being articulated (by

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[144] In some ways, the topic raised the same scientific uncertainties addressed by Nagel's (2005/1974) seminal paper 'What is it like to be a bat?'

[145] Only the Pattonsvale collective had access to dialogue from both cohorts as they had teachers in both Cohort 2 and Cohort 3.

the two subgroups). For example, Gill proposed an integration of perspectives by matching the DET Quality Teaching approach with the generative approach:

> *If only [meaning 'just'] the syllabus outcomes are treated as mandatory within the school, there is far more flexibility for the sorts of things a generative approach suggests we do. (Or for that matter a Quality Teaching approach - consider the Intellectual Quality dimension just for starters, very much what you're saying here Samantha)*

In suggesting the compatibility of these approaches, the moderators were proposing a new association, a recombination (or variant) of the ideas that had been proposed by the teachers. Gill, as a DET consultant who also had close proximity to the UTS collective, was in a good position to propose such a recombination.[146] Her generalisations across multiple school contexts afforded the cohort closer proximity to the wider school system. Grant also suggested an integration of the two perspectives:

> *I have conflict with my ideas about teaching and learning when I listen to this video. On one hand, I can see the critical importance of providing opportunities for students to generate and regenerate their ideas, but there is a strong tendency to want to intervene so they get to the point quicker. "Good teaching might be about getting the balance right!"*

Grant's dilemma appeared to arise from a tension between a learning orientation (articulated here through generative terminology) and a teaching orientation (typified here by intervention). He suggested the solution may come in a recombination, or balancing of these. As a senior executive in Science education with the DET, Grant was well placed to address this issue. Yet his post demonstrated that the issue was far from unproblematic, even from his perspective.

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[146] Within a community of practice, meaning may be negotiated through *boundary encounters* (Wenger, 1998, p. 112). This may include encounters between representatives of different communities of practice. In this sense, Gill may be conceived here as a boundary worker.

Grant's expression of professional uncertainty made it clear that the Moderator collective shared the teachers' perplexity on this issue. In addressing this professional concern the teachers were therefore engaging in *authentic* knowledge building for their profession. Yet Grant also made explicit an association between Thomas' investigation and a DET Outcome. In doing so, Grant implies that Thomas appears to be at an appropriate conceptual level for his age. This is the perspective articulated by Sally and Samantha.

Through their posts in this excerpt, the moderators suggested compatibility between the two orientations being articulated by participants. In a sense then, the moderators had begun the task of integrating the different perspectives into a single vision of Science and Technology education: that is, to *establish a common world*.[147] Yet in doing so, Gill and Grant were themselves clearly influenced by their own professional contexts within the Department of Education (DET). They brought to the conversation a focus on departmental supports for teaching Science through their discussion of such things as outcomes and scope and sequence statements.

In this respect they expanded the group's collective exploration by representing the DET subgroup. Just as the UTS subgroup often formed associations to shared resources such as academic papers, the DET subgroup was now encouraging teachers to utilise the shared resources from the DET. Yet whilst their understandings and values may have been influenced by their professional context, these moderators still utilised collective strategies common to the DESCANT culture. These included collective intellectual orientations, as well as collective strategies of *exchange*, such as Grant's communication of professional uncertainty.

So, this analysis suggests that the newly emerging collective patterns of operation and interaction in Phase 2 may have had a strong influence on collective investigations of Science and Technology learning within the DESCANT Colony. In particular, this ecological account develops an association between these collective patterns of interaction

[147] Again, from a political ecology perspective, this does not imply the need for an integration in which all perspectives were equal, but rather an integration in which associations were articulated *between* the perspectives.

and the emerging (or generative) conception of Science and Technology learning in DESCANT, contributing to the intellectual terrain of the DESCANT Colony.

In some cases, this emerging *articulation* of Science and Technology learning was characterised by an extension of the collective learning of Cohort 1. In this regard, various Phase 2 collectives (online and in local school contexts) expanded what needed to be *taken into account*. In other cases, Phase 2 investigations were characterised by resilience, as an emerging intellectual collective actively buffeted challenges to dominant collective understandings and values.

From a learning systems perspective, these patterns of operation and interaction may be associated to the *proximity* of individual agents to one another. In an adaptive learning system, agent proximity may be closely associated to the types of ideas and behaviours (that is, strategies) that are accepted or rejected (Axelrod & Cohen, 2000). As agents associate themselves to collectives, it is common for them to utilise these collective entities as a means of acquiring effective governing values (Axelrod & Cohen, 2000).

I therefore extend this analysis by interrogating these excerpts for the proximity of agents and entities within the DESCANT learning system.

8.1.3. Of what importance, if any here, is the proximity of agents in the DESCANT learning ecology?

Analysing the factor of proximity within a learning system may relate to the proximity of agents to other agents, as well as the proximity of agents to other entities in the system (Axelrod & Cohen, 2000).[148]

[148] For the purpose of this analysis, I separate these two types of proximity. Yet in doing so I recognize that, within a learning ecology, such a separation may be more pragmatic than ontological.

Agent to Agent Proximity and Collective Exploration

Although the reasons for Samantha's very quick alignment with the generative perspective can only be speculated, one influential factor may have been her early start in Cohort 2's initial intake (see Figure 8.1 above to locate this period on the Phase 2 timeline). By undertaking her online immersion earlier than many of her cohort, Samantha was afforded an extended period of dialogue with the Cohort 1 mentors and the moderator collective, as well as a more relaxed timeframe for reading materials from the online library.[149]

Also of influence may have been Samantha's pattern of engagement with her *online cohort*. Samantha frequently contributed to her cohort's online dialogue, thus engaging strongly with the ideas and values of the dominant generative orientation. In contrast, the Pattonsvale collective utilised a very different pattern of operation within the project, one that more heavily relied upon their local, school-based collective.

With the exception of posts by Samantha and, much later, by Camilla, Cohort 2 teachers in this set of threads, either did not post at all, or in the case of the Pattonsvale teachers (Caitlyn, Casey and Tom), posted a set of opinions developed as a school-based group. This localised strategy represented a new pattern of operation within the DESCANT context: *a school-based collective strategy of exchange.*

Whilst school-based professional development sessions were encouraged throughout the DESCANT project, the UTS and DET collectives expected that these localised private sessions would encourage members of these school-based groups to contribute to ongoing *online discussion* with their cohort. Nevertheless, both in Cohort 2 and Cohort 3, this was often not the case. As is shown in this thread, the Pattonsvale teachers utilised a strategy of creating *one-off* posts that summarised their shared discussions, ideas and understandings.

[149] This is a clear example where exogenous system design related to activation (or timing), may have influenced the emergence of endogenous patterns in Phase 2 DESCANT.

One consequence of this school-based strategy for the *cohort's* collective process of learning was that any *variation* within the perspectives and values of individual Pattonsvale teachers remained unknown. The Pattonsvale school-based collective presented their opinions as a cohesive unit with little transparency as to possible differences of opinions that had existed, or still existed in the group. From a generative perspective, these school-based contributions may be conceived as a form of *collective explanation*.

Cohort-based patterns of exploration (as discussed in Chapter 4) often involved *individuals* generating and articulating *emergent* thoughts which could then be tested and reformulated, or regenerated, through a collective cohort process.[150] In contrast, within school-based patterns of exploration, it seemed to be *collectives* that were *generating* contributions to the online cohort, following their school-based sessions. As such, online cohorts were less able to access the emergent thoughts that had coalesced into a cohesive collective explanation in a school-based collective.

This collective pattern of operation may have reduced the variation of questions, ideas, concerns and understandings being pooled in the *cohort's* investigation into Science and Technology education. From a systems perspective, this may have lessened the diffuseness of the online interactions between individual cohort members. That is, without the variation of these individual teachers' opinions and values, the cohort-level dialogue may have been depleted. From this, it may be inferred that the population of ideas and understandings that the cohort collective could select from, in subsequent stages of its collective learning process, would also have been more limited.

Furthermore, this school-based pattern of operation may have influenced the collective investigation of the Pattonsvale collective and its individual teachers. For instance, without sustained dialogue with their cohort collective, the Pattonsvale collective may have been less exposed to the values and understandings of other teachers online.

[150] Although most Cohort 1 participants had school-based colleagues, their contributions to online discussion were invariably based on individual ideas and values. This may have been partly due to the fact that online contributions were often formulated and posted from home.

Yet ironically, the Pattonsvale group's independence from their cohort's professional dialogue may have, in other ways, benefited the collective investigation taking place online. It is possible that the Pattonsvale group's lack of proximity to the online collective may have increased their *independence* from the pervading intellectual culture online. School-based reports, such as those that came from Pattonsvale may therefore have increased the diversity of values and understandings being offered to the online collective, thus increasing the diffuseness of online dialogue.[151]

Whilst this seems to run counter to the claim that the school-based strategy reduced diffuseness in the system, this is an issue of scale. The initial claim involved the diffuseness related to individual engagement at the cohort level. However, this latter point relates to collective engagement at the cohort level. Whilst Pattonsvale teachers as members of the cohort collective were rarely visible, the Pattonsvale collective proved extremely visible, possibly far more so than if each Pattonsvale teacher had contributed individually.

So, this Learning Ecology analysis has helped identify a range of ways in which agent to agent proximity in the DESCANT learning system may have affected collective learning. In particular, the analysis suggests that school-based patterns of interaction may make individual agents less visible to their cohort, and the wider DESCANT learning system, whilst making collective agents more visible. This may have important consequences for collective exploration in a generative learning system, changing the diversity and cohesion within the ideas and values that are pooled there.

Yet these patterns of interaction may also influence the proximity of agents to other entities in the learning system, entities central to developing powerful articulations of Science and Technology learning in the system. These are discussed in the following section.

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[151] As discussed in 1.2.2, Surowiecki (2004) conceives 'independence' to be an important determinant in the collective intelligence of a group. Higher independence between agents serves to militate against premature convergence on particular values and understandings (through herding or imitation and information cascades). However he also recognises that some feedback is useful as someone else might have information necessary for an individual to make a good decision to add to the group. Thus this could add to more diverse 'forecast'. So, in this view, some problems are better off worked through together.

Agent to Entity Proximity and Collective Exploration

In Phase 1 of DESCANT, the specificity of teachers' contributions (that is, the manner in which propositions were articulated) was deemed important to the group's collective exploration (see 6.1.2). In this regard, the GVC was found to support high levels of specificity regarding student learning and Science content, particularly through a collective engagement with student videos and learning theory. As participants collectively operated this e-learning environment, the specificity of their responses increased the variation of strategies being articulated during the Phase 1 online immersion period (Chapter 6).

In Phase 2 however, the GVC was replaced by the DESCANT Colony, as an e-learning context through which participants (or agents) could collectively engage with entities (in the political ecology sense) such as videos of student learning and learning theory. It is therefore pertinent to address the specificity of teacher contributions in this prototype environment and the influence of this on collective exploration.

Cohort 2 teachers were often unwilling to engage explicitly with the domain area being discussed. For example, in the Plant Food forum the Pattonsvale teachers discussed teaching activities related to plant structure. Yet at no time did they discuss the *specific* ideas and understandings currently held by Thomas. The biological understandings appropriate for Thomas' age are therefore never discussed.

This was common to all the Cohort 2 teachers who contributed to this thread. Without employing a dialogue strategy of *specifying particular instances* of domain understanding, the teachers avoided specificity in the discussion of Thomas' conceptual understanding. This affects the pool of ideas developed by the Cohort, as a collective, resulting in a lack of ideas related specifically to the knowledge *Thomas already possessed*.

Even Samantha, who acknowledged the value of Thomas' ideas, did not specify domain details so as to support her stance in the group. This level of articulation may have then influenced the cohort's discussion regarding the importance of Thomas' *current* conceptual understandings for developing increasingly powerful explanations regarding plants. The ecology of associations that had been articulated failed to develop a proximity to the actual domain ideas related to plant food. This level of articulation may be contrasted to the ecology of associations developed by Cohort 1 participants within the GVC. The articulation of student learning there had included explicit associations to the students' ideas about electricity and electrical circuits.

In the Caterpillar forum, there was a slight increase in domain related specificity. Both Samantha and Tom demonstrated a willingness in this thread to discuss the domain ideas underpinning the Caterpillar video. Tom (17^{th} June) discussed these domain ideas in order to emphasise how far Thomas' current conceptions are from scientific opinion. He thus used his own domain knowledge to critique the approach taken in the video. In contrast, Samantha (22^{nd} June) articulated the video's main biological concepts, as a means of validating the approach undertaken by Thomas. The dialogue strategies employed by these teachers introduced another level of specificity to the group's exploration of the videos. However, the opportunity to make use of these ideas was lost through the lack of dialogue between cohort members.

This brief analysis relating to agent/entity proximity highlights a deficit in specificity within online dialogue in Phase 2. According to this analysis, this deficit may have important consequences for the types of propositions (in the political ecology sense) that were being articulated as part of the online collective exploration in Phase 2.

In Chapter 7, Sally's Culminating Task was interpreted as a (nested) learning ecology made up of various entities in association. Now in this Chapter 8 analysis, it may be that the manner in which Phase 2 participants incorporated (or articulated) these entities into their own propositions influenced their collective learning.

So, here in 8.1.3, discussion of the systems concept of proximity has revealed a number of potentially important associations between collective patterns of interaction in Phase 2 and the shifting, *yet increasingly resilient*, intellectual and social terrain within the DESCANT

Colony. According to this analysis, the varying collective patterns of interaction that were evident in Phase 2 may influence the *proximity* between agents and other agents, and between agents and other entities (for example, domain ideas).[152]

Similarly, the analysis suggests that varying proximity is likely to have influence on the *values* that were used to test the worth of ideas and professional strategies in this excerpt. In the case of agent to agent proximity, this relates to the governing values of both individual agents and collective agents (for example, the Pattonsvale school-based collective, and the DET collective). In the case of agent to entity proximity, this may relate to the governing values that emerge within an ecological association, values underpinned by the affordances and constraints of an ecological system (Gibson, 1979).[153]

Now that the potential influence of proximity (Axelrod & Cohen, 2000) on collective patterns of operation and interaction in Phase 2 has been addressed, I can answer Chapter 8's central research question: Can the investigation of the Science and Technology learning of a second DESCANT generation be understood as a Learning Ecology?

8.2 Answering Chapter 8's Research Question: an analytical summary

Here in Chapter 8, a Learning Ecology analysis can therefore make much sense of the collective investigation of a second DESCANT generation. Initially, such analysis required attending to the manner in which the political ecology (including intellectual, social, cultural and environmental dimensions) that had been 'passed on' by Phase 1 participants was developing in this second phase. That is, participant contributions have been understood here as a *trajectory* of collective learning in the overall DESCANT system.

This analysis suggested that *contributing* Phase 2 teachers (a minority of the entire population) were active in selecting, rejecting or modifying the understandings,

[152] Once again, in a political ecology, collective learning is conceived to proceed through the development of associations between entities, which may be both human and nonhuman such as scientific data or domain knowledge (Latour, 2004).
[153] In Chapter 6, the same dynamic was discerned as participants navigated the affordances and constraints of the value-laden GVC environment.

professional concerns and uncertainties that had been ‘passed on’ from Phase 1 (through their Culminating Tasks). In this regard, contributing Cohort members in Phase 2 were engaging with the learning environment as the Cohort 1 teacher-designers had anticipated, in a generative manner.

Nevertheless this period of online collective investigation, or collective exploration, was clearly hampered by the lack of *cohort-based* participation in Phase 2. This second generation of DESCANT teachers, in combination with the various supporting collectives (such as the mentor and moderator collectives) appeared to have established subtle forms of collectivity based on their collective patterns of interaction and exploration. I thus sought to understand how these collective patterns of operation, particularly those within school-based collectives, may have been influencing the proto-culture that was being generated within the DESCANT Colony.

This secondary analysis suggested that the various collective patterns of interaction within Phase 2 may have had an influence on the collective understandings that had come to characterise the intellectual terrain of the DESCANT Colony. Whilst it cannot be known what led to teachers and collective agents in DESCANT developing particular understandings, there is evidence that a collective understanding had developed in much of the population. From a complexity position, this understanding, which related to the need to closely align instruction with the current intellectual positions of a learner, may be conceived as a dynamic attractor within the DESCANT network, a network that includes the classroom contexts in which ideas and behaviours were being tested.

Yet collective investigation in Phase 2 was far from homogenous. I have described a learning ecology characterised by tension between conflicting viewpoints, an active buffering of the dominant generative position, and an expanding collective (re)formulation of what needed to be *taken into account* (in the political ecology sense) in order to articulate Science and Technology learning appropriately. Moreover, the DESCANT learning system was cast (using the systems concept of proximity) as a complex ecological dynamic governed by *nested collective values*, some of these values being associated to the various DESCANT collectives, others to the interaction between agents and entities in the learning system.

So, the analysis detailed here in Chapter 8 articulated a conception of collective learning in DESCANT characterised by an ecological terrain that was heterogenous, yet with emerging pockets of cohesion, some expected and solid, others unexpected and subtle. Increasingly evident in this ecological terrain were deepening patterns, or contours, formed as collectives cohered around, or resisted, particular collective understandings, and ways of behaving. These were not rigid, uniform contours, but rather dynamic and often unstable ones, shifting in tune with collective participation, yet governed by the (collective) values that underpinned participation. By incorporating the measure of proximity, this even more detailed conception of this ecological terrain was possible.

What remained to be understood was whether and if so, to what extent, the *learning* of school-based collectives (as a product of their collective investigations) might constitute a learning ecology. This concern had become increasingly salient given the dominance of school-based patterns of operation and interaction in Phase 2. Accordingly, the following chapter attends to participants' local school contexts, as a means of gaining even greater appreciation of the nested nature of collective learning in the DESCANT context.

Chapter 9
Describing and Analysing Learning in Groups IV
School-based contributions in DESCANT's Phase 2

In Chapter 8, I described and analysed *cohort-based* investigations during the Phase 2 online immersion period. During these online investigations, a minority of Phase 2 participants were found to self organise around areas of professional concern, some of which had been foregrounded in the Culminating Tasks of Cohort 1 discussed in Chapter 7.

As in Phase 1 (see Chapter 6) this self organising, network dynamic was interpreted as a (political) learning ecology that included moderators, Cohort 1 mentors and an ecological web of entities (for example, research papers and classroom videos). This analysis suggested that an emerging professional learning ecology, incorporating intellectual, social, cultural and environmental orientations (and articulated through complex ecological propositions), had transcended the phases of DESCANT, as well as the various subgroups or collectives that operated there.

On the whole however, the online immersion period of Phase 2 was characterised by low levels of contribution at a cohort level, a phenomenon that was accompanied by increasingly dominant school-based patterns of operation and interaction. In Sections 8.1.2 and 8.1.3, I described and analysed the complex manner in which this shift towards localised, school-based collectivity may have influenced *cohort level* investigation, thus re-shaping the form of collective learning that had been described in Phase 1 of DESCANT (Chapters 6 and 7). However, this analysis remained focused on the online cohort as the central arena of collective learning.

Here in Chapter 9, my analysis shifts away from the cohort level, in recognition of the new patterns of operation in DESCANT. The central concern here is to understand if, and if so how, the learning of local, school-based groups may have contributed to the wider DESCANT network, *beyond* cohort-based contributions. In doing so, I aim to extend the analysis of previous chapters by investigating other possible forms of collective learning, beyond cohort-based investigation and design (as described in Chapters 6, 7 and 8). This final analysis thus aims to answer the question:

Did the learning of local, school-based collectives contribute to the DESCANT learning ecology in Phase 2, and if so, how?

Firstly, in 9.1, I describe and analyse the learning of local, school-based collectives in Phase 2 of DESCANT, reconstructing aspects of it as far as I am able post hoc using data generated from final face-to-face conversations with participants. Then in 9.2, I utilise the findings of this initial analysis as a means of investigating how the learning of school-based collectives may have contributed to the wider DESCANT learning ecology through Culminating Tasks, ratings/evaluations and finally, through the Learning Landscape (the DESCANT Colony's Recommender System - see 7.2.1).

In order to investigate whether, and if so how, the learning of local, school-based groups may have contributed to the DESCANT learning ecology in Phase 2, it was first necessary to investigate the professional learning that may have occurred in these groups.

9.1 Final school-based conversations as windows on group learning in Phase 2: Did collective learning occur within local, school-based groups?

Due to the paucity of cohort-based contributions in Phase 2, it was likely that localised, school-based learning, if it occurred, had not been articulated within online discussion (see 8.2). Here in Section 9.1, I therefore look outside these online discussions to data obtained from final school-based conversations Figure 9.1 locates these conversations in the DESCANT Phase 2 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 2</th></tr>
<tr><td>Intro. workshop: Cohort 2 (1st intake)</td><td>Intro. Workshops: Cohort 2 (2nd intake) & Cohort 3</td><td rowspan="2">Online immersion: DESCANT Colony (Full Cohort 2 & Cohort 3)</td><td>Participants Upload & Rate Culminating Tasks</td><td></td></tr>
<tr><td colspan="2">Online immersion: DESCANT Colony (Cohort 2: 1st Intake)</td><td></td><td>Final School-based Conversations</td></tr>
<tr><td>29th Mar +</td><td>1st – 6th June</td><td>June- July</td><td>Aug-Sept</td><td>Oct</td></tr>
<tr><td colspan="5">2005</td></tr>
</table>

Figure 9.1 Locating school-based conversations in the DESCANT Phase 2 timeline.

In the final stages of DESCANT, the UTS Collective initiated final conversations with Phase 2 participants in their school contexts.[154] These sessions were attended by members of the UTS collective, with the occasional assistance of Kerrie (formerly of Cohort 1).[155] During these discussions, teachers were encouraged to discuss various dimensions of their DESCANT experience. This included technical and logistical issues surrounding their participation in DESCANT and the ways local collaborations may have unfolded in each school context. Teachers also described how local and online participation had influenced changes in their teaching practice, professional understanding and school-based collaboration. [156]

Thus, these school-based conversations provided a means of establishing the nature of any professional learning that may have occurred within local, school-based contexts. They supplied a suitable basis for analysing if, and if so how, any localised collective learning may have contributed to the wider DESCANT learning ecology (beyond cohort investigations and design). Three data excerpts were chosen in a bid to understand the local school-based professional learning that occurred, as described by Phase 2 teachers themselves, and to investigate contributions, if any, that it made to the learning ecology.

The first excerpt, taken from the final conversation at Pattonsvale, enabled further insights into the learning of a local school collective that had exhibited school-based patterns of interaction online, analysed in Chapter 6 (see 6.1.2). During this short segment of conversation, these Pattonsvale teachers describe collective shifts in their teaching of Science and Technology and in doing so allude to changes in their understandings of how to support learners.

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[154] In two instances, due to the logistical difficulties, these final conversations were undertaken by teleconference rather than face-to-face.

[155] At the time of these conversations, Kerrie was temporarily relieving Gill as Science and Technology consultant for her school district. This represented an intriguing example of shifting identity within the DESCANT system. Kerrie's DESCANT identity had shifted from a Cohort teacher, to a mentor, and finally to part of the Moderator Collective as a Science and Technology consultant.

[156] These discussions had a development purpose as well as a research purpose. Transcribed by the UTS Collective, they were a way of helping teachers to describe and analyse their 'learning journey', a shared text representing their experiences in the project. These draft learning journeys became a school-based contribution to a cohort-based Wiki (that is, an online collaboration space). By integrating the various 'learning journeys', each Cohort developed their Learning Legacy (see Appendix 4.1), which could be viewed by future DESCANT participants (see Appendix 2.2).

The second excerpt, taken from the final conversation at Tallerack, enabled further insights into the learning of a school-based collective that had exhibited both school-based patterns of interaction, and cohort-based patterns of interaction online. The Tallerack teachers differed from the Pattonsvale school-based collective in their propensity to contribute to online, cohort-based investigation from diverse individual positions, rather than as a cohesive localised group. These patterns of interaction were interpreted in Chapter 6 as having the potential to influence the proximity of agents and entities, and thus the nature of collective learning in a learning ecology (see 6.1.3). This school-based collective had undertaken a range of these patterns of interaction, blending in its own way school-based and cohort-based collectivity.

The third and final excerpt, taken from Blackwood, enabled further insights into the localised, school-based learning of a Phase 2 participant whose DESCANT experience had not been characterised by local, school-based collaboration. Whilst Jack did have a school-based colleague at Blackwood, local organisational difficulties of working in a small rural school prevented much collaboration between him and his school colleague. Jack instead became an enthusiastic contributor to cohort-based discussion (see 8.1). Whilst in Chapter 8 Jack's cohort-based investigation was described and analysed, the selected excerpt from his final conversation in DESCANT, provides a means of describing and analysing his professional learning at a localised, school-based level. The inclusion of this excerpt thus provides a means of representing an example of school-based learning potentially influenced, not by school-based patterns of interaction in DESCANT, but rather cohort-based collectivity.

9.1.1 Excerpt 1: The Pattonsvale final discussion

A final discussion was undertaken with the Pattonsvale group, which had thee members in Cohort 2 and two members in Cohort 3. The small excerpt below provides indications of group-level understandings related to learning and teaching in Science and Technology education.

Having described their own professional engagement in DESCANT, the Pattonsvale teachers went on to describe a new level of student enthusiasm and engagement for Science and Technology. In discussing this change, Nichola noted that their Science and Technology topic had extended across the entire term. This prompted Tom to note the same phenomenon in his class.

Tom: We could go probably till the end of next term if they keep it going. They'd want me to go all day.

Lyn: But that says something too doesn't it?

Tom noted the connection between this extended timeframe and the approach he was now adopting in his Science and Technology teaching:

Tom: Yeah, because this idea of testing and retesting and then checking what knowledge they have.

He then described the students' enthusiasm for experimentation, the other Pattonsvale teachers agreed. He quoted the students in stating:

Tom: "And can we add a little bit more then go back and test and retest and come up with a bit more knowledge."

Pauline: mmm. So you're testing.

Tom then briefly alluded to the shared language that the generative approach had given him and his students as they undertook scientific investigations. He described their collective knowledge building as an expanding wedge.[157]

[157] Elsewhere in the discussion, Tom discussed in more detail the manner in which he had used the generative heuristic (generate, test and regenerate) as a shared language in his classroom. No other

Tom: A bit more language, so the wedge is getting wider as they go along, rather than just, 'Oh that's that.'

Pauline: Yeah exactly.

Nichola: Yeah.

Tom went on to describe this from the point of view of a student.

Tom: It's more than just, "That's that." "That is that because I can see this happening in front of me. I can validate that happened. This person did it as well and it happened twice or three times."

Lyn: So evidence-based.

Tom: Yeah, definitely. For them it's an important step to actually see that scientists have a reason for doing things and the evidence has to be there before they can make most of their generalisations, not all, but most. We do have to theorise sometimes.

Lyn: Mmm. They're lovely stories, aren't they?

Tom: I think the fact that all five of us were very keen to do science in the first place helped, because there was no like, "Do we have to explain?" It was like, "Yeah, let's get going".

Lyn then raised a common concern for teachers employing a more student driven approach to Science and Technology education.

Lyn: A lot of people say, you know, the lack of control fazes them.

DESCANT teacher reported sharing the generative learning theory as explicitly as Tom did with his students, as a resource for learning Science and Technology.

Tom: No.

Nichola: I think we ???

Tom: I think that actually…

Pauline: Yeah [to Nichola's point?]…

Tom: The lack of control actually creates new directions-

Nichola: Yep

Tom then emphasised the manner in which his students were driving the investigations based on their current interests.

Tom: - you think you're going here, then suddenly, you're 'whoop' over there somewhere else because they wanted to find out this little aspect. They didn't care about the main thing. They wanted to move, hop, jump, here and there.

As Tom made this last point, Casey, nodding in agreement, was clearly on the verge of making a comment. However it was Pauline who came in first. She noted how pervasive this approach can become to one's professional practice.

Pauline: It's actually teaching style really, isn't it? Like you were saying you know, it's in everything that you do, you might plan a lesson and the next minute you're doing something completely different -

Nichola: [finishing Pauline's point] - that wasn't planned.

Casey then managed to find a gap in the conversation. She emphasised the centrality of students' current conceptions as a driving force behind the process that was being described by the other teachers. Casey's point built on Tom's earlier conception of investigations being guided by students' own interests.

Casey: Because you sort of find out more-

Pauline: It's still the same outcome. [still referring to her last point.]

Tom: Adds on to it [to Pauline.]

Casey: But you find out more [of] what the kids know. You're not trying to teach something that they already know-

Pauline: Where they're at. Yeah.

Casey: You're sort of going, 'Okay, well you already know this, so where do we go from this?'

Pauline: Yep, so let's, yeah.

Casey directed much of her comment to Tom, her school-based DESCANT partner. Whilst there was no reaction from Caitlyn, her other DESCANT colleague, Tom expanded on the point, from a personal learning perspective,

Tom: One of the things I noticed when I was watching the children learn, and I think this was a critical learning point for me, was the fact that you didn't have to take a direct line for them to learn it. Their mind doesn't follow a textbook line. It follows what they want answered at that moment. Then they've solved that problem. Then they think, 'Now I want to answer this question over here, and then I want to answer that one that was back there'. And all those build up to be the knowledge that they will actually need for Science or even just any subject area. It's not a direct line, as often teachers think it has to be taught that *way. It's where they want to go at the moment that leads them to the path you want to get to in the end.*

This prompted Lyn to ask whether Tom attributed at least part of this learning to his engagement with DESCANT. In his reply Tom raised the commonly discussed issue of the challenge of integrating a student-driven approach into the outcomes-based Science and Technology curriculum.

Lyn: And so are you saying that this particular context and this particular set of experiences was more helpful in, helping you appreciate that fact [of the non-linear nature of student learning]?

Tom: Oh, yeah definitely because I wasn't constrained by the curriculum this time as I said to you in my first [answer]. I'm not going to follow the curriculum, I'm going to follow where they go. Goodness knows where we'll end up. Well, it was quite good and they kept on coming up with new ideas to go and I said, 'Yeah, we'll do that. Yeah we'll do that.'

Lyn: Because lots of people say, 'Well, what do they learn from the curriculum? You know, what can you tick off at the end?'

It is clear from Tom, Pauline and Nichola's response that they believe a student-driven approach needn't conflict with curriculum requirements.

Tom: You can tick off a lot of things. What we did was all there in the curriculum-

Nichola [to Pauline]: That whole outcome.

Tom: -but wasn't in a set line.

Pauline: People, it's odd, I mean, you can achieve an outcome in any way you want. Like an outcome is just what's at the end, but it's all this process stuff that you can alter.

Nichola: But the whole outcome, the predicting, the testing, it's.

Whilst Nichola stopped here of her own volition, it was Tom who expanded on the issue. He emphasised that their teaching approach must derive from how the students are actually learning, especially when operating within such a wide curriculum.

Tom: Yeah, I think if we can tap into the way they actually learn, then that affects the quality teaching that we teach them, the way that we teach them, rather than just the way that we have always done in the past. The ways we've always done in the past was when we had very narrow curriculum. These days it's a very wide curriculum and we can't expect to be going just one path. We've got to be prepared to sway and move about to suit the learning at that particular moment. I think that's why this particular thing worked quite well.

Lyn: Mmm

Tom then expanded on how he perceived the new approach benefited the students' Science and Technology investigations.

Tom: It gave them a chance to actually explore and then come back with their generalisations for what they learnt that linked to something else over there - in a sense of that generative learning.

The Pattonsvale school-based collective describe here an approach to Science and Technology education that has been developed, apparently collectively, during their participation in DESCANT. This approach is largely *student-driven*, based on the need to remain vigilant over students' current needs, rather than imposing preconceptions of what is required in the way of teaching. Tom describes this as tapping in to the way students "actually learn", while Casey asserts the advantage of understanding what students actually know.

The approach corresponds closely with the generative orientation that was dominant in the DESCANT Colony. Given that the Cohort 2 Pattonsvale group seemed to initially challenge this generative orientation (as detailed in Section 6.1) this appears to indicate a shift in the group. Moreover, there is a strong sense that these teachers had independently tested this approach in their classrooms and school. For instance, they seem to have developed their own solutions to the dilemma of integrating the flexibility of a generative approach with achieving mandated outcomes.

Tom articulates this solution with the clarity he has derived from his classroom experience, yet obviously he is influenced by the dominant intellectual positions discussed within DESCANT:

> *One of the things I noticed when I was watching the children learn, and I think this was a critical learning point for me, was the fact that you didn't have to take a direct line for them to learn it. Their mind doesn't follow a textbook line. It follows what they want answered at that moment. Then they've solved that problem. Then they think, 'Now I want to answer this question over here, and then I want to answer that one that was back there.' And all those build up to be the knowledge that they will actually need for Science or even just any subject area. It's not a direct line, as often teachers think it has to be taught that way. It's where they want to go at the moment that leads them to the path you want to get to in the end.*

It was clear that this was a shared position within the Pattonsvale school-based group. For these teachers the generative orientation, the DET outcomes and their school practice were integrated into a single, yet complex and diverse, collective understanding. This collective orientation was tuned within their school contexts and experiences, a product of iterative classroom testing and school-based collaboration.

The following excerpt involves the Tallerack school-based collective from Cohort 3. Throughout DESCANT, this group had, like the Pattonsvale collective, worked closely with each other to extend their professional understandings of Science and Technology education. Yet in other ways their patterns of interaction in DESCANT had been quite different to those of Pattonsvale. For instance, individual Tallerack teachers had contributed to online discussion in Cohort 3 *as individuals*, rather than through collective explanations (as discussed in Chapter 8). In this sense they had demonstrated both cohort-based and school-based patterns of interaction.

9.1.2 Excerpt 2: The Tallerack final discussion

During the final face-to-face conversation with the UTS collective, the Tallerack teachers were discussing their conceptions of DESCANT as a model for teacher education, and the challenges it presented. Lucy was reminded of a conversation with Kaila, in which they had questioned the differences in learning outcomes resulting from the application of this approach to Science and Technology teaching and learning. The discussion that followed provided some insight into the possible influence of DESCANT's approach on their students' learning in Science and Technology.

Lucy: I was just thinking as you said that, do you remember we had that conversation about whether, um, if you did it, whether the children would really have the understanding if you'd done it the 'old way' and then you've done it this way, would it, would the children have the same understanding, or better understanding, what do you think? It's hard [to know].

Kaila: It is hard.

Lucy: I thought about it a lot when you [raised that issue], because I thought sometimes when we did it the old way I don't know whether they really had the understanding. That was what I thought at the time, and I still don't know, you know…Because they have done it this way, I wonder what [understanding] they've got.

In discussing her students' learning, Kaila alludes to the changes in her teaching practice in Science. In handing over the responsibility for experimentation to the students, it seems that Kaila's role as provider of information shifted to the students, fuelled by the findings of their investigations:

Kaila: I think, I think they've actually got a very good understanding. Because when the CSIRO came and they were asking - we had the CSIRO come and do some activities after we'd done all our bits and pieces. And what the kids were coming back with 'and we did this and we did that, we found this and we found that'. So they really had a very good understanding of things that I would have done experiments on. I would have shown them. Like the poles and like where it's attracted to. And they learnt from each other, which I thought was really valuable. The children, someone had discovered that, so they'd share it with someone else, and they'd go and test it themselves then. And so there was a lot of sharing within the groups even though they were all on different tasks. They very quickly spread the word about what they'd discovered and the others would then try it.

So I think they ended up at very much the same place we would have led them in a lot of ways. There's still a couple of things I know my class- I just haven't had time to get back to, that they'd come up with that I want to go back [to], [to]challenge a couple of ideas that I know a couple of boys have got, I want to challenge [them]. But I think they've got a depth of understanding that they mightn't have had before. I found they couldn't express themselves so well,

Corina: They didn't have the metalanguage.

Kaila:[simultaneously to Corina] They didn't have the language

Kaila: No. But they had the concepts.

Lucy: Yes, that's right. I thought that, yes.

This recognition of the conceptual development of students led Corina to note that the generative model provided the latitude for supporting students in meeting their current learning needs:

Corina: And that's probably what they'll maintain for longer than us standing out the front saying, 'Let's all investigate this.' I actually thought that the generative learning model as such, supported um, or allowed the children at different learning levels, ah, in regards to the topic. It allowed them to investigate at their level, So some of them already knew that magnets had North and South poles, so they had moved on to a variety of different investigations as opposed to more elementary ones [in which] other children were still saying, "Oh, [the magnet]sticks to metal." These children had already worked out it didn't stick to all types of metal, and they were now further in their investigations. So, it was broad enough and open ended enough to allow a variety of children to be working at a variety of different levels, but also sharing and collaborating on their knowledge base.

Shortly after, the teachers were discussing the flexibility afforded to them through the DESCANT model of professional development. Kaila discussed the manner in which they, as a professional development group, approached Science and Technology during DESCANT.

Kaila: And I've looked at some of the other videos people have done [of their students' learning]. I think we've done it in a much broader sense than a lot of people, who seem to have picked just one aspect of their topic, but we sort of had the whole topic as being open.

The challenges of developing a classroom practice based on theory were still apparent to Kaila.

Kaila: And it's been challenging in that, trying to keep track of what the kids have covered and, and where everyone is and what they've been doing. As a teacher you sort of feel like you need to know, what they've achieved and where they are and what they're doing and that's been a bit, that's been daunting I suppose, in some ways. 'Cause you feel like, oh *what have they got and what haven't they got and where are they going? So that's been challenging. So, I don't know. I still think about it. I still challenge myself. Would I do it the same way?*

Kaila then detailed how the DESCANT approach provided more flexibility for the students. She discussed the manner in which she began topics and the value of this approach both for student learning, and as a means of formative assessment.

Kaila: I liked it in that, as Corina said, it allowed the children to choose the area that they liked and they felt they wanted to pursue and so you weren't having children who already knew things doing things that they'd already done, and they already knew. So that was good because a lot of them did [already know things]. And that first, I thought that first play session, I ended up doing two [sessions], where I just let them play, and let them discover and, and they did a lot of that entry - 'Yes it sticks to metals, but not all metals.' And they came up with a lot of those things initially just by playing. And so, that was really valuable I think, from my perspective, to say well, normally we'd say to kids, on a pre-test,' What do you know about magnets?' Not as easy for kids to write that down. You don't know. You don't always think that it's important, that's what people want to know.

This prompted Lucy to note an apparent mismatch between the students' scope of investigation and the domain resources.

Lucy: And also when I think of the materials that we saw in books that we looked at before, some of those whole lessons were on what sticks and what doesn't stick, or in that magnet kit, you know.

Kaila: Whereas the kids had covered that [clicks her fingers] in two seconds flat.

Lucy: And yet, the kids had done that in, you know, your class had covered most of those concepts-

Corina: Yes, in the play session.

Kaila: In the play session, yeah.

The teachers then noted the same issue in relation to the DET syllabus document.

Lucy: - that were the ones that are in the [syllabus] document really too. [The students covered content] very quickly.

Kaila: Well that's it, the, the syllabus indicator is they can devise a test for deciding what is attracted to magnets and what magnets attract and that sort of thing. Well they covered that [clicks her fingers].

Lucy: Yes, in five minutes flat.

Corina: It's almost limiting.

Kaila then qualified the issue by noting that not all students were so fast in achieving particular scientific understandings - alluding to the ongoing nature of the educational process.

But then I've got my little group who still think that magnets will only stick to metals that are solid, not hollow. You know that's the one I still want to challenge.

Later in the conversation, Lachlan asked Corina to expand a little on a parallel she had earlier drawn between their learning as teachers and the model for student learning. The discussion that followed detailed how she was developing principled classroom practice from generative learning theory, and how she felt this was meeting the learning needs of a wide range of students.

Corina: Well norm-, what I suppose I felt I was trying to articulate was that normally [in professional development] we're provided with models and people will model to us, "This is what it looks like at this stage. This is what you expect the children to do." For example, reading recovery and it's very lock step. Whereas this [approach in DESCANT] was much more open ended and we were able to head into the project and make of it as, whatever we could. Basically, read the articles, understand it, have discussions about it and then attempt it in the classroom, go back and revisit the articles, refine it. We were basically generating our understanding of the articles, then we were testing it in the classroom, [with humour] the poor children, and then refining it and then retesting as we went along. It was like a parallel exactly to what was discussed or put forward in the generative learning process, in the theoretical papers and then what we were doing in the classroom was virtually a parallel modelling it with the children. That's what I found.

Lachlan: Mmm.

Lucy: And yeah.

Corina: Which was, what I was wondering if that was your underlying purpose? [laughs]

Kaila then expanded on Corina's point, noting the continuing process of extrapolating a practice from generative principles,

Kaila: Yeah, because I think the articles again gave you the process of the generative learning but they didn't give you any idea on how it would look in the classroom, and that's what we, and I still feel, I grapple with that. How much do we try and steer? How much do we allow the children to follow their own investigations? And that's why we started off so openly, 'cause we really didn't know, what it was meant to look like.

Like Corina said, so often we're told, "It will look like this," or "This is how you do it." And so, we're not, we're not used to that either. As we said to the children, they're not used to coming up with their own investigations. Well, we were doing exactly the same sort of *thing. So we were paralleling that model exactly. So, that, that was the hardest bit I think, is, "What do we mean? What will it look like in our classroom and did we do it right?" That's what you keep saying, "Is this right? Is this what we're meant to be doing?"*

Corina: Because we're so used to being told, This is what it will look like." It was like, well, "Are we doing it right?"

Kaila: Is this right or not?

Corina: Is this what we're supposed to have?

For Lucy, the answer to these questions lay in the comments made earlier regarding the speed by which students had surpassed the level of domain knowledge set as the end goal in resources books and through other indicators, including as set out in curriculum documents.

Lucy: But then that's that question again, do you think they- You answered that though. You said that you felt that they really learnt all those things in the first couple of minutes and that was, to me that was like, well yep.

Kaila: Well I even said-

Lucy: That's like the first six, eight pages from such and such and such and such in all those books that you can see.

Kaila: That's right.

Corina: Five weeks of learning and they've done it in an initial investigation.

Lucy: That's it. That's right. They really did do it. So I think that's the answer.

Kaila then introduced a very strong test of the adequacy of the approach they had developed for Science and Technology education:

Kaila: And I suppose my initial concern was, "Would it suit all children? Or, or, all the learners in the class?" And that's because I tend to have the lower stream. You sort of think, "Is this going to work in my room?" And it did, I mean it really did, and even those, in the end I said to the kids, after we'd done this for five or six weeks, I said, you know, "Who remembers how you normally do Science?" And I said, "Do you prefer what we've just been doing? And I told them we were doing something different, "Or do you like what you used to do?" And three said, "Oh, we liked it when we'd get given an experiment and told what to do and you sit down and you do it." But all the others said, "No we really love this." And even little ones that aren't normally so engaged with tasks, it got to the point where they were ready to go each week, and we knew what we were going to do, and we brought our materials in and we were organised. So I thought that was really valuable.

The Tallerack school-based collective articulate here an approach to Science and Technology learning. This approach afforded students the flexibility to drive their own learning and specify their level of investigation, whilst being closely supported by their teachers. Again, this approach resonated with the generative, learner focused approach to Science and Technology education that had dominated the intellectual terrain of the DESCANT colony.

Yet the Tallerack teachers made it very clear that they did not see themselves as *copying* a particular approach to Science and Technology in the classroom. Instead they described how they used the literature available to them through DESCANT, as a means to generate pedagogical approaches which could then be tested in the classroom. Corina articulated this collective pattern of operation succinctly:

> *Basically, read the articles, understand it, have discussions about it and then attempt it in the classroom, go back and revisit the articles, refine it. We were basically generating our understanding of the articles, then we were testing it in the classroom, [with*

humour] the poor children, and then refining it and then retesting as we went along. It was like a parallel exactly to what was discussed or put forward in the generative learning process, in the theoretical papers and then what we were doing in the classroom was virtually a parallel modelling it with the children.

This was a view that was shared by all three Tallerack teachers, who spoke throughout the discussion from a collective intent as a school-based professional development group. These teachers' frequent use of 'we' as a means of referencing their professional development endeavours was an indication that the Tallerack school-based group had developed a we-intentionality (Searle, 1995; Plotkin, 2003), an important theoretical conception underpinning collectivity and collective learning (see 1.2.3).

The collective understanding that is evident in this excerpt seems to have been developed at a school-based level through a generative process that resembled the classroom teaching approach itself. These teachers have been able not only to understand the fractal nature of the DESCANT strategy, whereby teachers and students undertake similar processes of (generative) learning. They have also been able to articulate it in words. Such deep understanding affirmed that they now held a conception of teacher learning as harmonising with student learning. Here in this collective was the project's core epistemology, an epistemology that had led initially to the choice of a musical acronym as its name: a descant line supplies harmony for the main melody.

It seems that this collective generative process, when coupled to pragmatic classroom experimentation, led to a strikingly similar collective understanding to that developed within the Pattonsvale school-based collective. Both groups note that this approach allows them to ensure the students' learning needs are being met, whilst also helping teachers understand what students already know. Furthermore, when enacted, these shared understandings appear to have encouraged a similar classroom culture in both school contexts, one in which students engaged deeply with investigations and simultaneously discussed findings with their peers.[158]

In the final excerpt below, Jack from Cohort 2 explains to the UTS collective (and Kerrie from Cohort 1) the manner in which his approach to Science and Technology education shifted as a result of DESCANT. Unlike the Pattonsvale and Tallerack teachers in the previous excerpts discussed in this chapter, Jack largely engaged with DESCANT as an individual participant rather than as part of a school-based group.

9.1.3 Excerpt 3: The final discussion with Cohort 2 participant Jack

During his final conversation, Jack discussed his previous interest in the potential of online learning environments for professional learning. He cited this curiosity as a central reason for joining DESCANT. Towards the end of the discussion, Lyn asked Jack directly how his conceptions of the project might now have changed. Jack began by discussing his early conceptions when approached by Gill, his regional Science and Technology consultant, to participate in DESCANT.

J: Yeah, it, it's changed from, see, at first as I say, I thought [the project]was very much a physical site thing and then, in talking further with Gillian over time as well she was- It's always wonderful to see excitement in others. Consultants are paid to be excited about things. It's the nature of the occupation, but there was a real depth of, depth of excitement I suppose. Gillian had the knowledge of where this was going and what it was going to pan out to be and that was infectious. She was assuring us that it's very much more looking at what goes on behind the scenes in our heads as teachers, the personalisation of our teaching. That, we all come to things from such, varied personal backgrounds, generational backgrounds, cultural and ethnic backgrounds even, and how might we

[158] Though a thorough description of the learning of Cohorts 1, 2 and 3 is not of immediate relevance here, there were other developments that occurred in Cohorts 2 and 3 that did not in Cohort 1 (and vice versa). For example, Cohort 1 teachers had struggled with how to encourage generative conversations between students, rather than just between a teacher and a student. It seems that these Phase 2 collectives had succeeded in supporting the growth of a collaborative intellectual culture through the approaches they had generated in their classrooms.

explore those differences, and bring them, bring those differences together, and work from those differences, as a point for strength. Rather than you know, we have teachers who will very much go at each other, "You're not doing this right!" and "I do this better than you!" and it's very strangely enough, competitive. I think teaching should be one of the least competitive occupations possible. We're all here for a not-for-profit sort of exercise.

As he continued to talk, Jack gradually incorporated his subsequent experiences into his early conceptions of the project as afforded through Gill,

But, this [project] was very much, "Let's share those differences and work from the differences as the point of origin." Rather than try and ignore the differences so that we don't offend each other, it was very much a different model and we were encouraged to explore those differences and to really focus on our underlying beliefs.

Jack began to note the challenge inherent in a model that values diversity, through the resulting expectation of sincere individual contribution to the wider group,

I had to sit back a couple of times and re-read emails and diary entries and stuff. And really try and fathom what was being asked of us. It wasn't a simplistic task, or a simplistic look at things, you know. Normally I'm able to jot off replies or answers to things that require a very small amount of brain power, you know. I'm doing three other things at the same time as I'm typing up a response to something, but this [project] made me sit back and go, "Geeze um, what do I actually think about this? How am I, how am I showing that, in my teaching? What am I doing in my teaching?" And I found great holes in my own teaching. In reflecting on what we were discussing in the environment. So I might continue on that, if you like?

Lachlan: Mmm.

Jack then shared a frank account of the manner in which the DESCANT process had influenced his classroom practice.

Jack: Looking at- I found, -I'm very confident in my own communication abilities and I take that into the classroom and into my interactions with kids. I'm able to process information and work mentally very, very quickly and I find that I'm not very tolerant sometimes of, of students who can't keep up with that. I'll lay out the instructions and deal with the feedback and that's that. You know? It's all, it's all been done and I'm, I'm twenty minutes ahead already. That's okay, in some learning environments but not in others and it made me really reflect on who are my clientele in this school at this time and how am I servicing them? Am I affecting their learning because of my own predisposition to wanting to teach in a particular style? Not uncommon I don't think. Teachers should be reflecting on that and do reflect on practice quite well sometimes. But, I found I was limiting my kids because I was correcting their mistakes immediately and not giving them time to, to think through their own mistakes.

Jack then related this specifically to the field of Science and Technology and Maths education, fields he believed had commonality in the manner in which domain knowledge was presented to learners:

This is an interesting one for Science and Technology and Maths. It's a, they're both subject areas where there are right and wrong answers. There are greys there of course but we're not dwelling in those grey areas. We, we go very much for the "Nah, that's wrong, this is right." There are x number of planets; they, they circle the sun in this rotation; and they do this that and the other. Electricity works in this way. Light isn't a particle; it's a wave. There are distinct, facts, I suppose. And it's in the, the transmission and the teaching of those facts that we don't explore them. We teach fact as fact; we don't teach fact as an area to be explored and for knowledge to evolve inside of.

Jack related this back to his own learning through the DESCANT project. In doing so, he acknowledged concerns that were still unresolved.

The most significant thing I've taken away from involvement in this project has been, "Just let 'em think it through for themselves." Don't go, "No, that's not right." Let them. And, *it's hard to say, how long can we give them, give the students to do this. You know, how long can you allow a student to dwell in a misconception before that misconception becomes fact, and embedded fact for them? And you're then, up against it to try and remove that misconception, um, remediate that misconception and give them the actual fact. That's a grey area still and one that I'll, I'll continue to work on as a teacher. But it's in that area that I think I've evolved as a teacher.*

In this excerpt, Jack admits that he was not content with superficiality within professional development. He was driven to articulate ideas about Science and Technology education that were *associated* with his classroom practice. In doing so he "found great holes in [his] own teaching". For instance, he notes:

> *…it made me really reflect on who are my clientele in this school at this time and how am I servicing them? Am I affecting their learning because of my own predisposition to wanting to teach in a particular style?...I found I was limiting my kids because I was correcting their mistakes immediately and not giving them time to, to think through their own mistakes.*

So, like the teachers in Excerpts 1 and 2 in this chapter, Jack appeared to be *testing* the intellectual terrain of the project within his classroom, that is, within an authentic educational context (or system). Jack noted that this testing led to a deepening understanding of the need to support learners to progress their understanding idiosyncratically, through their own investigative thinking.

In this regard, there are strong similarities between Jack's learning and that of the Pattonsvale and Tallerack school-based collectives. Whilst Jack's understanding is not associated *explicitly* with a collective in DESCANT, his committed *Cohort-based* pattern of operation during the project (see 6.1) provides the grounds to interpret this learning as a collective phenomenon.

Jack describes a more individualistic process of contributing to DESCANT than was evident in Excerpts 1 and 2 in this chapter. Without recourse to a school-based group to discuss his ideas, Jack contributed to the online discussions and activities from an individual position. Nevertheless, Jack found himself contributing from a deeper personal perspective than he was used to doing in professional development. He states:

> *Rather than try and ignore the differences so that we don't offend each other, it was very much a different model and we were encouraged to explore those differences and to really focus on our underlying beliefs…. [this] made me sit back and go,'Geeze um, what do I actually think about this? How am I, how am I showing that, in my teaching? What am I doing in my teaching?'*

It seems that the project's explicit recognition of the importance of *individual diversity* encouraged Jack's deep personal engagement. In a sense then, he appreciated that without genuine individual contributions the collective process may remain, "obtuse in the face of the greatest differences" (Latour, 2004, p. 86). In a political ecology sense, Jack seemed to be conceiving DESCANT's collective process as a means for the professional population to become *sensitised to difference*.[159]

The task for Jack, then, was not to *replicate* a specific population-level strategy for Science and Technology education, but rather to contribute to a (*generative*) collective process requiring authentic individual contributions.[160] Furthermore, it was in striving for his own,

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[159] As discussed in Chapter 2, a proposition's capability of *sensitising to difference* may be conceived as a measure of its value for collective learning (Latour, 2004). "Thus the dividing line does not pass between speech and reality through the fragile gulf of reference, as in the old polemical model of statements that are simply true or false, but between propositions capable of triggering arrangements that are sensitive to the smallest differences, and those that remain obtuse in the face of the greatest differences" (Latour, 2004, p. 86).

[160] The Cohort 1 teachers also recognized the importance of contributing their own ideas and opinions to the Cohort's online investigation, regardless of their lack of certainty or expertise (see 6.2). In the 1st Design Day Workshop, they articulated this understanding as a means of arguing for a design that encouraged participants to share any emergent ideas, rather than spending a long time editing and re editing contributions. Vaughan noted that too much private editing and personal reflection, without cohort contribution, "…would not facilitate the growth of what's happening and I think it's better that's what we have to have, the honesty in ourselves, that's what we think at the moment...you think about it, you prepare it, you post it, it's food for thought, it carries on, it grows. Then you can change it later on. Because often I think, people who've done it on the side they, they don't bother posting. It's not shared, it's important to share." This was an indication that

deeply *personal* articulation of professional knowledge that Jack seems to have become sensitised to the “great holes in [his] own teaching”.

Jack also seemed comfortable to maintain the collective strategies of exchange that underpinned the mini-culture of the DESCANT learning environment. He was, for instance, prepared to express professional uncertainty and maintain perplexity. With respect to supporting students to work through their own ways of understanding phenomena in ways that might differ from scientists’, he noted:

> *That’s a grey area still and one that I’ll, I’ll continue to work on as a teacher. But it’s in that area that I think I’ve evolved as a teacher.*

Thus Jack seemed unperturbed by his lack of certainty in this area, even though the professional development project was at an end. As an autonomous professional learner, he seemed confident in his ability to maintain a learning trajectory on the basis of his DESCANT experience.

So, Jack seemed to have succeeded in using the DESCANT Colony to drive his own professional learning. On one hand, he was an autonomous agent, articulating individual positions, selecting salient ideas and experimenting with them in his own local system. On the other hand, Jack appeared to *harmonise* his professional behaviour with the intellectual and social patterns dominant in the DESCANT system. This corresponds to a conception of professional learning that is self-organising (Maturana & Varela, 1987) yet also closely coupled to collective strategies, and nested within a wider learning system.

Here in Chapter 9, I set out to establish whether the learning of teacher collectives, as explained by their individual agents, may be understood as progression within a learning ecology. This analysis firstly required an understanding of what it was that teachers thought they had learned through DESCANT. In this regard, there were clear

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the Cohort 1 teachers, like Jack, perceived the importance of the collective process and the contributions of individuals in furthering collective endeavour.

commonalities in the learning that agents and collective agents alike drew from their DESCANT experience.

In particular, teachers and collectives appeared to have formulated their own learner-driven approaches to Science and Technology education in their classrooms. Within final discussions they described how these approaches had proven successful in encouraging active student participation whilst addressing diverse learning needs, including those required by syllabus documents. Across the various school-based sites, teachers described an enhanced capability for 'letting go' of some control during investigations and experimentation. This capability had apparently allowed members of the various school-based collectives to more adequately align their teaching with the dynamic requirements of their students.[161]

Yet whilst there was similarity in the emerging strategies of these various school-based groups, their approaches did not seem to have been copied from the DESCANT environment. Instead they appeared to have been developed through various blends of collaborative professional engagement and classroom experimentation supported by a growing appreciation of a variety of learning principles that may help explain any success or failure there. As such, these classroom solutions and the collective understandings that underpinned them may be interpreted as a dynamic attractor associated with professional learning in Science and Technology education.

In Chapter 6, a similar attractor was identified within *online* investigations in Phase 2. Now there was evidence of this same attractor existing at the level of school-based collectives and within individual professional practice in Science and Technology education.

In an ecological sense, this complex collective understanding could be conceived as a progression, or development, of the DESCANT learning system. Initially, Cohort 1 had *generated* and articulated their shared understandings. These understandings had then been

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[161] It is one of many key examples of foresight that, in their Introductory Workshop, Cohort 1 teachers had emphasised the need for understanding better how to 'let go of control' within Science and Technology education (see 6.1).

tested, both individually and collectively, in the classroom and elsewhere in the DESCANT system (for instance, through cohort-based discussion). Now a *regeneration*, or reformulation of the initial collective understanding appeared to have emerged, one that bore striking similarity across these school and cohort contexts.

The DESCANT Colony seemed to have succeeded in becoming a generative learning system. Moreover, this learning system could now confidently be described as including, not only the DESCANT Colony (where many ideas may have been generated), but also the school and classroom contexts in which collective understandings were being tested.

From a political ecology perspective the shared collective understanding established within this learning system, in all its complexity, diversity and uncertainty, may be conceived as a collective proposition, one that had emerged within, rather than been imposed upon, the DESCANT population. As such, this collective understanding held the possibility, when articulated, to establish a collective orientation relating to Science and Technology education, a "common world" (Latour, 2004) that was diverse yet also coherent across several school contexts.

Thus using a Learning Ecology analysis, it is possible to understand the learning of school-based teacher collectives as a progression or (re)generation of collective understanding within the DESCANT learning system. Yet the (collective) understandings discussed in this chapter, and gained through face-to-face conversations, were not easily accessible to future DESCANT participants.[162] Phase 2 participants would largely 'pass on', or articulate, their (collective) learning through their Culminating Tasks and through individual ratings (and comments) using the Colony's Recommender System. It was therefore through these design features that future DESCANT participants would engage with the intellectual and social terrain of the DESCANT learning ecology, as it existed at the end of Phase 2.

[162] To some extent, as already noted, future DESCANT participants could access parts of these discussions in order to understand the learning that took place in past cohorts. These final conversations were recorded and transcribed by the UTS Collective and teachers used them as the basis of their contribution to the Learning Legacy, a collaboratively developed text that described the learning journey of each cohort.

Already, in Chapters 7 and 8, I demonstrated the utility of a Learning Ecology interpretation in understanding how these environmental elements (that is, Culminating Tasks and the Recommender System) may contribute to intergenerational collective learning in DESCANT. In the following sections I examine whether and if so, how the learning of school-based collectives (as described above) may have contributed to the DESCANT network, interpreted here as a learning ecology.

9.2 Did these school-based collectives contribute to the DESCANT Colony, and if so, how?

In the previous section, I described an apparent attractor amidst the collective learning of individuals and school-based groups in Phase 2 of DESCANT. In final conversations, teachers had described a newly acquired appreciation of flexible, student-driven approaches to Science and Technology education. In particular, they described approaches that tuned teaching to the dynamic, moment-to-moment needs, interests and drives of learners (see 9.1). In some cases this appreciation was associated to the generative orientation, now dominant within the online DESCANT Colony (see 9.1.1 and 9.1.2).

Having described and analysed the learning of some school-based collectives, I now seek to establish how this localised collective learning may have contributed to the DESCANT learning ecology, in ways other than through cohort investigations and design. For this purpose, I examine one teacher's Culminating Task and some teachers' ratings/evaluations from Phase 2. Figure 9.2 locates the period in which participants undertook Culminating Tasks and ratings/evaluations in the DESCANT Phase 2 timeline.

<table>
<tr><th colspan="5">DESCANT Phase 2</th></tr>
<tr><td>Intro. workshop: Cohort 2 (1st intake)</td><td>Intro. Workshops: Cohort 2 (2^{nd} intake) & Cohort 3</td><td rowspan="2">Online immersion: DESCANT Colony (Full Cohort 2 & Cohort 3)</td><td>Participants Upload & Rate Culminating Tasks</td><td></td></tr>
<tr><td colspan="2">Online immersion: DESCANT Colony (Cohort 2: 1^{st} Intake)</td><td></td><td>Final School-based Conversations</td></tr>
<tr><td>29^{th} Mar +</td><td>1^{st} – 6^{th} June</td><td>June- July</td><td>Aug-Sept</td><td>Oct</td></tr>
<tr><td colspan="5">2005</td></tr>
</table>

Figure 9.2 Locating Culminating Tasks and ratings/evaluations in the DESCANT Phase 2 timeline.

Following their online immersion, Phase 2 participants were supported to create and upload their Culminating Tasks (as required by the Cohort 1 design, see 7.2). They were then encouraged to rate and evaluate the Culminating Tasks of other participants, including those of Cohort 1. Culminating tasks, ratings and evaluations thus provided an alternative source of data (beyond online investigations as in 8.2.1 and 8.2.2) by which to examine how the collective learning of school-based groups may have contributed to the DESCANT Colony, as a learning ecology. This analysis prepares for an investigation (in 9.2.3) of how the DESCANT Colony's Recommender System may have worked to represent the collective learning of school-based groups on its Learning Landscape (see 7.3.2).

9.2.1 Can a Culminating Task, as a contribution to the DESCANT learning ecology, incorporate the learning of school-based collectives?

Before analysing in detail a single Culminating Task, I describe how Phase 2 participants undertook this task.

The Culminating Tasks of school-based collectives

In accordance with Cohort 1's design specifications (see 7.2), Phase 2 teachers were required to create their own Culminating Tasks as a means of "passing on" their learning to future participants and allowing the environment to "evolve" (in the words of Katrina and Vaughan). This process was supported remotely by the Moderator Collective who provided technical assistance to teachers as they filmed, edited and uploaded their videos and texts to the DESCANT Colony. I took a leading role in providing this support. The Phase 2 population created twenty-one Culminating Tasks, eleven from Cohort 2 and ten from Cohort 3.[163] This represented a significant expansion of videos and texts available in the DESCANT Colony for investigating student and teacher learning in Science and Technology education.

[163] Of the eleven Cohort 2 Culminating Tasks, two were later removed from the DESCANT Colony by their creators. In explaining the reasons for his actions, Jack at Blackwood commented that the video had not adequately represented the learning of the students. He later wrote in the ratings section of the DESCANT Colony, "the [video] technology changes the pedagogy…our own video is an example of horrible teaching and learning."

As in Phase 1 (see 7.3.1), the Culminating Tasks developed by Phase 2 teachers had much in common, whilst also reflecting these teachers' diverse aims and concerns. Nearly all Phase 2 Culminating Tasks explicitly incorporated a professional concern for shifting away from teacher control, to a more student driven approach to Science and Technology education. Whilst in some cases this was associated with a generative orientation, in other cases this orientation towards learners was not explicitly grounded in any particular learning theory.

Some Culminating Tasks sought more adequately to represent the entire classroom context, just as Angela had done in her Birdhouses video and text (see 8.1). Others incorporated syllabus outcomes as a means of representing the aims of their classroom initiatives in Science and Technology education.

I now detail a Culminating Task, produced by a teacher associated with a school-based collective (described in 8.1), that illustrates a variety of the central features common to Phase 2 contributions. This Culminating Task was therefore able to illuminate how school-based collectives could contribute to the wider learning ecology in the DESCANT Colony.

A Phase 2 Culminating Task

The Accompanying Text of Corina's Culminating Task (from the Tallerack school-based collective) is reproduced here in full. Her video (titled Magnetic Forces) can be viewed online in the DESCANT Colony.

Magnetic forces
Corina

Introduction:

As many of the earlier cohort videos demonstrated design and make in the classroom, this video attempts to explore generative learning as applied to the process of investigation.

Introduction to the video footage:

The footage is taken very early in our class magnets unit. Two year 3 students attempt to demonstrate what they initially chose to investigate and then show how their investigations evolved. Later the students begin to articulate their knowledge.

Background:

The whole class were required to record what they knew about magnets before the unit began and what they wanted to learn. The responses were many and varied. The children were actually very interested and self-motivated throughout the unit. Each science session began with the children reflecting on their knowledge to date and rereading their notations in their Science Diaries. Before they began their investigations, they were required to identify an area they wanted to investigate. The children worked in pairs or groups of three and after each investigative session they were asked to record their changed or new knowledge and any questions for next time. The questions at the end of each session usually became the investigations for the new session.

The video:

I chose these two students for the video as they were one of the earlier groups to generate their own ideas to explore without specific teacher influence and direction.

These two students were particularly engaged and interested in their task. They were generating their first idea and then their tests evolved as they chose. While the investigation itself is fairly simplistic, the students were obviously functioning at this elementary level and required the time to investigate and therefore develop this essential magnetic knowledge before they could move on in their knowledge development.

Interesting ..... Possible Matters of Concern

Student Initiated Investigations: The students initially found the expectation that they would identify and create their own purpose for investigating very challenging. Their investigations did become more adventurous as their knowledge developed which was very pleasing.

Teacher Question: My real dilemma centred on how much input and metalanguage I should express and develop with the students to support their learning. This is one aspect I have not fully come to terms with and will need to develop further when I utilise this form of teaching again.

Through her accompanying text Corina makes it clear that her Culminating Task aims to expand the means by which generative learning is represented within the DESCANT Colony. She writes:

> *As many of the earlier cohort videos demonstrated design and make in the classroom, this video attempts to explore generative learning as applied to the process of investigation.*

Corina's Culminating Task was therefore a means of articulating the investigative stage of generative learning, as it occurred within her school-based context. Furthermore this Culminating Task can be considered a *learning ecology* that formed a web of associations between hybrid entities, as a means of articulating and collectively exploring generative learning (see 6.3.1).[164] This ecological association of entities included:

- A specific professional orientation (regarding "student initiated investigations");
- An authentic teaching context (a Year 3 investigation of magnetic forces);
- A specific instance of student initiated investigation (video excerpt);
- A theoretical interpretation of this learning (utilising generative theory);
- An expression of professional uncertainty (regarding the means by which to support student initiated investigation).

This complex proposition (in a political ecology sense) was found to have strong correspondence to the learning and intellectual orientation articulated by the Tallerack school-based collective during final conversations (see 8.1). In particular, Corina had

[164] Just how a Culminating Task may be interpreted in learning ecology terms was established in Chapter 6, using the Culminating Task of Sally as an example. For this reason, I do not describe in detail here the specific learning ecology that was articulated through Corina's Culminating Task. Instead my analysis focuses on the means by which this Culminating Task may have *articulated* the collective learning of the Tallerack school-based collective.

represented her school-based collective's theoretically-grounded efforts to afford students the flexibility to drive their own learning and specify their level of investigation, whilst being closely supported by their teachers (see 8.1 Excerpt 2).

It seems then, that Corina had successfully utilised her Culminating Task as a means of expressing, or representing (in a political ecology sense) the learning of her school-based collective to future DESCANT participants. The outcomes of their school-based experimentations (see 8.1) were now articulated for future participants as a complex proposition, embedded within the DESCANT Colony as video and text.

Yet the learning of the Tallerack group was not articulated by Corina as an isolated example of Science and Technology in their local school context. Rather her Culminating Task was contributed as a means of expanding the scope of the DESCANT Colony as a means of understanding generative learning. In doing so, Corina explicitly connected the learning of her school-based collective to that of the wider DESCANT collective.

In effect, Corina used her Culminating Task as a means of furthering a common world (in the political ecology sense) within the DESCANT Colony. Her proposition, as a candidate entity for the collective (Latour, 2004), explicitly associated the professional concerns, classroom experimentation, and shared learning of a local school-based collective with an expanding articulation of generative learning in Science and Technology education in the global DESCANT ecology.[165]

For Corina, this professional learning process still incorporated perplexity and professional uncertainty, just as it had for Cohort 1. She ends her Accompanying Text by articulating the central "teacher question" that had emerged from her DESCANT investigation:

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[165] The term *global* is used here to represent professional development initiatives that seek to enact systemic reform or 'best practice' across many schools and regions, thus incorporating the 'global' agendas of teacher educators, academics and other stakeholder groups associated with education (see 1.2.2). This global learning agenda was contrasted, in chapter 1, to the 'local' learning agenda of school-based groups and individual teachers (Barab, MaKinster & Scheckler, 2004).

My real dilemma centred on how much input and metalanguage I should express and develop with the students to support their learning. This is one aspect I have not fully come to terms with and will need to develop further when I utilise this form of teaching again.

Whilst Corina's professional concerns remained unresolved, her own DESCANT investigations appear to have consolidated a trajectory for future professional learning. Furthermore, given that her Tallerack colleagues shared her concerns regarding the best ways to support student-driven investigations (see 8.1), there seems some likelihood that this emergent question may be addressed as a school-based collective in the future.

So, Culminating Tasks were one means by which the collective learning of school-based groups (as indicated within final discussions see 8.1) contributed to the wider DESCANT learning ecology. In this sense, the Phase 2 Culminating Tasks became a means by which school-based collectives could articulate complex propositions (in the political ecology sense) to the wider DESCANT population, including future participants.

In some cases these complex propositions reinforced conceptions regarding student and teacher learning that had been articulated by other DESCANT participants, including Phase 1 teachers. In other cases, the Phase 2 population sought to expand the scope of the DESCANT Colony by forming complex propositions that included new entities, professional concerns and approaches. Nevertheless in contributing these Culminating Tasks, with an intention to expand the ongoing investigation of student and teacher learning, each school-based group may have helped establish a "common world" (Latour, 2004) within the DESCANT Colony.

In the following section I expand this analysis, by investigating if, and if so how teachers' ratings/evaluations of these Culminating Tasks may have provided another means by which school-based collectives could contribute to the wider learning ecology of DESCANT.

9.2.2 Can participant ratings and evaluations be interpreted as contributions to a learning ecology, and if so, how may they articulate the learning of school-based collectives?

Towards the end of their participation in DESCANT, Phase 2 teachers were encouraged to evaluate and rate the Culminating Tasks that had been uploaded to the DESCANT Colony. Cohort 1’s original e-learning design (see 7.2.1), asked teachers to gauge how helpful they found each video for understanding how children generate, test and regenerate their ideas. Yet, as noted in 7.2.1, four extra rating questions (see Appendix 2.2) were later added at the DET DESCANT Partners’ request. These partners believed that teachers should also interrogate the DESCANT videos for their clarity with respect to learning and teaching generally on the one hand, and paradigmatic Science and Technology as portrayed in syllabus documents on the other.

A Likert Scale allowed teachers to rate the extent to which each Culminating Task helped them understand these various dimensions of Science and Technology education. Teachers could choose from four options: 'Not at all', 'A little', 'Moderately' and 'A lot'. In addition, teachers were encouraged to contribute a brief explanation of each rating by comment. These ratings and evaluations were then available to the entire DESCANT population through the Comment Archive (see Appendix 2.2). This design meant that ratings and evaluation were not displayed in a cohort specific manner, as were the discussion forums.

I describe and analyse here a set of ratings/evaluations undertaken on Corina's Culminating Task (see previous section) in order to assess how this evaluation mechanism may have allowed school-based collectives to contribute to the wider DESCANT ecology.[166] The ratings/evaluations associated with this particular Culminating Task were selected as a means of maintaining continuity with the previous analysis.[167] I have chosen as the focus of

[166] The data example selected for this purpose was chosen so as to correspond with the previous analysis of Corina's culminating task (see 8.2.1). The example also demonstrated the manner in which other school-based participants (discussed in section 8.1) contributed to ratings and evaluations. However in this regard, many other examples could have been utilised, given the high levels of participation of these school-based teachers in rating and evaluations.

[167] The ratings/evaluations of other Culminating Tasks can be viewed for their differences and commonalities, online in the ‘Comment Archive’ section of the DESCANT Colony.

this analysis the three rating criteria that placed Corina's Culminating Task in the highest percentile band. By examining these three rating criteria, I can describe and analyse how school-based collective learning may have contributed to the collective valuing of this particular Culminating Task.

Children’s Testing of Ideas

Here, teachers’ ratings and evaluations (shown below) were in response to the following prompt:

> *List how students test their ideas in this video. How helpful are the video and accompanying material in making sense of the students' tests?*

Jack
Rating: A little

They test them in a singular method, through experimentation. What was the idea students were testing?

Marla
Rating: A lot

The students tested their idea by sweeping the bar magnet over the ball magnets, then covered the balls with paper and repeated, then covered the balls with a book and repeated the sweeping again.

Tom
Rating: Moderately

They had a clear process of testing and then developing more difficult tasks. They had planned quite well the process and they must have evaluated each activity before going on *to the next task. The teacher notes [the accompanying text] explained clearly why the children were doing the task and at what stage of the lesson it was representing.*

Caitlyn

Rating: Moderately

Good evidence of the children testing their ideas.

Hannah

Rating: Moderately

They conduct different experiments to test their theories.

Kaila

Rating: A lot

Students move from one idea to another and test as they go. They are curious about what happens when????....What if we ?????

In undertaking these ratings and evaluations, the six teachers expressed a range of opinions and professional discernments. Jack discerned a lack of clarity in the Culminating Task, regarding the intent behind the students' experimentation. This observation perhaps explains his low rating. Marla, on the other hand, gave the highest rating for this criterion, explaining where she discerned the students testing their ideas.

Kaila (of the Tallerack school-based collective) agreed with Marla that the video was useful for understanding how students tested their ideas. Her comments however were more in keeping with those of Tom, given their focus on the manner students seemed to drive the investigation through their testing. Yet Tom and Caitlyn (both of the Pattonsvale school-based collective) rated the video as moderately helpful for understanding student testing. In this regard, Tom describes how the students used testing to progress from one activity to another. Their rating was also shared by Hannah who, like Caitlyn and Tom, remains somewhat vague as to the details of the students' experiments.

On the basis of these ratings, the DESCANT Colony's recommender system placed Corina's Culminating Task in the highest percentile band for this criterion, relating to children's testing of ideas. Whilst teachers did not rate the video and text as highly for its clarity about children's generating and regenerating ideas, they did score it highly with regard to its clear depiction of 'investigating scientifically'.

<u>'Investigating Scientifically'</u>

Once again, a prompt was used to explain the basis for ratings/evaluations with respect to this criterion:

> *The K-6 Science and Technology document emphasises the importance of investigating scientifically. How helpful are the video and accompanying material in making sense of this?*

Jack

Rating: A little

...key issue here, what is the difference between investigation and experimentation? i don't think there is enough information in video or text to support an investigation.

Marla

Rating: A lot

The students used the concept of a fair test, changing only one variable (the density of the covering).This would constitute a fair test although they may not have done repeat testing to ensure the same results. The text is inconclusive about this, and I don't think the video stated it.

Tom

Rating: A lot

Clearly presented scientific investigation, even if it is not technically advanced it still demonstrates that they had thought about magnets and their effect on metal and the degree of interference that could be tolerated by paper. The video is essential in this demonstration.

Caitlyn

Rating: Moderately

Good investigations.

Hannah

Rating: Moderately

They looked like they were enjoying themselves.

Kaila

Rating: Moderately

Students are investigating systematically their ideas and progressing their ideas on their topic.

Once again, the teachers differed in their appreciation of Corina's Culminating Task. Jack was again sceptical of its value. This time he questioned its worth as a means of making sense of investigations in Science and Technology. Once again this was in strong contrast to the rating and evaluation of Marla. While Marla acknowledges the limitation of the video in representing the entire investigation, she discerns and describes where students undertook a fair test.

Like Marla, Tom gives Corina's Culminating Task the highest rating for its demonstration of this investigation. His school-based colleague, Caitlyn differs in this respect by giving the video a moderate rating. Whilst Caitlyn is vague in the reason for this rating, Hannah targets the dimension of student enjoyment in her evaluation. Whilst Kaila gave the same rating as Caitlyn and Hannah, she chose to focus on the manner in which students were driving their investigation.

Once again, on the basis of these ratings, the recommender system placed Corina's Culminating Task in the highest percentile band with regard to this particular criterion. These same teachers also rated Corina's video and text highly with regard to its focus on student learning in Science and Technology education.

‘Learning Science and Technology’

Whilst the ‘Learning Science and Technology’ rating criterion had been added by DET Partners subsequent to Cohort 1’s design, it was perhaps the closest in intent to the DESCANT Colony’s priority purpose (to progress participants’ understanding of student and teacher learning in Science and Technology education (see 7.2)). Here, participants were again given a prompt for their ratings/evaluations:

> *No doubt you will have been thinking about learning in Science and Technology. How helpful are the video and accompanying material for deepening these ideas?*

Jack

Rating: Moderately

There was a lot of silent, almost empty time in this video. Is this normal for the activity, or did the kids learn something about how the teacher wanted to film?

Marla

Rating: A lot

I liked the way the teacher let the children create their own investigations, and the fact that one investigation often led to further questions and investigations. This is surely scientific investigation at its most exciting.

Tom

Rating: A lot

It is quite clear that these children are testing and regenerating ideas and building on past experiences to develop further more challenging activities. I think it was very helpful to see them discussing ideas behind each activity.

Hannah

Rating: A little

The notes help a little.

Kaila

Rating: Moderately

The girls displayed curiosity about how magnets work and the video shows how they pursued their ideas, designing simple investigations that answered their questions about how magnets worked.

This third set of ratings and evaluations demonstrates a level of consistency with the comments of the six teachers. Jack again voiced a degree of scepticism regarding the ability of this video to represent student learning in Science and Technology education. Marla, on the other hand, again rates Corina's Culminating Task highly. In her written evaluation, she focuses on the manner in which it represented student-driven investigation and learning.

Tom again agrees with Marla's high appraisal. In describing the student learning that he discerned within the Culminating Task, he utilises generative terminology and also seemed to appreciate the student driven-nature of their learning. Tom's rating and evaluation is in contrast to those of Hannah, who appears to have gained little in the way of student learning from Corina's Culminating Task. On the other hand Kaila (like Marla and Tom) seems to focus on the manner in which the video represented a student-driven investigation.

In evaluating and rating Corina's Culminating Task, Phase 2 teachers articulated a range of observations, values and opinions. Of those who undertook these ratings/ evaluations, Jack was perhaps the most critical of Corina's Culminating Task. Across all three rating criteria, he questioned the value of Corina's video and text for making sense of the various dimensions of student learning in Science and Technology.

From a political ecology perspective it appears that, for Jack, Corina's Culminating Task was insufficient as a "reliable witness" (Latour, 2004) for representing these dimensions of Science and Technology education. In this regard, Jack's position may have reflected that of some Cohort 1 teachers, who questioned the validity of videos that did not incorporate classroom realism (see 7.1). Jack had already indicated an alignment with this position by contributing strongly to Angela's Birdhouses video, the only Cohort 1 Culminating Task to portray the investigation of an entire class (see 8.1.1). Now it seemed these values, which had been articulated at a cohort level (in both phases), were now influential in rating and evaluating a Phase 2 video showing learning at the micro level of individual students rather than at the macro level of whole classes.

In rating Corina's Culminating Task from this perspective Jack demonstrated (like Angela in Cohort 1) how a minority view could contribute to the wider DESCANT ecology. This is also emphasised in the individuality exhibited within ratings across all three of these criteria. In recording how Corina's Culminating Tasks had “Moderately” helped make sense of student investigation three teachers wrote:

"Good investigations" (Caitlyn)

"They looked like they were enjoying themselves." (Hannah)

"Students are investigating systematically their ideas and progressing their ideas on their topic." (Kaila)

Thus, even where ratings were identical, the teachers articulated a diverse range of explanations for these ratings. In this regard, school-based collectives did not seem cohesive in their ratings. Pattonsvale teachers clearly rated from an individual perspective, rather than as a school-based collective, as they had in cohort investigations (see 8.1.2).

Nevertheless, whilst school-based collectives were not found to be cohesive in their ratings, a pattern was evident regarding the focus on the student-driven dimension of Corina's Culminating Task. This focus was evident in many of the evaluations, for instance:

> *Students move from one idea to another and test as they go. They are curious about what happens when????....What if we ????? (Kaila)*

> *They had planned quite well the process and they must have evaluated each activity before going on to the next task. (Tom)*

> *Students are investigating systematically their ideas and progressing their ideas on their topic. (Kaila)*

> *I liked the way the teacher let the children create their own investigations, and the fact that one investigation often led to further questions and investigations. This is surely scientific investigation at its most exciting. (Marla)*

> *It is quite clear that these children are testing and regenerating ideas and building on past experiences to develop further more challenging activities.(Tom)*

The girls displayed curiosity about how magnets work and the video shows how they pursued their ideas, designing simple investigations that answered their questions about how magnets worked. (Kaila)

In each of these evaluations, the teachers discerned how students drove their own investigations by undertaking and evaluating their experiments with magnets. It appears that teachers considered this dimension of Corina's Culminating Task of high value for making sense of student learning in Science and Technology education, thus leading to a high overall rating across these three criteria.

This focus on student driven investigation appears to correspond with the pattern of school-based learning discerned in final conversations with Phase 2 participants (see 8.1.1). This pattern of collective learning (and the values that apparently underpinned it) was interpreted as an attractor emerging across the various school-based contexts, on the basis of classroom experimentation, cohort participation (although rare) and engagement with the ideas and values available in the DESCANT network. Moreover, in the previous section I established how this attractor appeared, at least in one instance, to have been articulated through a Culminating Task in Phase 2. These ratings/evaluations now seem to suggest that here at least, the same collective value was being applied as a basis for determining the worth of this Culminating Task. In this sense, these ratings/evaluations may have become one manner in which the shared or collective values of DESCANT participants (interpreted above as a school-based attractor) could have contributed to a population level selection regarding the worth of particular Culminating Tasks.[168]

Yet in this regard, the ratings/evaluations were also influenced by the constraints of the Recommender System and, in particular, the choice of rating criteria by which to judge the value of particular Culminating Tasks. For example, by undertaking evaluations of these Tasks' clarity with respect to children's tests of their ideas, teachers exhibited a willingness to utilise the generative heuristic as a means of structuring their observations of student

[168] As such, this could be associated with the tertiary level of the generative heuristic (see 3.2), where ideas and values are selected on the basis of shared or collective values (Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000).

learning, just as the GVC subgroup had done in Phase 1 (see 6.1). In doing so, these Phase 2 teachers established complex propositions (in the political ecology sense) that formed a web of associations between, for example:

- classroom videos;
- specific instances of student learning;
- *the 'test' step of the generative heuristic*; and
- their own observations as classroom teachers and DESCANT participants.

Moreover, this ecological interpretation of teacher contributions (as established in full in 6.1) provides a conceptual basis by which to analyse how these ratings/ evaluations may have allowed school-based collectives to contribute to the wider DESCANT ecology.[169]

In Chapter 8, I noted that school-based collectives in Phase 2 commonly chose to forego cohort-based contributions to the DESCANT Colony (see 8.1.2). Nevertheless here in the rating and evaluation section of the environment, these same teachers (for example Tom and Caitlyn of the Pattonsvale school-based collective) were articulating their observations and perceptions of student learning to the wider DESCANT population. Furthermore, whereas in cohort-based discussion, these teachers had often failed to engage (even experimentally) with a generative and learner-focused orientation (see 8.2), here their contributions utilised the generative heuristic as one means (amongst others) of discerning student learning.

These teachers also rated Corina's Culminating Task on the basis of the DET-related criteria, forming complex propositions (as discussed above) explicitly associated with Syllabus documents. Their contributions therefore worked to incorporate into the DESCANT Colony, conceptions of learning and teaching of Science and Technology

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[169] Having already established, in 6.1, how a learning ecology framework can make sense of contributions in this way, I do not expand upon this interpretation here, with regard to these Phase 2 contributions. Instead I co-opt this interpretation as a means of understanding how the learning of school-based collectives (whilst not articulated within cohort investigations) may have contributed to the wider DESCANT learning ecology.

salient to the wider educational network, and represented in DET syllabus and support documents.

Thus through Phase 2 ratings and evaluations, the political ecology of DESCANT was expanded to include complex propositions that formed associations between the values and understandings of:

- Individuals (for example, Marla and Jack articulate very different opinions regarding the evidence of student 'testing' in the video);
- school-based collectives (for example, Tallerack and Pattonsvale's concern regarding student-driven investigation); and
- an intergenerational intellectual orientation (for example, through the rating criteria which structured evaluations on the basis of the generative heuristic);
- the wider educational network (for example, through rating criteria framed specifically around the concerns of DET syllabuses and support documents.)

In this regard, the DESCANT Colony can be interpreted as an emerging common world that actively formed associations between various (nested) agents and entities as a means of articulating, with increased differentiation and sensitivity, matters of professional concern in Science and Technology education.

In a political ecology, "…reality grows to precisely the same extent as the work done to become sensitive to differences" (Latour, 2004, p. 86). In this sense, the collective learning of the DESCANT Colony can be considered to have progressed *through the work* undertaken by (for instance) the authors of Culminating Tasks (and the students within them), the teachers who discussed, rated and evaluated them, and the teacher designers who chose criteria for evaluating them. As discussed in previous sections, each of these forms of work was underpinned, to some extent, by collective learning, whether within school-based collectives or the cohort collective.

In this section and 8.2.2, I have described and analysed how the collective learning of school-based groups (as described in 8.1) was articulated through their Culminating Tasks and ratings/evaluations. This significantly extended the analysis of Chapter 7 which described and analysed how the collective learning of a cohort could be represented through a Culminating Task (see 7.3.2). In all these examples, I described complex propositions (in a political ecology sense) that incorporated the collective learning of teachers *as well as* various technological entities in the DESCANT Colony.

In the following section, I extend this analysis by examining the DESCANT recommender system (see Appendix 2.2) with the aim of describing and analysing how this technological component may have worked to represent professional learning in the DESCANT Colony. In particular I am interested in describing and analysing how the recommender system may have represented the learning and contributions of school-based collectives (as described in previous sections).

9.2.3 How may collective learning, including that of school-based collectives, be represented on the Learning Landscape as part of the DESCANT learning ecology?

As Culminating Tasks were rated, towards the end of Phase 2, the recommender system dynamically plotted each Task on the Learning Landscape according to their score (see Appendix 2.2). Thus by the end of Phase 2, the Learning Landscape depicted which Culminating Tasks (both from Phases 1 and 2) were currently rated highly by the DESCANT population with regard to each of the various criteria (detailed in the previous section).[170]

[170] The recommender system also calculated which Culminating Tasks were rated medium and low, depicting these also on the Learning Landscape.

A Learning Landscape

I now examine a Learning Landscape (see Figure 9.3), generated from the ratings of the entire DESCANT population.[171] The screenshot of this Learning Landscape indicates where Corina's Culminating Task (see 9.2.1) was currently located with regard to its clarity about children's tests of their ideas (see 9.2.2).[172] With a mean rating of 3.333, Corina's Culminating Task (see blue dot or 'trace') was situated in the 'High' rating category on that criterion.[173] Given the dynamic nature of the Learning Landscape, this location could change at any time as any cohort participant contributed a new rating.

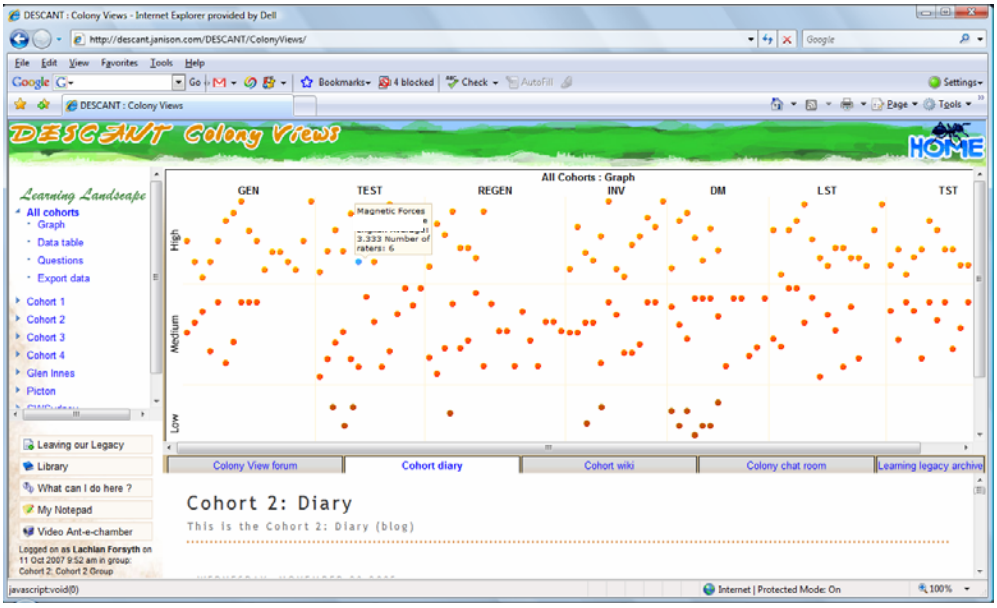

Figure 9.3 Phase 2 Ratings on the Learning Landscape

Figure 9.4 below shows the floating screen that would appear if a user clicked on Corina's Culminating Task on the Learning Landscape.

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[171] The Recommender System could also generate learning landscapes representing the ratings of a particular cohort (see Appendix 2.2).

[172] Whilst any Culminating Task could have been utilised as an example here, Corina's Culminating Task was chosen as a means of preserving some continuity with the analysis undertaken in previous sections of this chapter.

[173] Whilst Corina's Culminating Task was currently rated highly on this criterion, the information box states that only six people had undertaken ratings of this video and accompanying texts (see previous section). In contrast, the Culminating Task of Cohort 1 teacher Kerrie was located in the same region of the Learning Landscape, yet had been rated by 15 participants.

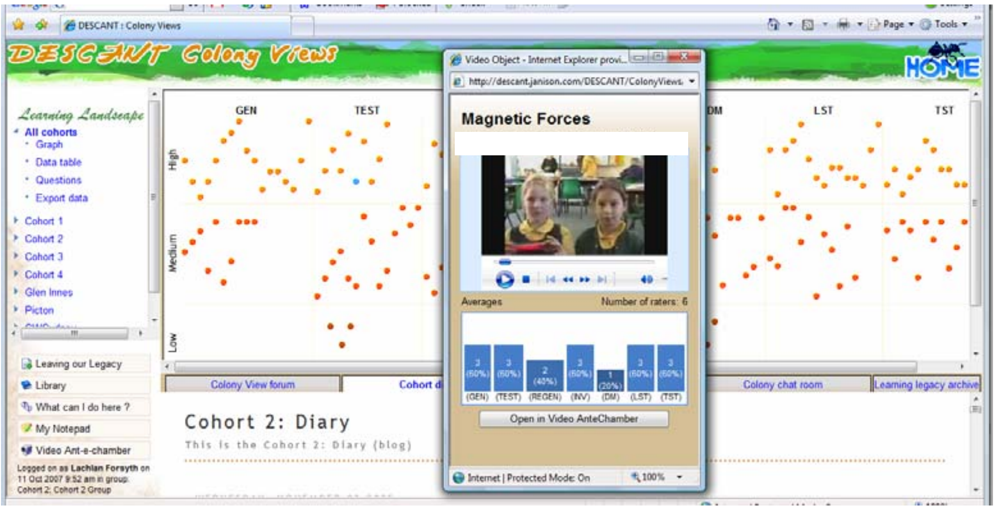

Figure 9.4 Floating Video Object: Corina's Culminating Task

This floating box details how Corina's Culminating Task was currently rated with respect to the other rating criteria. It also allows users to watch the video, whilst providing a link to the Video Ant-e-Chamber where teachers could undertake cohort-based investigation and discussion relating to this particular Culminating Task.

Once again, the learning ecology framework can be used to describe and analyse this data. In a political ecology sense, the Learning Landscape articulated a complex proposition that, essentially, sought to sensitise the DESCANT population to collective patterns in the DESCANT Colony. In order to achieve this, the Learning Landscape formed a web of associations between various entities, including:

- The testing stage of learning within the generative heuristic;
- Corina's Culminating Task (see 9.2.1);
- a graphic representation which showed that Corina's Culminating Task was rated as *High* for helping viewers discern and understand children's testing of their ideas, as portrayed in generative learning theory;
- the 'High' value region of the Learning Landscape, incorporating mean ratings over 3;
- the individual ratings of Corina's Culminating Task (see 9.2.2);
- the algorithm underpinning the software's Recommender System;

- the six other criteria by which this Culminating Task had been valued;
- the Video Ant-e-Chamber, where participants could access other complex propositions through, for example, cohort investigations (see Chapters 7 and 8) and Culminating Task evaluations (see 9.2.2)

Some of these entities have already been interpreted as complex propositions, underpinned by individual and collective learning (for example, participant Culminating Tasks, see 7.2.1 and 9.2.1 and ratings/ evaluations, see 9.2.2). Now the Recommender System had essentially translated these complex propositions, *including the (collective) learning that underpinned them*, into entities as a means of representing collective patterns in the DESCANT population.

The Recommender System may thus be considered a means of sensitising the DESCANT population to collective patterns associated with individual and collective understandings, values and practices being articulated in the DESCANT Colony. In a political ecology sense, these collective patterns may be understood as a (democratic) representation of the collective intelligence (Surowiecki, 2004) of the DESCANT population, afforded through the instrumentation of the Recommender System. In this view, the technologically articulated proposition (as detailed above) provided a means by which the DESCANT network could become 'sensitive to difference' regarding the collective intelligence of its population. In this regard Latour (2004, p. 86) notes that in a political ecology:

> *…reality grows to precisely the same extent as the work done to become sensitive to differences. The more instruments proliferate, the more the arrangement is artificial, the more capable we become of registering worlds.*

In this way, the DESCANT Recommender System may give representation to agents or entities that might otherwise remain inarticulate or mute within collective learning (Latour, 2004). Having gained representation through the Learning Landscape, the collective intelligence of the DESCANT population had the potential to become an entity within other complex propositions being articulated in the DESCANT Colony. That is, this collective intelligence could become a political entity, involved in progressing, or 'evolving' (in Vaughan's words) the DESCANT network as a learning ecology. In the words of Latour (2004, p. 250) this collective intelligence (as represented on the Learning Landscape) could 'speak' as a "Reliable Witness":

> *…capable of testing the faithfulness of representations, in the knowledge that the distribution between what speaks and what does not speak is no longer definitive…*

In this view, Corina's Culminating Task along with the other Culminating Tasks whether they are associated with the same 'high' value region of the Learning Landscape or with the medium or low value regions, may be considered (on the basis of collective intelligence) "reliable witness[es]" (Latour, 2004) for their ability to sensitise the DESCANT population to specific dimensions of Science and Technology education, in this case, student 'testing', scientific 'investigations' and student 'learning' in Science and Technology education (see 9.2.2). In a political ecology, this faithfulness is not considered an objective measure. Instead it remains closely coupled to the shifting collective intelligence of the DESCANT network as articulated through the dynamic Learning Landscape.

9.3 Answering Chapter 9's Research Question: an analytical summary

Through the analysis documented in this chapter, I sought to investigate whether the learning of local, school-based collectives could contribute to the DESCANT learning ecology, even where these collectives had not participated in cohort-based investigation (as detailed in the previous chapter).

Based on this analysis, it appears that individual Phase 2 participants represented (in the political ecology sense) the collective learning of their school-based contexts through Culminating Tasks, and ratings/evaluations. This did not negate the strong individual contributions made by these teachers. Through their Culminating Tasks and ratings/evaluations, Phase 2 participants were found to articulate a wide range of concerns, values and understandings through the complex propositions that they articulated to the DESCANT Colony.

Yet, whilst these contributions typically incorporated the unique perspectives of these individuals as teaching professionals, they also were found to form complex associations between, for instance, the collective learning of Cohort 1, as well as the values and understandings of the UTS and DET collectives. The analysis thus described a complex interdependency between various contexts for collective learning.

For example, perhaps the ratings/evaluations of the Tallerack and Pattonsvale school-based collectives (see 9.2.2) may have been influenced by their shared focus on student-driven investigations (see 9.1.1 and 9.1.2).[174] If this was the case, then patterns of school-based collective learning may have contributed to the current shape of the Learning Landscape (9.2.3) as a representation of the collective intelligence (Surowiecki, 2004) of the DESCANT network.

Thus given the apparent interconnection of the various parts of the DESCANT network (as described in this chapter), any self-organising change within the various nested learning ecologies (whether deriving from cohort, school-based or population-level collectivity, as detailed above) may potentially ripple through the DESCANT system. Furthermore, the Recommender System and the Learning Landscape appeared to provide a mechanism for translating and articulating any such self-organised change with respect to the learning of the population.

[174] In this respect, it is likely that individual ratings still maintained a strong degree of variation, especially where participants were not part of a cohesive school-based collective (for example Marla, see 8.2.2).

Chapter 10
An Analytical Summary
From Collectivity to Systemic Renewal: Making sense of this study's findings as an Adaptive Landscape

In Chapter 1, I described an emerging zeitgeist concerning networked collectivity, and interrogated some contemporary approaches to professional learning in education for the extent of their resonance with that zeitgeist. My review supported the potential of Web-based networks for establishing participatory *learning systems* that were capable of supporting professional learning across adaptive nested levels of an education system (Snyder & Wenger, 2004; Bentley, 2003; Laszlo, 2003; Banathy, 2000). Yet I concluded that a need remained for empirical accounts of professional renewal that more adequately represented the nested complexity of novel, networked learning ecologies. For educational researchers, this represented an ethical, theoretical and pragmatic challenge, one that necessarily addressed the relationship between local and global dimensions of teacher professionalisation and systemic renewal in education.

I then laid out in detail, in Chapters 2, 3, 4 and 5, the precise nature of the ethical, theoretical and pragmatic challenges to be addressed if professional learning contexts are to support teachers' collective learning. In a study designed on these methodological foundations, hedging the possibility that collective learning would occur, it was then possible for me to examine cohorts of teachers' learning – in this case, within the particular context of their professional development in K-6 Science and Technology.

In Chapters 6, 7, 8 and 9, I described and analysed that learning to see if an ecological framework, informed by complexity thinking and political ecology (Latour, 2004) could make sense of what occurred. I was able to identify associations and relationships between learning at different levels in the DESCANT project's professional network, uncovering evidence that collective understandings, strategies and values (including those incorporated into environmental design) appeared to influence development and learning across the network.

The analysis thus revealed collective professional learning in DESCANT to be a multifaceted learning ecology. Yet this analysis fell short of integrating the various parts of this learning ecology into a unified empirical account of collective learning in DESCANT. In particular, there remained a need to address the relationship between local and global dimensions of participatory, community-based professional learning in DESCANT.

In this chapter, I respond to this need. In Sections 10.1 to 10.4, I revisit my study's findings, articulating the relationship between distributed and local sites of collective learning across the nested and coupled DESCANT network. In doing so, I speculatively propose the utility of the metaphor of an adaptive landscape (after Wright, 1931) for understanding interrelationships between the various types of collective learning, including patterns of collective investigation, operation, interaction and design.

10.1 Phase 1: Cohort 1 teachers' investigation

During their online immersion in Phase 1, participants critically investigated a range of professional strategies (through exploring ideas, values, understandings, and practices) for Science and Technology education (see Chapter 6). The propensity for collective exploration in this period was found to vary greatly both within and across the study's numerous subpopulations, as participants navigated the ecological affordances and constraints of the GVC (see 6.1) and the Webboard (see 6.2).

Cohort 1's exploration of student learning in Science and Technology was considerably expanded by a small subgroup of teachers who worked to develop *complex propositions* (Latour, 2004) within the structured, theory-laden GVC environment (See 6.1.1). These propositions suggested (or *articulated*) ways the Cohort might discern specific instances of student learning in Science and Technology; and they modelled evidence-based patterns of collective interaction (that is, *social* collective strategies) for professional knowledge building, in particular in making sense of students' Science and Technology learning (See 6.1.1).

These learner-focused propositions represented a significant shift from the teacher-focused representations of Science and Technology education being articulated by the majority of Cohort 1 participants during initial online discussion (See 6.2.1).[175] In exploring conceptions of student learning, the *specificity* and range of the GVC contributions (as ecological propositions) contrasted with the more general, anecdotal strategies for professional interaction more common in other teachers' online conversations (See 6.2.1).

So, focusing deeply, almost forensically, on student learning through a specific theoretical lens in the GVC, may have represented a novel adaptive orientation for this subgroup of teachers. Furthermore, this learner-focused orientation was underpinned (as was the teacher-focused orientation) by a complex (political) ecology of interrelated strategies.

10.1.1 An Initial Adaptive Landscape

I now propose that the *adaptive landscape* (after Wright, 1931) offers a potentially fertile metaphor for understanding this collective learning across a nested and coupled population. An adaptive landscape is a *selective surface* of peaks and valleys, a terrain that visually represents the fitness (in biological terms) of various combinations of interdependent strategies in a population.[176] Each peak on the adaptive landscape represents a combination of high fitness, with each valley representing a combination of lower fitness. Forces of selection, in this view, "…should act to push populations to the top of the peaks and frustrate the movement across valleys from one peak to another" (Cockburn, 1991, p. 75).

I can depict DESCANT's initial online immersion period (Phase 1) as an adaptive landscape (see Figure 10.1) that consists of two fitness peaks, each an orientation for addressing student learning in Science and Technology education.

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[175] This teacher-focused orientation associated student learning with a complex web of interrelated classroom strategies involving (amongst other things) classroom management, learning objectives and small-group activities (see 6.2.1).

[176] In its original form, these strategies relate to the fitness of various combinations of genes in a population (Wright, 1931). Nevertheless, the adaptive landscape model has since been successfully adapted to other fields, by substituting the fitness contribution of other entities such as Balinese water temples (Lansing, 2003).

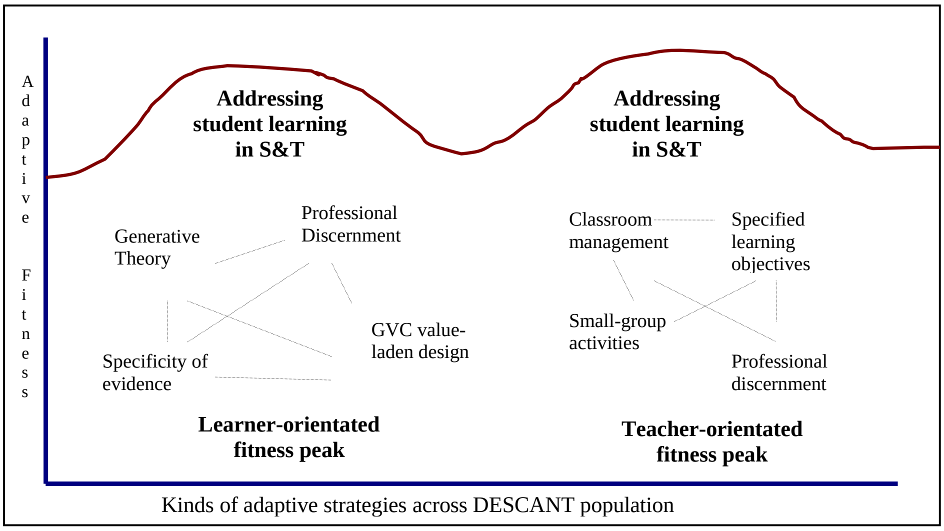

Figure 10.1. Early Phase 1 online immersion period: Two fitness peaks. This adaptive landscape depicts two fitness peaks, each representing one of the orientations discerned in the initial stages of DESCANT. Each fitness peak is underpinned by a hybrid combination of adaptive strategies (only a few of which are represented here). That is, taken together, these adaptive strategies can be considered as a particular *orientation* to addressing student learning in Science and Technology (S&T) education. In the early stages of DESCANT, the learner-orientated fitness peak (on the left) was associated with the UTS collective and the GVC e-learning environment (designed on generative learning principles). In contrast, the Phase 1 teacher population was closely associated with a teacher orientation, depicted as the fitness peak on the right. Whilst more members of the DESCANT population exhibited teacher-orientated strategies in this initial part of the project, the learner-orientated strategies were represented strongly through the GVC environment. From a political ecology perspective, both orientations were therefore represented strongly in this initial period -- thus the equal height of each fitness peak.

This view essentially reconfigures the learning ecology as part of an adaptive landscape. Rather than conceiving interrelated genes contributing to overall fitness in a population (after Wright 1931), I describe here a political ecology of interrelated strategies contributing to an overall fitness in a collective. This fitness relates to an increased capability to collectively make sense of student learning in Science and Technology education. Thus each fitness peak is underpinned by a complex and interconnected set of adaptive strategies, including ideas, understandings, social behaviours, values and practices.

The GVC contributions of this subgroup may therefore be interpreted as an experimental break from an *existing* fitness peak (or collective orientation) concerning how best to address student learning in Science and Technology education. In this regard, the GVC provided a *niche* that supported professional strategies associated with the learner-orientated fitness peak. In this view, the structured design of the GVC acted as a selective force that accommodated particular strategies and constrained (Gibson, 1979) others (see 6.1.2). The GVC essentially represented (in a political ecology sense) the collective learning, or fitness peak, of the UTS collective (a fitness peak that, in DESCANT, could be associated with the 'global' professional development agenda of this academic collective.)[177] Thus, when the small subgroup of Cohort 1 teachers navigated the (selective) terrain of the GVC collectively they were required to reshape their strategic responses to Science and Technology learning radically in order to adapt, that is, in order to operate collectively in this environment.

This did not require the GVC subgroup to select these strategies permanently. After all, the GVC was a learning environment with very different selective forces from the school-based environment in which these teachers operated every day. Nevertheless, their successful operation of the GVC allowed them to *explore* strategies for Science and Technology education associated with a fitness peak quite distinct from the one to which they were accustomed. In doing so, this subgroup of teachers may have changed their own prior relationships to student learning in Science and Technology.[178]

10.1.2 Traversing the Valley: population shifts on an adaptive landscape

In population ecology, the adaptive landscape model has been used to infer that natural drift, in combination with selection, may drive evolutionary change (Wright, 1931). According to this view, when populations become separated, the decrease in variation acts to inhibit selection thus allowing previously untenable (gene) combinations to survive. This then allows a population to explore new possibilities and hence *traverse* valleys on the

[177] For the UTS subgroup (See 4.2.1 Moderator Collective) focusing collectively on student learning in a highly theoretical and evidence-based manner represented a pre-DESCANT fitness peak for professional learning in Science and Technology education. It was an orientation arrived at through empirical research trials and informal experimentation over many years. Within the DESCANT network, this orientation can therefore be associated with a systemic or global reform agenda in the education system (see 1.2.3). The principled design of the GVC, as an e-learning environment or niche, supported this fitness peak.

[178] From an ecological standpoint, this dynamic can be understood as an example of self organisation undertaken by a collective agent as a means of preserving an adaptive coupling with an environment (Maturana & Varela, 1987). In this sense, the GVC subgroup may have expanded their professional repertoire of adaptive strategies (and thus their capability for adaptive self organisation in Science and Technology education) through their experiential history (that is, their history of structural coupling) in this e-learning environment.

adaptive landscape. If new variants lead to enhanced fitness for a population, that population begins to climb another peak on the terrain. Evolution can therefore be understood as a shift from one fitness peak to another (Wright, 1931). Furthermore, it is natural drift that permits an *exploration of adaptive space*, by providing a mechanism for the retention of new variants.

Metaphorically then, the GVC subgroup may be conceived as experimentally *traversing the valley* between the fitness peak supported by the GVC environment and the existing fitness peak of the Cohort 1 population (as depicted in Figure 10.1). In doing so, they articulated propositions (in a political ecology sense) that were a *displacement of point of view* (Latour, 2004) to their cohort population (see 6.1.2).

The majority of Cohort 1 teachers did not however traverse this valley in any collective sense during the online GVC immersion. Despite repeated invitations and encouragement from the Moderator collective, most Cohort 1 teachers did not contribute within the GVC environment. Instead, some appeared to consolidate their existing orientation or fitness peak, by questioning the value of the GVC for professional learning on the grounds that it lacked 'classroom realism' (See 7.1.1).[179]

On an adaptive landscape, this consolidation may be expected within situations where selective forces are strong, thus acting "… to push populations to the top of the peaks and frustrate the movement across valleys from one peak to another" (Cockburn, 1991, p. 75). In this case, these teachers' intimate knowledge of the interrelated *local* constraints of their school and classroom environments may have acted as a selective force that prevented them traversing the valley to a new fitness peak, or even experimenting with such a movement. For these teachers, the various school-related strategies underpinning their existing orientation for addressing student learning (in Science and Technology education) were not represented adequately in this novel learner orientation. I can depict this dynamic on the adaptive landscape as in Figure 10.2.

[179] Through this critique of the GVC (see 7.1.1), the Cohort 1 teachers essentially questioned the fitness contribution (in biological terms) of the various adaptive strategies that underpinned a learner-focused orientation and fitness peak.

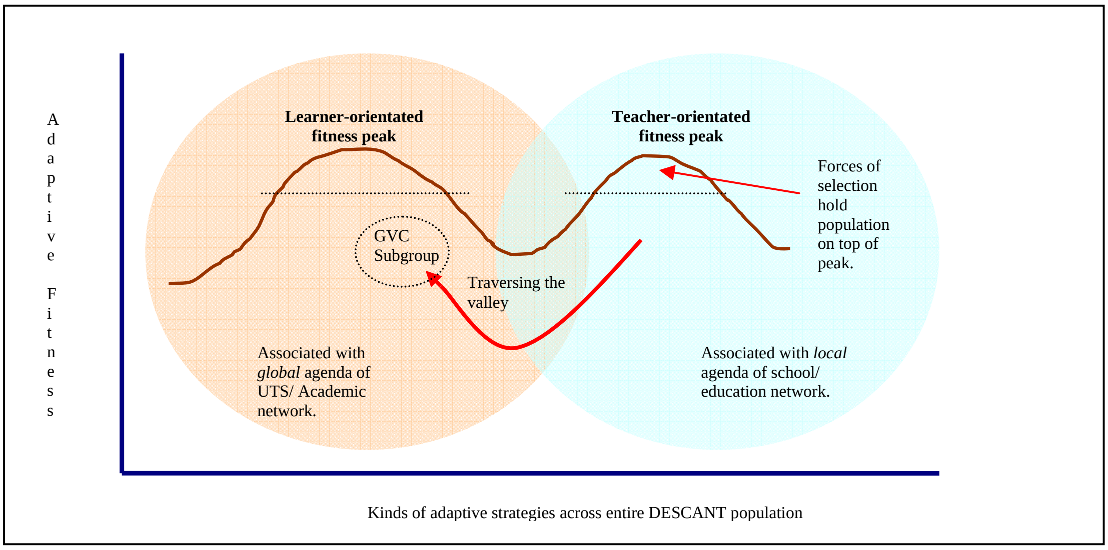

Figure 10.2 Traversing the valley. As the GVC subgroup collectively engages with the learner-focused orientation (in the GVC), they experiment with novel professional strategies (associated with the global agenda of the UTS collective). This shift in strategic orientation may be depicted as traversing the valley of an adaptive landscape, towards a new fitness peak. On the other hand, where novel strategies are rejected on the basis of strong forces of selection, such as those operating within local school contexts, teachers may remain wedded to their initial fitness peak.

Evidence of teachers' collective investigation in the Webboard, the second e-learning environment in Phase 1, supported this analysis. In the Webboard, Cohort 1 teachers were afforded much greater latitude in exploring and evaluating their existing strategies (ideas, theories, understandings and practices) relating to Science and Technology education (see 4.2). Initially, these strategies were characterised by a teacher or classroom-based orientation, even when teachers were discussing student learning (see 4.2.1 Excerpt 1). In this respect, the group's collective values may have reflected the pragmatic and managerial strategies commonly ascribed to time-stretched teachers as they deal with challenging content and pedagogy in Science and Technology education (Appleton, 2003; Gomez, Fishman, and Pea, 1998).

Perhaps this strategic orientation had proven successful for these teachers in the past as they balanced the demands, logistics and constraints of their shared school and classroom environments. A teacher or classroom orientation (as distinct from a learner orientation) may well have been the *result of selection across a distributed population*.[180] From this perspective, the learner focused orientation being advocated by the GVC collective may have been considered untenable within the current constraints of the education system.

Yet, judging by the Cohort 1 teachers' strong engagement with DESCANT as a professional learning context, they clearly aimed to reach new levels of fitness. With the support of the Moderator Collective, they undertook a robust exploration of their existing strategies for addressing student (and increasingly teacher) learning in Science and Technology education. Participants shared and evaluated diverse ideas, understandings and practices which had been developed and tested over years of professional experience in the classroom and elsewhere (see 6.2 Excerpt 4).

Teachers also discussed and evaluated the existing strategies of the Moderator collective. They discerned commonality and difference with respect to their own understandings of learning (for example, regarding learning as a process of selection, see 4.2 Excerpt 4: Moderator Collective). This investigation included a collective exploration of the propositions being articulated by the UTS collective, who described learning as a value-based, generative process (after Edelman, 1992, Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000).[181]

On the Webboard as they explored potentially adaptive strategies, Cohort 1 teachers *expanded* the variation of ideas, understandings and values available to the entire DESCANT population, including the Moderator collective and its subsidiary DET and UTS collectives. For instance, they articulated alternative models of learning and teaching that represented a *displacement of point of view* (Latour, 2004) from the perspective of the UTS collective (See 4.2 Excerpt 5: Cohort Collective). In doing so, they commonly articulated these strategies with reference to their collective experience as educators and the selective forces of their shared school culture. At other times the complex propositions being

[180] Similarly, a generative theory of learning conceives that ideas and behaviours may be tested on the basis of shared or collective values in a culture (Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000).
[181] In Phase 1 the *articulation* (Latour, 2004) of this generative orientation was extended by the GVC e-learning environment.

articulated by teachers and moderators alike, represented distinctive re-combinations of both viewpoints (See 4.2 Excerpt 2 and 4.2 Excerpt 4: Moderator Collective).

Collective investigation in the Webboard can therefore be characterised as a dynamic and creative tension between the two fitness peaks (of a learner-orientation and teacher-orientation) discussed previously. Each of these fitness peaks, when articulated through their respective collective propositions, represented valuable adaptive strategies for addressing student (and teacher) learning in Science and Technology education within the context of this study.

10.1.3 DESCANT's Emerging Culture: utilising uncertainty for transformative learning

As Phase 1 progressed, the online population (both teachers and moderators) explored professional strategies that incorporated a blend of the two orientations being articulated in DESCANT: the teacher-focused orientation and learner-focused orientation (depicted in Figure 10.1 above, as two fitness peaks). The integration of these perspectives into a *common world* (Latour, 2004) was not, however, unproblematic. The DESCANT network thus became characterised by authentic uncertainty and perplexity.

Nevertheless, perhaps in response to this instability, a "mini-culture" (Wenger, McDermott and Snyder, 2002. p. 39) emerged in which participants enacted powerful professional *strategies of exchange* such as expressing professional uncertainty and sharing emerging and tentative ideas (See 4.2, Excerpt 4 Cohort Collective and Excerpt 5, Moderator Collective). These strategies appeared to promote the discussion of ideas that were neither optimum nor even fully formed.[182] Yet within the *bounded* DESCANT network, these emerging ideas were buffered to some extent from the selective forces and constraints of surrounding educational and academic networks. Thus, it seems emerging strategies were given an opportunity to become stepping stones towards more optimum professional

[182] The Cohort 1 designers seemed to recognize this generative potential of bounded groups, conceiving them as a means of controlling or regulating the network (see 7.2.1). In this sense, the bounded group provided a means of limiting competition within the network: a mechanism that facilitates exploration within an adaptive landscape by reducing the capacity of selective forces to cull variants (Wright, 1931). One participant described this buffered exploratory dynamic as a professional "sabbatical" (see Appendix 1.4).

strategies: ones that integrated teacher and learner orientations, thus helping *establish a common world*.[183]

So, far from impeding collective exploration regarding Science and Technology education, the instability of the DESCANT network appeared to generate even greater variance in the ideas and behaviours of the Phase 1 population. [184] In this regard however, the adaptive landscape model predicts that *increased* variation, when combined with strong forces of selection, may simply act to push populations to consolidate their existing fitness peak.[185] In DESCANT, however, *transformative* professional learning required a shift away from current fitness peaks. Thus something more than a pooling of diverse strategies may have been required for effective collective exploration to occur.

According to the adaptive landscape model, when populations become separated, selection is weakened thus allowing previously untenable (gene) combinations to survive. This then allows a population to explore new possibilities and hence *traverse* valleys. The bounded structure of DESCANT may have buffered novel strategies from the selective forces of the surrounding education system. This may have provided the somewhat sheltered conditions required for DESCANT's mini-culture to emerge, by preventing emergent and newly formed ideas from being selected against prematurely.

So, the society and culture of the DESCANT network may have assisted the entire DESCANT population to *traverse the valley* between fitness peaks by allowing them to "maintain perplexity" (Latour, 2004) and strive towards a new collective understanding, or fitness peak. Importantly, this was no longer a population-level movement towards one of the existing fitness peaks (as depicted in Figure 10.2). Instead, the entire DESCANT

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[183] This integration was most evident in the articulation of *complex propositions* (Latour, 2004) that incorporated a learner focus on an engagement together with the constraints of classroom practice.

[184] Thelen (2005, p. 264) describes this process from a complexity perspective stating, "It is a tenet of dynamic systems that they must lose stability to shift from one stable mode to another (attractor states). When patterns are very stable, there are no opportunities to explore and reassemble new solutions." Similarly, in political ecology it is necessary for a collective to maintain perplexity in order to discern what needs to be 'taken into account' in order to establish the common world (Latour, 2004).

[185] For instance, whilst variation may lead to an increase in the height of an existing fitness peak, strong forces of selection (by frustrating exploration into a fitness valley) may mean that the development of novel adaptive strategies occurs only on this local peak (Wright 1931).

population might be seen to be traversing a new valley towards a third fitness peak, one that established a common world from the two prior orientations. I can depict this dynamic on the adaptive landscape three dimensionally, as in Figure 10.3.

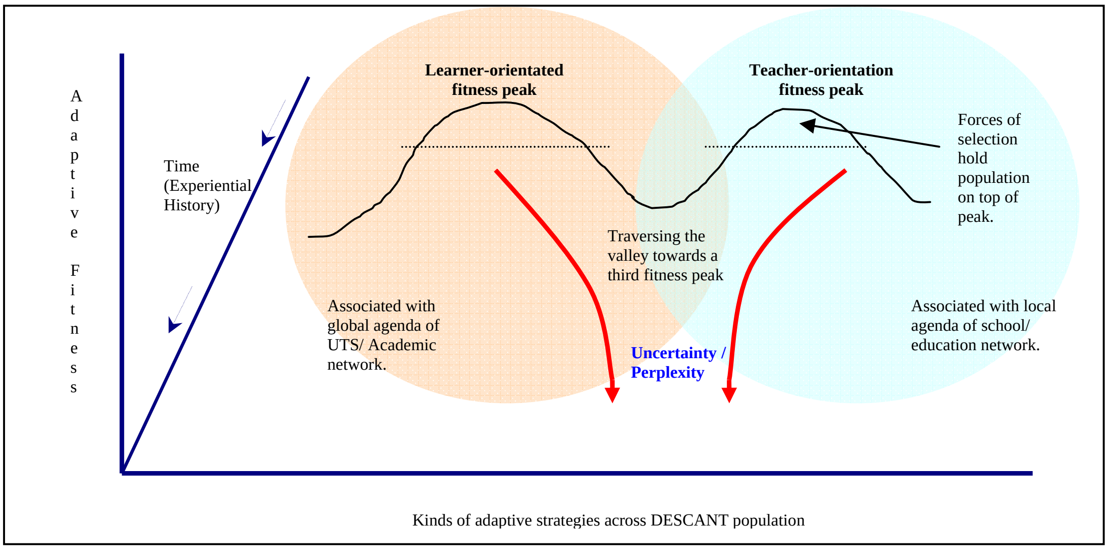

Figure 10.3: Traversing a new valley towards a third fitness peak. The emergent mini-culture of the DESCANT network (which 'maintained perplexity' after Latour, 2004) assisted the DESCANT population to traverse a new valley towards a third fitness peak that integrates the teacher and learner orientations. By incorporating a third axis (Time), I can depict this population level shift as a movement away from the previous fitness peaks (see red arrows). This movement across the new valley towards a third fitness peak is supported where selective forces are weak, for instance, by the boundedness of the DESCANT network. This permits novel strategies to survive even when they may not be optimum in their initial form: that is, when they are emerging ideas and strategies.

Here in 10.1, I have used the adaptive landscape model to make speculative sense of collective investigation in Phase 1 DESANT. This analytical approach foregrounds the local and global dimensions of professional learning early in the project. Moreover, it provides a means of discerning how these two dimensions were negotiated, and increasingly integrated, within the DESCANT network: a process supported, I have speculatively suggested, by the network's emerging culture and bounded structure.

In 10.2, I extend this analysis by describing the shift from collective investigation (or exploration) to a process of collective selection.

10.2 Phase 1: The selections of Cohort 1 teachers

DESCANT sought to support a teacher population to design an e- learning environment for professional development in Science and Technology education. To achieve this collective goal, the DESCANT population needed to use both existing and newly developed knowledge to design a principled response to the challenges of professional learning in Science and Technology education. This design-based strategy ensured that later in Phase 1, strong selective forces would be brought to bear on the range of ideas, understandings and practices being explored by the group as viable strategies for professional learning in Science and Technology education.

In other words, as the Phase 1 population prepared for their e- learning design task, the exploratory dynamic of the online immersion period (as described in 10.1) shifted to one of selection.

There were early indications that Cohort 1, as collective designers, were increasingly interested in understanding (generative) student and teacher learning as a basis for professional development in Science and Technology education (see 7.1.1). This apparent shift in collective values was confirmed during the 1st Design Workshop, when the Cohort 1 teacher-designers selected as the environment's priority purpose, 'to understand better how we (students and teachers) learn, initially by consideration of a generative model of learning, specifically in the context of designing and making and investigating in order to improve student learning in K-6 Science and Technology' (see 7.2 Design Decision 1).

In choosing this priority purpose, Cohort 1 teacher-designers essentially selected a generative, learner-focused orientation as an adaptive strategy for improving Science and Technology education. This choice reflected, to a large extent, the (global) UTS fitness peak which had been articulated throughout the online immersion (see 10.1).

However, the teacher-designers were also careful to incorporate a mechanism for representing the locally derived strategies (ideas, understandings and practices) of teacher populations such as themselves. They conceived that teacher cohorts would create Culminating Tasks that could be archived and represented through a recommender system (see 5.2 Design Decision 2). This would allow teacher populations, including themselves, to *pass on* (in the words of Cohort 1 teacher, Katrina) the learning they had achieved through professional development. Through this intergenerational transmission, the teacher-designers conceived their e-learning environment as a learning entity in its own right, capable of *evolving* (in the words of Vaughan) through iterative experimental trials in the classroom and in cohort based professional development (see 5.2 Design Decision 3).

It seemed then, Cohort 1 had not abandoned the locally-derived adaptive strategies associated with their initial classroom-focused fitness peak (as discussed in 10.1.1). Instead, they had made design selections that incorporated this school-based orientation as a fundamental means of progressing collective learning in the DESCANT network (see 7.2).

In doing so, the Cohort 1 teacher-designers had essentially provided a mechanism for (democratically) representing their pragmatic, classroom-orientated strategies within the political ecology of DESCANT. Furthermore, through their priority purpose (as detailed above) they challenged future DESCANT participants to engage with the complex propositions underpinning a generative, learner centred orientation. Accordingly, the Culminating Tasks of Cohort 1 teachers articulated complex ecological propositions regarding Science and Technology education that incorporated both orientations (see 7.3).

This Phase 1 design process can be interpreted as a process of selection occurring on an adaptive landscape. Having traversed the valley from their two initial fitness peaks (see 10.1.3), the Phase 1 population essentially required a means of establishing a new fitness peak. On an adaptive landscape model (Wright 1931), discovering a new fitness peak may only occur when selective forces again become a dominant mechanism by which to discriminate between viable and non-viable strategies. As forces of selection grow stronger on an adaptive landscape fewer variants have adaptive capability. A population may thus ascend from a valley to climb a fitness peak (Wright, 1931).[186]

As a population begins to climb a fitness peak, there is the chance that the new fitness peak will incorporate a combination of adaptive strategies previously associated with other fitness peaks. Furthermore, having broken away from the confinement of local fitness peaks (as described previously), this recombination of adaptive strategies may take a population towards a new optimum fitness peak with respect to a particular environment (Wright, 1931).

In DESCANT, I speculate that this corresponds to the shift from collective investigation, where forces of selection were weak, to the later period of collective design where selective forces became crucial. In the prior investigation stage, I suggest that a lessening of selective forces in the bounded DESCANT network had allowed the population to traverse a new valley, away from initial fitness peaks, in search of a fitness peak that *established a common world* (Latour, 2004) from its local and global dimensions. In other words, the task of collective design in Phase 1 re-established selective forces, now on the basis of shared values in the DESCANT population. On the basis of this selection, I maintain that the DESCANT population actively discriminated between viable and nonviable strategies for their e- learning design, based on their collective understandings.

Within the adaptive landscape of DESCANT, the Cohort's e- learning design (including their Culminating Tasks) may be interpreted then as an integration or recombination, of the adaptive strategies that underpinned the two prior fitness peaks. This development might be understood as the emergence, by selection, of a third fitness peak. I can depict this value-laden political ecology (Latour, 2004), or more accurately, political learning ecology (see 7.3) on the adaptive landscape of the DESCANT network as in Figure 10.4, as a third fitness peak emerging from the experiential history of the network (and its collective and individual agents).

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186 Alternatively, in biological populations, strong selective forces may cull all variants. In such cases, the population fails to find another fitness peak and the population ceases to exist (Cockburn, 1991).

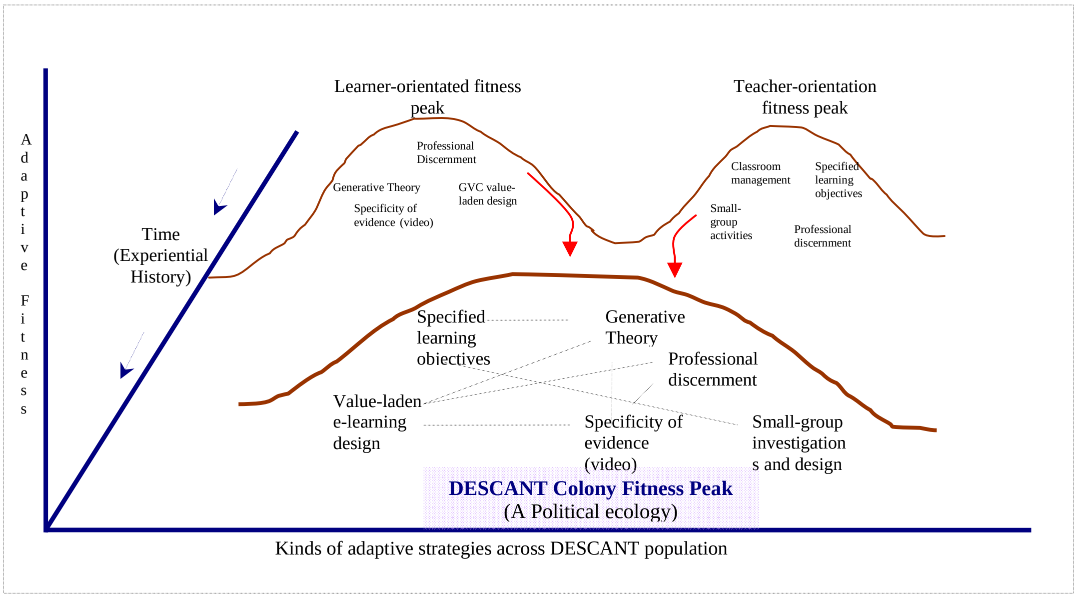

Figure 10.4 The DESCANT Colony fitness peak: As forces of selection strengthened within the DESCANT network (through collective design) a third fitness peak emerges. Once again, this fitness peak is underpinned by a complex web of adaptive professional strategies (some of which are depicted here). These professional strategies incorporate a blend of learner orientated and teacher orientated strategies. This new fitness peak, articulated through the DESCANT Colony (as a political ecology), thus integrates the previous two fitness peaks, and thus the global and local dimensions of professional learning in the DESCANT network.

The e-learning design itself (the DESCANT Colony) can therefore be seen to represent, both technologically and politically, a new fitness peak. In its turn, it was then poised to exert its own *selective* pressures on adaptive strategies articulated within the DESCANT network, in the same way that the GVC had supported the fitness peak advocated by the UTS collective (see 8.2.1). In this sense, the DESCANT Colony environment can be considered an e-learning *niche* that had the potential, when nested within the wider educational system, to shift the adaptive landscape (that is, the professional strategies that may be selected as adaptive by DESCANT participants).

In this view, the collective selection of adaptive strategies in Phase 1, underpinned as it was by collective learning and exploration (involving numerous individual and collective agents) can be considered a form of *niche construction* in which "…the niche extends deep into the individual mind and binds it tightly to the minds of others and to the material world of culture" (Plotkin, 2002, p. 246).

After all, this niche, as a nested learning environment, had been designed to support future participants in exploring and evaluating the adaptive strategies that had been articulated by other DESCANT participants through Culminating Tasks (see 5.3.1). Making sense of these teachers' collective learning as an adaptive landscape enables recognition of this key feature as the mechanism by which the entire network could evolve into a different niche, on the basis of future selections. In essence, on this view, this mechanism delivers the potential for professional renewal.

Accordingly, as new teachers were recruited for Phase 2 of DESCANT, the exogenous (or externally designed) dimensions of their professional development experience would largely be shaped by the intellectual, social, cultural and ecological terrain of the adaptive landscape underpinning the DESCANT Colony (see 7.5). This corresponded well with a design-based approach to research where, "…the design aspect involves designing an intervention that reifies a new form of learning to articulate and advance a particular position on learning" (Tabak, 2004, p. 226).

In Phase 1 of DESCANT, what had been reified through collective selection in design was essentially an emergent fitness peak associated with student and teacher learning in Science and Technology education. Nevertheless, as Phase 2 of DESCANT began, it remained to be seen how the next population of teachers would engage, especially if such collective exploration necessitated 'traversing the valley' away from any initial fitness peak.

10.3 Phase 2: Cohort 2 and 3 teachers' investigation

As participants immersed themselves online in Phase 2 (see 8.1.1 and 8.1.2), moderators and teacher mentors helped them to engage with Cohort 1's Culminating Tasks. Each of these Culminating Tasks articulated a *complex proposition* regarding student and teacher learning in Science and Technology education (see 7.3). This engagement was undertaken collectively within the DESCANT Colony e-learning environment, a political ecology shaped by intellectual, social, cultural and environmental influences. So, Phase 2 participants might be seen to be exploring the fitness peak that had emerged from Phase 1 of DESCANT and had subsequently been articulated through an e-learning environment, or niche, for professional development (see 10.2).

Despite repeated encouragement from the Moderator Collective and Cohort 1 Mentors, the Phase 2 online immersion was characterised by low levels of cohort-based investigation (see 8.1.1). This indicated a significant shift from the patterns of operation and interaction exhibited by Cohort 1 teachers to those exhibited by Cohort 2 and 3 teachers. Phase 2 participants were largely unwilling to operate the DESCANT Colony collectively with their online cohort, preferring instead to work collectively with their school-based colleagues (see 8.1.2).

Nevertheless, some Culminating Tasks *did* succeed in encouraging a healthy level of discussion, intellectual posturing and debate within the Phase 2 online immersion period. Angela's Birdhouses Culminating Task (amongst others) was found to be salient for its explicit representation of the teaching difficulties involved in enacting flexible, student-driven investigations and design (see 8.1.1). By selecting this as a focus for their initial online discussion, Cohort 2 teachers indicated the relevance of Angela’s classroom-level (or macro) representation of a generative, learner-focused orientation (see 7.3.1). It seemed the "classroom realism" (see 7.1.1) of her macro-level video, together with her expressions of professional uncertainty, had made the Birdhouses Culminating Task a “reliable witness” (Latour, 2004) for investigating the Phase 1 fitness peak.

Cathie's Culminating Task, on the other hand, became salient as an intimate representation of generative student learning in biology (see 8.1.2). Cathie’s micro-focused video, whilst not representing ‘classroom realism’ like Angela's video, provided an articulation of generative student learning that included the student’s own conceptual shifts. This fidelity distinguished Cathie's proposition as one that could perhaps more adequately represent (in a political ecology sense) the subtle ways students may test and progress their conceptual understandings of Science.

By incorporating *specific* instances of conceptual reasoning in biology, Cathie's videos proved valuable for encouraging Phase 2 teachers, *and school-based collectives*, to express their ideas, understandings, and practices with regard to this specific instance of student learning. This collective engagement, *at a cohort level*, facilitated the pooling of a variety of perspectives and values, particularly regarding the teaching strategies most suitable for supporting the student to progress his understandings of plants (see 8.1.2).

Whilst members of the Moderator Collective actively participated in Phase 2 online discussion, they commonly took on a supportive, mediator role whilst allowing cohort participants to initiate topics of concern and lead discussion (see 8.1.2 Moderator Collective). Thus, in the absence of external direction as to which videos and text should be discussed, a minority of Phase 2 teachers self-organised around salient professional concerns, just as Cohort 1 had done in Phase 1 (see 6.2). Again, it seemed that a teaching-focused orientation was evident as an initial attractor for this second population of teachers (see 8.1.1 and 8.1.2).

As in Phase 1, this teacher-orientation may have influenced the manner in which these teachers engaged within the political ecology of DESCANT. For instance, the Phase 2 teachers seldom specified *particular instances* of students' domain understanding, as captured within the numerous videos of student learning. This lack of collective proximity between the teachers and the domain knowledge being articulated by students seemed to influence the manner in which the Phase 2 collective *discerned* the subtleties of student learning (see 8.1.3 Agent to Entity Proximity and Collective Exploration).

Here, again, a teacher-orientated fitness peak for addressing student learning in Science and Technology education is apparent, one presumably established, over time, within the complex school and classroom constraints being described by teachers (see 8.1.1).[187] Perhaps the similarity of the *initial* fitness peaks exhibited by the Phase 1 teachers (see

[187] For example, Samatha of Cohort 2 described the challenge of enacting generative investigations where time constraints restricted the possibilities for student driven investigation (see 8.1.1 Excerpt 1).

10.1) and the Phase 2 population may be explained by the environmental and cultural conditions (and selective forces) common to both teaching populations.

Nevertheless, discerning a fitness peak in the Phase 2 population on the basis of their online investigation was complicated by their lack of cohort-based exploration. For the most part, the Phase 2 cohorts lacked the collective *strategies of exchange* that had characterised collective exploration in Phase 1, such as sharing emerging ideas and expressing professional uncertainty (see 6.2.1). To a large extent, these strategies of exchange seem to have shifted to local school contexts (see 8.1.3), thus diminishing collective exploration at a cohort level.

Furthermore, where members of cohesive school-based collectives *did* post online, their contributions often masked any differences of opinions that may have existed in their local, school-based group (see 8.1.2 Excerpt 2). This is likely to have reduced the variation of questions, ideas, concerns and understandings being pooled by *individual* cohort participants during online investigation and hence the quality of the cohort's collective exploration (see 8.1.3). On the other hand, the *discrepancy* between the intellectual orientation of *school-based* groups (who often lacked proximity to the online political ecology) and the dominant *online* intellectual culture (articulated by teachers, mentors and moderators) appeared to encourage Cohort-based contributions (see 8.1.2).[188]

As discussed in 10.1, collective exploration across such an adaptive landscape may be frustrated by forces of selection that hold populations at the top of local fitness peaks (Wright, 1931). In Phase 1, the bounded DESCANT network and its collective patterns of interaction seemed to have buffered against the premature selection of adaptive strategies and design, thus allowing the population to traverse the valley from their initial fitness peak (refer to Figure 10.2). In Phase 2 however, the shift to school-based patterns of operation

[188] As an aside, the online intellectual tension created by the lack of proximity of school-based collectives can be considered a source of variation within online discussion (see 6.1.3). In this view, the diversity of perspectives articulated as a result of the independence of school-based groups may have strengthened the collective intelligence of DESCANT's emerging intellectual culture by operating against overly cohesive group-think (Surowiecki, 2004). Such variation may well have the potential to ensure a rich pool of possible future directions from which professional renewal can emerge.

may have diminished the capability of the bounded DESCANT network to buffer against forces of selection operating (on novel strategies) within interconnected networks, for example local school networks.[189]

I can map this complex dynamic of collective exploration on an adaptive landscape as Figure 10.5. It depicts the fitness peak of school-based collectives during the Phase 2 online immersion period, where these collectives remained largely isolated from the DESCANT Colony and thus from the dominant fitness peak articulated through its political ecology.

The capability of school-based collectives to engage, even *experimentally*, with the generative orientation may have, at times, been hindered if the forces of selection were strong in local professional networks and school cultures. In such cases, novel strategies (whether they were ideas, understandings, values or practices) may have been quickly conceived as untenable and prematurely selected against, thus slowing (yet not preventing, as will be shown) school-based groups from traversing the valley from their initial fitness peak (see for example, 8.1.2).[190]

[189] This suggestion does not seek to denigrate the capability of local school networks or communities for undertaking professional learning, but rather seeks to emphasise how local fitness peaks may consolidate their existing adaptive strategies, especially where transformative adaptive strategies may appear, initially, untenable (see 10.1). Of course, this dynamic also applies to the fitness peak developed within DESCANT. The concern here, within a political ecology, is to establish a common world (Latour, 2004) which can integrate local and global fitness peaks. The aim, in this respect, is to establish an *explicit* relationship between the nested and coupled levels of professional knowledge in an education system (Holling, 2001).

[190] Whilst the influence of school-based networks in this sense remains speculative, final conversations in schools did provide some support for this position. For example, Abbey and Arlene of the Cransvale school-based collective discussed the importance of the online, cohort-based investigation as a means of gaining fresh perspectives that were not prematurely judged by 'school sceptics'. Arlene stated, "I think it's good too that [DESCANT] is like, on the internet too. We could be part of it with Cohort 1 that, you know, live all the way out in [a remote district] or whatever. And you do something with your staff, you're getting the same people and the same kind of responses and the same approaches and the same motivation and the same all the time." This led Alley to add, "And the same sceptics…you go in with this new idea and I mean you could walk into- and once you know the staff- and I mean every staff has the sceptics. You know? She won't believe me…they won't do that, they won't listen to me."

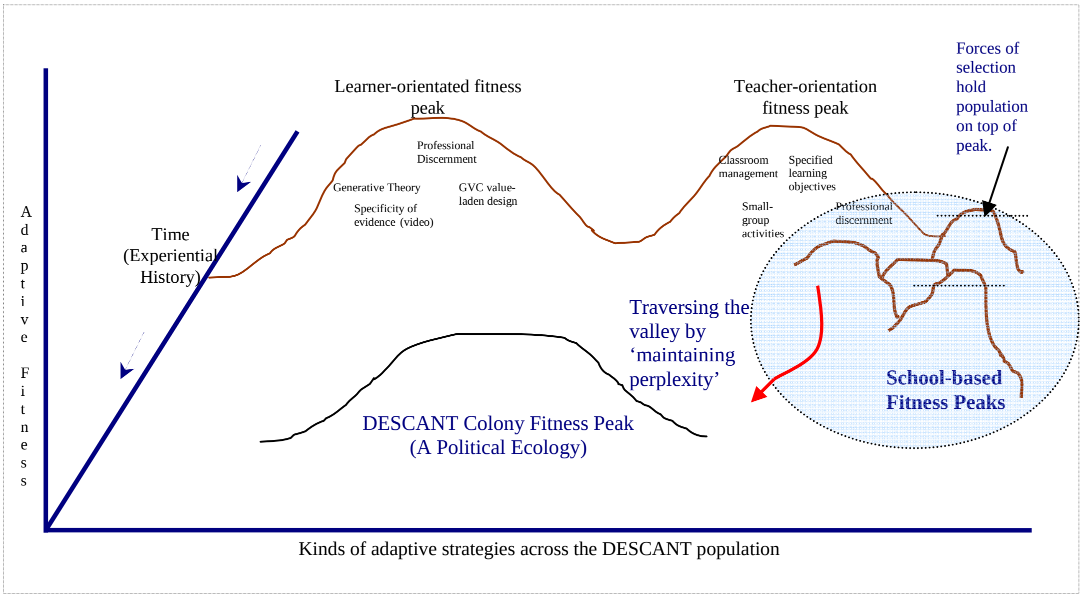

Figure 10.5 School-based fitness peaks: In contrast to the single teacher-orientated fitness peak depicted from Phase 1, a rugged landscape (Kauffman & Weinberger, 1989) representing various school-based fitness peaks is now depicted. This represents the relative lack of proximity between these various school-based groups (in contrast to the Phase 2 population). These distributed school-based orientations are however depicted within the same region of the adaptive landscape, as a means of representing the similarity between the adaptive strategies underpinning these teacher orientated fitness peaks. The school-based peaks are also represented as if emerging from the same experiential history, so as to represent the manner in which these adaptive strategies had been established over time, through professional experience, in local school contexts. Local forces of selection may have slowed isolated school-based groups in traversing the valley towards the DESCANT Colony fitness peak. In contrast, those Phase 2 teachers with closer proximity to the online network may have used this bounded network as a means of sustaining perplexity and expressing emerging ideas, thus allowing them to traverse the valley towards a new fitness peak with greater ease.

In contrast, the Phase 2 teachers who exhibited close proximity to the *online* DESCANT network (both its agents and entities, see 8.1.3) may have experienced (during their initial investigation of novel strategies) a greater buffering from the selective forces of their local school contexts. This buffering may have supported these teachers to *express* and *sustain* greater uncertainty in their exploration of these new strategies (see 6.1.1). As in Phase 1 (see 8.2.1) these collective *strategies of exchange* may have supported these teachers in expressing and exploring emergent ideas, underlying professional concerns and dormant learning agendas, without the threat of premature selection, thus assisting them to make an experimental trip across the valley (see Figure 10.5 above).

As this occurred, the dominant intellectual culture of DESCANT, spanning teachers, mentors, moderators and numerous ecological entities (as discussed previously), may have become increasingly cohesive as a self organising, intellectual force. This diverse collective was certainly increasingly active in countering alternative positions to the learner centred, generative orientation that represented their fitness peak. This was most evident in the contributions of cohort teachers and mentors who argued strongly against perspectives that they believed did not engage sufficiently with a generative orientation (see 8.1.2). Whilst moderators also contributed to this dominant intellectual culture, they worked to integrate the varying perspectives and to acknowledge their own professional uncertainties (see 8.1.2 Moderator Collective).

So, plotting the collective patterns of interaction (and proximity) during the Phase 2 online immersion period as an adaptive landscape allows us to speculate about the endogenous timing (or activation) of collective exploration in the DESCANT network. This dynamic is considered of central importance when analysing (or seeking to harness) complex adaptive systems.[191]

Nevertheless, regardless of these various patterns of interaction and their influence on proximity and activation in the DESCANT network, at the completion of the investigative (or exploratory) stage of the project, it appeared that most school-based collectives had engaged *to some extent* with the ideas, values and practices that had been articulated through Cohort 1 Culminating Tasks (see 9.1). Indeed, conversations with school-based collectives suggested that school-based collectives had used the online network *as a resource* by which to explore their *local* school-based fitness peaks on the basis of classroom experimentation.

In doing so, the various school-based collectives seemed to have established remarkably similar professional concerns, understandings and practices (see 9.1.1, 9.1.2 and 9.1.3). In

[191] Endogenous activation in the DESCANT network is considered to exist in a dynamic relationship to the exogenous timing or activation of events in Phase 2, as designated by the project timeline (see 5.6). From a complexity perspective, both types of activation must be considered for understanding the emergent outcomes of a particular complex system or network. Axelrod and Cohen (2000, p. 75) explain this importance by writing, "If [an interaction] takes place before events that it would otherwise have followed, it may change the character or likelihood of those events. The system can have an entirely different history as a result." Given this importance, I have sought to indicate here, some endogenous influences on the activation of collective exploration in Phase 2, with particular reference to those factors related to agent and entity proximity, a second influential determinant on patterns of interaction in a complex system (Axelrod and Cohen, 2000).

particular, school-based collectives described an increased capability and concern for undertaking dynamic, student-driven approaches to Science and Technology education.

I interpreted this collective pattern, emerging as it did across various, relatively independent school-based sites, as a distributed domain of attraction associated with the wider education system within which these school-based collectives and individuals operated (see 9.1). On an adaptive landscape, this attractor can be re-interpreted as a fitness peak associated, once again, with addressing student learning in Science and Technology education.

This fitness peak had apparently been established through various local patterns of operation and interaction involving both a wide variety of engagements with the DESCANT network and local classroom experimentation in Science and Technology education (see 9.1.1, 9.1.2 and 9.1.3). Through these diverse patterns of engagement, school-based collectives (for example, the Pattonsvale school-based collective, see 9.1.1 Excerpt 1) appeared to have traversed the valley from their initial fitness peaks (see 8.1.1) towards a shared professional renewal in Science and Technology education. I can depict this process on the adaptive landscape of DESCANT Phase 2 as Figure 10.6.

The resulting school-based fitness peak was underpinned by various adaptive strategies (depicted in Figure 10.6) that incorporated both adaptive orientations that had been previously articulated in the DESCANT Colony (see 10.1 and 10.2). [192] According to the teachers themselves, each of these underpinning strategies contributed to their overall fitness for addressing student learning in Science and Technology. Such contributions included, in many cases, a strategy of acknowledging where further professional learning was required, as a natural trajectory of the investigations that had been initiated through DESCANT (see 9.1.2 and 9.1.3). These teachers and collectives appeared to be "maintaining perplexity" (Latour, 2004) as part of individual and collective professional renewal within their local, school-based (political) learning ecologies.

[192] It is possible that other emergent school-based fitness peaks existed in the DESCANT network. The example referred to here was found to be particularly salient on the basis of a wider interrogation of the entire DESCANT data set.

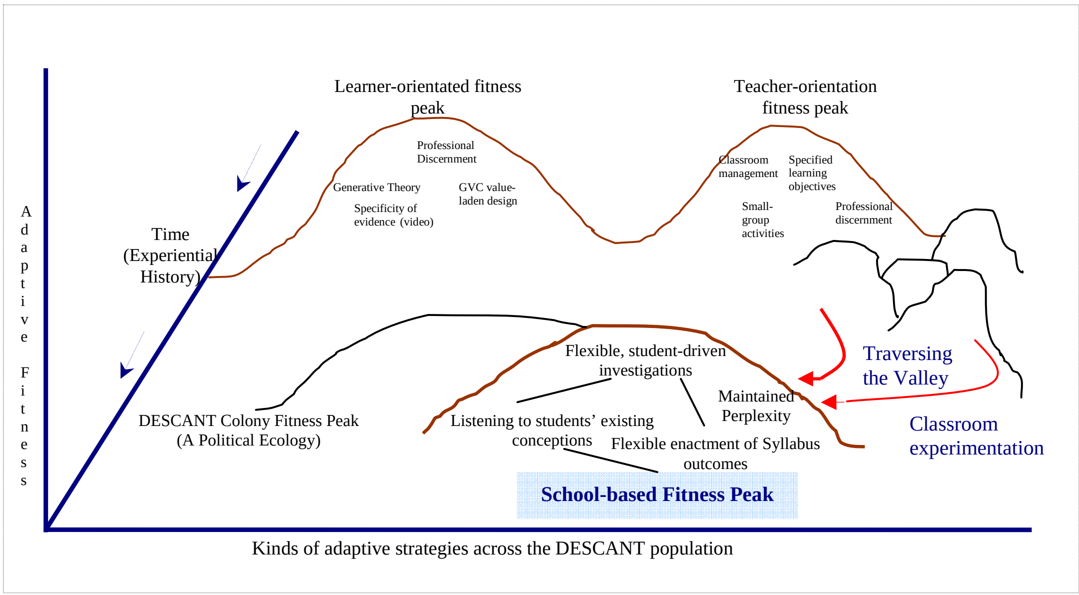

Figure 10.6: School-based Emergent Fitness Peak. This adaptive landscape depicts a fitness peak that was discerned through final conversations with school-based groups (see 9.1). This fitness peak was underpinned by various adaptive strategies including an increased concern and capability for enacting flexible, student driven investigations and design within Science and Technology education. This fitness peak overlaps the DESCANT Colony fitness peak, representing the influence of this political ecology. However, the emergent school-based fitness peak is still represented as a separate peak to the DESCANT Colony, representing the manner in which this adaptive orientation was yet to be articulated within the DESCANT Colony.

Given its incorporation of both orientations discussed previously, the school-based fitness peak paralleled many aspects of the dominant intellectual culture within the DESCANT political ecology (see 9.1). Nevertheless, this fitness peak had emerged within local school contexts rather than within the DESCANT Colony as a distributed political ecology. As such, it remained as an interrelated and overlapping *yet distinct* fitness peak on the DESCANT adaptive landscape (refer to Figure 10.6 above).

This distinction emphasises that the school-based fitness peak discerned within final conversations with the UTS collective had not emerged on the basis of *interactions* between the various school-based collectives (as semi-autonomous agents). Instead, it had been discerned within a research context through local conversations. Yet for the DESCANT Colony to operate effectively as a decentralised, community-based learning system (as intended by the Cohort 1 teacher designers) the collective learning of school-based groups had to be articulated *within* the e-learning environment, as a "common world" (Latour, 2004). Such integration could then, potentially, harness the *selective force* of the

DESCANT network as a political ecology: a process of selection that had the potential to reshape the DESCANT Colony as a niche for professional learning (see 7.2).

In addition to cohort-based discussion (which had proved relatively unsuccessful in Phase 2) the articulation of individual and collective school-based learning was possible through two other central mechanisms in the DESCANT Colony: the uploading of Culminating Tasks (as complex propositions) and the rating/evaluation of these Culminating Tasks. I now revisit my study's findings with regard to the operation of these mechanisms in Phase 2 of the DESCANT project.

10.4 Phase 2: The selections of Cohort 2 and 3 teachers

In Phase 1, the collective intention of Cohort 1 to design an e-learning environment acted as a catalyst for testing and selecting adaptive strategies for Science and Technology education (see 7.1). From this *cohort level* exploration and selection, a discernible fitness peak had emerged, one that became embodied within the design of the DESCANT Colony (see 10.2).

The DESCANT Partners' strategy for Phase 2 incorporated, once again, a *cohort-level* design role for teacher participants. During the information sessions, at the beginning of Phase 2, each cohort of teachers was informed that the prototype environment represented a 'work in progress' rather than a final product. Participants were thereby informed of the expectation that they would, like Cohort 1 teachers, become co-designers of the e-learning environment. For instance, they were expected to recommend changes or adaptations to the original design based on their understandings and learning throughout the project.

Nevertheless, despite repeated attempts to initiate this design process in Phase 2, neither Cohort 2 nor Cohort 3 teachers exhibited any desire to contribute to the e-learning design. Instead, the Phase 2 teachers' participation as *designers* shifted to the classroom and school level, as they focused on creating classroom videos and texts (that is, Culminating Tasks) that could be embedded within the DESCANT Colony (see 9.2).

As discussed previously, this shift may have influenced the forces of selection acting on newly developed strategies (that is, ideas, values, understandings and practices) being established and pooled in Phase 2. In Phase 1, the online community had established collective values which acted as a means of selection in the later stages of collective design (see 10.2). This process had distilled the collective intelligence of a heterogeneous population of teachers, academics and Science and Technology consultants. In Phase 2, however, the collective learning of school-based groups (see 9.1) had largely remained independent of the online community discussion and debate in the DESCANT Colony (see 8.1.1 and 8.1.2). The collective understandings that were emerging within school-based collectives were not therefore tested collectively within the online population of professionals. This may have influenced the collective values by which these school-based collectives tested their ideas, thus potentially influencing their selection of professional strategies on the basis of these tests.

On the other hand, it seemed that the emergent school-based fitness peak *had* survived the selective forces operating within authentic classroom and school contexts (see 9.1.1 and 9.1.2). School-based groups were utilising many of the intellectual values in the DESCANT environment as a means of testing and selecting novel strategies through classroom experimentation. It appears this provided an effective means by which to integrate the values of the DESCANT and school networks. This also seemed the case where *online* (cohort-based) discussion provided an iterative means for teachers to test strategies being trialled within classroom practice (see 9.1.3), a pattern of operation perhaps most resembling that in Phase 1.

This is not to suggest that Cohort 1 teachers had not undertaken similar forms of experimentation within their classes and schools. On the contrary, Phase 1 participants often discussed how they had tested the ideas being discussed online within their classrooms and in their personal lives. Nevertheless, in Phase 2, there was a discernible shift towards organised school-based collaboration in which teachers worked together to progress their understandings regarding the ideas being discussed in DESCANT. This collaboration appears to have replaced, to some extent, the online collaboration that was central to Cohort 1’s investigation of student learning in Science and Technology.

It seems, then, that the fitness peak evident across various school-based contexts (see 10.3) had emerged from a complex blend of testing and selection that incorporated local and global dimensions of the DESCANT network. Importantly, it appeared that the collective learning underpinning this school-based fitness peak *had* been articulated with the DESCANT Colony (see 9.2). In particular, many of the adaptive strategies underpinning the school-based fitness peak (see 9.1) were explicitly articulated through the Culminating Tasks of the Phase 2 population (see 9.2.1). This represented an important (non-cohort) means by which the learning of school-based collectives contributed to the wider DESCANT ecology.

In this respect, the Culminating Tasks of Phase 2 could be interpreted as representations (in the political ecology sense) of the individual and collective learning that had emerged within local school contexts through individual and collective investigation (see 10.3). As in Phase 1, each Culminating Task was articulated as a unique ecological proposition with regards to the individual and collective professional learning that underpinned it (for example, see Corina's Culminating Task 9.2.1). Taken together then, Phase 2 Culminating Tasks could be interpreted as a complex (democratic) representation of *a particular* school-based fitness peak, contributed by individual participants to the DESCANT political ecology.

Thus as the Culminating Tasks of Phase 2 teachers were uploaded to the DESCANT Colony, the school-based fitness peak was, to some extent, integrated with the *online* political ecology. In this way, the DESCANT Colony and the complex fitness peak it articulated were expanded. I can depict this fitness peak on the DESCANT Phase 2 adaptive landscape as Figure 10.7.

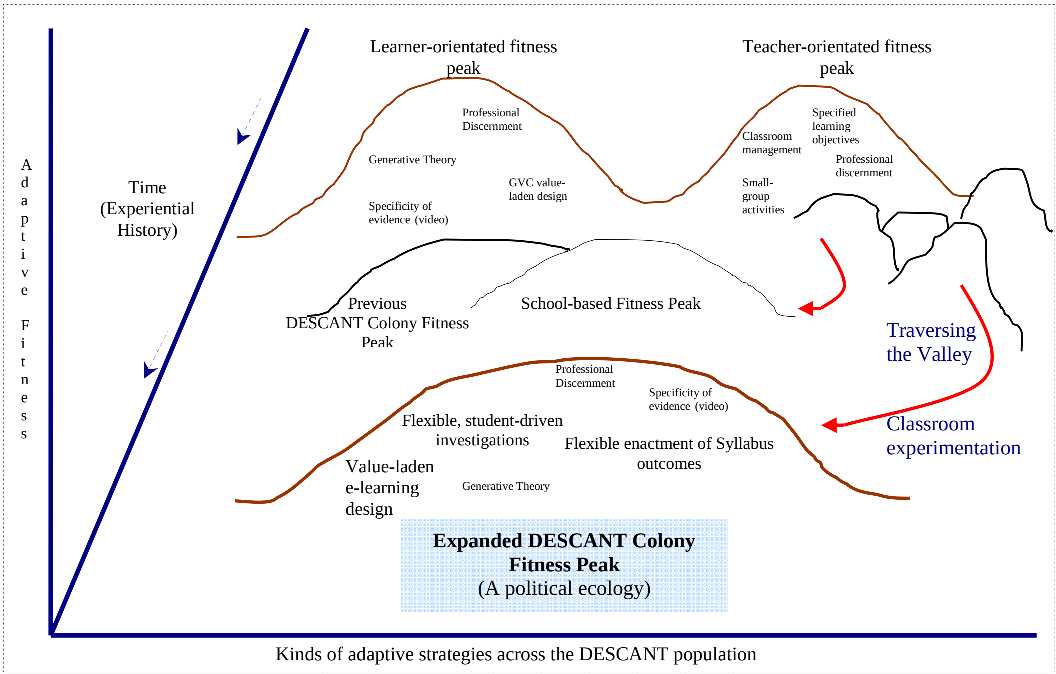

Figure 10.7: Expanded DESCANT Colony fitness peak. This adaptive landscape depicts the political ecology of the DESCANT Colony as a new fitness peak, expanded by the Culminating Tasks of Phase 2 teachers. These culminating tasks, as complex propositions, articulated the collective learning of school-based groups, as well as individual learning. As such, they became one means by which the school-based fitness peak became integrated with the DESCANT Colony as a political ecology. This expanded the underpinning adaptive strategies (depicted within the fitness peak) being articulated as potentially fertile ways by which to address student and teacher learning in Science and Technology education.

Yet as a single fitness peak, or *common world* (Latour, 2004) the DESCANT Colony was becoming increasingly complex. That is, the various adaptive strategies that were contributing to the overall fitness of this political ecology were increasing in number and being articulated as increasingly *interdependent* entities within Culminating Tasks (see 9.2.1).

According to a more recent interpretation of the adaptive landscape model (Kauffman & Weinberger, 1989), increasing complexity such as this diminishes the capability of selective forces to cull disadvantageous strategies, by making such strategies less visible within the overarching adaptive orientation. Furthermore where there is high interdependence between the various underpinning strategies (each contributing to overall fitness), optimum strategies cannot contribute strongly to increasing the overall fitness due to the increase of conflicting constraints within the highly interdependent system (Kauffman & Weinberger, 1989).

This was a salient issue for the DESCANT network as a learning ecology. The Cohort 1 teacher-designers had envisaged the DESCANT Colony as more than a *collection* of diverse adaptive strategies, made visible through an online network. For them, it was important that a mechanism for selection *could* help discern which of these Culminating Tasks (as representations of local collective and individual learning) were of most value to the DESCANT Colony as a learning niche (see 7.2). They conceived that the DESCANT network would evolve and progress (in synergy with its local networks) on the basis of collective *selections*. This was made possible through the recommender system (see 7.2).[193]

In a sense then, the recommender system, with its rating criteria, provided the instrumentation by which the DESCANT network (as a political ecology) could overcome the complexity of its own rugged landscape (Kauffman, & Weinberger, 1989).[194] As will be shown below, this involved collective selection, and paradoxically, an increasing *interrelatedness* between the various adaptive strategies within the political ecology of DESCANT.

In Phase 2, ratings and evaluations were characterised by a diversity of positions and values, even within school-based collectives (see 9.2.2). In this regard, Phase 2 ratings and evaluations may have represented the *individual* values and understandings of school-based collectives in a way that was less apparent during online cohort-based investigation (see

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[193] During the 2nd Design Workshop, Vaughan had described this dimension of their e-learning design noting that it "…would allow us to put something out there and allow people to test it and modify it, and so it could wander off…. then it would gradually evolve as it went on wouldn't it?" Gill, on the other hand, had discussed a similar dynamic within the Webboard, describing "…the survival of 'ideas' within the collective understanding. Some become established and generate a whole line of descendants that come to occupy an important and lasting place in "the way we see things around here" (is it stretching the metaphor too far to suggest an ecology of ideas?) others sink into extinction." (9/9/2003). See 7.2.

[194] On a rugged adaptive landscape there are many local fitness peaks but little means by which selective forces may *distinguish* between them *by way of adaptive success* (Kauffman & Weinberger, 1989). This complex dynamic seems of particular concern in education where the complex and subtle nature of learning and teaching makes it difficult for the field, as a professional collective, to discern adaptive success: a dilemma that has led to the adoption of a seemingly endless array of educational approaches, often without any connection between them. Schaverien and Cosgrove (1999, pp. 1223-4) note "…by contrast with the theorising that has occurred in technology-and-science, educational research has failed to yield a powerful and coherent explanatory 'theory' of learning, spawning instead a variety of 'approaches' (Thagard 1992 p. 245). In fact, Ziman (1978/1991 p. 158) has gone so far as to ask, of the social sciences in general, if it is even possible to acquire 'reliable, consensual knowledge about human behaviour'."

8.1.2). The apparent independence of such contributions promised to harness the *collective intelligence* (Surowiecki, 2004) of the DESCANT population as a means of discerning which Culminating Tasks had adaptive value for professional learning.[195] Yet the individuality of these ratings did not negate the potential influence of *collective* learning on these evaluations.

The rating criteria ensured that ratings and evaluations were explicitly associated with the generative heuristic of generate/test/regenerate, whilst also being learner focused. Essentially, this encouraged and supported Phase 2 participants to *engage with* the values and understandings (that is, the fitness peak) of Cohort 1 and the dominant intellectual orientation in DESCANT. By choosing rating criteria related to the generative heuristic (see 7.2), Cohort 1 had ensured that this selective process would incorporate their own collective values and understandings (at least until these generative criteria were replaced entirely). As they did so, they created complex propositions (in the political ecology sense) that articulated *associations* between (amongst other things) the generative heuristic and their own observations and strategies as teaching professionals (see 9.2.2). This paralleled to some extent the complex propositions that had been articulated by the GVC sub-group at the beginning of DESCANT as they worked to shift from their initial fitness peak (see 6.1).

On the other hand, the evaluations of the Phase 2 participants commonly incorporated the values and understandings of the *school-based* fitness peak (see 10.3) discerned through final conversations (see 9.1). Thus, the Phase 2 evaluations/ratings seemed to harness many of the shared values and understandings that were developed within local school contexts, yet rarely articulated during online investigation (see 8.1.2). In doing so, complex propositions were articulated that may have worked to *establish a common world* (Latour, 2004) between the fitness peak of Phase 1, and the emerging fitness peak of Phase 2 (depicted above in Figure 10.7).

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[195] As detailed in 1.1.2, a group's collective intelligence may be threatened if collaboration decreases the independence of contributions made by individual participants (Suroweicki, 2004). In this view, individual ratings, when distilled into a single solution, may provide a more intelligent answer than a solution formulated through collaboration.

Thus, whilst the individuality of Phase 2 rating/evaluations may have worked to establish the collective intelligence of the DESCANT population (as suggested above), it was likely that this intelligence remained *coupled* to various other forms of collective intelligence and learning evident in the DESCANT network, including school-based collective experimentation, and cohort-based collective investigation and design. This blend of collective selection and increasing interdependence (or complexity, after Kauffman & Weinberger, 1989) resembles that which is described by Latour (2004, p. 227) as a characteristic of political ecology:

> *What if freedom consists in finding oneself not free of a greater number of beings but attached to an ever-increasing number of contradictory propositions? What if fraternity resides… in the obligation to work with all the others to build a single common world?*

Similarly, the Recommender System, by facilitating collective selection, provided another means by which the school-based fitness peak of Phase 2 could become *attached* to the fitness peak that had emerged from Phase 1 and become articulated within the DESCANT Colony. Yet this increasingly *common world* incorporated selective forces capable of discriminating *between* the various Culminating Tasks being articulated within the increasingly rugged landscape (Kauffman & Weinberger, 1989) of the DESCANT Colony (as detailed above). That is, a mechanism existed for this common world to *progress* as a political ecology: the dynamic results of collective selection of were represented on the Learning Landscape (see 9.2.3).

On the Learning Landscape, the individual and collective learning within the DESCANT network could be *translated* by the Recommender System (through a complex ecological proposition) into an entirely different fitness peak: a fitness peak coupled to individual and collective learning (see 9.2.3). This fitness peak did not relate directly to adaptive professional strategies but instead represented those Culminating Tasks (as complex propositions) that had proven salient for sensitising the DESCANT population to important dimensions of Science and Technology education.

As just one example of many, the fitness peak depicted below (refer to Figure 10.8) represented a population of Culminating Tasks that had proven (through collective selection) to have fitness yields for making sense of student learning in Science and Technology education (see 9.2.3).

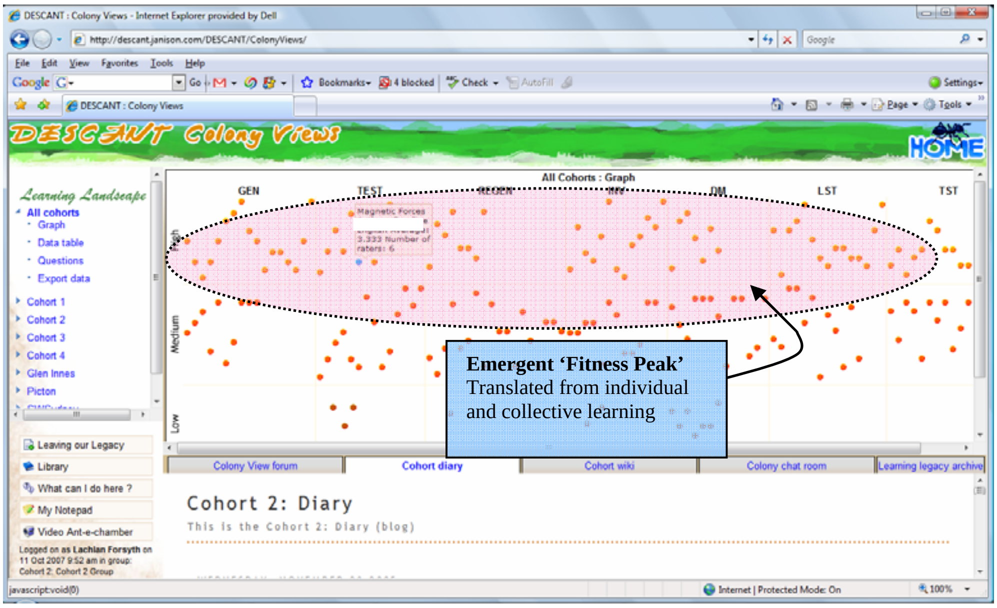

Figure 10.8: DESCANT Colony Emergent Fitness Peak. The recommender system translates individual and collective learning in the DESCANT network into a novel depiction of an adaptive landscape. In doing so, a novel type of fitness peak is created (shaded area), corresponding to the High region on the Learning Landscape. Culminating Tasks scoring > 3 are dynamically plotted in this high region, according to various criteria. In this example, Corina's Culminating Task (blue dot, or 'trace) is one of many complex propositions (in the political ecology sense) currently situated upon this fitness peak based on current ratings (see 9.2.2).

In a political ecology sense, this novel fitness peak (democratically) represented those complex propositions which had articulated Science and Technology in such a way as to sensitise teachers to differences they may not have previously discerned (for example, related to the ways students test ideas, see 9.2.2). Furthermore, as a technological means by which the DESCANT Colony, as a political ecology, could represent its own evolving adaptive landscape, it could be inferred (in the words of Latour, 2004, p. 86) that:

> *"…reality grows to precisely the same extent as the work done to become sensitive to differences. The more instruments proliferate, the more the arrangement is artificial, the more capable we become of registering worlds.*

In the case of DESCANT, the potential for this emerging collective distillation, one coupled to both online and school-based networks, could only be partially realised given the limitations on the project's duration. Nevertheless, the DESCANT Colony as an expanding political ecology transcended the boundaries of the project studied here. Therefore, the potential remained for this political ecology to continue to expand and *evolve* (in Vaughan's words) on the basis of future cohorts' collective investigation, contribution and selection.

Summary

In 10.1, I summarised how various forces of selection operating within various e-learning environments, local school contexts and the DESCANT network as a political ecology, may have influenced collective exploration within Phase 1. I showed how such learning could be well understood in terms of a dynamic adaptive landscape. The DESCANT network as a bounded and cultural political ecology, appears to have supported the DESCANT population in shifting from pre-existing orientations (both global and local) towards a new integrated fitness peak.

When selective forces were brought to bear on this emerging political ecology, through a process of collective design, the resulting e-learning environment could be interpreted as the articulation of a new fitness peak within the DESCANT network. In 10.2, I described how those adaptive strategies underpinning each of the initial orientations (or fitness peaks) were integrated within this political ecology, as an articulation of the collective learning of the Phase 1 population. Of particular relevance in this regard was the manner in which the Cohort 1 teacher-designers integrated the generative orientation (associated with the *global* agenda of the UTS collective) with a dynamic mechanism through which future DESCANT teachers could utilise their *local*, school-based understandings as a means of progressing, or evolving, the DESCANT Colony.

What was unexpected however was a significant shift in Phase 2 away from Cohort-based interaction towards school-based collective patterns of operation and interaction. In 10.3, I described how these new patterns of collective investigation and exploration may have influenced collective learning in the nested and coupled DESCANT network. In particular, I described how school-based patterns of operation may have shifted the forces of selection operating on the novel ideas being articulated within the political ecology of DESCANT, a shift that, analysed in terms of a dynamic adaptive landscape, can clearly be seen to have had a ripple effect through the DESCANT system.

Final conversations held with Phase 2 participants revealed however, that a pattern of collective professional renewal was discernible across the various school-based sites. Again adaptive landscape modelling helped to emphasise that, if the pattern of professional learning (or attractor) that had been discerned through school-based conversations was to contribute to the evolving DESCANT political ecology, then it would have to be articulated within the DESCANT Colony. Only then could the DESCANT political ecology *act* as a selective force upon this professional learning, thus working to *establish a common world* (Latour, 2004).

In 10.4, I described how the adaptive fitness peak that had emerged across distributed school-based populations became *represented* in the DESCANT Colony, through Culminating Tasks, ratings and evaluations. These mechanisms helped articulate the learning of DESCANT teachers and school-based collectives that had not contributed significantly to Cohort-based discussion. Moreover, through these mechanisms, complex propositions were articulated that worked to *establish a common world* (Latour, 2004) between the fitness peak of Phase 1, and the emerging fitness peak of Phase 2.

The Learning Landscape provided another means of articulating the collective learning of the DESCANT network. Through its recommender system, the Learning Landscape provided a means of establishing a dynamic fitness peak based on the collective intelligence of the DESCANT population.

Having now established an analytical summary of the study's findings I now proceed, in Chapter 11, to conclude by discussing its implications, with recommendations for future work.

Chapter 11
Implications

This study has established the worth of a learning ecology framework for making sense of the collective learning of cohorts of teachers in an e-learning mediated professional development project. In Chapters 6, 7, 8 and 9, I tested the value of this interpretation, in fine grain, over the lifespan of the DESCANT Project. In Chapter 10, I summarised these findings analytically, showing how conceiving of teachers' collective learning, in broader brush, as occurring on an adaptive landscape can help us understand how such collectivity might underpin systemic professional renewal.

It only remains, in Chapter 11, for me to consider, in the light of my study's limitations, the implications of my findings for professional development and further research.

11.1 Democratic Professional Learning: responding to the ethical challenge

Making sense of group learning as a learning ecology (as summarised in Chapter 10) foregrounds the importance of ensuring democratic *representation* (in a political and ecological sense) to all participant entities of learning systems.

Such an interpretation makes a case for the epistemic importance of such representation (if a common world, after Latour, 2004, is to be established). For example, it attends carefully to the dynamic interplay between local and global dimensions of professional knowledge-building, both of which "co-exist and shape each other" (Wenger, 1998, p. 131). As well, this interpretation argues for there being appropriate resolution of issues of power in professional development systems, so as to enable all the relevant voices, types of knowledge, data, and evidence to be heard. As Groundwater-Smith and Mockler (2005) note:

> *Teachers can and should be able to hear each other out; bureaucrats can and should be able to engage with the profession in more liberatory ways; governments can and should seek more consensual routes. It is not that the very idea of an emancipatory*

> *knowledge interest may be a misconceived one, but that we are not yet ready to reach for the radical resocialisation that would be required to realize that ideal goal.*

The account I have given in this study illustrates how educational researchers might capture, describe and analyse the complex webs of associations being articulated by participants, participant groups, principled learning environments and emergent knowledge bases, at diverse levels of learning systems. Such detail can hedge the likelihood of supporting the "radical resocialisation" of which Groundwater-Smith and Mockler (2005) speak. Indeed, the collective learning of DET officers, consultants, academics and Cohort 1 teachers in DESCANT might well provide an example of just such realisation of that "ideal goal."

A learning ecology framework such as the one developed in this study could well usefully underpin and strengthen current calls for the kinds of sweeping political and cultural shifts necessary to enact democratically-principled teacher professionalisation in education. As Grossman, Wineburg and Woolworth (2001, p. 59) note, achieving this aim requires identifying and brokering difference as much as it requires identifying common ground:

> *A democratic society such as ours rests upon the premise that individual voices are important, that different perspectives can be productive, and that ultimately the wisdom of the collective exceeds the wisdom of any individual. But in a pluralistic society such as ours, democracy will also involve wrestling with the fault lines that threaten to divide us.... If teachers [and here, all parties in education] themselves cannot reclaim a civil discourse and an appreciation and recognition of diverse voices, how can they prepare students to enter a pluralistic world as citizens? If we are unable to broker the differences that divide us, how can we tell students to do otherwise?*

The learning ecology framework may help in this respect by making visible the ecological means by which the knowledge, values and learning of these "diverse voices" is articulated and progressed towards a common, yet still highly differentiated, world (after Latour, 2004).

This is not to suggest that this study's ecological analysis of professional learning addressed *all* instances of diversity and difference in DESCANT. The expanding population of teacher participants and the project's duration over many years meant that this study was limited in its ability to address and represent the values, attitudes and learning of some teachers and school-based collectives.

For example, formative analysis suggested that a small number of teachers was largely unwilling or unable to engage with the intellectual core of DESCANT, regardless of the encouragement and support they were offered through its community-based strategy. Furthermore, the same teachers were often unwilling to participate in online collaborative investigations, thus failing to enter into dialogue regarding their intellectual differences. Whilst the knowledge and perspectives of these teachers was considered a valuable source of diversity in the DESCANT population, their failure to engage *collectively* with the project meant their learning (or lack thereof) remains largely unrepresented in this study of e-mediated professional collectivity.

In effect, this first trial of a learning ecology framework necessarily focused on giving an explanatory account of the collectivity of teachers and groups who undertook the specified *minimal* requirements for participation in DESCANT: that is, to engage intellectually and collaboratively with the project as part of a heterogeneous community.
Having now explained collective learning ecologically (for that population that met these minimal requirements), it remains to test the framework for its ability to *represent, where possible and appropriate*, those individuals and collectives who choose to *disengage themselves from particular* professional learning initiatives such as DESCANT.

Of course, individuals and groups have a right not to be represented in collective assembly, if they so wish. Nevertheless, subtle and respectful investigation may help us understand those underpinning political ecologies (Latour, 2004) that create teachers' *separate* professional worlds, and address "the fault lines that threaten to divide us" (Grossman, Wineburg and Woolworth, 2001). Such research may assist the establishment of *a common world* (Latour, 2004) between transformative educational reform initiatives, and local parts of an education system that, for one reason or another, may be particularly resistant to change. It may be, that in at least some cases, such local ecologies have important *yet hard to access* professional reconfigurations of value for the wider educational system.

In essence, this study affirms that addressing ethical concerns in the design of professional learning is of paramount importance if collectivity and a democratically principled knowledge base are to emerge. Furthermore, careful scrutiny of whether such democracy is evident is integral to establishing whether collectivity has actually occurred. Ethical implications for collective professional development include the following:

- The worth of incorporating frequent opportunities for networked discourse within and between groups of learners;
- The exploration of diverse (including e-mediated) ways of capturing, distilling and representing communities' ideas and values and making these available, wherever appropriate, to all participants and participant communities;
- The importance of sustaining open and frank communication between different participant entities, as appropriate;
- The worth of utilising collaborative networks as professional laboratories (or collaboratories), to attend to the epistemic basis of knowledge, strategies and professional requirements of all levels of education systems.

These implications support the ethical worth of many of the professional learning strategies identified in Chapter 1. For example, the TryScience (Harlen & Doubler, 2004) and ILF (Barab, Mackinster & Scheckler, 2003) online collaboratories offered teachers the opportunity to engage in professional dialogue with *representatives* from other parts of the education system, including other knowledge systems derived from Science. A learning ecology perspective sheds new light on this ethical dimension.

From a learning ecology perspective, the TryScience (Harlen & Doubler, 2004) strategy can be considered ethical in its representation of Science in teacher learning, as an ecological network of knowledge, epistemic values and domain experts (all of which may be considered participant entities). A further ethical step may be to represent the knowledge of the online professional community in the same manner. After all, in recognising the network-based organisation of the scientific community, scholars have typically found little need to separate scientific knowledge, its authorship and the manner of its publication (Zitt & Bassecoulard, 2004). Given the increasing recognition of education's network-based organisation (as described in Chapter 1) it may be ethical to establish similar ecological accounts in participatory knowledge building settings.

To some extent, the ILF strategy (and others, for example, Nemirovsky and Galvis, 2004) already address this ethical implication by providing opportunities for teachers to represent their ideas, values and learning through video artefacts, each of which articulate an ecological network of associations between classroom practice, professional discernment and inquiry-based learning theory. Yet this study's findings suggest there may be fertility in representing more than the knowledge of *individual* teachers. Moving towards a truly participatory ethic for teachers as knowledge builders for their profession may require a greater representation of the ideas, values, *evidence* and *data* (Little, 2007) of teacher *collectives* and heterogeneous learning communities.

The DESCANT case study provides just one example of how such collective learning or collective intelligence (Levy, 1997) may be captured, distilled and represented. As technological advances continue to offer new possibilities for representing the "diverse voices" (Grossman, Wineburg and Woolworth, 2001) of nested and coupled collectives, the field's capability for addressing these ethical implications is likely to expand (Espinosa & Harden, 2007; Noveck, 2005). Ultimately however, the choice to utilise technological and methodological strategies for *representing* the ecological co-existence between locally and globally situated knowledge may remain tied to a political willingness to establish *genuine representative assemblies* (Latour, 2004).

11.2 Re-conceiving Collectivity: responding to the theoretical challenge

The learning ecology framework offers a conception of collective learning that incorporates the *ethical pragmatics* of political ecology (Latour, 2004) with the *theoretical pragmatics* of a generative learning theory and complexity sensibilities (for example, Davis & Sumara, 2006; Axelrod & Cohen, 2000).

The generative theory (after Edelman, 1992, Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000) appears to align well with complexity sensibilities in its assertion that learning occurs through a generate-test-regenerate (g-t-r) heuristic that is identifiable at three *nested* and *coupled* levels (after Plotkin, 1994):

- At a primary level, in genes, by natural selection, as genetic knowledge-gaining;
- At a secondary level, in organ systems (immune systems and brains), as selection of ideas and behaviour on individuals' values (honed over evolutionary time and in life-experience); and
- At a tertiary level, in groups and cultures, again, as selection of ideas and behaviours, but this time tested, as well, against communal or cultural values.

The study's findings suggest that networked professional learning may be strongly influenced by a generative tertiary heuristic *that extends across many coupled and nested collective populations*. For educational research and design, this warrants continued investigations into the complex nuances that may exist *between* the generative (and hopefully transformative) collective learning of distributed online cohorts, school-based groups and the emergent intellectual culture of teacher development networks.

This study's intended focus on the online dimension of this learning ultimately limited the data set that was available for accessing the school-based dimensions of collective learning in DESCANT. Nevertheless, its findings suggest the worth of future research that can harness proven methodologies for studying the *intellectual* dimensions of face-to-face collective professional learning (for example, Davis & Sumara, 2006; Grossman, Wineburg & Woolworth, 2001) for the purpose of more adequately theorising how this *local* collective learning relates to the learning of online network-based ecologies.

In theorising this learning (as a starting point for future research) this study's findings suggest that adding a *fourth-level* heuristic to the generative theory may help *take into account* (Latour, 2004) the possibility of *ecological* collective learning occurring as a political ecology (Latour, 2004). That is, utilising an additional ecological heuristic may help portray the politically-charged *composition of the common world* (Latour, 2004) on the basis of pragmatic, value-based experimentation and selection, such as that described in DESCANT.

This study provides some indication of how this speculative theoretical heuristic may help interpret empirical data derived from participatory and community-based teacher development. For instance, the study's ecological account of generative learning identifies where *collective, value-based selection* took place in DESCANT. Yet it does not interpret this selection as a political/cultural phenomenon, a strategy that may inadequately represent non-human entities, such as those made visible through scientific data (Latour, 2004). Neither does the study interpret this value-based selection on the basis of unified principles of 'nature' that have been established *outside* the representative assembly of a political ecology (Latour, 2004). This strategy was also considered unethical, in that it leaves many cultures and individuals with no recourse to representation in establishing the world in which they live (Latour, 2004).

Instead, the learning ecology framework identified generative, value-based selection operating as an ecological phenomenon (incorporating human and nonhuman dimensions) that progressively and democratically established its *own* values for selection, based on the current *best guess* of the collective (that is, the *common world*, after Latour). Recognising a 4^{th} heuristic level of generative learning thus acts to unify the previously distinct realms of cultural/group *learning* (for example, Popper, 1968, 1970; Chitpin & Evers, 2005) and the environment (as a unified 'nature').

In this new view, environmental forces are still considered to influence selection at the first three heuristic levels (after Edelman, 1992, Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000). However, at the fourth heuristic level, selection occurs through *due process* in a political ecology (as summarised in Chapter 2), so as to adequately *represent* (in an ecological *representative assembly*) both the human and nonhuman realms.

As a theoretical implication arising from this study, the veracity of this speculative view remains to be tested in further studies and research contexts, especially those which aim to address a similar ethical foundation for collective learning. Yet, from a pragmatic perspective, the unifying power of a fourth-level heuristic (as described in the previous paragraph) may have implications for research and collective knowledge building. As Latour contends (2004, p. 45):

> *From this point on [here, parties] can no longer be defined as different cultures having distinct points of view toward a single nature- to which "we" [here, researchers] alone would have access; it becomes impossible to define them as cultures among other cultures against a background of universal nature. They are… collectives that seek to know...what they may have in common.*

In essence then, the addition of a fourth-level generative heuristic offers a means of addressing ethical and theoretical challenges relating to collective learning (as identified in Chapter 1), by integrating them into a single pragmatic framework. In the following section, I expand upon the pragmatic implications arising from the study.

11.3 Designing Collective Teacher Professional Development and Research: responding to the pragmatic challenge

Design-based research (as summarised in Chapter 4) provided a pragmatic, yet principled, basis by which to test the learning ecology framework, for its ability to interrogate the collaborative learning of teachers in a participatory teacher development context. In keeping with the pragmatics of design-based research, the study's findings, whilst speculative and limited, aim to inform the future design of research and teacher professional development.

I thus conclude my account by interrogating my study for six key epistemic values (after Fletcher, 1995): its unifying power, its simplicity, its internal coherence, its external coherence, its fertility and its predictive accuracy. These values provide benchmarks for viewing my study's shortcomings and for suggesting avenues for further research and teacher development.

11.3.1 The unifying power of an ecological account of learning

By depicting networked professional learning as an ecological (re)formulation and verification of what “various [local and global] propositions have in common” (Latour, 2004, p. 247), this study may provide insight into the complexity of studying and enacting democratically-principled *learning systems* (Baraniuk, 2006; Snyder & Wenger, 2004; Bentley, 2003; Laszlo, 2003; Banathy, 2000).

For example, the study's findings suggest the educational worth of discerning, analysing and supporting the complex *synergy* that may exist between:

- community-based investigation;
- participatory design;
- network-situated collective understandings and strategies (or attractors); and,
- the collaborative operation of e-learning environments.

It was necessary to interrogate how this complex synergy was occurring, in order to *represent* the epistemic dimensions of collective learning in the DESCANT network adequately (as discussed in 11.1). Nevertheless, in this regard, the study’s data set was still limited in its ability to represent the enormous complexity underpinning each of these collective acts.

Building upon this work, future research may aim to represent the complex synergy identified above more adequately, by capturing more and different data about these various acts of collectivity. In particular, targeting the *learning synergy* between participatory teacher design and the pragmatic experimentation that may occur in online and school-based networks (including individual classrooms) may be informative for understanding the complex learning ecologies underpinning participatory teacher development.

This recommendation supports existing calls for more adequate teacher participation in the design of learning environments (Konings, Brand-Gruwel, van Merrienboer, 2007; Barab, MaKinster & Scheckler, 2003). In this regard, the study confirms that teacher populations are capable of contributing powerful educational designs well beyond the more common (yet still valuable) web-based sharing of unit plans, lessons and resources (for example, Baraniuk, 2006). This may act as a reminder to educational researchers and participatory teacher educators of the need to attend to the potential of web-based networks to harness the rich, *ecological* dimensions of teachers' knowledge and learning.

Whilst web-based networks are undoubtedly valuable as resources for meeting the day-to-day demands of teachers (Baraniuk, 2006), understanding their value for *transformative* teacher learning and systemic reform may require supporting and researching how participatory learning can establish, and be informed by, web-based ecological learning *niches* in education.

11.3.2 The simplicity of an ecological account of learning

By harnessing the *self-similarities* of learning across biological, personal, cultural and network domains this study's ecological account of collective learning achieved a limited degree of simplicity.

Theoretical physicist Gell-Mann (2007) recently used the metaphor of layered onion skins to describe how self-similarity across levels of explanation unifies and simplifies theory, making it more beautiful:

> *…each skin of the onion shows a similarity to the adjoining skins so the mathematics for the adjoining skins is very similar to what we need for the new one, and therefore it looks beautiful because we already know how to write it in a lovely concise way.*

In a similar vein, this account revealed self-similarity of learning across nested and coupled networks (Davis & Sumara, 2006), in particular, of generative learning - across biological, personal and cultural realms (Edelman, 1992, Plotkin, 1994, Schaverien and Cosgrove, 1999, 2000). Extrapolating from existing learning theory (in particular, generative theory and complexity sensibilities) became pragmatically possible, establishing an 'adjoining skin' that serves a new purpose: in this case, to explain and support learning as a complex political ecology (Latour, 2004).

The study's findings suggest that the 'adjoining' learning ecology layer, as a speculative realm of collective learning, did have self-similarity to existing learning theory, thus strengthening the veracity of its claim (Gell-Mann, 2007). Further research is necessary however, to establish if this self-similarity would exist in other research contexts and teacher development networks. It remains uncertain, for instance, how DESCANT's focus on Science and Technology education (including the generative theory itself) may have influenced the types of political ecologies that emerged in this case study.

Further work is therefore necessary to establish if a political learning ecology is discernible in other research contexts, and if so, how it may progress in ways other than through the *generative, value-based selection and articulation* described in this study. Situating this research in, for instance, literature and literacy education or the arts, may indicate if the exogenous and endogenous constraints and affordances of another subject area (as a complex network, or political ecology) may lead to a differing co-existence between local and global dimensions of learning and knowledge.

11.3.3 The internal coherence of an ecological account of learning

Ultimately, the worth of such research may be derived, not from its capability to simplify or unify explanations of collective learning across domains or research contexts, but rather from its capability to sensitise the field to *differences* that may remain obtuse in other accounts (Latour, 2004).

From the perspective of political ecology (Latour, 2004), the internal coherence of this study's account of collective learning represents a measure of its capability to *sensitise* educational researchers and designers of teacher development, to patterns of professional collectivity and learning that may remain obtuse within more individualistic accounts and strategies.

For example, the study's ecological account of learning may help sensitise others to the (creative) tensions that may exist between the ecology of online networks (including their intellectual, cultural and environmental dimensions), and school-based ecologies (as expressed online). The study's findings suggest that developing sensitivity to this ecological aspect of collective learning (as it exists *across* nested and coupled levels) may foreground where important *correspondences* exist in teacher networks.

For instance, a Learning Ecology analysis revealed a novel correspondence in the DESCANT network between:

- *patterns of interaction* (for example, maintaining professional perplexity/uncertainty);
- intellectual and geographic distance (or *proximity*); and,
- the propensity for local school-based groups to undertake *transformative* professional shifts, in line with the aims of systemic reform.

The veracity of this network characteristic remains to be tested as a part of further design-based research in complex nested teacher networks. Nevertheless, developing sensitivity to this correspondence may inform the design of future design-based initiatives by suggesting the value of bounded and distributed contexts for professional development. Such learning networks may support *transformativ*e collective professional development that is capable of progressing both local and global educational ecologies by destabilising *both*, within supportive *collision spaces* (Rogers, 2004).

Such an avenue provides an example of how an ecological approach to the study of collective learning may inform educational research and the design of teacher development, by "…triggering arrangements that are sensitive to the smallest differences, [in contrast to those articulations] that remain obtuse in the face of the greatest differences" (Latour, 2004, p. 86). In this respect, this study's findings are limited in scope. Nevertheless, from the pragmatic perspective of design-based research, its ability to inform is experimental and principled. Ultimately then, this study's formulation of collective learning is itself an experimental proposition, a candidate entity serving to "articulate the [research-based teacher development] collective" (Latour, 2004, p. 213) and sensitise it to difference.

11.3.4 The external coherence of an ecological account of learning

By making sense of teacher development as a learning ecology, this study supports fundamental conceptual reformulations that underpin social and cultural accounts of cognition and learning, in education and beyond.

By depicting professional collectivity as an ecological phenomenon, this study's empirical account of learning established explicit connections between:

- individual and group learning;
- the human subject and the objective entity (for example scientific data);
- the environment and the learner; and
- the realms of culture and the environment.

In doing so, this ecological account corresponds with the increasingly pervasive DEEDS literature, "… a loose and internally fluid philosophical and empirical coalition comprising the **D**ynamical-, **E**mbodied-, **E**xtended-, **D**istributed-, and **S**ituated- approaches to knowledge and cognition" (Marsh & Onof, in press, p. 2).

Of particular relevance in this regard, may be this study's empirical illustration of the *co-evolution* between the collective learning of DESCANT's population, and the shifting terrain of its e-learning environments (or learning niches). The learning ecology framework interpreted this co-evolution as a distributed and situated learning phenomenon in which adaptive professional strategies (and values) were represented both *conceptually* and *materially* across various parts of the DESCANT network.

This approach coheres with Stahl (2006), who recently utilised a mediated and distributed conception of learning to establish a theory of group cognition that is associated with Computer Supported Collaborative Learning (CSCL). In this view, cognitive and cultural artefacts (such as collaborative learning environments) are conceived as mediating both collaborative *and* individual knowledge building, through the affordances designed into them (Stahl, 2006, p. 326). Cole (2007) promotes a similar conceptual reformulation in viewing an artefact as:

> *…an aspect of the material world that has been modified over the history of its incorporation in goal directed human action. Artefacts are simultaneously ideal (conceptual) and material. They emerge in the process of goal directed human actions. They are ideal in that their material form has been shaped by their participation in the (successful, material) inter-actions of which they were previously a part and which they mediate in the present.*

The findings of this present study suggest that such conceptual reformulations may be particularly fertile for studying and supporting the co-evolution of community-based teacher development and participatory design (for example, Barab, Mackinster & Scheckler, 2003). Harnessing the expanding DEEDS literature (Marsh & Onof, 2007) for this purpose may help discern, for instance, how the *group* and *cultural* dimensions of generative collective learning (as occurring at its 3rd heuristic level) may be dynamical, embodied, extended, distributed, and situated.

However, this account has gone one step further in conceiving learning as a collective, distributed and situated phenomenon. It has illustrated the value of *pragmatically* removing the distinction between learners, and the artefacts (conceptual and material) that are mediating their learning. Doing so within open knowledge-building systems (Gibbons,

1999) may overcome the epistemic weakness of *teacher-generated* ‘artefacts’ (conceptual and material) in their *collision* (Rogers, 2004) with systemic and scientific ‘facts’.

As Latour (2004, p. 87) laments, "Inanimate objects [and artefacts], do you then have a soul? Perhaps not; but a politics, surely.”

11.3.5 The fertility of an ecological account of learning

The learning ecology framework may prove fertile for its capability of depicting the political ecology underlying three pragmatic dimensions of democratically principled *learning systems*: 1) their action-learning capacity, 2) their cross-boundary representation, and 3) their cross-level linkages (Snyder & Wenger, 2004).

As has been indicated in previous sections, the study's account of collective learning worked to identify in DESCANT:

1. An ecologically-situated *action learning capacity*, for discerning and addressing salient professional concerns across its population, including a means by which to reshape the environment itself, based on valued solutions. This network learning capacity harnessed cohort investigation, school-based professional collaboration and classroom experimentation.
2. *Cross-boundary representation*, as an ecological *network of associations* between its human population (including teachers, school-based groups, academic groups, consultants and executives from the DET) and its non-human population (including e-learning environments, data sets, knowledge bases and e-learning orientations to Science and Technology education).
3. *Cross-level linkages*, as an ecological interplay and negotiation between locally-situated and globally-situated knowledge and learning, occurring across the nested and coupled network.

Snyder & Wenger (2004) identify these three network characteristics as essential design specifications for establishing a *world learning system* that is capable of responding to complex, dynamic and distributed global challenges:

> *To address such challenges, we must increase our global intelligence along several dimensions: cognitive, behavioral, and moral. We must increase, by orders of magnitude, our societal capacity for inquiry; our ability to continuously create, adapt, and transfer solutions. A world learning system that can match the challenges we face must meet [these] three basic specifications [action learning capacity, cross-boundary representation, and cross-level linkages.]*

This case-study of a small teacher development network is clearly limited in its capability of informing such a systemically ambitious 'world learning system' as that proposed by Snyder and Wenger (2004). Nevertheless, the study's findings (with regards to the three criteria above) suggest that DESCANT may offer a design-based research strategy and teacher development model that enacts Snyder and Wenger's (2004) vision. Moreover, the study identified where professional learning was occurring across various levels of DESCANT, as co-evolving political ecologies (Latour, 2004) that incorporated cognitive, behavioural and moral (or ethical) dimensions, as specified by Snyder and Wenger (2004).

This suggests the fertility of trialing a scaled-up version of the project for its worth as a strategy for increasing "by orders of magnitude [education's] capacity for enquiry; our ability to continuously create, adapt and transfer solutions" (Snyder & Wenger, 2004). A decentralised and intergenerational e-learning environment such as the DESCANT Colony may be necessary to scale up a similar participatory strategy, given the need to support *and represent* the learning of larger numbers of teachers, school-based groups and cohorts. In this regard, the limitations of the DESCANT strategy leave many important challenges to be addressed, including:

- The technical challenge of remotely supporting the IT and multimedia concerns of teachers, most of whom are far less technologically savvy than the computer-literate students they teach. The DESCANT project continued to struggle with the logistics of this challenge, and there remain systemic challenges for affording such support within a scaled up trial.

- The logistical challenge of supporting the professional learning of bounded, yet also distributed, professional groups. Whilst the DESCANT Colony represented an increasingly decentralised learning environment, there still remained a role for online moderators. Again, there are systemic implications for meeting such support requirements.
- The systemic challenge of providing adequate time (and thinking space) for teachers to engage deeply with novel ideas, professional strategies and collaborative activity. This remained a continual concern throughout DESCANT, even though teachers were allocated release time from their normal professional duties. Any future initiative may need to deal more adequately with the crowding out of this allocated time by other professional responsibilities. One response may be to engage more actively with existing school-based professional communities, thus avoiding conflicts of interest (Parr & Ward, 2006).

From a network learning perspective, these pragmatic challenges relating to institutional sponsorship and technical support can be associated with collective learning at a systemic and organisational level (Wenger, McDermott & Snyder, 2002). The learning ecology framework might usefully be used in a scaled up version of DESCANT, to study the collective learning that may occur at an organisational level, as these challenges are addressed. This study’s findings suggest that potential changes may well correspond to complex political ecologies that will inform and be informed by the local and global dimensions of knowledge and learning in education, but exactly how, at scale, remains to be seen.

11.3.6 The predictive accuracy of an ecological account of learning

By depicting how teachers' collective understandings became represented in the DESCANT Colony (as a learning ecology), this study's findings suggest the potential of e-learning networks to *model* systemic professional learning.

This study's ecological analysis worked to discern how the individual and collective learning of DESCANT participants gradually became represented in the DESCANT Colony. The study also illustrated how this learning was represented in different forms, and with different levels of fidelity. For example, the population's *collective intelligence* was represented on the Learning Landscape as a dynamic *best guess* regarding which videos and texts were most powerful for professional learning. In contrast, the Culminating Tasks of teachers were found to represent the understandings of both individuals *and* school-based collectives.

These finding may have pragmatic implications for utilising e-learning environments to understand and support the professional learning of teacher *populations*. By portraying the individual and collective understandings of teachers through rich political ecologies (Latour, 2004), such environments may indicate which professional concerns, strategies, questions, student conceptions, or orientations to learning and teaching are currently being valued or neglected across teacher populations.

Moreover, if (as this study's findings suggest) such environments are capable of distilling the *collective intelligence* of populations (whether school-based groups, cohorts or distributed populations), there may be value in studying their worth as a resource for modelling the *expectant states* of professional networks. This research agenda would correspond with contemporary network strategies which utilise the collective intelligence (Surowiecki, 2004; Rheingold, 2001) of distributed populations to generate emergent solutions through online recommender systems (Newman, 2005; Resnick & Varian, 1997; Goldberg, Nichols, Oki & Terry, 1992).

Within complex educational systems, prediction is typically conceived as problematic due to the non-linear, emergent and self-organising dynamic operating across nested and coupled levels (Csermely, 2006; Davis and Sumara, 2006). However, the requirements of designing, supporting, understanding and harnessing complex systems within our increasingly networked societies makes such predictions a pragmatic, if not theoretical, necessity. The notion of predicting may be replaced however, by the notion of establishing *expectations, or best guesses* on the basis, for instance, of evidence-based understanding of the *principle driving forces* within such systems (Axelrod & Cohen, 2000). This pragmatic approach is also in keeping with the experimental sensibilities of design-based research (as summarised in Chapter 4).

Currently, the potential for using (democratically-principled) educational recommender systems to distil *best guesses* that are predictive of collective trends or systemic requirements remains to be established. This present study only touched upon this potential through its demonstration of how collective understandings become distilled within an e-learning environment. Further research is necessary to interrogate the value of the collective patterns of valuing that may emerge within large distributed networks that include some mechanism for evaluation (Ravitz and Hoadley, 2005).

A promising innovation in this respect is the advent of large web-based educational networks that incorporate dynamic peer-review that extends more basic systems of ratings and evaluations (Baraniuk, 2006). Increasingly sophisticated peer-review systems, when coupled to participatory teacher development and design (as discussed in this study) may provide a fertile context for studying professional learning as a learning ecology that can intelligently represent itself.

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Through this investigation I set out to enquire into the nature of teachers' collective learning. In the process however, a more encompassing conception has emerged of collective learning, one that has at its heart the notion of *representation*. If Education is to progress its understandings of the world through truly democratic means, then adequately representing the *voices* of all parties becomes a collective learning process in itself.

Ultimately however, representation may need to be earned on the merit of these voices: that is, on the clarity by which they can portray what no other voice can. *There*, lies the work of those who speak in the representative assemblies of Education, and those who support them to do so. For in establishing a common world through democratic means, not all collectives are equal:

> *We shall say of a collective that it is more or less articulated, in every sense of the word: that it "speaks" more, that it is subtler and more astute, that it includes more articles, discrete units, or concerned parties, that it mixes them together with greater degrees of freedom, that it deploys longer lists of actions. We shall say, in contrast, that another collective is more silent, that it has fewer concerned parties, few degrees of freedom, and fewer independent articles, it is more rigid.*
>
> *Latour (2004, p. 86)*

Appendix 1

Plans and Support Documents

Appendix 1.1
Introductory Workshop Plan

DESCANT (SCIENCE AND TECHNOLOGY)

MONDAY 4TH AUGUST 2003
Venue: DET District Office

9.00-9.30 Meet the other team members over coffee

PARTICIPANTS: Lyn Schaverien, Lachlan Forsyth, Gill Mulholland, James [NSW DET], Louise [NSW DET], Ingrid, Katrina, Cathie, Angela, Vaughan, Rob, Kerrie, Kathryn [NB: The names of four attending teachers who later withdrew from DESCANT are not shown here, as permission was not obtained to use their names.]

9.30 – 10.30 Round table discussion

10.30 – 11.00 Webboard preparation. For the next session you will need to have a valid email address, be registered on the board and have something to attach, all of which will be taken care of in this session. Please bring your current email address if you have one.

11.00-11.30 MORNING TEA

11.30-1.00 Introduction to Webboard. The webboard will be the main vehicle for our vitally important conversations over the rest of the term. The purpose of this session is to ensure everyone understands their role in that discussion and is able to participate fully.

1.00-2.00 LUNCH

2.00-3.30 The Generative Virtual Classroom. In this session we will be exploring this e-Learning environment, which Lyn has been using in her work at UTS.

<u>In preparation you might want to think about:</u>

- Recalling our conversations from last week, what would you like to add, revisit, share with the rest?
- What initial visions or hopes do you have of what we're doing?
- A child's "aha! moment" in science and tech, a point where you were aware that lights had gone on, new realizations had occurred, something had suddenly clicked.

Appendix 1.2
E-learning Immersion Plan

DESCANT timeline (August to September 2003)

This timeline summarises our ideas about a broad framework within which our community might work over the next few weeks, as we prepare for the design of an e-learning environment for teacher professional development in K-6 Science and Technology.

Date	Activity/conversation	Comment
Aug 4-8	GVC immersion: views of learning	With reference to intellectual quality – deep understanding/learning
Aug 11-15	GVC immersion: views of learning (extension)	With reference to DET/QTP syllabus definitions
August 18-22	GVC immersion: views of learning (extension)	Encouraging evidence-based dialogue.
Aug 25-29	GVC immersion: views of technology Professional development needs.	Understandings of Technology What are OUR p.d. needs?
Sept 1-5	GVC immersion: views of technology	
	PD needs including e-learning focus.	How might these be served through e-learning approaches?
Sept 8-12	Examine other e-learning environments for teacher p.d.	Critiquing ILF in relation to community PD needs and design ideas.
Sept 15-19	Research/ reflection focus: Evidence-based investigation and focused digest.	Investigation of e-learning resource of choice: using evidence-based research tech.
22-26	Teacher preparation for DESCANT workshop day	Good ideas for e-learning environment – report to DESCANT community to share at workshop day.
15 Oct	DESCANT workshop day, and follow-up conversations with teachers through school visits – to flesh out design ideas	Preparation of a community storyboard for an e-learning environment for professional development

Appendix 1.3
1st Design Workshop Plan

DESCANT (SciTech) Workshop 2: October 15, 2003
DET District Office

Goal for the day: To crystallise ideas about our e-learning environment, by day's end, in the form of an initial agreed draft storyboard design and to plan a draft strategy for prototyping it.

Plan for the day

9.00-9.30	Participants arrive ready for a 9.30 sharp start. Welcome! Introductions…
9.30 – 10.30	Begin to distil our purposes for our design: Building our design on our understandings of how we (as teachers) learn. • Unpacking the design principles that underpin the GVC and others in its family of e-learning environments and • Setting alongside these, a range of initial ideas about purpose we expressed in our webboard discussions.
10.30-10.50	Describe our first task: Refining purposes for our e-learning environment and indicators by which we might gauge success. After morning tea, split into two halves: • to critique purposes – add, modify, delete, move around – and check for accuracy • to prioritise purposes – choose no more than three as highest priority for our prototype e-learning environment for teacher professional development in K-6 science and technology • to write up a small set of indicators that might allow us to check for achievement of these purposes
10.50-11.05	Morning tea break
11.05-11.45	Work in two groups to produce a small set of key purposes and indicators for the environment we want to design (as described prior to morning tea) – for whole-group discussion and decision-making.
11.45-12.00	Whole group – consolidation of small, key set of purposes and indicators for our environment.
12.00-12.30	Learning models – starting points for designing our environment: Syllabus flowcharts (the investigating process and the design process) (GM) and the generative model and theory.
12.30-1.15	Lunch
1.15-1.45	In two groups, draft an initial e-learning design to achieve priority purposes, selecting each component according to its worth for teacher learning. Refer, if needed to: • Evidence from our own learning and teaching experience (including that discussed on webboard) about how teachers learn best; • Interactive teaching sequence – an approach we might use as a basis for building our e-learning environment back in our schools (LS); • Other e-learning environments (LF).
1.45-2.15	Consolidate the two groups' designs through whole group discussion.
2.15-3.15	Devise a strategy, as a timeline/action plan, for building this design.
3.15-3.30	Concluding comments, questions, issues, thanks… Distribute copies of planning process to all participants. Safe trip home!

Appendix 1.4
Professional Needs Support Document: three nested purposes

1. Sabbatical Purpose

To provide a sabbatical for teachers:

- Other practices
- Fresh approaches
- New ways of thinking
- Excursion – trip away
- Resources, ideas

NB: Webboard references in italics refer to thread titles, as opposed to conference titles.

Webboard	Other practices	Transcript
Our Professional Development Needs. Ingrid 26/8	Sharing and discussing ideas/ practices etc through professional dialogue with other schools.	"I'd like to see what's happening in other schools and how other teachers are approaching this subject - what else is being done out there???? And do I need to rethink my own style of teaching."
Katrina 28/8		"…I really think hearing about how other schools have successfully organised resources and programmes and simply taken the fear factor out of teaching things that could be a bit on the scary side, would be beneficial."
Original Workshop: Learning and the GVC *Reflecting on the A-Ha! moments* Kathryn 15/8	Reflecting upon previous professional development and training in the context of sustained professional dialogue.	"… I agree with you …I remember doing a course with my degree about Oral children's learning and we had to tape ourselves…"

Webboard	Fresh approaches	Transcript
Our Professional Development Needs Katrina 28/8	Rethink syllabus.	"I need to get in and pull it (The S&T document) apart and reflect on it and trial it, and not just rely on getting by with what I have already done before." (See also Gill *'Another PD need'* 14/9)
	Make links between models of	"She [Marissa from GVC]

Understandings of Technology Vaughan 28/8	learning and the syllabus.	also demonstrated that she was able to achieve UTS3.9 (...meet the requirements and constraints of investigation and design tasks.) She could only have achieved this outcome if she had developed a design, being aware of the task, tested it and re-designed the task to achieve the end she required.(gen / test / re-gen)”
Gill 29/8		“Authentic D&M is in its essential nature generative!” (See also Understandings of Technology 14/9)
<< The ILF Angela 15/9	<< eg. New ICT-mediated community approach to class-based research projects.	<< “There is an immediate need to tap into a community based approach to research rather than relying on the (sometimes) limited resources within a single isolated school”
Cathie’s Learning journey	Providing motivation for pushing outside ones ‘comfort zone’ within challenging curriculum areas.	“Technology the big “T” work has been something I have flirted with, played with the edges, learnt just enough to get by, but never really come to grips with. Descant has provided an opportunity, a motivation to push me out side of my comfort zone, to look and develop my skills.”

Webboard	**New ways of thinking**	**Transcript**
Our Professional Development Needs. Sally 17/9	Encouraging deep thinking.	“…I'm trying to get to that deep-thinking level necessary.”
Original Workshop: Learning and the GVC *The GVC and Learning* Sally and Cathie 25/8	Engaging in professional dialogue regarding models for thinking/ learning.	“We have been discussing … about having a thinking object, ie the block, in terms of concrete learning to abstract.”
Reflecting on the A-Ha! moments		“I wonder if processing through has something to do

Kerrie 8/8		with having time to think about the "event" just after it happened….Should we always give children time to digest what they have learned in a session and give them time to reflect?”
Vaughan’s Learning Journey	Reflecting on our beliefs/ practices.	“We really have reflected upon long-held beliefs, shaken them, read evidence, learnt, refined them and deeply considered the intelligent offerings of our community… I guess that’s what the old sabbatical was designed for.”
Rob’s Learning Journey		“Whilst the focus here is on children as participants in eLearning, I believe the same beliefs hold true for adults. For me, the key words are: “the opportunity to change the mix”.”

Webboard	**Excursion- trip away**	**Transcript**
Ingrid’s Learning Journey	Opportunities to experience other e-learning sites may provide stimulation for professional development dialogue.	So, I guess I've really seen the enormous potential in an ILF-based forum for teacher PD and if we can translate that potential into reality I think we'll be providing our colleagues with a very powerful and potent resource.

Webboard	**Knowledge, Resources, ideas**	**Transcript**
Our Professional Development Needs Cathie 25/8	Providing a solid knowledge base	“I feel that I need a solid knowledge base before I can let my kids explore. I'm happy to let them drive it, the learning, so long as I have a basis with which to help, guide.”
Vaughan 30/8		“We require knowledge. We are more effective if we have the knowledge or the skills to access that knowledge.I believe that as teachers or

		leading learners we are more effective if we possess the knowledge which allows us to moderate the direction of investigations; to facilitate success.”
The ILF Sally 14/9	‘Registry’ of resources	“Perhaps the provision of resources, or a registry of sources for resources is a pd need.”
Cathie 16/9		“I like the idea of some areas in the e-learning environment that can be prescriptive, and provide lessons, resources and actual videos of lessons as I think this will cater for those individuals who "need", want this type of structured environment.”

2. Mystery Purpose

To unravel the mystery of deep student learning and investigate good ways of supporting it:

- What questions/ideas/phenomena engage/are relevant to students?
- How do we find out?
- What constitutes progression?

NB: Webboard references in italics refer to thread titles, as opposed to conference titles.

Webboard	**What questions/ideas/phenomena engage/are relevant to students?**	**Transcript**
Our Professional Development Needs Sally 25/8	How to create engaging lessons	“I think I need "how to" help. I find it a bit daunting working out how to set up sessions where everybody is completely absorbed in what they're doing , provision of equipment is another issue. How do we best provide what's needed.” (see also 2nd Sept)
Ingrid 29/8		“What needs to be done to wipe the blank looks from the faces of children who

		seemingly just aren't connecting with a lesson on any level whatsoever?”
Vaughan 30/8	How do students learn?	“We require an understanding of the way students learn. We require an understanding of how we can teach students to recognise the way they learn best.”
Understandings of Technology Katrina 1/9	Gaining insight into children’s understanding of technology.	“Do the experiences that children have had in technology change the meaning of what technology is for them?”
Original Workshop: Learning in the GVC 4Mat and other models Kathryn 25/8	Professional dialogue regarding various models that may help explain student engagement and learning.	“…it is fantastic to hear how excited you are about the 4MAT course. I have not heard of that course before but I have been involved in Multiple Intelligences and Brain Gym for many years.”

Webboard	**How do we find out?**	**Transcript**
Our Professional Development Needs Vaughan 22/9	Observing how students already act upon the world, as a basis for teaching strategies.	“…recognising that we owe it to our students to observe their ways so closely we are prepared to help them 'unlearn' some of the 'stuff' we've thrust upon them because it was prudent, or convenient, or easy, or obviously within our control.”
Understandings of technology Ingrid 1/8		“Also, how relevant did your son think this [technological] ability of yours… was to him?”
Original Workshop: Learning and the GVC The GVC and Learning Cathie 18/8	Linking observation of student practice with professional development	“I couldn't agree more. I talk to myself all the time, especially when faced with a new challenge or difficult task. A group of my kids today were doing exactly that. I had

Cathie's Learning Journey	dialogue.	set a design task using the dacto lego kit. It was interesting to listen to the pair discuss their task…" "I found myself engaging my youngest son. 6yrs, in deeper conversations to test what I saw on the GVC. When he realised I was actually listening and interested he formulated complex theories and went to considerable efforts to explain his theories and relate them to his own world. I was delighted to see him doing, thinking and generating ideas as well."

Webboard	What constitutes progression?	Transcript
Vaughan's Learning Journey 30/9	Specific observations from classroom learning can provide basis for discussing student progression in s&t.	"The outstanding moment for me was probably the instance when, on the GVC, the one-so-young was able to differentiate between (referring to electricity)"what it does" and "what it actually is".

3. Content Purpose

To understand how to approach a particular content area:

- How might we teach X?
- What are significant objects to think with about X?
- How do students think about X?
- What analogies do they/we generate with respect to X?
- What activities/opportunities are powerful for teaching X?

NB: Webboard references in italics refer to thread titles, as opposed to conference titles.

Webboard	How might we teach X?	Transcript
Professional Development in E-learning Contexts Angela 23/9	Content specific components.	"I definitely agree with the notion of providing content specific components to our e-learning environment."

Understandings of Technology Angela 13/8 Cathie 10/9	Investigating what 'skills' are involved in becoming a 'technologist.' Gaining insight into the nature of technology.	"…perhaps Sci and Tech isn't delivered as well as it could be because we overlook the skills involved in technology!!!" "This taxing problem of just what is technology continues to haunt us…. Maybe it is a mind shift we need to make????"

Webboard	**What are significant objects to think with about X?**	**Transcript**
Original Workshop: Learning and the GVC A Good example of Learning (in the GVC) Vaughan 23/8	*Specific* (shared) examples of learning/teaching provide focus for pd discussion related to teaching specific domain area.	"The 'rich experiences'… as seen in the videos provide opportunities for deep conversation and deep understanding during the discussion, testing and investigation of ideas (hypotheses, I guess)."

Webboard	**How do students think about X?**	Transcript
Original Workshop: Learning and the GVC GVC and Learning Gill 11/9	Using specific classroom examples as basis for professional dialogue regarding how students think in a particular domain area.	"Coming back to this after Wednesday (I spent Wednesday pm at Strathsland in Cathie's and Sally's classes) A group in Sally's class were talking with me about their circuits…"

Webboard	**What analogies do they/we generate with respect to X?**	**Transcript**
Sally's Learning Journey	The creation and use of analogies provides a basis for understanding in both teachers and primary students	"I think of something like that spinning around in my brain when I'm trying to zero in and control my thoughts. I think about bad gateways and connections, useful and

		useless sites, spam and recycle bins. It certainly is an interesting analogy. (Perhaps a bit like the chillis in batteries)”
The Commonroom *Professional Dialogue.* Vaughan 16/8 (See also Gill 17/8)	Aspects of e-learning as an ‘object-to-think-with’ about learning	“E-mediated interaction /dialogue…benefits from the built-in opportunity for reflection before a reply the response. This is a special characteristic of what we are doing and a vital part of our teaching - providing time to ponder and reply rather than being rushed on to the next step which has been pre-ordained by the teacher.”
Kerrie’s Learning Journey	E-learning as inventing the future – an enabling technology for learning opportunities in s&t.	“I approached the Descant project with enthusiasm and excitement as it was the embodiment of a vision for the future.”

Webboard	**What activities/opportunities are powerful for teaching X?**	**Transcript**
Sally’s Learning Journey	By relating new models of learning to specific examples (ie. from video/ classrooms/ experience etc) insights can be gained into what experiences may provide powerful learning opportunities in a particular domain area.	“Without going into too many details, I believe I saw generative learning taking place on many levels during the almost 2 hour session, with the 3 year-old staying as focused as the 18 year-olds. It was most inspiring.”
Kerrie’s Learning journey	Focused investigation of student learning in a targeted curriculum area.	“I would see the GVC being most valuable to me to be tied to a specific curriculum area…”

Appendix 1.5
2nd Design Workshop Plan

DESCANT Workshop 3: 10 May 2004.
DET District Office

Draft running sheet

9.00: Welcome tea and coffee on arrival.

9.30: Brief introduction to day:

1. Purposes:
   - To refine the contexts that will accompany our video selections.
   - To firm up the e-learning environment design as a whole and each of the components we discussed in the last workshop, for developers
   - To progress ideas, incidentally over the day, that DESCANT participants are curious about – and so enrich the development process.
2. Introduction to video – *The Man Who Made Up His Mind* – generative learning video – with some very beautiful and interesting ways of helping people understand ideas. So, two aims in view:
   - More on generative learning
   - Main purpose (for today): Watch video and think about it – with a view particularly to noticing what techniques video uses to make it easier/clearer for us to learn something.

Watch Video

10.30: Very brief, general responses to the video:

- generative learning and
- techniques for helping us to understand

Look at one video excerpt – go through the process of designing some context as a whole group exercise together – first view excerpt, and then hear from designer:

1. **Why did you choose this excerpt?**
2. **What in your group experience of DESCANT enabled you to appreciate this?**
3. **What experience might evoke this insight in others?** (perhaps use techniques to help with this … whole group conversation)

Scribe this at end, on whiteboard, once context idea has firmed.

[Includes: responses to video (Sally's brain metaphor as starter– important to mention this anyway); use sheet (LF), to think about places in video where we were able to learn something by the use of a articular technique (metaphor, action, image, question, contrast, …)]

11:00 Repeat with second video excerpt.

11.30: MORNING TEA

11.45: Purpose: To firm up environment design, wholistically.

Distribute overview of generative learning – as a way of thinking about previous session and the environment as a whole.

Distribute 25 November Initial Design Ideas summary and discuss, in a whole group with a view to discussing and eventually gaining consensus on the questions/issues still open, in the following order:

1. (2) [video excerpts and contexts],
2. then (4) [culminating task] and
3. (3) [notepad and discussion forums] together – preface with Kerry's web design if possible, opening up ideas about COLLECTIVITY and how trends in the group's appreciation of excerpts that are of worth for learning might be made explicit for members.
4. Distribute LF's summary of the ideas group has assembled for (1) [self-test] at this point

Collectivity Design: Whole/ small group discussion, as necessary.

1:00: BREAK FOR LUNCH

2:00 Continue

3:00 Recap to gain clarity (and consensus) as group.

3.30: Concluding comments about where to from here?

Deadline for locking off content: 4 June.

Appendix 1.6
Phase 2 Introductory Workshop Plan

[NB: The same workshop plan was utilised, with minor changes, for all three Phase 2 Introductory Workshops.]

DESCANT Workshop: Introducing Cohorts 2 and 3: Draft 1 Running Sheet
1 June 05: Kgi Campus

9.00-9.15: Welcome – project intent – research into professional development – cutting edge – group of co-researchers – much spin off in terms of professional development – in many ways – requirement – up front – **ethics** – forms, signing – informed consent, possibility of withdrawal at any time!!!

9.15-9.45: Scardamalia quotation – little DESCANT story- introductions by way of: personal connections with quotation and project as described and current Science and Technology topics.

9.45-10.15: Little descant story –

- Project framework
- Community learning explicit
- Purpose of Colony (as Cohort1 designed it)
- Immersion – as precursor to informed understanding

10.15-11.00: Into the Colony – **Colony Views –Learning Landscape** to Video Ant-e-chamber, **view video and discuss** (commenting as discussion progresses on generative learning, specific examples of issues/concerns/challenges for Science and Technology learning, knowledge types – domain, student, self, tutorial).

11.00-11.15: Morning tea (fix logins)

11.15-12.45: In computer lab – brief walk through Colony (LF) – 15 mins?, individual exploration – with headphones – contribute to forum on video watched, introduce themselves online. Don't do Entry Survey. (GM leaving at 12 noon – so good if teachers were online by 11.30 for GM?

12.45-1.00: Payment logistics?? (Louise [DET]) Not checked yet – could be just before morning tea.

1.00-1.45: Lunch

1.45-3.00: Teachers' questions, thoughts, comments – general discussion. The following points were made at Mar 29 workshop (some relevant here):

- **Comfort in environment** - non-threatening place to develop ideas together – emphasis today on feeling at ease – responding in supportive ways to each other as we grow ideas about Science and Technology learning and teaching in the DESCANT colony.
- **Specific aims of DESCANT** – investigation of an e-learning mediated approach to K to 6 Science and Technology professional development for a large, diverse educational system – one that privileges what teachers want in their professional development. Case study of if/how it works. So, specifically –
- **Science and technology learning** – drill down to these ideas – not just looking at developing general-purpose ideas about learning and teaching – there should be some clear spin-off for teachers in improved confidence and competence in this KLA – and specifically in understanding student learning in this KLA – so the

possibility (probability) of **developing some new ways of thinking about learning generally and learning in Science and Technology in particular.**

- Looking at how teachers might **learn in cohorts** – together with others in communities/collectives and not just as individuals.
- **Ethics issues** – consent forms – for teachers and students – and anonymity/confidentiality issues surrounding this.
- **Specs:** Flash download – getting started – very important to sort issues prior to holidays.
- **Noticeboard:** There will be a flow of activities – leading towards leaving our traces in the colony **-** ratings of videos, so Learning Landscape forms, collaboratively working up a Learning Legacy within the cohort, capturing, selecting, uploading our own video excerpts and then rating these towards the end of our time in DESCANT for cohorts to come.
- **Expectations regarding contributions** (specifically with respect to **time** commitment – 5 days – **strong plea** for respect for this – importance of getting contributions from teachers to be able **to test how the environment actually works when teachers use it**.
- Teachers’ comments/questions/thoughts…
- Sincere thanks for coming on board – strong hope that people will find this professionally and personally refreshing – that there will be gain, now and in the future… Safe trip home – see you in the Colony!

Appendix 2

E-learning environments

Appendix 2.1
The Generative Virtual Classroom (GVC)

This document illustrates the central features of the GVC e-learning environment. The GVC was designed by Assoc. Prof. Dr Lynette Schaverien (based on learning theories published by Schaverien and Cosgrove (1999) and deriving from the writing of Gerald Edelman and Henry Plotkin.) The following overview is adapted from a poster accompanying the conference presentation later published as Schaverien (2000).

Background
In order to adopt innovative science and technology teaching approaches, teachers need to relinquish views of learning as occurring only by being instructed. The GVC is an attempt to help teachers succeed in resolving deep conflicts between the values underlying their existing practice and those implicit in a generative view of learning. The Generative Virtual Classroom is an interactive multimedia-based, web-delivered set of nested virtual classrooms: a primary one, in which learners are privy to children's science and technology learning and a tertiary one, in which these learners themselves are provoked, as part of a learning community, to think about views of learning.

Target Population
The Generative Virtual Classroom is intended for use by teachers and Education students (but it can also be used for other purposes by researchers and other members of Education communities, including parents), in diverse locations, synchronously or asynchronously, individually or in small groups.

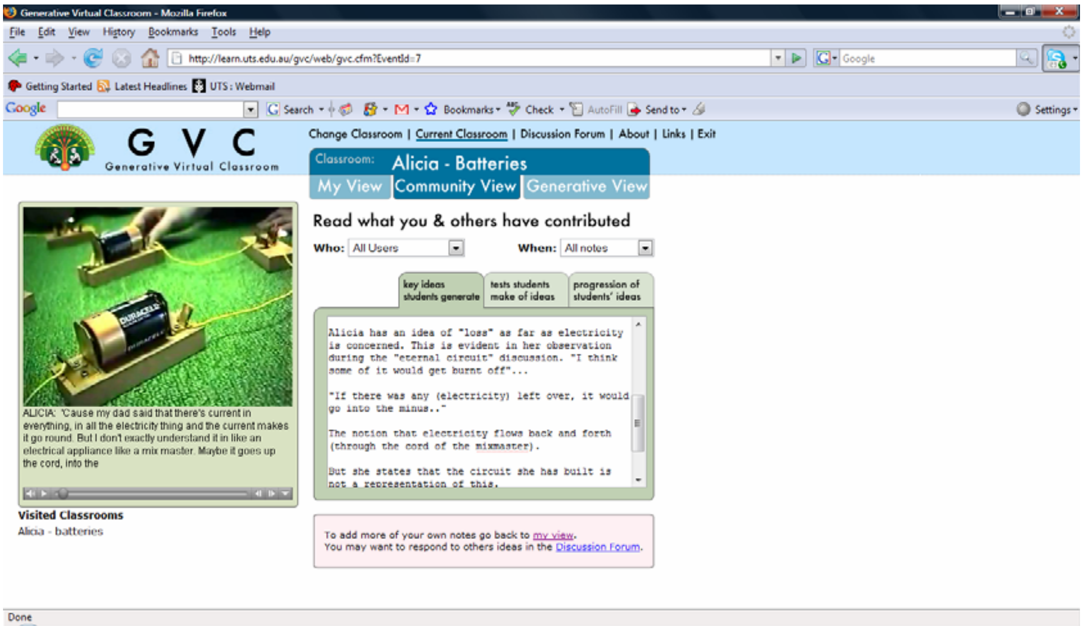
Using the GVC
In the Generative Virtual Classroom, learners observe authentic science and technology learning and teaching events, recorded in primary school classrooms, and use them as a basis for their theorising about learning and teaching science and technology. They are provoked to make their own ideas about these events explicit and challenged to think deeply about the value of their own and others' ideas in explaining the learning they see.

In the Generative Virtual Classroom students can:

• watch children learning science and technology in the virtual primary classroom;
• record their ideas about that learning and store them in a community database for learners themselves and others to access (see Appendix Figure 2.1);

Figure 2.1 Recording Your Views Here you can watch learning events, record your comments about them on a notepad, and store your ideas about key aspects of the children's learning in a community database for you and others to access.

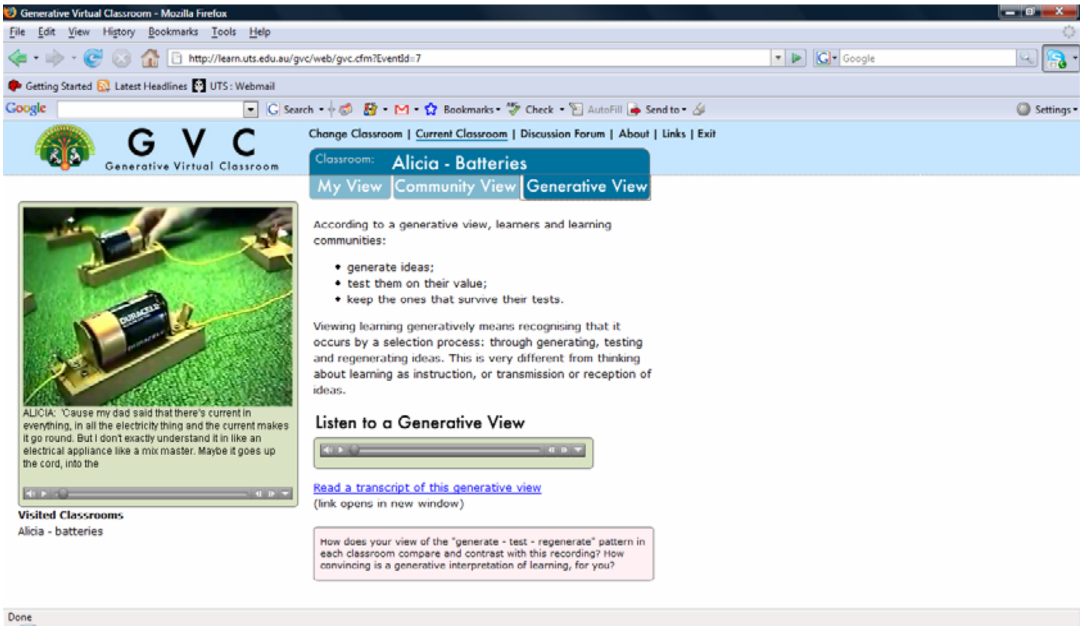
• read others' ideas about these learning and teaching events and review their own ideas over time (see Appendix Figure 2.2);



Appendix Figure 2.2 Community Views: *Here you can search the community database for other people's thoughts or your own from previous visits to the virtual classroom.*

• listen to and consider pre-recorded conversations or narratives, in which a particular (generative) view of these children's science and technology learning is presented (see Appendix Figure 2.3); and

• think and talk about learning and teaching, participating in a threaded email discussion group with other members of the virtual tertiary classroom.



Appendix Figure 2.3 A Generative View: *Here you can listen to a pre-recorded conversation or narrative about each learning event, in which a particular (generative) view of these children's learning is presented. By entering the Discussion Forum, you can participate in a discussion of ideas about these learning events with other students in the Generative Virtual Classroom.*

Appendix 2.2
The DESCANT Colony

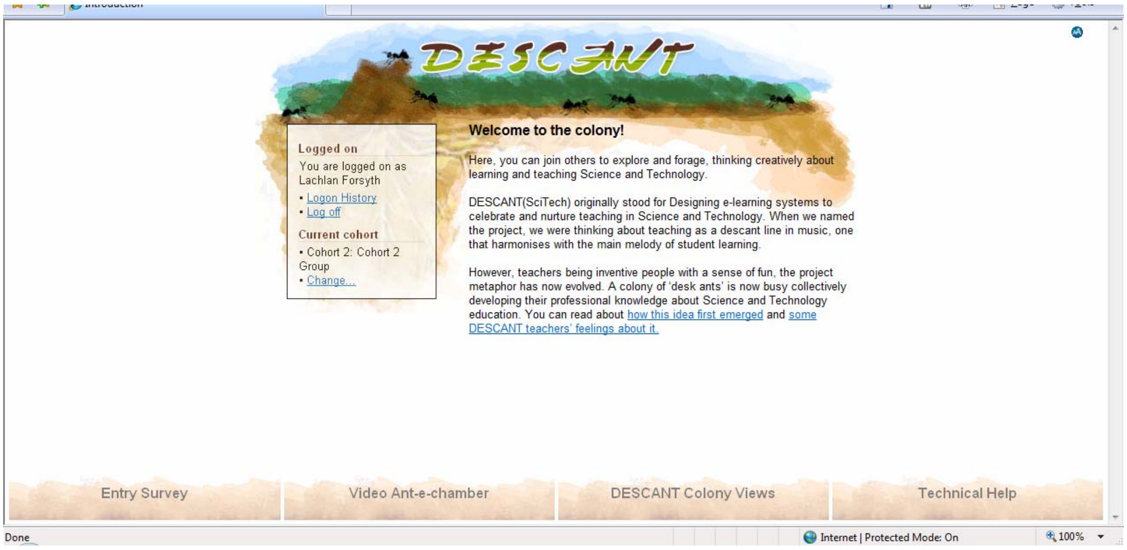
This document illustrates the central features of the DESCANT Colony e-learning environment.

Priority Purpose:

> *To understand better how we (students and teachers) learn, initially by consideration of a generative model of learning, specifically in the context of designing and making and investigating in order to improve student learning in K-6 Science and Technology.*

Homepage:

Before entering the DESCANT Colony, teachers must log in to their allocated Cohort. By restricting public access to the site, a bounded cohort structure is established in the Colony. This affords teachers a degree of privacy in their collaborative professional learning. Appendix Figure 2.4 shows the DESCANT Homepage, which is depicted metaphorically as an Ant Colony (a metaphor chosen by its teacher designers).



Appendix Figure 2.4 DESCANT Colony Homepage From this welcome page users have four navigational options (see bottom row). They may undertake an Entry Survey (for new participants), go to the main video viewing area (the Video Ant-e-chamber), enter a more general purpose communal area (Colony Views) or access technical support.

On entering the Colony, new participants are encouraged to undertake an entry survey.

The Entry Survey

A short survey taps the initial interests of new participants, addressing some of their expectations and questions about what they will do once they enter the Colony.

Having undertaken the entry survey, participants can engage with the Colony at two nested levels:

1. By choosing to access Colony Views or
2. By entering the Video Ant-e-Chamber

They can toggle between these levels at will.

Entering the Video Ant-e-Chamber

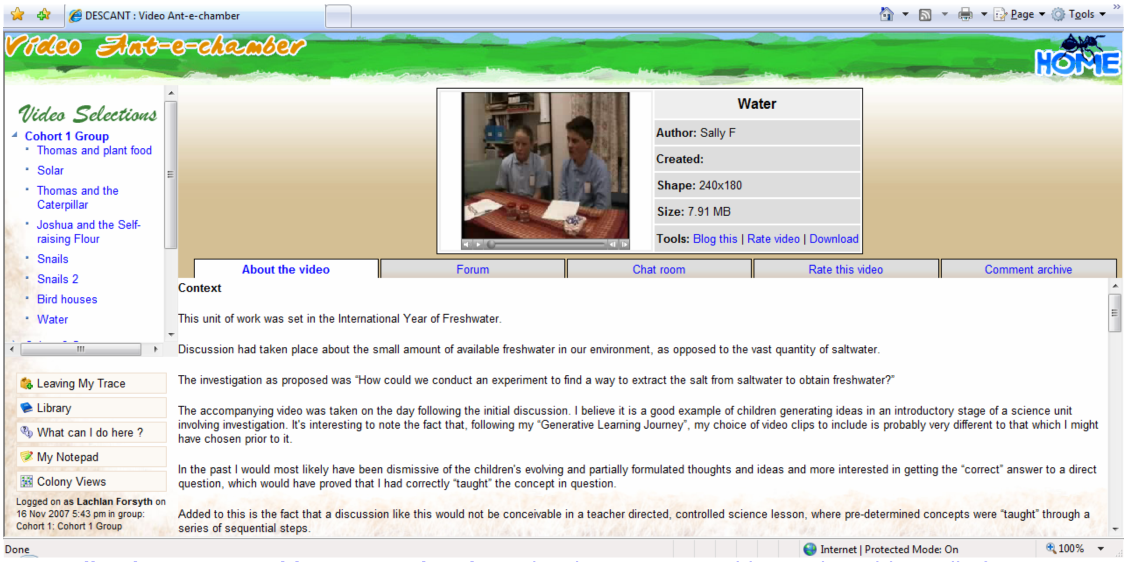
It is in the Video Ant-e-Chamber that teachers can think in fine-grained ways about the particular Science and Technology learning events that previous cohorts have left as traces of their own journeys.

Here, users can:

- View and review video excerpts of learning events videoed in the classrooms of teachers in previous cohorts;
- Read and consider accompanying texts these teachers have written discussing their videoed learning events;
- Participate in moderated online forums and chats with other learner-teachers in their cohort, to discuss the learning events they see;
- Rate and comment on the videos, for their worth in helping them understand aspects of Science and Technology learning and teaching;
- Make private notes of their thoughts about these learning events in a personal blog (or ‘Notepad’).
- Visit the library, containing useful documents, links and resources contributed by the DESCANT community.
- Upload a classroom video excerpt and accompanying text, as part of their Culminating Task. This is referred to as ‘leaving a trace’ for future DESCANT participants.

Towards the end of their DESCANT journey, teachers are expected to leave their ‘trace’ by capturing on video a learning event in their own classroom, writing an accompanying text for it, and uploading these to the Colony for others to view. This came to be known in DESCANT as the ‘Culminating Task’. Each Culminating Task seeks to highlight a progression of ideas regarding Science and Technology practice, one that is a consequence of teachers’ work in the Colony.

When a teacher uploads a video to the DESCANT Colony, a dedicated Video Ant-e-Chamber page is automatically generated for this new addition. In this manner, the e-learning environment establishes a collaborative space to investigate and discuss each video and text. Appendix Figure 2.5 shows the Video Ant-e-Chamber page for ‘Water’, a video/text authored by a Cohort 1 teacher. Users can view any video that has been uploaded to the DESCANT Colony, discussion forums and chat rooms are cohort specific.



Appendix Figure 2.5 A Video Ant-e-Chamber, showing ‘Water’, a video authored by Sally from DESCANT Cohort 1. Sally’s Accompanying Text is also open for viewing in the lower half of the screen. Having read this Accompanying Text, users may use this same space to participate in forums, chat rooms or other activities.

DESCANT participants are also expected to consider and rate the Culminating Tasks of their own and subsequent cohorts. This rating is typically not undertaken until the end of their DESCANT journey, so as to utilise any new insights, understandings and perspectives on Science and Technology education. Appendix Figure 2.6 depicts the rating/evaluation section of the DESCANT Colony.

Appendix Figure 2.6 Ratings and Evaluation. In this example of the ratings/evaluation section of the DESCANT Colony, the user is asked to judge the worth of Sally's Water Culminating Task on the basis of criteria specifically related to student learning in Science and Technology education.

Users rate and evaluate videos on the basis of seven criteria. In each case, teachers are asked, 'To what extent does this video help you make sense of':

1. How students generate ideas in Science and Technology
2. How students test the worth of their ideas in Science and Technology
3. Any progression of the students' scientific and/or technological ideas during this event – that is, how students regenerate their ideas once they have tested them
4. How students investigate scientifically
5. How students design and make
6. How students learn in Science and Technology
7. How to teach Science and Technology

A four point Likert scale is used for teacher ratings in each of these seven criteria. A text box also allows users to indicate the reasons for their ratings. By accessing the 'Comment Archive', users can see the ratings/evaluations of DESCANT participants from any Cohort. This provides users with a means of accessing the ideas, understandings and values of teachers in previous or current cohorts.

Accessing Colony Views

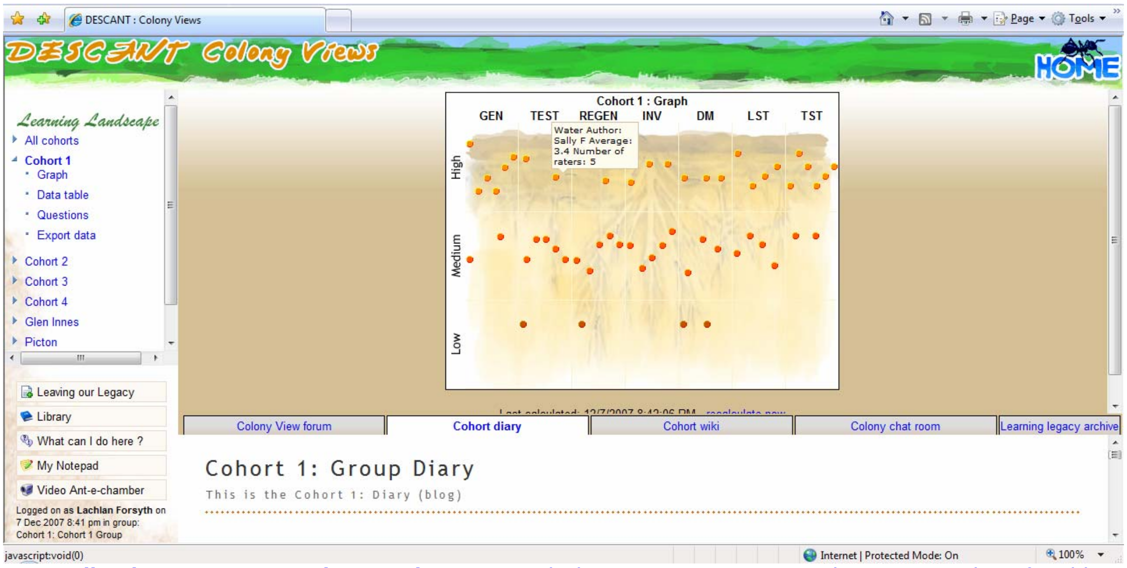
It is in the Colony Views that users gain insights into the *collective* thinking of cohorts that have gone before. It is also here that teachers work together with their current cohort to frame up their cohort's understanding and expression of the worth of their DESCANT journey.

Here, users can:

- Access Learning Landscapes from previous cohorts of learner-teachers (see description below).
- Read and consider Learning Legacies of previous cohorts: collaboratively written text descriptions of the worth of their DESCANT Journey;
- Participate in moderated online forums and chats with others in their cohort, to discuss ideas about Science and Technology learning and teaching that transcend particular videos;

- Contribute to a cohort diary (in the form of a group blog), with a view to forming a collaborative text (through a cohort wiki) describing and analysing the worth, for the cohort, of their DESCANT Journey.

Appendix Figure 2.7 provides an example of a Learning Landscape. Each Learning Landscape graphically represents the *value* that teachers and cohorts have assigned to classroom videos and texts. Each Learning Landscape, is generated on the basis of a dynamic rating system. Teachers rate each video using a series of criteria related to learning and teaching in Science and Technology (see Ratings section below).



Appendix Figure 2.7 A Learning Landscape. Each dot, or trace, represents the current rating of a video on one of the seven criteria. In this example, the Learning Legacy (or wiki text) of Cohort 1 is open in the lower part of the screen. This text gives teachers from other cohorts some idea of the perspectives, values and understandings that may have underpinned the ratings on the Learning Landscape.

Participant ratings are aggregated on the fly, so as to plot each video depending on its mean score on each criterion. The Learning Landscape enacted teacher-designers' need to pass on knowledge about the perceived value of learning events to future cohorts. Quantitative data passed on through the Learning Landscape is complemented by text, generated at the level of the cohort (through the Learning Legacy) and the individual (through the Comment Archive.) The Learning Landscape was conceived as a way of assisting teachers to find pathways valuable to them in a busy DESCANT Colony.

Appendix Figure 2.8 (following page) shows how, by clicking on a trace in the Learning Landscape, users can bring up a direct link to the corresponding video in the Video Ant-e-Chamber. The floating box also shows the video's rating statistics across all seven criteria.

Appendix Figure 2.8 Navigating using the Learning Landscape. By clicking on the trace for Sally's water video on the Learning Landscape, a user is shown more rating statistics for that video. This also provides a direct link to Sally's Culminating Task in the Video Ant-e-chamber (see bottom of pop-up window). Users may watch 'Water' in the floating pop-up box depicted here. Yet by navigating to the Video Ant-e-Chamber dedicated to Sally's video (using the link at bottom), they are able to participate in discussion forums and chat rooms related specifically to this Culminating Task.

In the Colony Views, each cohort also uploads an agreed text description of their collective thinking about their DESCANT Journey at the end of their time in the Colony, called the Learning Legacy. This text is stored in the Legacy Archive for future cohorts. The Learning Legacy text aims to complement the graphical Learning Landscape composed on the fly within the system as cohort members rate videos.

Appendix 3

Ethics Forms, Protocols & Participant Pseudonyms / Titles

Appendix 3.1
Teacher and Consultant Consent Form

UNIVERSITY OF TECHNOLOGY, SYDNEY
CONSENT FORM (TEACHERS AND CONSULTANTS)

I ____________________ *(participant's name)* agree to participate in the research project *Researching the design and implementation of systemic, sustainable, school-based teacher professional development in K-6 Science and Technology using e-learning approaches* being conducted by Dr Lynette Schaverien (UTS: Education, PO Box 222 Lindfield, NSW 2070, Ph: 9514 5077), [Details of NSW DET Partners removed to ensure confidentiality.]

I understand that the purpose of this study is to explore, prototype, research test and scale up teachers' and consultants' ideas for e-learning mediated professional development in K-6 Science and Technology.

I understand that my participation in this research will involve conversational interviews with other project team members about learning and teaching, video- and audiotaping lessons and discussions, preparation for and participation in project-related learning, teaching and researching events in and out of class, participation in developing new e-learning systems and electronically mediated collaboration with other participating teachers and consultants. (I understand, too, that it will be possible to identify me from videotapes.) Though most commitments will occur in school time, there will be occasional after-school meetings and some travel may be necessary to other participating schools and districts or for research presentations.

I am aware that I can contact Dr. Schaverien if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason and without any effect on my professional standing.

I agree that Dr Schaverien (and/or another named partner investigator, as appropriate) has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me by name.

____ ____/____/____
Signed by

____ ____/____/____
Witnessed by

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Susanna Davis (ph: 02 - 9514 1279, Susanna.Davis@uts.edu.au). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix 3.2
Parent Information Sheet

Information Sheet

DESCANT (SciTech)
Designing e-learning systems to celebrate and nurture teaching

This information sheet provides background of a research project in which we are seeking your permission to involve your child (see attached consent form).

The present research project is designed to trial an approach to enhancing teachers' science and technology teaching in primary classrooms – an approach that makes use of electronic technologies to deliver advanced teacher professional development. In this project a computer-mediated (e-learning) environment is being used to help teachers to think imaginatively about ways that advanced teacher education in K-6 Science and Technology might be provided by way of computers in their classrooms.

We are seeking parental permission, in particular, to videotape and/or audiotape students in and out of class, because we need to include effective learning and teaching events, from real classrooms, for teachers to think about and discuss as a part of the computer-mediated environments in which they will learn. We need to show examples of the clever ways young students think scientifically and technologically, and how good teachers can build such opportunities for students to shine.

Appendix 3.3
Parent Consent Form

UNIVERSITY OF TECHNOLOGY, SYDNEY
CONSENT FORM (PARENTS AND STUDENTS)

I ____________________ *(parent's/guardian's name)* agree to my child's participation in the research project *Researching the design and implementation of systemic, sustainable, school-based teacher professional development in K-6 Science and Technology using e-learning approaches* being conducted by Associate Professor Lynette Schaverien (UTS: Education, PO Box 222 Lindfield, NSW 2070, Ph: 9514 5077), [Details of NSW DET Partners removed to ensure confidentiality.]

I understand that this study will develop and test e-learning environments for the professional development of teachers in K-6 Science and Technology.

I understand that my child's participation in this research may involve any or all of the following: conversational interviews with project team members about learning and teaching, video- and audiotaping of lessons and/or discussions in and/or out of class. I understand that all project-related activities will be strictly subject to the ethical guidelines of both the UTS Human Research Ethics Committee and the NSW Department of Education and Training, and in particular, to Child Protection legislation. I understand that video and/or audiotape of my child may be used in the e-learning environments being developed in this project and that these environments may then be used for professional development of teachers in educational systems more broadly and for researching teachers' learning; and I give permission for such uses, being aware that it will be possible to identify my child from videotapes, though all efforts to protect my child's confidentiality will be made.

I am aware that I can contact Dr. Schaverien if I have any concerns about this research. I also understand that I am free to withdraw my child's participation from this research project at any time I wish and without giving a reason and without any effect on his/her academic achievement. Should I withdraw my child from this research project, I understand that all identifying material concerning my child will be destroyed.

I agree that Dr Schaverien (and/or another named partner investigator or project team member, as appropriate) has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify my child by name.

________________________________	____/____/____	____________________
Signed by Parent/Guardian	Date	Name (please print)
________________________________	____/____/____	____________________
Signed by Child (to indicate consent)	Date	Name (please print)
		____________________ Class
		____________________ School

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer, Ms Susanna Davis (ph: 02 - 9514 1279, Susanna.Davis@uts.edu.au). Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix 3.4
DESCANT Participant Names, Pseudonyms & Titles

NB: Only schools that have been referred to in this thesis have been given pseudonyms here.

Phase 1: Teachers	
Names	**Position & School Pseudonym (where used)**
Katrina	Teacher
Angela	Teacher
Vaughan	Deputy Principal
Rob	Teacher & Technology Coordinator
Kerrie	Teacher
Kathryn	Teacher
Sally	Teacher (Cumbly Public School)
Cathie	Teacher (Cumbly Public School)
Ingrid	Teacher

Phase 1: NSW DET Senior Executives	
Pseudonyms	**Position**
James	Chief Education Officer, Science DET
Louise	Chief Education Officer, Technology DET

Phase 1 & 2: Other Participants	
Names	**Position**
Lyn	Chief Investigator, UTS
Lachlan	Phd Student, UTS
Gill	Science and Technology Consultant (DET)

Phase 2: Teachers	
Pseudonym	**Position & School Pseudonym (where used)**
Jack	Cohort 2 Teacher/ Principal (Blackwood Public School)
Samatha	Cohort 2 Teacher/ Principal
Camilla	Cohort 2 Teacher
Sandy	Cohort 2 Teacher
Marla	Cohort 2 Teacher
Hannah	Cohort 2 Teacher
Caitlyn	Cohort 2 Teacher (Pattonsvale Public School)
Casey	Cohort 2 Teacher (Pattonsvale Public School)
Tom	Cohort 2 Teacher (Pattonsvale Public School)
Nichola	Cohort 3 Teacher (Pattonsvale Public School)
Pauline	Cohort 3 Teacher (Pattonsvale Public School)
Lucy	Cohort 3 Teacher (Tallerack Public School)
Kaila	Cohort 3 Teacher (Tallerack Public School)
Corina	Cohort 3 Teacher (Tallerack Public School)
Abbey	Cohort 3 Teacher (Cransvale Public School)
Arlene	Cohort 3 Teacher (Cransvale Public School)

Phase 2: NSW DET Senior Executives	
Pseudonyms	**Position**
Grant	Chief Education Officer, Science DET
Louise	Chief Education Officer, Technology DET

Appendix 3.5
Final School-based Conversations Protocol

- What can you tell us about your own Learning Journey in the DESCANT project? What were your expectations about your own learning journey? (What were your own aims?)
    - What were achieved, what still remains a goal?
    - Matters of concern?

- Did you perceive any ways others have contributed to your own learning?

- Some people have said "It has taken me quite a while to get a good understanding of this whole process." (Samatha Cohort Diary 4th Sept.)
    - What is your understanding of the project now, and how might it have progressed?
    - Which of these aims/purposes do you think were achieved?
        - [Different dimensions eg. Professional development, technical/logistics ie. videos, learning & teaching in Science and Technology, teachers as researcher and designers.]

- What might the next steps be? Do you have a vision for how this might work in the future?
    - Challenges- design points?

Appendix 4

Teacher & Cohort Texts

Appendix 4.1
Learning Legacy Texts

Cohort One Learning Legacy

Like our Colony, the DESCANT journey has many layers, some shallow, others that may have practice-changing effects which alter, not only one's teaching style, but also thinking in regard to children's learning.

DESCANT offers the challenge of being intellectually involved in a meaningful project. There is the opportunity to participate within a supportive community of fellow learners, thinking deeply about and discussing enthusiastically, a range of issues related to the generative theory of learning.

We really saw what a powerful tool the Generate-Test-Re-Generate model was once we applied it to our own classes and 'saw it in action' so to speak. The model showed us that it was possible for ALL children to succeed and achieve in Science & Technology, particularly, through the use of careful and reasoned questioning techniques. Learning is an active process, the spark for that learning must come from within the learner him/herself. The stimulation for that spark can be external, or it may be to answer a need felt by the learner himself.

Developing and refining relevant teaching techniques, in light of our new insight into student learning, was a big step for us, and giving children the opportunity to sometimes fail BEFORE they succeed was a big mind shift. The children respond with enthusiasm and generate their own learning and learning path with us guiding and hopefully questioning to allow them to explore their own ideas. This style produces deep knowledge and substantive conversations that enrich learning.

Thus, the DESCANT journey "forced" us, in gentle ways, to look at our teaching, questioning and delivery. The reflection, through sharing with the colony, made us look more deeply into the way we taught in Science and Technology (and other KLAs.) Part of our learning journey was to take on this generative learning process and learn from it ourselves. We have generated teaching and feedback, leading to regeneration of ideas until we are at a stage where the generative learning seems to be part of us, and it is hard to pull apart/revisit the differences within.

We approached the DESCANT project with enthusiasm and excitement, as it was the embodiment of a vision for the future. We were part of the project from the beginning and had input that was of value to all involved, including the researchers and other people involved in the project.

Yet, how does a teacher feel when confronted with a request to explain how a child in the video is learning? Once they can accept the challenge to comment, valuable insights can be shared. We know as teachers the need to encourage children, to be kind, to not pooh pooh genuine attempts to learn and grow. During DESCANT we have refined those skills further to look at our peers as communicants in a learning journey. We think we have come to a point in our teaching/learning where we can look at something and we can speak about it without the arrogance of ridicule and with definite leanings to encouragement of the presenter, but still able to point out difficulties, offer suggestions etc. We don't have to challenge, be afraid of, feel less than. We're not on our own -we're part of a colony working toward the same goal: a bigger and better nest for those who come after us.

Cohort 2 Learning Legacy

DESCANT created for us a cycle of teaching/learning opportunities. It became a path of learning that generated greater scientific investigation as we struggled to understand what we saw and what we knew. The model itself was impressive, it was very interactive as opposed to a one-way learning model.

DESCANT ensured that the students were learning in all three areas of sci-tech and it helped us to establish new goals for learning about teaching. It has made us think about how to marry generative learning, the outcomes and the different elements in 'Quality Teaching in NSW public schools, and how to offer them all.

Generative learning gave students the opportunity to investigate and make generalisations that needed further testing and observing. It gave students independent investigation and design activities needed to cover the variety of outcomes, empowering the children to take some direction in their learning and testing. The students were free to come up with questions, which they discussed and analysed. They went on to ask, “What do we do about that?” regenerating a new path of discovery. They were allowed to make decisions.

During this project all students have been encouraged to verbalise their thoughts out loud. Some of the more reticent types were inspired by fellow students to have the confidence to give it a go. Excitement in their learning activity was a key factor to the gaining of greater wisdom. Less teacher control meant that students had a choice of many different options.

Students with learning difficulties were given the opportunity to express what they hold inside. DESCANT engaged them because it allowed them to test and express ideas to their peers in a friendly arena.

A number of changes to our modes of teaching occurred. DESCANT encouraged us to give students a very broad scope within which to work. It allowed us to follow an interest, to pursue what we found fascinating in professional learning. We experienced a substantial feeling of ownership of the learning process and felt more confident about taking risks. We gained insight into what teachers and researchers think about how children learn.

A couple of things we found helpful were the initial meeting round a table - a good way to start and the library– reading theories and testing them in the classroom made us more analytical in watching videos.

A group of teachers in a larger school who had to focus and listen to each person's viewpoints developed better communication skills. They had each other to lean on or ask for confirmation of ideas.

We all faced obstacles and made decisions that suddenly lead us in new directions. The challenge left us open to learn more as we progressed, and as we felt that what we were doing was valued by the DESCANT community then we wanted to keep going with it.

The DESCANT journey has been frustrating at times. The technology didn't always work and larger schools seemed to access support more easily. The environment was sometimes a little confusing when trying to understand where to add things, and the chat room seemed a little underused.

Having videos was a great idea; however there was too large a number to study in depth. Rating would have been easier if the questions were simplified, less repetitive and more open-ended.

The hardest part of the whole project was finding the time to devote to it. Procrastination developed even within given timelines. The medium had probably something to do with this, as at times it was all too much and we needed a great deal of self-motivation. Another big hurdle was trying to get some substantial communication going with the students, and overcoming their tendency to be camera shy.

We don't get a lot of science professional development. This is the only science and tech professional learning some desk ants have come across. Some teachers found it hard, others have been very positive.

We see opportunities for the future, linking schools, academia and student teachers and allowing them to interact with experienced teachers and watch professional debates unfold. DESCANT is a non-threatening environment where beginning teachers could share their ideas with a wide range of teaching mentors. DESCANT could lead to significant changes in pedagogy and professional learning of teachers using the Descant methodology to get them to think about what they believe, and embedding self-reflection in their teaching.

Some small schools suggested having a contact person, and the opportunity to 'meet' on-line with other small school teachers to continue collegial learning is a possibility.

Desk ants are still on the journey and always will be. That's what lifelong learning is all about. If you stop learning you might just as well be feeding worms.

Cohort 3 Learning Legacy

The DESCANT project provided a learning curve for both teachers and students alike. The project encouraged teachers to evaluate and share philosophies of learning and teaching in a non-threatening on-line environment. All members of the DESCANT project were given opportunities to develop an understanding of the generative learning model and to share these ideas with each other. Students were engaged in the process of formulating, testing and regenerating ideas in the context of science learning.

Through the application of generative learning, teachers were encouraged to provide a more investigative approach in lessons and to incorporate open ended questioning. This would facilitate the students in generating their own ideas. Teachers had an important role in this model of learning in that there was a need for balance between structure, explicit teaching and allowing the students' freedom to generate their ideas. The students developed their skills and understandings in science by articulating their thoughts and ideas to their peers and teachers. This process allowed students to take ownership of their learning and encouraged enthusiasm and curiosity.

The DESCANT ‘knowledge building environment’ allowed teachers, through on-line discussion, to raise their concerns and discuss possible solutions and different perspectives about generative learning. At first, most teachers seemed anxious about putting their ideas ‘out there’ for others to comment on. The majority of teachers seemed to feel much more comfortable with face-to-face conversation. However, with time and the continued support provided by the DESCANT team, the on-line discussions became an integral part of the whole learning process. The DESCANT journey enabled teachers to come to a combined understanding of generative learning, to implement this understanding in their classrooms and to report back on the impact this had on their teaching styles and the learning of their students. This ‘new’ understanding came through the ability to access the knowledge of prior participants of the DESCANT project, creating an environment in which all teachers became part of a single learning community that was able to grow and change.

Inevitably matters of concern were raised. These ranged from issues on how to incorporate generative learning into our teaching, to how the model would benefit the individual learner. Teachers were also concerned about how the use of open-ended questioning and stimulating conversation could be used to encourage children to go beyond their comfort zone and enrich their thinking. Teachers were concerned with finding a balance between teacher-directed learning and student-generated investigation, coming to the conclusion that it is necessary to guide the students through the brainstorming process and to facilitate the generation of their ideas. Then using a thorough knowledge of the scientific process teachers can encourage students to test their theories in a supportive environment that ensures that the knowledge attained is sound from a scientific perspective.

The technical elements in making, editing and uploading the required videos provided a challenge that required extensive expert support to ensure successful completion. The essential component of DESCANT was the financial support to schools allowing teachers the time to fully engage with the project. Without the time allocation, teachers would not have been able to participate at an optimum level. Despite initial teacher reticence in relation to video production, there were great benefits from completing the video component of the project. The videos provided an applied reference point for our own development and challenged teachers to reflect on the generative model and its application in the classroom. The video rating process was valuable as it enabled Cohorts Two and Three to regenerate their view of the model and then continue to test it in their own contexts. The videos for Cohorts Two and Three reflected different understandings of the model compared to the Cohort One videos. The videos generated by Cohort One were more focussed on the initial generation of ideas, whereas Cohorts Two and Three had more of a focus on the testing and regeneration process.

Being part of the DESCANT project gave teachers the opportunity to develop skills and confidence in the teaching of Science and Technology, which in turn allowed students to develop deep knowledge and understanding in the classroom environment.

Appendix 4.2
Angela's Accompanying Text

Bird Houses

CONTEXT

The unit has evolved from a playground discussion about 'What happens when we are not here?' I shared an experience that I had one afternoon which saw a mass influx of birdlife into the school grounds. Stimulated by the challenge of 'How we can see this during school hours' this unit has been designed to extend the thought processes of the students and to employ some 'real-life' skills which cross into other areas of the curriculum.

The Initial Task - You are to individually design a bird house that will be suitable for our school. The success of your design will be measured by peer decision and testing the bird house to see if it does indeed, attract more birdlife to the school during school hours.

Discussion prior to Individual Design - What things do we need to consider before designing our bird houses?

Student Led Responses Included - suitable materials, aesthetics - does the bird house fit in with the surrounds, what birds are we hoping to attract here?, what things will affect the birds ability or desire to stay here? - predators, climate, temperature

The children in this video are at the design stage of their project to attract birds to their playground by creating houses for these birds.

<u>Segment 1</u>

Alex speaks confidently about the design that she has produced. It is a result of individual thinking, that has evolved following the group discussion about 'points to consider'

She's obviously thought deeply about the features and is able to explain them in detail –the types of birds she hopes to attract, the materials she proposes to use, the functions and purpose of the various parts of the house.

<u>Segment 2</u>

At this point, all individual designs have been scrutinised in class groups. Each group has had to select and justify selection of a design that they thing is the most appropriate for this exercise. A representative is now presenting their selection to the class. Following each presentation, a single design will be selected, as the most appropriate for this exercise.

The questioner asks very detailed questions and it is obvious that he has a personal interest in the project. No doubt he has considered many of the aspects he asks questions about in coming up with his own design. Although there is no direct evidence of it, there is the feeling that he is applying mental tests to his own ideas. The detailed answers given reflect the deep thinking that has obviously taken place prior to the video.

When questioned about the materials to be used, the child appears to be regenerating ideas about how she will actually build her birdhouse. She seems to be clarifying her thoughts as we watch.

This is a good example of the strategic question helping to clarify an idea. It’s not necessarily the teacher who asks these pertinent questions. The idea generated about the soap on the pole is a further example of some knowledge from the past being regenerated and briefly tested in the present situation.

One of the most impressive aspects of this video is the sense that it gives of a group concern and a group response to that concern. These children are obviously comfortable with each other and with their teacher and this provides the environment so necessary for learning to take place.

AFTER THE VIDEO

Following the selection of a bird house design, students were then asked to set about the making process. Thoughts have now shifted from the design process to the implementation /production of the design. This section of the unit relied heavily on a degree of mathematical competency. Students were asked to calculate, estimate and propose ideas about building, joining, ordering materials, collecting all appropriate materials, budgeting for the associated costs, etc.

I AM HAPPY ABOUT

The discussion and thinking that this project generated. I was impressed by the lengths that students where going to, in order to justify the benefits of one design over another. It clearly grouped students into 'thought competency groups'. Some were stuck at the point of drawing and explaining a design. Others made it to justifying one design over another. Whilst the more advanced students were able to indepenently provide you with material lists, specific measurements and detail as to how construction would take place.

THINGS TO DEVELOP

The power of conversation has certainly impacted on my delivery in the classroom. Even though I considered myself to be a listener of the student, the video proved that I did prevent directions of the conversation, because I had my idea of the finished product. This led me to the notion and necessity for open ended outcomes. As a result of this project I am also aware of the need to provide guidelines to students that are still at an early stage of their design and make 'though processes'. Some students will not have the confidence to take the project to its completion and will need moments where they can continue their journey by using a simple 'yes or no' option.

Appendix 4.3
Cathie's Accompanying Texts

Thomas and Plantfood

Context

These segments are at the conclusion to the unit on Living Things: How and why things grow. Initially we discussed as a whole class what could make things grow and then divided into small groups.

Each group's task was to devise an experiment to test one of the theories that they came up with on why things grow. The experiment's ideas included: a) plants need food, b) plants need sun, c) plants need manure, d) plants need water.

Things I am happy about:

The children in these clips discuss in detail the effects of their experiments on the plants. They use existing or background knowledge about the way plants work as a starting point and add their results from their experiments to generate ideas about why and how plants grow. Some of these ideas are not exact, some are completely wild, but the clips demonstrate the way the child has come up with an idea, or generated a thought rather than merely stated textbook knowledge. The processes observed in the clips demonstrate the child understands of the plant and its growth and how they view the plants growth with their intervention and experimentation.

Before my contact with the generative learning style I would not have chosen these clips as examples of my children's best learning. I would have chosen the ones who could repeat the facts, verbatim stating the printed word they had read. Now, a new me has emerged, I can view the learning and development of that learning as vital to the child's progress towards understanding. Joshua is a wonderful example of a thinking child who takes evidence that he has discovered through his own experimentation and talks through his results and generates theories and other possibilities he can explore. He is ready to re-test his theories through more experimentation.

Excerpt:

Thomas is in year 2; his groups experiment tested the effects of different food types for their plant including eggs, self-raising flour, vegemite, and peanut butter. Their theory was that these foods made kids grow so they would also make the plant grow. The segment begins when Thomas is discussing the results of the experiment they devised after an elapse time of four weeks.

Thomas is generating ideas about the way the plant functions from his own background knowledge. He says, "I think that the flour must of got in there, got into the roots and grew another flower." He continues, " Probably, like, putting the egg in it, it dries it, and when you put the flour and water, the flour gets into the middle...” Thomas continues his generation of ideas by saying, “it (meaning the self raising flour) dries the dirt”. He then expands on his ideas by adding another layer of knowledge about the plants root system. He says when referring to the roots, “where it’s growing from,” and concludes that the pink flower, “must of started from the roots… it must of come through another root.”

He is generating when he interprets the results as he sees them in his plant. He begins with an understanding of roots taking nutrients through their root system and uses this to explain his results; i.e. the flour and eggs travelling through his plant via the root system. Thomas is using his understanding as he discusses the circulation of food up the roots of his plant.

Where to from here?

After these clips we needed to set a further series of experiments to test their new theories on the growth of plants. We could set up a test plant with flour & without to follow through his thinking. We could also do some tests on the effects flour had on soil by mixing some in controlled amounts with soil and testing the water absorption.

I would also set the children some research assignments using internet sites on plants so they would be able to view a scientific view and contrast this with their thoughts and findings in their own experiments. This type of follow up would also help clear up any of the misleading theories the children generated and help to widen their background knowledge ready for their next level of investigation into the plant world.

Things to Develop

Changes to my teaching since discovering generative learning:

My generative learning journey has had some dramatic effects on my teaching practice. I have come to understand that questioning and questioning techniques play a vital role in the children’s ability to be generative thinkers. I f questions are closed or offer no room for thinking, children just repeat existing knowledge they don’t get the opportunity to be creative, generative thinkers in an environment fosters the understanding, not just rote learning.

I also think that generally I tend to “jump in” to quickly and not give children the opportunity to think, or mull over ideas. I am now very aware of giving children time to think, mull over. I don’t think that all pauses are pregnant, but realise that some times kids need to think in their own head before verbalising, others like Joshua seem to think while they talk things through. So talking and discussion is also much more evident in my science and general teaching practice.

Perhaps one of the other big changes has been letting go, allowing the children to have a more direct input into the general direction that our learning might take us. For example in this unit I let the children design their own experiments. Previously I would have set it up, provided all the necessary equipment, instructions and directions to have “a proper” science experiment that produced the proper results.

The ideas that I have been learning and using with this class have many positive effects that I can now see in other areas. For example our latest Science unit was an investigation into dinosaurs and how they lived and died. Some of the discussion and project work was terrific. The children did not just repeat great screeds of information about a particular dinosaur but were able to interpret that information. For example one child was able to relate that their dinosaur had a brain the size of a walnut and that would have meant he was not very smart! Another reported that their dinosaur had teeth that were sharp and 13cm long. They went on to compare the teeth to steak knives, which they then duly got to demonstrate how the teeth would have actually looked.

Thomas and the Caterpillar

Context

These segments are at the conclusion to the unit on Living Things: How and why things grow. Initially we discussed as a whole class what could make things grow and then divided into small groups.

Each group's task was to devise an experiment to test one of the theories that they came up with on why things grow. The experiment's ideas included: a) plants need food, b) plants need sun, c) plants need manure, d) plants need water.

Things I am happy about:

The children in these clips discuss in detail the effects of their experiments on the plants. They use existing or background knowledge about the way plants work as a starting point and add their results from their experiments to generate ideas about why and how plants grow. Some of these ideas are not exact, some are completely wild, but the clips demonstrate the way the child has come up with an idea, or generated a thought rather than merely stated textbook knowledge. The processes observed in the clips demonstrate the child understands of the plant and its growth and how they view the plants growth with their intervention and experimentation.

Before my contact with the generative learning style I would not have chosen these clips as examples of my children's best learning. I would have chosen the ones who could repeat the facts, verbatim stating the printed word they had read. Now, a new me has emerged, I can view the learning and development of that learning as vital to the child's progress towards understanding. Joshua is a wonderful example of a thinking child who takes evidence that he has discovered through his own experimentation and talks through his results and generates theories and other possibilities he can explore. He is ready to re-test his theories through more experimentation.

Excerpt 2: Thomas and the Caterpillar

Thomas discusses the actions of a caterpillar on his plant, generating ideas about the taste of the plant and why the caterpillar chose one plant over another. He says “the taste gets in” because the plant likes a particular food.

He generates further by attributing human senses to the plant and also the caterpillar. He says, “ there's been some caterpillars through it or something…” and goes on to discuss the taste of the plant to the caterpillar saying, “ its probably like ……yum” and uses the colour of the flower to explain the caterpillars preference of a particular flower. “Ours has pink flowers and theirs has red”

He continues in this vain saying, “That one might taste like Self Raising Flour and that one might taste like flour and raw egg.” He continues saying, “the taste gets up into the leaves.” His group agrees that the red plant will taste like manure as it has been fed with manure and he concludes that he would like the plant with the red flowers. He seems to forget that he has just agreed that the red plant will taste like manure and relies solely on the colour of the plant for his eating preference.

Where to from here?

After these clips we needed to set a further series of experiments to test their new theories on the growth of plants. Thomas' ideas about bugs could be similarly tested by introducing caterpillars to several plants and observing the results.

I would also set the children some research assignments using internet sites on plants so they would be able to view a scientific view and contrast this with their thoughts and findings in their own experiments. This type of follow up would also help clear up any of the misleading theories the children generated and help to widen their background knowledge ready for their next level of investigation into the plant world.

In summary;

Things to Develop

Changes to my teaching since discovering generative learning:

My generative learning journey has had some dramatic effects on my teaching practice. I have come to understand that questioning and questioning techniques play a vital role in the children's ability to be generative thinkers. I f questions are closed or offer no room for thinking, children just repeat existing knowledge they don't get the opportunity to be creative, generative thinkers in an environment fosters the understanding, not just rote learning.

I also think that generally I tend to “jump in” to quickly and not give children the opportunity to think, or mull over ideas. I am now very aware of giving children time to think, mull over. I don't think that all pauses are pregnant, but realise that some times kids need to think in their own head before verbalising, others like Joshua seem to think while they talk things through. So talking and discussion is also much more evident in my science and general teaching practice.

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