Can we sustain primary Science and Technology education in school systems by casting teachers as e-designers? The DESCANT-SciTech Project.

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SCH05495

Abstract

The disciplines of Science and Technology present well recognised professional development challenges for primary teachers. We focus in this paper on the particular challenge of systemic, sustainable professional renewal, for large, geographically dispersed but centralised education systems, and on whether, and if so, how, a novel e-learning mediated strategy might address that challenge. We report on the beginning phase of an ARC Linkage Project, the DESCANT-SciTech Project (Designing e-learning systems to celebrate and nurture teaching in Science and Technology) in which a foundation cohort of teachers was assisted to develop an e-learning environment for the communal professional development of future cohorts of their peer teachers. We describe and analyse the development of these teachers’ environment, ready for a second and third cohort of teachers to engage with it. We conclude speculatively, anticipating some key implications of this case study for the continued health and sustenance of Science and Technology teaching, from generation to generation – implications that will be tested in the next project phase.

Introduction

Effective systemic professional development of elementary Science and Technology teachers is a key challenge for education providers. In particular:

1. There is a history of low teacher confidence and competence in and valuing of the teaching of Science and Technology, in studies of teaching, teacher education and student learning internationally (see, for example, in Australia, DEET, 1989; Goodrum, Hackling and Rennie, 2001).

2. A growing realisation that rapid cultural change, particularly with the advent of e-learning, requires a double-edged professional development response from education systems: Teachers need to be equipped to teach emergent disciplines in innovative and e-learning mediated ways (Schaverien and Cosgrove, 1995, 1997; Schaverien, 2000); and teacher professional development itself must at least keep pace with the educational possibilities these new technologies afford (Marx, Blumenfeld and Krajcik, 1998).

3. A vast set of useful guiding principles, models and frameworks has been developed for teacher professional development in primary Science and Technology teaching, and e-learning mediated teaching, from policy, commissioned inquiry, anecdote and scholarly practice (as recommended frameworks, such as Loucks-Horsley, Hewson, Love and Stiles, 1998; McIntyre and Byrd, 2000; Sparks and Loucks-Horsley, 1989 and as outcomes of teacher professional development research and development, such as Bell and Gilbert, 1996; Clark, 2001; Schaverien and Cosgrove, 1997; Smith and Neale, 1991).

One of the best-known sets of principles characterising effective systemic professional development programs for Science teachers is Loucks-Horsley’s et al (1998). These researchers identified seven principles of such programs:

- They are driven by a well-defined image of effective classroom and learning and teaching;
- They provide opportunities for teachers to build their knowledge and skills;
- They use or model strategies teachers will use with their students;
- They build a learning community;

They support teachers to serve in leadership roles; 
They provide links to other parts of the education system; and 
They are continually assessing themselves.

Furthermore, there appears to be a measure of agreement over these seven principles. They map neatly onto those of the Texas Regional Collaboratives for Excellence in Science Teaching (Meyer, Barufaldi, Fletcher, Tinoca and Lee, 2004); and these researchers recognise synergies between these principles and those noted by other researchers in the field, citing, amongst others, Garet et al, 2001 and Supovitz and Turner, 2000. (p. 2)

These sets of principles provided a valuable starting point for designing and researching professional development programs. However, such specifications are quite obviously minimalist; and as Meyer et al (2004) contend, although effective professional development has been cited as the most promising way to retain and renew science teachers, there is very little research in the area that describes effective strategies. (p. 2). Even more pointedly, although there is a large body of international literature on professional development, little high-quality research has been conducted on either the relationship between characteristics of professional development and change in teachers’ classroom teaching practice or the relationship between characteristics of professional development and gains in pupil achievement. (Boyle, While and Boyle, 2004, p. 48)

A reminder to consider their epistemology sharpens our perspective on these principles for effective, systemic approaches to teacher professional development (Putnam and Borko, 2000). These researchers note that though new ideas about the nature of knowledge, thinking and learning are beginning to inform student learning, less attention has been paid to the implications of these ideas for teachers’ learning. Furthermore, not only might such ideas be used as lenses for understanding recent research on teacher learning, [they might also be used] to explore new issues about teacher learning and teacher education that [such perspectives might bring] to light. (p. 4) In their own case, Putnam and Borko argue that a situative perspective – one in which cognition is (a) situated in particular physical and social contexts; (b) social in nature; and (c) distributed across the individual, other persons, and tools (p.4) – argues for the importance of authentic [learning] activities (p.4); and they describe how professional development programs might enact such authenticity with respect to (a) where to situate teachers’ learning experiences, (b) the nature of discourse communities for teaching and teacher learning, and (c) the importance of tools in teachers’ work. (p.5)

Similarly, there have been diverse attempts to leverage sociocultural and anthropological ideas about local and global communities – and, specifically, communities of practice – to design and understand teacher professional development in Science and Technology (see, for example, Schlager and Fusco, 2003 and Barab, MaKinster and Scheckler, 2003). As well, and of importance for the present study, a biologically based generative theory of learning has been tested, in use, to design and deliver teacher professional development in primary Science and Technology (Schaverien and Cosgrove, 1997; Clark, 2001). In a broad and deep unifying synergy with neuroscience and evolutionary epistemology (after Edelman, 1992 and Plotkin, 1994, 1997, 2002), this theory conceives of learning as generating ideas, testing those ideas on their value and keeping those that survive these tests (Schaverien and Cosgrove, 1999, 2000).

The research question at the heart of the present study is: Can we sustain primary Science and Technology education in school systems by casting teachers as e-designers? In this paper, we consider how data from the first phase of a large Australian Research Council Linkage between NSW Department of Education and Training (DET) and the University of Technology, Sydney (DESCANT-SciTech - Designing e-learning systems to celebrate and nurture teaching in Science and Technology) bears on this question. In essence, DESCANT aimed to increase teacher equity in

professional development, by casting teachers as designers of an e-learning environment in which cohorts of teachers could learn to teach primary Science and Technology. Furthermore, DESCANT’s intervention itself was generatively principled (Schaverien and Cosgrove, 1999; 2000): teacher-designers were immersed in a range of activities and tasks to encourage and support them to generate ideas for the design of an e-learning environment; then the teachers’ prototype e-learning environment was built to their specifications and tested on its worth for learning with two further cohorts of teachers, with a view to further refinement or regeneration. In these ways, DESCANT’s research approach “[blended] empirical educational research with the theory-driven design of learning environments, [thereby fashioning] an important methodology for understanding how, when and why educational innovations work in practice” (The Design-based Research Collective, 2003, p. 5). So, the project’s research design and methodology fitted comfortably within this emerging paradigm of design-based research.

We have described elsewhere the process by which the DESCANT environment was conceived during the first project phase (Forsyth and Schaverien, 2004; Mulholland, Forsyth and Schaverien, 2005). Our purpose here is to interrogate that first phase data set (including the process of development of this e-learning environment by teachers, as well as the features of the product they conceived) for those components Clark (2001) identified as hedging the likelihood of a successful, generatively principled professional development approach. Thus, this paper begins to answer our study’s central research question speculatively and in anticipation, in the knowledge that the designers were themselves members of the target learner population. Of course, we await corroboration of these exploratory insights, as we look towards gathering other more conventional kinds of data about teacher learning by introducing two further cohorts of teachers into the colony at the time of writing.

**The DESCANT-SciTech Project and teachers’ conception of an e-learning environment**

We begin by summarising how teachers conceived the DESCANT e-learning environment within the context of the Project strategy. Table 1 lists key project events, once the DET had selected two adjacent rural school districts to initiate the DESCANT Project and the Science and Technology consultant (GM) had called for expressions of interest. Those planned experiences for Cohort One deliberately addressed the risk that without clarity about new paradigms or educational media, teachers might design an e-learning environment that “[filled] in the gray areas based on their existing understandings and practices.” (Stein, Smith and Silver, 1999, p. 950)

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| Jun - Jul 03 | Local information evenings with interested teachers.  
Eleven teachers (a broad cross-section with respect to experience and confidence) agreed to participate.  
Conversations between UTS researchers, consultant and participants at schools to gather baseline data from Cohort One teachers (including professional development experiences and ideas about Science and Technology learning and teaching). |
| Aug 03  | Introductory face-to-face workshop with Cohort One teachers:  
Morning session: Introduction to the Webboard (communication |
medium for the nascent community).

Mid-morning session: Introduction to the Generative Virtual Classroom (GVC), a generatively theorised e-learning environment developed by the project leader (LS) and a key immersive environment in coming months.

Afternoon session: Teacher discussion.

Sep – Oct 03 Teachers participated in a range of online experiences designed to assist their thinking about the worth of this medium for teacher learning in Science and Technology education, including:

- Immersion in the GVC;
- Extensive webboard discussion (moderated by the consultant, the doctoral researcher (LF) and the project leader) of Science and Technology, and learning, teaching and professional development in these disciplines, supported by a range of resources including DET syllabus materials and academic research papers;
- Virtual excursions to online Science and Technology professional development sites; and
- Deepening consideration of theories of learning and of the worth of their own learning journeys in DESCANT.

Oct 03 Cohort One teachers attended the Design Workshop Day:

- Morning session: Teachers discussed the (generative) theoretical bases of a range of e-learning environments.
- Midmorning session: Teachers articulated their purposes for the e-learning environment they were to design and set indicators by which they might gauge whether these purposes had been met.
- Afternoon session: Teachers conceived, in first draft, the design for their e-learning environment for teacher professional development in Science and Technology: the DESCANT Colony.

Nov 03 - Mar 05 Building of the DESCANT Colony was unfortunately slowed by a major departmental restructure and project budget-related difficulties. Eventually, once development was contracted to an independent software development firm (with strong links to the DET):

- LF, LS and GM could act as brokers, liaising between the teachers’ original design and contractors to develop the Colony; and
- Two further meetings with Cohort One teachers were held (May 2004 and March 2005) to firm up design and prototype for the next cohorts.

Mar - Sep 05 Cohorts Two and Three entered Colony in staggered time periods, each beginning with a face-to-face Workshop Day.

Sep 05 Exit conversations in schools with Cohort Two and Three teacher participants.

It was during the Design Workshop Day in October 2003 that Cohort One teachers first crystallised their conception of an e-learning environment. Early that day, in anticipation of their e-learning design, they reached consensus that their environment should address the following purpose:

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1 The GVC enables teachers to view, discuss and deepen their views about a set of video excerpts of Science and Technology learning events, online with a geographically dispersed cohort of colleagues.

2 In this paper, initials denote university and DET project members, and first names denote teacher members.

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.

Over the course of the afternoon session of the Design Workshop Day, in tune with their previously expressed purpose of enhancing understanding of learning, participants mapped an e-learning environment in the form of a journey, over which learner-teachers could chart progression. They suggested and discussed, in anticipation and in some detail, five components of this journey:

- A “self-test” with which learner-teachers would begin. This introductory activity would address technical set-up and learner-teachers’ expectations about the environment, both generating interest and making clear if learner-teachers’ own interests are compatible with the environment’s focus (Anna). Others suggested it might probe teacher-learners’ initial ideas about learning (JS, Cynthia) or guide navigation by offering suggested pathways (WH).
- A set of video excerpts of examples of student learning, captured in the designer-teachers’ own classrooms and accompanied by textual material that would focus learner-teachers’ attention or prompt their interest.
- A private notepad within the environment in which learner-teachers could record their views as they progressed, as well as a forum where community discussion could occur and be facilitated. Conversation dwelt on whether such functionality would be public or private, editable or non-editable, and different views were expressed about this. Teachers justified their views with reference to their own experience in the DESCANT webboard and on the GVC. Despite sustained conversation about their diverse levels of comfort about posting in various environments, consensus seemed to be reached on the need for both public and private functionalities, but without the ability to edit in either. It was Roger’s experience of forever polishing and never posting, and hence losing the crucial record of his learning journey that clinched that decision:
  It’s like dragging a piece of brush behind you rubbing out your footprints – you don’t do it. … I concur simply because of the experience I’ve been through where I’ve held back from responding immediately and then felt that my responses were no longer appropriate
- A culminating task, in the form of a video excerpt, captured in learner-teachers’ own classrooms and accompanied by textual material. For GM, this task aligned with the reflective journals teachers had completed in the first phase of DESCANT. For Vic, it was important that some kind of baseline or entry story had been told for judgments to be made on progression. For Roger, such a task would spur the kinds of worthwhile workplace implementation that he was familiar with in his role as a Technology in Learning and Teaching facilitator. For LyF, such a task would both encapsulate a learner-teacher’s progression and contribute, in its own right, to an expanding set of video clips for future cohorts of learner-teachers to consider.
- A rating process (proposed by Vic) whereby learner-teachers could judge the worth of videos or discussion comments, elevating over some threshold those contributions that are valued for some reason, so that other learner-teachers could easily find them. For Vic, such a process would address the challenge of keeping abreast of the rapid accumulation of large numbers of considered posts. For Kirsty, if 100 people valued a particular video for a specific reason as against five people that valued another, a learner-teacher might want to have a look at the former video to find out what was good about it.

From these key elements, and using a diverse collection of teacher comment on the project’s DET webboard site over the months of the project, the DESCANT Colony was built.
The Prototype: DESCANT Colony

Metaphors for the community’s experiences were often discussed formally and informally, explicitly and implicitly during the project. On the Design Workshop Day, the idea of building the environment on a particular metaphor was raised and teachers began to suggest some. After the workshop, they continued to discuss this matter on the webboard. LF told the story (now included on the Welcome Screen of the Colony) of how he had discovered a number of ants foraging around his desk whilst working at his computer at home.

As the ants navigated around my hard-drive and keyboard, I could see they were regularly stopping to communicate with their workmates. As I watched these little ‘ant chats’, I sat thinking about how these communications must ripple out through the colony: influencing the knowledge at a collective level. As these diligent ants came across my empty coffee cup (with its sugary rim), I thought about how the ant colony's knowledge had just changed: the collective had learned.

Over the succeeding days of discussion on the webboard, most teachers opted for the metaphor of an ant colony, for reasons that included the following:

I must admit to being attracted to the ant, tunnelling maze idea. This seems to me to not only relate/play on word, but to suggest a digging for knowledge, to seek different approaches, and also remain in the collective. It also gives a visual pathway for visual learners. (Cynthia, 23/5/04)

The "ant" metaphor has a welcoming warmth about it. It is important for new users to the medium to feel that they are not "alone". (Roger, 23/5/04)

I too like the idea of little desc ants running around in the maze that will be created. It also gives the impression that the journey will not necessarily be a straight forward one and that people should be prepared to wander in and out and around, perhaps into side chambers where they may just stop for a while why they follow that tangent, maybe then being directed to another place.

Maybe the new recruits could be the larvae, feeding on all the information that the desc ants are busily providing them with and then after a while of feeding and resting in their cocoons will come out as ants themselves, ready to work to feed the next generation of larvae. Some will be queen ants who will begin a new colony and work at creating more larvae to turn into busy desc ants. (Kirsty, 24/5/04)

Well, I think we're pretty unanimous in our feelings on the ants metaphor. I can only agree with what everyone else has written. It's simple but adds that little 'fun' element to the site and is entirely indicative of what we want to achieve. And of course ALL ants are valued in their colonies/communities - from the worker to the queen - just as all our human 'ants' will be similarly valued for what they bring to the site. It's a very well-conceived idea - I love it! Let's go with it! (Isobel, 24/5/04)

The environment was therefore built as an ant colony\(^3\). Immediately on entering, new desc ants are directed down the Entry Survey tunnel. This survey (originally the self-test) taps their initial interests,

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\(^3\) It is noteworthy that the DESCANT project was originally conceived on the basis of a musical metaphor, in which teaching was viewed as a descant line, tuned to, enriching and embellishing the

addressing some of their expectations and questions about what they will do once they enter the Colony.

They can then 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 desc ants 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, desc ants 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.

**Figure 1: The Video Ant-e-Chamber**

main melody of student learning. Their choice of the ant colony metaphor, for the reasons they found persuasive, is additional evidence of their ownership of the resulting environment.

Accessing Colony Views

It is in the Colony Views that desc ants gain insights into the collective thinking of cohorts that have gone before and work together with their current cohort to frame up their cohort’s understanding and expression of the worth of their DESCANT journey.

Here, desc ants can:

- Access Learning Landscapes from previous cohorts of learner-teachers. These Landscapes provide data for current desc ants about previous cohorts’ judgements about videoed learning events. They show how previously highvalued each video in helping them understand specific aspects of Science and Technology learning and teaching. In this way, the Landscapes help current desc ants choose which videos to view when they visit the Ant-e-Chamber;
- Read and consider Learning Legacies of previous cohorts: collaboratively written 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 public/group blog), with a view to forming a collaborative text describing and analysing the worth, for the cohort, of their DESCANT Journey.

Figure 2. Colony Views

At any time, desc ants can access materials other members of the DESCANT Colony have posted in the Colony Library. Towards the end of their Journey, they 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, consider and rate in their own and subsequent cohorts. This trace, which they leave in the environment for others, highlights the progression of their ideas about their Science and Technology practice as a consequence of their work in the Colony. The cohort also uploads an agreed text description of their collective thinking about their DESCANT Journey at the end of their time in the Colony, to be stored in the Legacy Archive for future cohorts. That text description complements the graphic composed within the system once individual desc ants in the cohort have rated videos.

Analyzing the DESCANT Colony design: Does it hedge the possibility that successful teacher learning will occur?

Having tested a generative model of teacher learning in her doctoral study, Clark (2001) was able to identify a set of features of effective professional development that appeared to be important to generation, testing and regeneration phases of learning. We speculate here as to the likelihood that each feature will be present or absent once the second and third cohorts begin their work in the Colony. We also comment in passing where appropriate, where we have noted some of these features during the first cohort’s design of the Colony – arguing that this first phase of the DESCANT project incorporates some aspects of effective professional development in its own right.

Generation Phase

We can look at the following specific ways in which the act of generating ideas might be supported within the Colony:

Sources of new ideas. The Colony allows for input from moderators and access to a range of sources that can be posted in the library on the recommendations of other members of the DESCANT community. As well, it affords discussion with others about specific observed learning events and ideas of general interest. In particular, teachers in the first cohort acknowledged the worth of new (generative) ideas about learning and designed the Colony so as to allow future cohorts the chance to become familiar with a generative theory of learning and test its worth for them as a way of understanding learning, at least as a starting point. This position further augments the pool of ideas available from DET sources (including Quality Teaching, Big Ideas and syllabus outcomes and indicators). As well, the Colony makes available common experience (through the viewing of videos) for discussion in the cohort, potentially allowing a diverse range of value bases for judgements to be made explicit.

A comprehensive range of teacher knowledge, including domain, tutorial, student and self knowledge. It is possible that any - or all - these forms will be addressed, though exactly how these forms of knowledge will play out remains to be seen in the second and third cohorts. Teachers in the first cohort provided starting points in the Colony for discussions about domain knowledge and tutorial knowledge (for example, Cynthia’s video provoked conversation in the first workshop for Cohort 2 about students’ prior views of plant nutrition and water transport and Sarah referred to the usefulness of a paper about students’ views about the changes of state of water.) Already, one teacher in Cohort 2 appears to be addressing the beginnings of some of these forms of knowledge:

We got into the practical side of our water unit today. We have done lots of brainstorming, I am now looking for some open ended questions/tasks using water and its properties. Today I asked them to make a lump of play dough float. We had a lot of fun and will now try to explain it (the hard part),

My biggest challenge is not explaining or correcting misconceptions. eg 'Rain is always snow before it gets near us and turns to rain.' I am trying to figure out a response that will lead them to more thinking about such ideas. Selena, 12/5/05.

Integration of the knowledge types. The project accommodates and encourages flexible use of the DESCANT environment in and around teaching at school, rather than diffused out of teachers’ everyday school experience, as is the case when they attend professional development workshops. Study of the second and third cohort teachers will help us understand whether and if so how the environment will support teachers’ integration of domain, tutorial, student and self knowledge.

Diversification. The Colony can accommodate a wide range of different ideas, media, contexts and approaches, thereby allowing teachers to form and pursue diverse learning agendas. Again, we are keen to see how effectively the environment supports second and third cohort teachers to progress these agendas.

Modelling. Teachers in the first cohort took a particular and distinctive position on the idea of modelling in the DESCANT environment. They decided against choosing to capture exemplary learning events on video as models of Science and Technology learning and teaching. Rather, they chose to select learning events that provoked deep thinking about that learning. For example, Sarah’s video clip shows a conversation with two students about a unit of work set in the International Year of Freshwater. Introducing her video, Sarah wrote,

Discussion had taken place about the small amount of available fresh water 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.

Sarah then tracks the students’ conversation, identifying in detail where she sees generating, testing and regenerating ideas, initially about aspects of the water cycle and evaporation, and then about how they might simulate the water cycle. Her accompanying text indicates that though she recognises the power of the learning event she also has misgivings, in places, about the way she handled it and appreciates, in hindsight, some alternative approaches she could have taken. At the Design Workshop Day, another teacher (Anna) had described their intent as to show a warts and all account. Perhaps, by designing in such videos and pairing them with deeply reflective text, the teachers in the first cohort

wished to model the actual process of teacher learning. The Colony now makes available such models: we await to see if and how future teachers take them up.

**Depth.** There is significant depth in many of the traces left by the first cohort, both as individual video events with accompanying texts and as their collective’s Learning Legacy, principally with respect to tutorial knowledge rather than domain, student or self knowledge. We await to see if and how the next cohorts will deepen their knowledge.

**Testing Phase**

We can look at the following specific ways in which ideas generated can be put to tests in the Colony:

**Trialing.** The Colony affords many different ways that teachers can trial their ideas, including discussing them with others in forums, chats and blogs, and pitting them against the evidence they see in the videos of learning events and in accompanying texts. The Colony also provokes them to make direct classroom tests of ideas being learned so as to be able to upload such evidence at the end of their journey.

**Support.** The DESCANT Colony provides support from other teachers and moderators, through constant encouragement and discussion. Models provide reassurance that learning is developmental and proceeds through gradual enlightenment, often in hindsight and rarely all of a piece.

**Monitoring own development.** By reviewing their contributions to forums, blogs and chats, and making a video and accompanying comment on a tangible selection of their practice, teachers have access to data by which to monitor their development over time. In this sense, the Colony casts teachers as researchers in their own right. This point was very clear to many, if not all, of the teachers in the first cohort, with respect to the nature of their contributions to the first phase of DESCANT. By way of evidence, we have commented elsewhere about these teachers’ decision to include video from their own classrooms in the DESCANT Colony,

...it ought not to surprise us that teachers decided to turn the video camera on their classrooms. They had already focused their lenses on the work of the DESCANT community and were already standing both in front of the camera and behind it. (Mulholland, Forsyth and Schaverien, 2005)

By asking future cohorts to provide such video, Cohort 1 teachers have preserved that evidence-gathering function for subsequent cohorts. However, how future teachers make sense of their development in terms of particular knowledge bases – domain, student, tutorial and self – will be important research questions, on which the effectiveness of the Colony as a professional development environment will rest.

**Reflection.** The Colony makes explicit space for many different kinds of reflection, both specific and general, through observation, discussion, rating, video capture and analysis and collaborative thinking and writing. Direct exposure to what others think is a key component of the environment, and is expected to provoke comparison and contrast with teachers’ own views.

**Regeneration Phase**

The Colony demands explicit acknowledgement of any progression that has occurred with respect to both individual and collective understanding – individual teachers upload tangible video and textual evidence, leaving their trace, and cohorts compose a collective Learning Legacy for future cohorts.
entering the environment. We can look at how the following aspects of regeneration might be supported in the Colony:

**Individualisation.** It is conceivable, though will now be subject to research testing in Cohorts 2 and 3, that individual needs and interests will be able to be catered for within the Colony.

**Transfer.** Similarly, the applicability outside the Colony (in classrooms, in other Key Learning Areas and teaching and learning contexts) of particular insights gained within the Colony is a matter for investigation.

**Intensification.** Though the study of Cohorts 2 and 3 will be short, it is likely to be intense, for at least some teachers. Immersion in the Colony will be integrated with teachers’ everyday lives in schools and outside them, in families and extended communities. This holism increases the likelihood that multiple, strong links will be made with valued ideas forming in the Colony and rich diverse tests of the range of ideas will be undertaken.

**Adaptation.** It is likely, though also of course subject to investigation, that teachers will further adapt their knowledge within the real worlds of their classrooms and homes. Exactly how they do so will be of interest to us in the next research phase.

**Continuation.** This, of course, is one of the acid tests of a successful professional development environment: that it seeds continuing learning, long after the intervention is past. Many of the teachers in the first cohort have elected to continue to work as mentors to future cohorts in the Colony; and several have been well placed to fulfil leadership roles using the knowledge they have gained within the project (one has been promoted out of the region and two others are using their insights to deepen and extend their teaching as specialist Science and Technology teachers in their schools). We will be interested to try to detect signs of such continuation in the next cohorts.

**Some Concluding Comments**

Clark’s (2001) framework provides a starting point for considering the ways in which the DESCANT Colony might hedge the possibility of successful teacher learning. However, this framework does not explicitly consider a key facet of this environment: DESCANT’s intention, from its conception, to address the challenge of systemic (and not simply individual teachers’) professional renewal. This intention is now explicit in the ways the DESCANT community’s design enacts its ant colony metaphor. Furthermore, this intention sits comfortably with a 21st century zeitgeist that has moved from talk of communities as contexts for learning to much more subtle ideas about community: first evident in early artificial intelligence notions about emergent collective intelligence (see, for example, Minsky (1986)), and more recently in ideas about smart mobs (Rheingold, 2002) and wise crowds (Surowiecki, 2004). As Rheingold (2002, p. xii) wrote,

> Smart mobs consist of people who are able to act in concert even if they don’t know each other. The people who make up smart mobs cooperate in ways never before possible because they carry devices that possess both communications and computing capabilities.

New technologies, such as those built in, in basic forms, to the DESCANT Colony, promise us new means to understand systemic professional learning in Education. In the first phase of the DESCANT project, we watched carefully and described as best we could, how the first cohort of teachers banded together to design an environment that might do a better job of capturing data about and enhancing systemic professional learning in primary Science and Technology than we have been able to do.
without it. To do so, in a principled way, we bootstrapped on a generative theory of learning. Now, as we look towards the next phase of the project, we hope, within the DESCANT Colony, to be able to capture and to theorise (Forsyth, in preparation) and eventually, over time, to enhance systemic professional learning in primary Science and Technology education.

References


