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using a team learning system

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LEARNING AS A GAME: EXPLORING CULTURAL
DIFFERENCES BETWEEN TEACHERS AND LEARNERS
USING A TEAM LEARNING SYSTEM

by

JOHN G. FINDLAY

M.B.A. (Southern Cross)

A dissertation submitted for the degree of

Doctor of Philosophy of

The University of Wollongong

2009

DECLARATION

I certify that the substance of this thesis has not previously been submitted for any degree and is not being submitted for any degree.

I certify that any help received in preparing this thesis and all sources used have been acknowledged.

Signed

.....
JOHN G. FINDLAY

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ABSTRACT

The research presented in this thesis aims to investigate the first-time use of a tool for collective knowledge creation in order to explain how cultural differences between teachers and learners in the context of the historical development of tools contributes to student engagement and learning. To this end, a study was conducted at a secondary school in the United Kingdom with 92 teachers and students. The study was exploratory and is presented as a series of case studies, using a mixed method approach including discourse analysis and social network analysis.

The study was interpreted via a complexity-activity framework based on cultural-historical activity theory (activity theory) as propounded by the original theorists (Luria, 1976; Vygotsky, 1978, 1986; Leont'ev, 1978) and more recent researchers (Engestrom, 1987; Miettinen, 1999; Tobach, 1999; Hedegaard, 2005). It is also informed by other theories of development or emergence including complexity theory and co-evolution (Cohen & Stewart, 1994; Kauffman, 1995), innovation theory (Rogers, 1983; Foster, 1987), brain sciences (Schore, 2000; Freeman, 2000; Goldberg, 2001) flow theory (Csikszentmihalyi, 1975) and theories of team development (Tuckman, 1965; Schein, 1988; Losada, 1999). Activity theory holds that humans develop culturally as well as genetically. Humans use language, symbols, gestures, signs and physical and psychological tools to transform themselves and society. Vygotsky showed that children develop in two main ways, via social interactions with adults and through collective play with their peers. Complexity theory offers a complementary explanation of the social, cultural and technological discontinuities and patterns of emergence in cognition and intersubjective relations that are evident in human activity.

The literature review revealed a new pattern of childhood development, in which young people are now learning what it is to be human by interacting with smart socio-cognitive tools and their peers. Many students are bored by their teachers' use of traditional monological pedagogical methods that maintain strict social control at the expense of learning. Students are frustrated by a lack of access to ICT and do not understand why teachers rarely use computers in the classroom. One in six students leave school unable to read, write and count, ill equipped for a world of work that demands high levels of literacy, numeracy, interpersonal skills and computer literacy for even the most basic jobs. At the same time, there are growing shortfalls for jobs that require complex negotiation and complex thinking skills to create, implement and maintain critical systems and infrastructure.

The main conclusion of the study is that teachers and students are separated by two generations of tool use. This finding is consistent with Vygotsky and Luria's original but discredited hypothesis of a periodic pattern to human learning and development at both a local and global scale. The teachers employed a centralized control model of tool use in their teaching that has its origins in the Industrial Age (1700-1940) whereas the students were more attuned to a social interactionist model that is Knowledge Age (1990-) centric. The teachers were reluctant users of the tool in the classroom and quickly reverted to the lecture, closed questioning and individual activities as their preferred pedagogy. However, the teachers made frequent use of the tool for their own professional development and community meetings. The students were enthusiastic users of the tool and enjoyed the opportunity to use high level thinking processes, discuss topics and express their own opinions. Some senior students who used the tool to recall memorized information saw little difference between the traditional classroom and the team learning system activities. In the role of the

facilitator, the teachers' and students' first performances were a chaotic mix of four speech types; the ideal and minimalist set of facilitator instructions required to coordinate a group, inner speech to guide the sequencing of the motor activity, previously learned speech routines applicable to other contexts and authority speech to maintain control. The facilitators' performances improved when the speech and motor activities became synchronised with the participant performances and the facilitator's fear of failure subsided in a shift from right brain to left-brain control. The senior students who were able to facilitate sessions competently after their initial training, were not encouraged to use their new skills in the classroom. All groups, with one exception, reported they were more engaged, enjoyed what they were doing and lost track of time when they participated in the team learning activity, which was consistent with the flow experience (Csikszentmihalyi, 1975). The groups also reported they felt more aware of their surroundings and each other, which may be indicative of a change of state in the group, from a disorganized structure focused on the self to a more aligned structure focused on the group. Questions and contributed concepts acted as catalysts, which sparked more concepts. In some sessions, the students generated avalanches of concepts consistent with team formation. Closed questions generated few responses. Open-ended discussible and high-level questions stimulated the most ideas and the most complex ideas.

The research findings have practical implications for school learning. The study showed that a tool such as the team learning system can scaffold rich questioning, promote high-level thinking and support leadership capacity in students, so that novice facilitators are able to successfully lead a group in complex learning activities after a few hours practice. A new model of learning characterised as “contagious learning” which involves playing “language games”(Wittgenstein, 1999) is proposed. Learners learn how to create and facilitate their own learning experiences and use the autocatalytic aspects of conceptual sets to accelerate the creation, spread and adoption of epidemics of ideas.

New theory developed during the course of the study contributes to the field of social psychology by resolving several of the contradictions in activity theory (Davydov, 1999; Engestrom, 1999). The model focuses on the co-evolutionary relationship between the humans and tools, the automation of speech and motor routines and the ability of learners to deal with novelty and plan ahead. The new complexity-activity theory explains the differences between incremental and transformational change, clarifies the relationship between individual and collective activity, and provides a classification system for types of activity that links the worlds of the material and the ideal.

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CHAPTER 1

INTRODUCTION

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This thesis explores the topic of “Learning as a Game” in the context of a computer-supported classroom where the use of a team learning system is exposing acculturation differences between teachers and learners. This chapter comprises an introduction to this area of study and an overview of the structure of the thesis.

Introduction to the area of the study

One of the useful features of the human brain is the ability to automate activities so they become routine and easy to do. Imagine a world in which you were forever trapped by having to think about how to raise the spoon to your lips without pushing the porridge up your nose. Or successfully get out of bed? Or clean your teeth? Or prepare breakfast? Or go to work?

What would life be like if we all had a Groundhog Day (Ramis, 1993) experience every time we drove a car and had to replay or relearn the entire procedure every time we ventured forth? Consciously open door, enter car, sit in driver’s seat, close door, insert key in ignition, switch on ignition, depress the clutch before engaging a gear and then simultaneously depress the accelerator pedal slowly as one engages the clutch so the car moves forward without jerking.

Fortunately, for our sanity and comfort, the human brain is able to automate most functions involving thought and action (Luria, 1976). And equally fortunately, humans have been able to create the tools that help us routinely perform very complex activities with little effort. Some of us have learned to fly jumbo jets. Others play

musical instruments. Some perform life saving surgery. There are even people who invent more tools that help society progress even further, that automate increasingly complex cognitive, social and physical activities. Most of us take these tools for granted and are blithely unaware of the impact on our lives. Tools give us the opportunity to play new and more powerful roles.

We have our ancestors to thank. At some time in the distant past humans usurped genetics and began to transmit accumulated knowledge from one generation to the next. Language and tools helped humans beat the rules of the Darwinian competition for survival. We began to diverge genetically, developmentally and culturally from our cousins, the great apes. As a result, we have become one of the most rampantly successful large forms of life on the planet both in terms of our ability to manipulate nature and the sheer numbers of our species.

The main cognitive differences between humans and apes have been attributed to the expansion of the frontal lobes that began four million years (Luria, 1976; Goldberg, 2001) when our primate cousins and we went our separate genetic ways. During the past 10,000 years, since we abandoned our hunter-gatherer existence for an agricultural way of life (Galor & Moav, 2002) our tools have become an evolutionary juggernaut while our genes have been plodding along. During this time, the human genome has drifted a mere .1 percent (U.S. National Human Genome Research Institute, 1997).

In a feedback loop between our ever-smarter tools and the same old “stone age” brain, we humans have managed to invent our way from a clutch of very ordinary looking tools of vocalisations, sign language, spears and fire to a dazzlingly rich cornucopia of technologies. When we use these new tools collectively, they give us almost instant access to almost anything – other people, other places and other experiences anywhere on the planet.

Humans have now reached a new evolutionary crossroads. Superficially, our system for creating and transmitting knowledge from one generation to the next appears to be robustly healthy, but our success has bred new challenges. Although we may have learned to create and accumulate knowledge on an unprecedented scale, we have yet to learn how to apply knowledge wisely. War, poverty, species loss, environmental degradation and climate change are the dark side of our success and a continuing source of dissatisfaction for many. The system for creating and transmitting new knowledge is also in difficulties, as young people abandon traditional ways of learning what it is to be

human, and learn by engaging with tools that have embedded capabilities we once considered uniquely human.

Context: Differences in tool use by teachers and learners

The complex, pervasive and capable tools that are both the source and the outcome of our evolutionary success are in the ascendancy as child minders, entertainers and informants. Young people are learning as much, and sometimes more through their use of smart psychological tools encapsulated in information and communications technologies (ICT) (Salamon, 1994) than from more advanced or capable others (Vygotsky, 1978). A new breed of socio-cognitive technologies gives almost anyone the power to use higher-level thinking and relating processes that once upon a time, only the talented few or professionals could use. Other tools simulate what it is to be human or support engagement with other humans in previously unimagined ways anywhere in the world. Some individuals can even communicate body-to-body via telecommunications links or invisible wireless connections between electrodes embedded in their bodies and brains.

Chapter 2 considers the extent to which young people use the most currently available tools in their personal and school lives, in particular socio-cognitive technologies such as the team learning system that is the subject of this study. This chapter also explores the state of the education system generally, the effectiveness of current teaching practice and what leading educators suggest might be more effective and a better fit with the emergent paradigm and available tools.

Because of accelerating large-scale transformations of society some people living on the planet today (Fitzgerald & Findlay, 2006), even in the same households, are unable to communicate as well as they might with each other. The oldest among us became acculturated into society during the Industrial Age (1700-1940), others during the Information Age (1940-1980) and the youngest during the Knowledge Age (1980-2000) (Findlay & Fitzgerald, 2006). The language we use is generally the same, but the meanings are often quite different. The consequences are a double-edged sword. Some young people thrive and learn to program software, produce movies, publish web logs, interrogate complex simulations, create personal websites or write and publish music with little or no assistance from their teachers or parents, well before adulthood (Mayfield, 2006b). Some are so far ahead of their human predecessors, that their parents

and teachers, who cannot comprehend their new social and technological world, regard it as problematic or even mildly toxic. Those of a more conservative nature put obstacles in the path of their offspring or students in order to “correct” or prevent deviations from customs and norms they regard as absolute truths. Other young people engage so infrequently with their parents and indulge in so much unsupervised use of television, computers and other social engagement devices they arrive at school in an “uncivilized” state with few social skills and equally limited language skills (D.A. Triggs, personal communication, May 10, 2005). As many as one in six leaves school unable to read and write (The Guardian, 2007, January 30). In Britain, the country in which this study is set, educators are contributing, often unwittingly, to the creation of a generation of millions of unemployable people (Levy & Murnane, 2004). This dark side of the education system has the potential to unleash a thousand Pol Pots or East Timors on an unsuspecting world because disaffected youth, denied deeply acculturated knowledge of what it means to be human, could easily become pathological for civilisation.

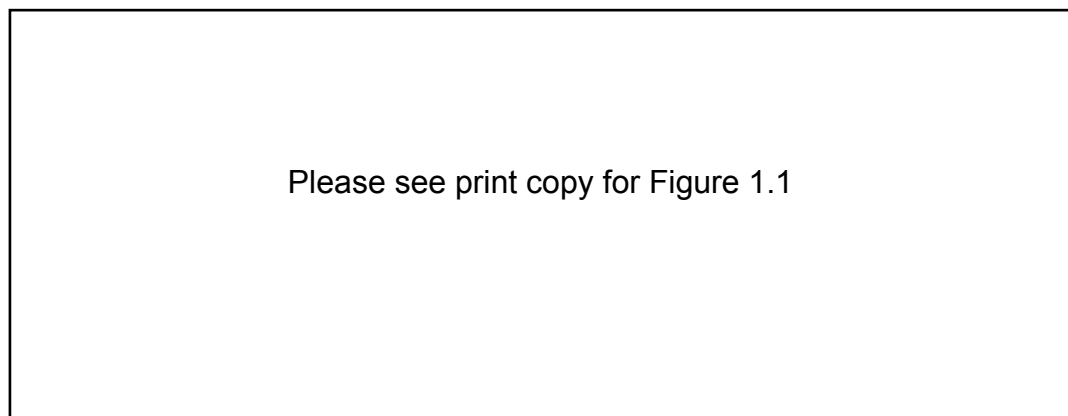
The area of interest to this study is how a technology for collaboration is appropriated by teachers and students. In particular, the study examines the use of a tool that is a variant of a group decision support system (GDSS) known as a team learning system which supports a new form of learning and development of young people (Findlay, 2003) in the socio-technological ways to which they have become accustomed.

GDSSs have become adopted globally and across business, government and universities since they were invented in the late 1980s (DeSanctis & Gallupe, 1987; Vogel, Nunamaker, Martz, Grohowski & McGoff, 1989; Dennis & Valacich, 1993; Kirkpatrick, 1992; Findlay, 1997) but less so in schools (Findlay, 2003b). GDSSs support higher-level group reasoning and help user organisations create and apply new knowledge faster in order to successfully deal with accelerating cultural, social and technological change (Findlay, 2003b). GDSSs provide the structure to help groups make decisions under the guidance of an expert technical facilitator and sometimes a domain expert as well (Watson, Ho & Raman, 1994). They support real time use of psychological skills such as problem solving, sense making and decision-making that was, and remains for some organisations, the primary role of expert consultants, leaders or managers (Poole & DeSanctis, 1990). GDSSs usually comprise a network of computers or keyboards which permit participants to record their ideas that accumulate

for further review, simultaneously and in real-time. Participants can also further develop the ideas. They may annotate, expand upon, vote, sort, weight or rank the ideas (Gallupe & Cooper, 1993).

The team learning system variety of the GDSS technology (see Figure 1.1) is of particular relevance to this study because it epitomizes the encapsulation in tools of human qualities such as values, leadership, modes of relating and cognitive processes (Findlay, 1997). The team learning system dispenses with the domain expert and instead relies upon the use of question sequences that capture and make explicit high-level thinking and decision processes (Elliott, 2003a) as well as more complex forms of interpersonal communication such as dialogue and dialectical discourse (Findlay, 2008). The questions can be supplied with the tool or crafted by a user who is knowledgeable about the rules of question construction (Fitzgerald & Findlay, 2006). The team learning system provides a shared conceptual space where participants are able to simultaneously view, contribute and exchange ideas with each other (Findlay, 1997). Users follow a facilitation model, or “etiquette”, which ensures that novices can conduct sessions involving complex thinking or decision processes after only a relatively short period of facilitator training. Students learn to create, save and facilitate their own learning activities using open-ended questions that might be otherwise employed in a conventional learning environment by an expert teacher or team leader. Images, simulations, digital documents or instructions to perform physical activities such as experiments are also incorporated into sessions as resources or challenges. This makes it possible for psychological and cultural tools to be dynamically developed and incorporated into a physical tool, thereby further evolving the tool (Fitzgerald & Findlay, 2006).

Figure 1.1 Groups discuss ideas using the team learning system. Source: Zing reseller kit (2008).



The team learning system is just one of a raft of new social technologies such as wikis, web blogs, tags and social book marking that allow people, and young people especially, to collaborate in an “always-on” world (Mayfield, 2006b; Prensky, 2007). Some of the tools such as expert systems and simulations also feature high-level “human-like” capabilities that extend human cognition (Mayes, 1992). The tools play a major role in the way business leaders remain intuitively in touch with the changes taking place in society by tapping into the creativity of their staff, stakeholders and customers, to reliably undertake innovation and engage in planetary-wide transformation. They do this not from choice, but necessity.

For business, it is a Darwinian competition for survival in the face of the unpredictable emergence of new competitors for markets, on time scales of weeks and months rather than years (Kauffman, 1995). However, all organisations are faced with a continuing human problem, the inability to adapt rapidly to changing conditions. They are the sum of many parts and the parts are humans with beliefs, values, skills and knowledge (Mintzberg, 1991b) acquired at different times of social and technological development (Foster, 1987) that have become dynamically concretised within interlocking socio-technological webs.

Young employees arrive at work largely unprepared by their school education for what lies ahead. Employers, now expect students to graduate from school with process rather than content skills and know how to work and learn in teams, solve problems, plan and implement projects and use technology so that employers do not have to retrain them to meet their needs for greater flexibility and agility (Australian Education Council, Mayer Committee, 1992).

Schools disenfranchise or alienate young people not just from school life but also from society (Barton, 2001). Up to one third of students are responsible for disorder in the classroom. One or two percent engage in more serious anti-social or problematic behaviour including, absenteeism, physical attacks, drug use and the verbal abuse of teachers continues (Beaman & Wheldall, 1997). This may not be a new problem, as Socrates (469-399BC) is said to have observed (Patty & Johnson, 1953):

The children now love luxury; they have bad manners, contempt for authority; they show disrespect for elders and love chatter in place of exercise. Children are now tyrants, not the servants of their households. They no longer rise when elders enter the room. They contradict their parents, chatter before company, gobble up dainties at the table, cross their legs, and tyrannize their teachers. (p. 277)

Today, the problem appears to have a new dimension. “Work, knowledge and communities” are being so radically and constantly transformed say Downes et al. (2001) that the “core activity of schools” should no longer be the “mere transmission of knowledge” but “knowledge creation and re-creation to prepare students for a very different world to their parents” (p. 16).

The research question

Research into the problems facing school education has identified many viable solutions to the gap between what schools teachers and learners need for success in a 21st century world. We broadly know what needs to be done, but remain unable to change the culture of schools and the pedagogy on a system-wide scale. Like the curates egg, the system is good in parts. Educational leaders (Becker, 2000; Downes, 2002; Leadbeater, 2004; Hargreaves, 2004; Caldwell, 2004; Elliott, 2005, April) have all called for a change to what schools deliver. What we now consider to be good teaching practice (Rowe, 2004, August) may no longer be relevant for a world in which play, dialogue and creativity is more important than study, memorisation and working alone (Lynch & Fleming, 2006).

The aim of this study is to unravel this perplexing issue through an examination, at cognitive, social and cultural scales, of teacher and student use of a collaborative tool that crosses the twin worlds of teacher reluctance, ICT use and pedagogies that make use of high-level thinking skills and discourse.

The research question that examines this issue is: How do the cultural differences between teachers and students and the historical development of tools explain the use of a tool for collective knowledge creation and how can this be translated into new models of learning consistent with a more robust theory of activity?

To answer this question, a new theoretical approach more aligned with the present cultural paradigm, and which escapes the assumptions and constraints of earlier cultural periods, appears to be required. The research approach that has been adopted is broadly analogous to the way theoretical astrophysicists approach theory building, so that the explanation for the phenomena observed at macro-scales must agree which what occurs at a micro scale and all scales in between, which in the context of this study,

requires a theory that explains human activity at the cognitive, collective and cultural scales.

Theoretical models for exploring cultural difference

A useful lens through which to explore the issue is cultural historical activity theory (activity theory) (Vygotsky, 1978; Leont'ev, 1978). Activity theory explains how human activity is mediated by social interaction, cultural tools, language, gestures, symbols and signs (Vygotsky, 1978) but also how the tools and cultures evolve on a global scale as a consequence of a heteroglossia or multiple interwoven streams (Bakhtin, 1982) of human interactivity. The main premise of activity theory is that the use of tools enables humans to develop culturally as well as genetically. The activity theory literature is reviewed in Chapter 3. Activity theory offers the ability to observe and make sense of learning and development across all scales from individual through group, community and society and from a brief moment in time to cultural evolution over many millennia.

However, as I will show, activity theory has some shortcomings and has been augmented in this study by other theories of development, especially complexity theory (Cohen & Stewart, 1994; Kauffman, 1995). Just as DNA shapes cellular development within a biological context (Cohen & Stewart, 1994), the collective interaction of humans and their tools within a cultural context shapes mental development. A contemporary researcher, Engeström (1987) has taken the original Vygotskian mediated model and expanded it to describe human activity in the context of community and introduced additional mediating factors including the division of labour (roles) and rules. A variation on activity theory advanced by Tobach (1999) offers an overarching explanation for the transformation of cultures and the relationship with local activity, and points to the direction that activity theory could take. Tobach shows that all inanimate and animate matter becomes differentiated into “dynamically interacting levels” (p. 133). New levels arise when internal contradictions within a level become so great it can no longer adjust internally and the tension is resolved by the eruption of a new level. This pattern of emergence in human development is largely ignored in activity theory. It may help to explain the differences in tool use by teachers and students.

Chapter 4 explores how complexity theory (Cohen & Stewart, 1994; Kauffman, 1995) and other theories of development offer a richer explanation of how humans and

their tools are transformed by activity than is presently provided by activity theory. In the same way that physical and chemical systems occasionally undergo periodic transformations to a more organised state, human and tool system appear to exhibit some of these same characteristics. Auto-catalysis, which is a mechanism by which self-organising systems develop, is considered as a possible explanation for some of these large-scale periodic changes (Kauffman, 1995). I will show that our tools have undergone three major structural re-organisations during the 10,000 years since human's made the transition from a hunter-gatherer society to an agricultural society. During the course of the study, participant preferences for change or certainty are evaluated using an innovation index adapted from Kirton (1976). Levels of participant engagement and enjoyment of the activity are explored through the lens of flow theory (Csikszentmihalyi, 1975; Chen, Wigand & Nilan, 2000).

A tentative complexity-activity theoretical model

In Chapter 5, a revised, tentative complexity-activity model is developed which builds on a model of periodic cultural development originally pursued by Vygotsky (1978) and Luria (1973, 1976) and a modern interpretation (Hedegaard, 2005) which explains development in terms of crises; the theory of scientific revolutions (Kuhn, 1962) that deals with the evolution of knowledge; innovation theories (Rogers, 1983; Foster, 1987) that explain how tools evolve within and across cultures, and theories of group dynamics (Tuckman, 1965; Schein, 1988; Losada, 1999) that explain how groups develop and become high performing teams or engage in creative or transformationally potent activity (Csikszentmihalyi, 1975; Chen, Wigand & Nilan, 2000).

At the micro scale, the study sets out to determine how a tool that is capable of scaffolding what it means to be human, changes the way teachers and learners create, or use new knowledge, and how they regard or relate to each other. At a macro or cultural scale the study considers whether any such changes might be incremental or transformational and how an understanding of these processes might inform a new theory of learning and development.

At the conclusion of the chapter, the research question is restated in the context of the tentative complexity-activity theoretical model.

The research method: A series of case studies

Chapter 6 describes the research method and approach. The setting for the research is a secondary school in the United Kingdom with 92 first time teacher and student users of the team learning system in years seven, eight, nine and twelve. The research is exploratory. The study is informed by activity theory (Luria, 1976; Vygotsky, 1978; Engestrom 1987'; Leont'ev, 1998) with support from complexity theory (Kauffman, 1995). The study is presented as a series of case studies (Yin, 1994; Skate, 1995; Burns, 1997) using a mixed methods approach (Tashakkori & Teddlie, 1998).

The primary unit of analysis is the change in human activity (Nardi, 1992), particularly how the aspirations of subjects are transformed, how their roles and relationships are determined by the way they use tools, the rules of communication, and whether the culture also changes.

The study also seeks to establish whether the changes that occur in the teacher and student activity – how they interact and exchange ideas – offers evidence for a quantum jump from a current state to a new state and whether some or all aspects of an activity systems are transformed. The secondary unit of analysis for the study of the facilitator performances is what the teachers or student facilitators say and do to coordinate the learning activities. The secondary units of analysis for the participant performances are the idea and the concept, especially how ideas are generated, shared, further developed and adopted.

Reporting the findings of the research

The results of the research are presented in Chapters 7, 8 and 9. In chapter 7, a series of 10 case studies reports on the student and teacher perceptions of changes in their activity when using a team learning system compared with their usual work or school-going activities. Their activity is analysed using a complexity-activity theoretical model that examines their use of the collaborative tool, their individual aspirations, the roles that the teachers and the students play, the rules of engagement, the qualities of the teacher-student relationships and the culture of the classroom. The analysis considers whether the changes in activity are incremental or transformational and whether the participants experienced high levels of engagement and enjoyment consistent with team development or the flow (Csikszentmihalyi, 1975) experience. The analysis also

explores how the various features of the tool, the question sequences, formal etiquette and the simultaneous contribution and view, influence the outcome of the activity.

Chapter 8 presents a detailed analysis of the performances of the facilitators to determine how differences in the use of speech and motor skills at critical stages of the activity changes the nature of the activity. A model is developed which explains improvements in facilitator performance as a shift from conscious right brain to automatic left-brain control involving the use of self-checking feedback against an internal model of an ideal performance. The analysis of the transcripts of the videotape records is considered through the lenses of four forms of speech; *facilitator speech*, an ideal form of clear instructions necessary to coordinate group activity; *inner speech*, a form of speech associated with the development of motor skills and the sequencing of activity; *automatic speech* that consists of previously learned speech routines spoken automatically and outside conscious control and *authority speech* which is language used to exert authority or maintain behavioural control. The analysis also considers whether there is a shift in the pattern of speech that might be indicative of a change in the power relationships between the facilitator and the participants.

Chapter 9 explores the level of participant performance in terms of the frequency, richness and regularity of contributions to determine whether the classroom activity becomes automatic and self-sustaining. Social network analysis is employed to determine whether various types of questions act as catalysts or if ideas or concepts also stimulate further ideas. The analysis considers whether some participants, more than others, are responsible for idea generation, transmission or adoption, and whether the levels of engagement and enjoyment of the participants are consistent with transformational or incremental change in their activity systems.

Conclusions and recommendations for further research

In chapter 10, the key findings from the three sets of analysis are summarised and related to the tentative complexity-activity model of human development, which gives equal weight to automatic operations and conscious goal-directed activity associated with the left and right frontal lobe functioning of the human brain. The analysis takes into account the autocatalytic effects of discourse, both language-based and gestures that appear to explain the periodicity of infrequent and disruptive transformations within human activity at an individual, collective and cultural level. The study also presents a new pedagogical approach that is more appropriate and culturally

relevant to the needs of young people that may enable the development and wider adoption of new tools.

CHAPTER 2

THE WORLD OF TEACHERS AND LEARNERS AND THEIR USE OF TOOLS

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Overview of the chapter

As infants, children arrive at school full of promise, bursting with energy and enthusiasm, ready and willing to learn. By their secondary school years many young people have become alienated by the system, poorly motivated or bored (Findlay, Fitzgerald & Hobby, 2004). Educational leaders world-wide are concerned at the growing trend towards classroom lawlessness in the most problematic schools and the rise of an underclass that remains in school but fails to develop the necessary literacy to participate fully in human society, except at a most fundamental level (Kirsch, Braun, Yamamoto & Sum, 2007). Employers continue to complain that school poorly prepares young people for work (Levy & Murnane, 2004; Cassen & Kingdon, 2007). Those responsible for school education seem unable to respond to what is happening in the system for which they are administratively responsible.

The purpose of this chapter is to explore the recent literature on the culture of schools compared with the world of work and the private lives of young people, the roles that teachers play in learning and pedagogy, the technologies that are available for learning and the classroom settings that have proven successful or problematic.

The review is in seven sections. The first section explores the rate and nature of changes in the world of work and the new skills required of workers. The second section

considers the efforts by school education authorities, particularly in the United Kingdom, where this study is located, to transform the way that teachers teach and children learn in order to better prepare children for the future. The third section explores the private lives of young people as consumers and citizens rather than school-goers to see what alternative and perhaps informal ways young people are being acculturated into society. This section also examines the gap between the types of tools children routinely use at home and at school. The fourth section focuses on the importance of knowledge construction, group work, dialogue and high level thinking skills as a way of preparing young people for the new world of work and explores possible reasons why teachers do not teach this way. Section five reviews the literature about the use of technology in schools and considers some of the barriers to technology use in the classroom. Section six explores the literature about the rapidly expanding category of social technologies that allow people to connect and collaborate with others anywhere in the world. Among these tools is a type of collaborative software known as group decision support systems that facilitate discourse between people and helps people create new knowledge, resolve conflicts and reach decisions faster and more reliably in the face of accelerating societal and technological change. Section seven reviews the literature that has been published about the Zing team learning system that is the subject of this study, its' history of development and use and its' relevance to school, community and corporate users.

The rapidly changing world of work

The forthcoming review of the literature about the world of work suggests that a shift or series of shifts of paradigmatic proportions is under way in the adult world for which many young people may be ill prepared. At the same time that schools have alienated many of their students by the boredom of traditional lessons, some children have discovered new ways to learn how to participate in human society that many adults are unable to comprehend. This review sets out to understand the nature, dynamics and scale of the qualitative shifts that are occurring in the separate cultures of youth, school and work and how these shifts may be related.

When young people join the workforce for the first time they discover their learning journey is not at an end but is only just beginning. The world of work and the

technologies and methods people use to engage with the world are changing so fast (Galinsky, 1999) that people need to be lifelong, just-in-time and innovative learners. Jobs-for-life are disappearing. British workers starting out today will change their jobs an average of 13 times in their lifetimes (Gillison & O'Leary, 2006). Jobs are being filled by people who accept or want flexibility in their lives such as opportunities to travel, work hours that suit family-oriented lifestyles, or gain experiences working for different employers. Short-term contracts are replacing permanent work. Work is also becoming more decentralized and globalised. Growing numbers of people are working from home and hot-desking has become common (Daniels, 1994). Staff members share desks in the same way that travelers use hotel rooms, only when you need one, or when you go to the office for a meeting. Asian workers are competing against Europeans and Americans for services work. Your phone call to a help-desk is equally likely to be answered by someone in Bangalore, India or Brixton, England (Gillison & O'Leary, 2006). Global nomads (D'Andrea, 2006; Wurgraft, 2007) do business all around the world, flying from city to city, staying away from home for weeks or months at a time. Many are one-woman or one-man global corporations that have productised themselves or offer their services to clients anywhere and use hotel rooms as an office (McKenna & Richardson, 2007).

Some categories of work are becoming extinct, not only in Britain, but across the developed world. Labour statistics for Britain and the USA tell the story. At the start of the 20th Century 14 percent of all Britons and 20 percent of Americans worked in agricultural production. A century later, the food for double the British population and six times the U.S. population is being produced by just 2-3 percent of the workforce (U.S. Department of Labour, 2001; Labour Market Division of the Office of National Statistics, 2003). Manufacturing work has also plummeted. In 1900, some 40 percent of Britons and 38 percent of Americans made physical products for people to use. In the year 2000, manufacturing employed just 15 percent of the total workforce in both countries. Financial services, cleaning, retail sales and tourism jobs grew from a small base to become the largest sector that now accounts for 70 percent of all work (including knowledge work). However, the services growth rate has begun to slow as jobs for knowledge workers grows and clever technologies drive old jobs to extinction.

Britain is one of the most knowledge intensive economies in the world. Between 1900 and 2005, knowledge work grew from about 10 percent of the workforce – about the same as the United States of America which Machlup (1962) estimates at 11 percent

of the workforce in 1900 rising to 43 percent of all jobs in 2000 (Economic and Social Research Council, 2008). One in four Britons holds a higher education qualification sufficient to enter a career as a researcher, consultant, programmer, teacher or lecturer (Economic and Social Research Council, 2008). The gender composition of the workforce has also changed dramatically. In the early 1900s, women represented about 30 percent of the workforce compared with 46 percent in 2000 (Miller & Skidmore, 2004).

Not all knowledge workers are highly educated and literate. Some have “high levels of literacy but low levels of education” having acquired many of their skills in the workplace (Pont, 2001, p. 99). The new knowledge economy competences according to the OECD (Ponte, 2001) are:

...team work and the ability to collaborate in pursuit of a common objective, leadership capability...motivation and attitude, the ability to learn, problem-solving skills, effective communication with colleagues and clients, analytical skills and....technological or ICT skills” (p. 106)

One of the underlying drivers behind this intense focus on knowledge work is the global digitalisation of human activities (Taylor, 1999; Parker, 2007). Few aspects of society have escaped the information and communications technologies (ICT) revolution. At one end of the scale, humans have handed to computers the automated control of complex systems (Coskun & Grabowski, 2003) such as telecommunications networks, power stations and air traffic control and landing systems, as well as on-line hotel, airline reservation and banking systems (Salomann, Kolbe & Brenner, 2006; Bielski, 2007). After several waves of mechanical and computerized automation, manufacturing and agricultural jobs are undergoing a further round of automation by self-monitoring, self-correcting, self-repairing, reconfigurable interconnected systems of machines (Mekid, Schlegel, Aspragathos & Teti, 2007). Machines are now talking directly to other machines on a grand scale. By 2010, twenty five million machines will be connected to each other (Adshead, 2006, October).

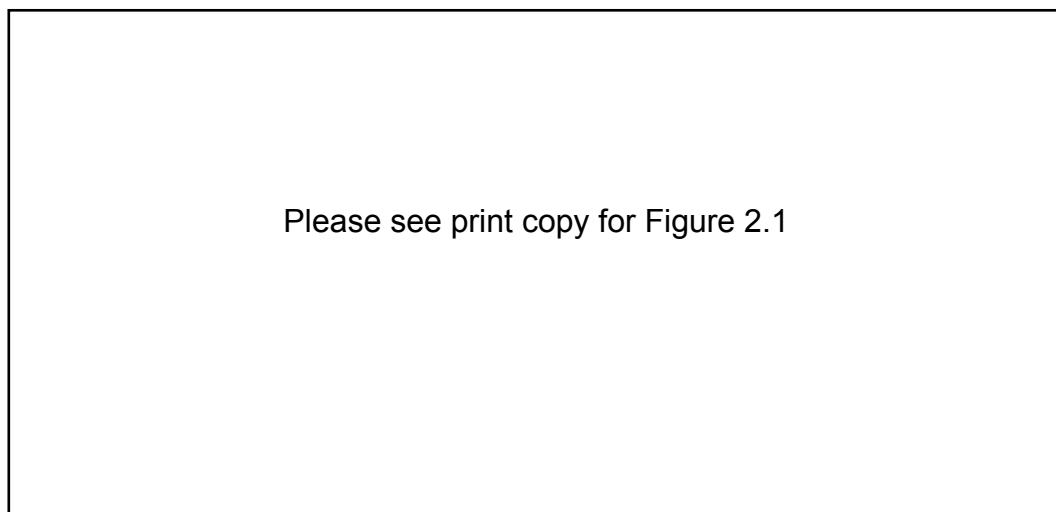
Frey (2007) uses the example of an on-line book purchase to illustrate how interconnected digital technologies have extinguished tens of millions of clerical jobs:

When a purchase is made, money flows into a transaction and is distributed instantly: no wait for payment to be authorized, and no wait for money to clear. For example, when you buy a book from Amazon.com, your payment is instantly divided four ways in a split between the author, the publisher, Amazon, and the shipping company. Additional recipients built into the fractal transaction

may be a co-author, a referring Web site that gets a commission, or a warehouse worker filling the order. (p. 10)

This revolution in the world of work offers few opportunities for people with low levels of literacy. A major study of changes in occupations between 1966 and 2006 by Levy and Murnane (2004) found that the highest growth has occurred in service occupations such as fast-food, clerical, mortgage and technical sales, professional and management work that requires the exchange of complex information (see Figure 2.1) and for services that are difficult to automate or offshore such as cafeteria workers, security guards, cooks and cleaners. Technical jobs that involve complex thinking such as solving novel problems, creating new products and services and dealing with uncertainty also rose. However, many occupations are in decline. Jobs that involve routine manual tasks such as labouring and assembly line work and routine cognitive tasks such as clerical work, which can be computerized or outsourced to other countries have fallen fastest (Levy & Murnane, 2004). Non-routine manual tasks such as driving a truck or cleaning a building went into steady decline as a percentage of all jobs but began to level out from 1990 onwards (Autor, Levy & Murnane, 2003).

Figure 2.1: Percentage change in task types 1969-1989



Levy and Murnane (2004, p. 19) point out that most jobs, including most manual jobs, can now only be filled by people who have the ability to deal with abstract ideas and complex tools such as spreadsheets, models, and digital readouts. A computerized tool may perform the calculations, but the worker needs to be able to record, interpret or analyze the results.

McKinsey & Company (Manyika, Roberts & Sprague, 2007) describe eight major business technology trends that will transform the workplace. The trends include co-creating knowledge distributed across organisation systems, engaging with the customer as a co-innovator, tapping into all forms of talent across the world, extracting more value from interactions, expanding automation, unbundling production from delivery, ensuring management processes are more scientific and creating new businesses out of information. Manyika and Sprague (2008) report that:

(a)...growing proportion of the labor force in developed economies engages primarily in work that involves negotiations and conversations, knowledge, judgment, and ad hoc collaboration via tacit interactions....By 2015 we expect employment in jobs primarily involving such interactions to account for about 44 percent of total US employment, up from 40 percent today. Europe and Japan will experience similar changes in the composition of their workforces. (p. 4)

What began as a strategy for capturing the tacit knowledge of key workers that could be lost if employees retired (Sveiby, 1997; Shariq, 1999) has become a generic strategy for creating and applying new knowledge (Nonaka & Takeuchi, 1995). Many business leaders now focus on becoming “learning organisations” (Davis & Botkin, 1994; Argyris & Schon, 1996) that not only possess knowledge but also create new knowledge to reduce waste, improve processes and replace salaries with capital. As well as performing a production or services function, a principal activity of such organisations is to constantly detect and correct their own errors and continually improve their effectiveness and efficiency in a close relationship with staff, customers and suppliers. The transition to this new form of organisation (Miller, 1998) is rupturing many of the entrenched relationships of past eras. As product and process lifecycles become ever shorter, learning by continuous improvement or incremental change is no longer sufficient (Virkkunen & Ahonen, 2002). Employees are no longer regarded as merely a means of production, but as co-learners who must have the skills to participate in generative learning to create new and better solutions to solve increasingly more complex problems and to appropriate new knowledge embedded in new products, tools, models, customers’ needs and processes (Hammer & Champy, 1993). Other forms of learning (Tinkler, Lepani & Mitchell, 1996) include contextualised learning, which takes knowledge acquired in one location or industry and applies it to a different context, customised learning, which is the redesign of the learning process so it meets the needs of particular groups and just-in-time learning which makes learning available when and where the learner needs it. Organisations no longer learn only from the best in

their own industry, but the best in other industries as well. Another form of reproduced knowledge is lifelong learning (Prestoungrange, 2002) which has emerged as a response by employers and employees to changes in the nature of work that has accompanied the increasingly shorter periods between social and technological upheavals. Workers who could once pursue a career after leaving school without further training or study, now find themselves unable to find work unless they acquire the skills necessary to use tools that did not exist at that time. In some industries, where successive waves of disruptive change have occurred, transformative learning or “double loop” learning has become necessary (Argyris & Schon, 1974). This type of learning involves the creation of “world views” or models that are a better fit with each new emerging period than the previous model. Another type of accelerated learning that anticipates future transformation, epistemic learning, pre-emptively challenges existing meanings and invents new meanings that contribute to the creation of new cultural landscapes (Bawden, 1995).

In some parts of the developing world, especially in South East Asia, entire countries have switched almost overnight from an agrarian economic model to a knowledge multiplier model. It is not just call centre jobs that are being created in Bangalore, Kuala Lumpur or Shanghai. Hundreds of thousands of highly qualified software programmers, engineers, artists and designers who compete against highly skilled Britons and Americans (Fox, 2003, November) for work in high-tech manufacturing, telecommunications, infrastructure development and the whole spectrum of science and engineering work for which developed nations wrongly assumed, they held a comparative advantage. The rise of the Asian tigers has also seen the transformation of their societies. Although India has over 600 million people living at or near the poverty line there are now 300 million people who are as well-off as their middle-class equivalents in Europe and America. China has moved 500 million people from rural areas to cities to feed the employment demands of the new economy (Dickie & Kygne, 2003, November 28). Hubacek and Sun, (2005) say:

China's development over the last few decades has been characterized by high rates of economic growth, large-scale migration from rural areas to the fast-growing cities accompanied by changes in lifestyles, and steady population growth. (p. 187)

Asia is fast developing a new connected generation (Global trends watch – Chinese youth: Wiring china's youth, 2007, March). Youngsters are flocking to

homegrown versions of MySpace and YouTube. For example, 130 million Chinese are now connected to the internet and this is increasing at 30 percent a year (Einhorn & Karif, 2007, January). The Asians have other strategic advantages that should send a strong signal to the developed world. Asian manufacturing plants and their workforce are younger and less fossilized than their European or U.S. counterparts. They have much to gain, whereas workers in Manchester and Coventry, and Detroit and Akron have much to protect. According to Blanchard and Izquierdo, (2007, November), 55 percent of Chinese manufacturing plants were built in the last 10 years compared with 9 percent of U.S. plants. Over 70 percent of U.S. plants are more than 20 years old compared with only 18 percent of Chinese plants. Asia has the advantage of very little Industrial Age baggage. The West is dogged not merely by ageing infrastructure but, as I will show, by an equally fossilised learning system.

Efforts to transform school education in the United Kingdom

The developed world is facing a nightmarish situation created by the combined effects of the shift to knowledge work, the automation of routine rule-based work by new technologies, the growing competition for high-tech jobs from the rapidly growing Asian economies and the failure of the education system to educate everyone to a new and higher standard. Although Britain was a leader in high value-added work in the late 1900s, it failed to deliver enough people in critical fields, particularly in the sciences and the traditional trades which have become high-tech to satisfy demand (Economic and Research Council, 2008). British political leaders realized they needed to make radical changes to the education system in order to remain globally competitive as a country.

When the Blair Labor government came to power in the United Kingdom in 1997 it inherited a one-size-fits-all approach to secondary education, run-down school buildings, almost total reliance on public funding and low levels of social capital (Caldwell, 2005, May). The government began a new series of reforms to the education system that built on the previous government's efforts to give greater autonomy to head teachers and schools for hiring staff and spending on equipment and resources. They set new and higher performance targets to create a "world class education system" (Horne, 2001, p. 9) but retained a centralised curriculum. The United Kingdom has one of the largest centralised, common curriculum education systems in the world, which in 2004-

2005 catered for the educational needs of 9 million students who were taught by 560,000 teachers (Economic and Social Research Council, 2008). Record numbers are staying on at high school and going to university. In 1922 just 23 percent of the 10,000 first degrees (less than 1 percent of the age cohort) that were awarded that year were conferred on women (Labour Market Division of the Office of National Statistics, 2003) whereas 260,000 people graduated from university in 2007 or 37.5 percent of the age cohort, of whom a slight majority were women.

British schools employ 12 percent of all new British graduates every year (Horne, 2001). Horne reports that teachers choose education as a career because they like working with young people (79%) or the school holidays appeal (15%), yet half leave teaching within five years. Poor pupil behaviour, an ever-increasing workload and low pay relative to other professions are the main factors in declining teacher morale (Horne, 2001). Teachers are also feeling the pressure of demands by government to deliver to a higher standard. A study of 150 primary and secondary teachers by Demos (Horne, 2001) found that teachers believed they were not resistant to change, of which they are frequently accused, but were resistant to delivering on the government's deeper and wider curriculum and the use of new and unproven teaching methods. They were also concerned about the lack of a say in the content of the curriculum. The government's reform program, which some, such as Horne (2001), described as "highly ambitious" but "generally successful", was pursued on an education system-wide scale (p. 20). The government introduced a national literacy and numeracy program, increased professional development and encouraged schools to develop specialties, often in partnership with the community. The government also focused attention on the large-scale restructuring of failing schools through an equally ambitious program of establishing city academies, which poured money into school rebuilding and new technology. Schools were funded to purchase laptops for teachers, install electronic whiteboards and overhead data projectors in all classrooms, network computers, connect to the internet via broadband and choose from a wide variety of educational software that was funded centrally but delivered locally. Schools were encouraged to become more entrepreneurial and take greater responsibility for hiring and developing teachers. They were also expected to make decisions about resources and work with community partners.

According to Horne (2001), teachers felt pressured initially by the reforms and business and educational leaders believed the money invested in new buildings,

pedagogy and technology would not pay off. Four years into the reforms Horne points out it was “striking that, despite the long history and growing intensity of this reform process” which extended over two decades it had “little real impact on the basic organisation” (p. 21) of schooling. At a structural level there were numerous changes. Most of the 3,000 secondary schools developed a specialist focus in one of 11 fields in technology, the arts, community and sport (Caldwell, 2004). Schools received additional funding when the programs were matched by in-kind or monetary investments from private and community sector partners.

In 2004 the government stepped up its reform effort by announcing a series of initiatives to deliver a tailor-made education for every child (Caldwell, 2004). Teachers and schools are now expected to involve children in making decisions about and planning their own learning. One of the authors of the “personalized learning” approach, former Professor of Education at Cambridge University, David Hargreaves, argues that schools and teachers must focus on the needs of individual students and customise what they do (Richards, 2004, October). Hargreaves says:

Education is beginning to go through some of the crises experienced earlier by the world of business and it is painful because the rate of change is so high. Teachers have generally responded well to the pressures on them to improve, but unless they are willing to reconsider the structure of the profession in a more radical way, the transition will be far more painful than it need be. Teachers will have to follow a similar path. Personalising learning will require pupils and parents to take greater responsibility for learning than ever before. Teachers may be engaging in the debate, but are the 'consumers' ready to play their part? (p. 1)

The British government also announced plans to ramp up their investment in school infrastructure. They are investing more than £50 billion in capital building programs that will see nearly every secondary school, and half of all primary schools, rebuilt or refurbished and equipped with the latest technologies by 2020 (Becta, 2008; Partnerships for Schools, 2008; Department for Children, Schools and Families, 2008). A pilot program of rebuilding and re-launching 20 run-down and failing schools as City Academies in partnership with the private sector has since been extended to a further 400 schools (Becta, 2008, Partnerships for schools, 2008). Novel school designs are trialled to suit the needs of different communities. Planning and design is undertaken in consultation with business and community leaders with assistance from leading educational and architectural consultants who are knowledgeable about social and technological trends as well as the pedagogical needs of young people.

The government has launched a series of cross-sector initiatives such as Every Child Matters (Department for Education and Skills, 2004) to encourage schools, police, justice, health and other services to work together to achieve 55 outcomes for young people. The anticipated outcomes include healthy lifestyles, protection from harm through reduced crime and bullying, self-responsibility, economic well-being and getting the most out of life. An Extended Schools (Department for Education and Skills, 2007) program has also been implemented nationally to encourage communities to make better use of school facilities and engage more with schools.

Despite this massive effort, the education outcomes for many young Britons are uncertain. Of the 577,000 British students who turned 16 in 2003, 5.5 percent or 32,000 scored no passes in the General Certificate of Secondary Education (GVSE) and General National Vocational Qualification (GNVQ) examinations and 25 percent or 144,000 scored no passes above a D grade – which is just above a fail (Cassen & Kingdon, 2007). Digby Jones (The Guardian, 2007, January 30), formerly director general of the Confederation of British Industry and appointed in 2007 by Prime Minister Brown as the government's skills envoy, says that Britain is “lagging woefully” behind its’ competitors. Over one in six people leave school each year ‘unable to read, write or add up properly’. Of a total population of 59 million, some 5 million adults cannot read properly and 11 million struggle with numbers. Jones warns that in the future there will be even fewer jobs available for unskilled workers than there are in 2007. Says Jones (2007) :

The fact that 11 million people cannot add up is a "disgrace"...This government has been in power for a scholastic generation....They are delivering into the workforce people who are not employable. (p. 1)

A similar gloomy picture is forecast by Mick Brooks, general secretary of the National Association of Head Teachers, the largest head teachers union. Brooks says that Britain is in danger of creating “an army of the unemployable” (The Daily Mail, 2007, May 7). Disillusioned teenagers leave school with no qualifications. Says Brooks (2007):

The current number of unskilled jobs in this country is estimated at about three million today. The effects of technology may well mean a huge shrinkage of this employment market. When this happens, we will not simply have an army of the unemployed, we will have an army of the unemployable - a huge threat to social cohesion. (p. 1)

In higher education, the United Kingdom has slipped from third to tenth in the world in terms of the proportion of young people completing a university education (Baker, 2007, September 21). Baker (2007) argues that the problem has its' origins further down the line in the 15-19 year old range where the United Kingdom is in 23rd position because just 78.5 percent of 15-19 year olds are still in education compared to the OECD average of 81.5 percent.

However, the disconnect between skills and jobs in Britain may be a common feature of education systems generally. Michael Barber, former British education supremo and now a consultant with McKinsey & Company, published a report that compared the best 10 school systems with the rest of the world (Barber & Mourshed, 2007). The top 10 school systems were benchmarked by the OECD Program for International Student Assessment (PISA) (OECD, 2006a) and included Britain, Canada, Finland, Singapore, Japan and Korea. McKinsey & Company (Barber & Mourshed, 2007) reported that:

Despite substantial increases in spending and many well-intentioned reform efforts performance in a large number of school systems has barely improved in decades. Few of the widely supported strategies (for instance, giving schools more autonomy or reducing class sizes) have produced the results promised for them. Yet some school systems consistently perform better and improve faster than others. (p. 5)

If Britain can somehow be regarded as one of the top 10 education systems in the world, and it is clearly a system that is unable to deliver for the least educated, then how much worse are other systems? Although the British system is one of the best, it may be merely one of the best of a bad lot.

Professor Brian Caldwell (2005, May), former dean of education at Melbourne University and consultant to the British Specialist Schools Trust says that while personalized learning and transformation of the teaching workforce are several of many bold steps being taken by British educators these strategies will not be sustainable unless the approach becomes woven into the fabric of society. He calls for a new enterprise logic of schools that places the student, not the classroom or school at the centre of the school system. He says that schools must no longer be isolated from the communities they serve. They need to create networks with business and the community, to share resources together, foster distributed leadership, energize and sustain the new relationships, and allocate resources in new ways. But most of all, says Caldwell (2004), there needs to be an “education epidemic”, a term first used by

Hargreaves (2003), to further and more radically transform the system in which many of the old ways – the timetable, the rigid curriculum, the classroom furniture and layout, and the pedagogical tools – need to be abandoned and reinvented for radically different times. Perhaps what Caldwell is describing, but does not directly articulate, is a systems failure in the form of a tragedy of the commons (Senge, 1992) where no one takes responsibility for the consequences of collective misuse. It seems to me that individually or collectively the teachers blame the children for being unruly and disengaged, employers blame the schools, students blame their teachers for boring them with lectures and denying them access to their favourite technologies and parents blame both the students and the teachers but go along with the present system because teachers provide a child minding service that allows all parents to work which for many is an economic necessity.

Young people as consumers and learners using technology

A review of the education and marketing literature shows that schools continue to be organised along the lines of a “curious mix of the factory, the asylum and the prison” (Hargreaves, 1994, p. 43) yet many young people have available to them, in their home lives, the means to learn independently of their “captors” or “keepers” using new kinds of tools for communication, collaboration and artifact construction they will use when they join the workforce. Sadly, some are denied access both at home and at school, and fall behind in terms of social and technological literacy.

An implied assumption in the education literature is that young people are unable or incapable of making informed choices about how and what they should learn and that this role is the exclusive province of government and teachers. What children must learn is enshrined in curriculum documents, examinations and performance targets set by the Qualifications & Curriculum Authority (2008) for each stage of a child’s development. Children have no choice. They and their parents must comply (Education Act, 1996), even in the context of “personalized learning”. What began as laws in 1844 to provide children working in mines and factories with some education and which was made mandatory in 1890 and free in 1891 for 5 to 12 year olds (Woodlands school, 2008) has become a yoke. It is only when children reach their teenage years that streaming into vocational and other variations to courses is allowed although some core subjects must still be studied.

In sharp contrast to the school education literature, the marketing literature reveals that young people are regarded as capable of making choices or being influencers from an early age, for both family and personal purchases of food, books, clothes, entertainment and sophisticated technologies such as computers (McNeil, 1972). Marketing researchers go even further and argue there is a need to involve young people in the design of new products, not for any idealistic notion, but because it is good business (Findlay, Fitzgerald & Hobby, 2004). Manufacturers are increasingly reluctant to bring products and services to market unless they know if and how kids will use them (McGee & Heubusch, 1997) and marketers routinely engage children in the process of inventing their own new toys, games and consumer products to avoid investing large sums in concepts that fail to sell.

At the start of the 1900s, marketers regarded children as dependent on their parents. Over the next five decades, marketers began to view children as autonomous consumers (McNeal, 1992). Now, in the first decade of the 21st century, children are regarded as not only active consumers but as the most connected and independent generation ever (Children's media: The future belongs to the kids, 2007, February). They have their own mobile phones, their own televisions, their own computers and even their own debit cards. For example, children can now get their own pre-paid MasterCard at age 13, or if they are younger, join the PAYjr Chore & Allowance System where they can track their bank balances on-line (Mark, 2007, May 26).

Marketers set out to give young customers what they want. They see children as knowledgeable and capable of making their own decisions about who they are through what they buy (Cook, 2000) even though others still see the child as innocent and the corporate world as preying on them (Steinberg & Kincheloe, 1997). Between the ages of five and 13 children enter into a kind of consumer apprenticeship (McNeal, 1972) where their purchases, especially what they buy for their own personal use, become increasingly important to them.

An article in Campaign (Kids: Stages of youth: child consumer preferences, 2006, May 5) illustrates how market-savvy young people have become:

Children learn brand loyalty before they can read. By the age of 15, they are fashion-conscious media junkies who trade items on eBay and pay for their own mobile phones....According to some studies, brand loyalty may begin as early as the age of two. At the age of three, before they can read, one out of five children is already making specific requests for brand-name products. (p. 4)

By age eight, children have acquired the necessary skills from parents, peers and TV to become independent consumers (Solomon, 1999). As consumers, children have had their own money to spend for several decades, and have had a say in the purchase of many household items (MacNeal, 1992). Guber & Berry (1993) found two thirds of six to 14 years olds cook for themselves one to five times a week, and half of these bought food for their family or participated in family shopping.

Children are “clued up about what they are buying and hate being talked down to” or patronised yet this is what schools and teachers do (Miles, 1998). Children think and talk about the media and are able to recognise and even resist extreme ideological positions and advertisers claims about products or toys (Tobin, 2000).

In the 1950s Gilbert (1957), a pioneer of marketing to children, gave this advice about how to engage young consumers, which is just as relevant to marketing today as it was when the baby boomers were born. Imagine, for a moment, if these principles were applied to school education. Gilbert said that marketers should provide children with opportunities for tactile exploration and make sure the images used in the advertising are of the appropriate age because seeing a picture of a younger child using a product is a turn-off. Gilbert warned that marketers should not patronise children but treat them with the respect accorded to others, because children are always striving for their own independence. He said marketers should satisfy the search for novelty that seems to be hard-wired into children. When children achieve this state, they should receive social recognition that affirms who and what they are becoming. Above all, youth constantly demands the new and “abhors anything that smacks of old-fashioned, out of-style or out-of-date” (p. 311).

Half a century later, children have become early-adopters of new and more complex technologies especially on-line media. They do so because it is dynamic, two-way, highly participatory and compelling (Montgomery, 1996). But, far from passively adopting what has been created by adults, young people are creating their own *agentive culture* (Jenkins, 2006) in which they not only interact with each other and with abstracted individuals in virtual worlds but also produce new artifacts using the products they consume.

Most kids in Britain are connected to the internet at high speed. Ninety one percent of all UK internet connections are broadband (National Statistics, 2008, February 21) which allows most children to be seamlessly connected to a world that is instant, interactive and always switched on. A media literacy audit of children by the

British Office of Communications (Ofcom, 2006) which regulates television, radio and telecommunications found that 48 percent of children aged 8-11 use the internet at home as do 65 percent of children aged 12-15. The 8-11 year olds use the internet for 4.4 hours per week while 12-15 year olds use the internet for 8 hours per week. Schoolwork, playing games, sending emails and instant messaging are the top four uses. The 12-15 year old students learn about or use the internet at school mostly in formal ICT lessons (60%), media studies (11%) and English (6%). All children watch television, often on their own. Some 71 percent of 8-11 year olds and 85 percent of 12-15 year olds listen to the radio. Mobile phone ownership amongst children is high and growing. Some 49 percent of 8-11s have their own mobile phone, as do 82 percent of 12-15 year olds.

Interactivity is a feature of how children prefer to engage with the world via digital technologies. Ofcom (2006) found that young people use seemingly non-interactive technologies in highly interactive ways:

Amongst those with a television at home and either internet access, a mobile phone or digital TV (92% of all children aged 8-15), half (49%) have interacted having seen something on television using a mobile phone (to send a text message), the internet (to send an e-mail or visit a website), or the interactive button on their TV remote control. Interactivity is significantly more common amongst 12-15s (57%) than amongst 8-11s (14%), with 12-15 year old girls significantly more likely to have interacted (69%) compared to 12-15 year old boys (44%). (p. 3)

The type and power of new technologies that facilitate playful participation and knowledge creation, and which incidentally have considerable potential in school education, is rapidly expanding, according to Prensky (2007) who says:

In the past five to ten years, we have seen the appearance of scores of new technologies that have strong potential uses in education. They include email, search, texting and instant messaging, blogs, wikis, the Wikipedia, podcasting, polling devices, peer-to-peer (P2P), complex computer and video games, networking, augmented reality, social and community building tools, digital cameras/videocams, phone-based cameras/videocams, GPS, speed enhancers, interactive whiteboards, DVDs, wireless technologies and many more. (p. 40)

Wason-Ellam (2002) argues that although children may be living within the geographical spaces of community most are engaged in structured play outside those parameters in the battery-operated, electronic or digital spaces of the virtual worlds.

Digital play has become a national British pastime (BBC, 2005); 65 percent of the total population aged between 6 and 65 play digital games, of which 48 percent are female. Virtually all 6-10 year olds and 97 percent of 11-15 year olds play computer and hand held games, as do 82 percent of 16-24 year olds.

Many children learn informally at home in a “technology rich” environment what they are prevented from learning at school usually through interactions with peers (Downes, 1999). They see computers, multimedia and the internet as both tools and an active form of leisure (Downes, 2002) or *edutainment* when fused with learning (Creighton, 1994). However, teachers continue to reject the artifacts students bring to the classroom from popular culture as an intrusion on class activities, and regard a much narrower range of educational programs or toys as acceptable (Bordieu, 1997). Any tacit or cultural knowledge that young people bring to the classroom is often seen as not real learning or a deficit which teachers must correct (Marsh 2000). Children learn not to speak to teachers about their interests and ideas (Arthur, 2001) to avoid the rejection of their world. Findlay, Fitzgerald & Hobby (2004) found that when teachers think about desirable classroom climates, they think of tasks and outcomes, but when teachers are asked to think about children’s interests, they acknowledge that children would prefer a classroom that has a focus on fun and social relationships. Yet teachers still opt for tasks over fun.

Surveys of computer use show that two thirds of students develop their computer skills away from the school classroom (Meredyth, Russell, Blackwood, Thomas & Wise, 1999). On average, students use a computer for more than five hours a week at home and for less than half an hour at school (Downes, 2002). A common use for computers in the primary classroom is to keep students occupied who have finished their conventional classroom work (A.S. Elliott, personal communication, April 28, 2004). Schools provide few opportunities for student teachers to observe the exemplar use of ICT or apply their new skills in a classroom (Elliott, 1999). According to Becker (2000), high school students mainly engage with computers in classes to teach them how to use computers or to undertake some kind of specific vocational training. In academic subjects, only a quarter of English teachers report frequent use. Becker also shows that only one in six science teachers and 1 in 10 mathematics and fine arts teachers used computers in their teaching practice.

British futurist Charles Leadbeater (2008) sees this gulf between teachers and learners as a change in the focus of society from work to play. Learning has become

collective knowledge creation through creativity. In his on-line book “We think: Why Mass Creativity is the next best thing”, Leadbeater (2008) says:

The power of mass creativity is about what the rise of the likes of Wikipedia and YouTube, Linux and Craigslist means for the way we organise ourselves, not just in digital businesses but also in schools and hospitals, cities and mainstream corporations. My argument is that these new forms of mass, creative collaboration announce the arrival of a society in which participation will be the key organising idea rather than consumption and work. People want to be players not just spectators, part of the action, not on the sidelines. (p. 1)

Some young people are excluded from this rich new world, partly due to their family, social and financial circumstances and partly because schools and teachers limit access to technology. A national survey of 9-19 year olds by Livingstone and Bober (2005) found that while 88 percent of middle class families had access to the internet at home, many working class families missed out, with only 66 percent connected. Lack of access at home and at school is helping to deepen the digital literacy divide.

Although children’s literacy experience is increasingly digital, involving multiple kinds of interactive media which is often related to popular culture (Arthur, 2001), the digital world has stimulated interest in other traditional media. The success of the Harry Potter franchise across the books, film and the internet is a prime example. Worthy, Moorman, & Turner (1999) found that sixth graders prefer to read scary books, popular magazines, comics and cartoons, yet only scary books are available at school. Learning to read books is no longer what it means to be literate (Giroux, 1997). Schools are still focused on print-based text and teaching methods ignore what children experience (Arthur, 2001) even though popular media is part of children’s daily experience of life. Salamon (1994) found that children exposed to novel forms of symbolic representation typical of film and television such as zooms and close-ups begin to use these forms in their thinking. Salamon also found that children who watch a lot of “jazzed up” shows such as Sesame Street become less capable of continuous school-like tasks and “jump-around” impatiently. However, studies of student engagement when using computers suggests otherwise (Kubey & Csikszentmihalyi, 1990) as interactive environments provided by computers and games maintain student attention (Woszczyński, Roth & Segars, 2002; Pilke, 2004).

Some of the differences in attitude between young people and their teachers can be explained by the changes in technologies that have swept through human society during the 20th century and continue to race away. Gillison & O’Leary (2006) say it

“took nearly 40 years for 50 million people to own a radio, 16 years for 50 million people to own a personal computer and just five years for 50 million people to connect to the internet” (p. 24). Yet *young* teachers, raised in a digital world, continue to use pedagogical tools such as chalk, the blackboard, closed questions and workbooks, that were readily available and appropriate a century ago to teach today’s Knowledge Age-ready youth (Findlay, Fitzgerald & Hobby, 2004).

Schools and teachers continue to resist change

Formal schooling for all has a history that extends over 100 years into a culturally different past – the Industrial Age (Abbott, 1997). The one-room all-grade school attended by children who worked part-time in factories and mines has evolved into graded classrooms (Riel & Fulton, 2001) where the students now do “learning work”.

According to Chang and Simpson (1997), four different cultures are to be found in school education, the lecture, self-study, concurrent learning and collaborative learning. They point out that the *lecture* involves the transmission of authoritative knowledge via a speaker to the learner in a lecture theatre or classroom composed of rows of seats or desks. In *self-study*, the learner reflects alone on what he or she reads, sees or hears and integrates it into their current knowledge. This is a key feature of university studies. In *concurrent learning*, the learner shares their views with others through email, discussion forums or databases. The core value is mutual respect and the group dynamic is democracy with equal say, but unequal roles. Some university courses may employ this model but it is rarely found in primary or secondary schools. The richest learning culture is *collaborative learning*, which is the co-creation of new knowledge within a community of learners, where all participants are able to play the role of leader or follower. This is the way that many corporate improvement processes work.

The school classroom of the 19th century had at its core the slate, the blackboard, the teacher’s desk facing the students, rows of students’ desks facing the teacher, and a monitor or person responsible for transmitting knowledge from the expert to the learners. This Industrial Age or factory production line model of learning has persisted for over a century. In many schools, you will still find rows of desks with the teacher’s desk located at the front of the room facing the children. The blackboard, or its

digital equivalent, the electronic whiteboard is used to support the lecture or note taking. Slates have been replaced by exercise books and chalk has transformed into a ballpoint pen. Most children from kindergarten through to grade 12, says Symonds (2000):

...attend schools designed for the industrial, if not the agrarian era. Everything from the school calendar, which still reflects the rhythms of farm life, to chalk-and-textbook instruction are better suited to preparing kids for the past than the future. (p. 116)

The learner experiences “formal instruction, uniform stages of progression, prescribed knowledge and a curriculum of self-contained packages of instruction” (Abbott, 1997, p. 12). All students are required to work alone, produce individual work, demonstrate their learning via regular tests or examinations and give factual responses to closed questions.

The main focus of school “work” continues to be the reproduction or copying of texts (Johnson, Maddux & Liu, 1997) also referred to as “knowledge telling” (Scardamalia & Bereiter, 1993, p. 35) rather than knowledge creation and re-creation (Downes et al., 2001) required for the 21st century workplace. Instead of “passing on the civilisation to succeeding” generations, schools are becoming places where growing numbers of young people become disenfranchised or alienated (Barton, 2001, p. 4), not just from school life, but also from society (Cullingford, 2002).

School classrooms are often dominated by “teacher-talk” (Rowe, 2004) where the teacher never stops talking. This causes many students to become disengaged. Students say, “In most classes you sit around at get lectured at” (Walker & Warhurst, 2000). Edwards (2000) refers to incessant teacher talk as “the sea of blah”:

The teacher stands at the front of the room and blahs all over the place – blah, blah, blah, blah, blah. The sea of blah fills the room and the students bob up and down like corks in this sea. Every now and again, they go under and take a gulp then bob up again for air, and then down again. The gulps are somewhat random. So students spend their days *gulping from the sea of blah*. The best analogy I can give you is to imagine you are reading your favorite novel, you go off on a mental tangent, when you come back half of the page has just vanished. Imagine the frustration. That is what *sea of blah* learning is like for the listeners. Yet teacher talk is almost certainly the major mode of instruction still in schools...and universities across the world, even though we all know better. (pp. 4-5)

Studies of student engagement and attention show that teenagers are becoming more disconnected from school, bored and lacking in motivation (Hidi & Harackiewicz,

2000; Eccles & Wigfield, 2002) and that for many students, particularly secondary students, classroom are dull places where students have difficulty staying focused and are easily distracted (Sousa, 1998). The flexible ways of working that students need to be successful in a constantly changing world are difficult to acquire in such a rules-based classroom (Cullingford, 2002). Students need to know generically how to use new kinds of technology (Australian Education Council, Mayer Committee, 1992), be able to create their own knowledge (Smith et al., 2003), use higher level thinking skills (Elliott, 2003a) and be able to work and learn in teams (Australian Education Council, Mayer Committee, 1992). The problem is that knowledge is constantly being transformed and has an ever-shorter shelf life (Smith et al., 2003) as a consequence of technological and social change (Windschitl, 1999). As I showed earlier in this chapter, there are only two areas of significant job growth according to the OECD (2007) Science Competencies for Tomorrow's World report:

In order to participate fully in today's global economy, students need to be able to solve problems for which there are no clear rule-based solutions and also to communicate complex scientific ideas clearly and persuasively....if students learn merely to memorise and reproduce knowledge and skills, they risk being prepared only for jobs that are in fact increasingly disappearing from labour markets....the kind of skills that are easiest to teach and easiest to test are no longer sufficient to prepare young people for the future. (p. 33)

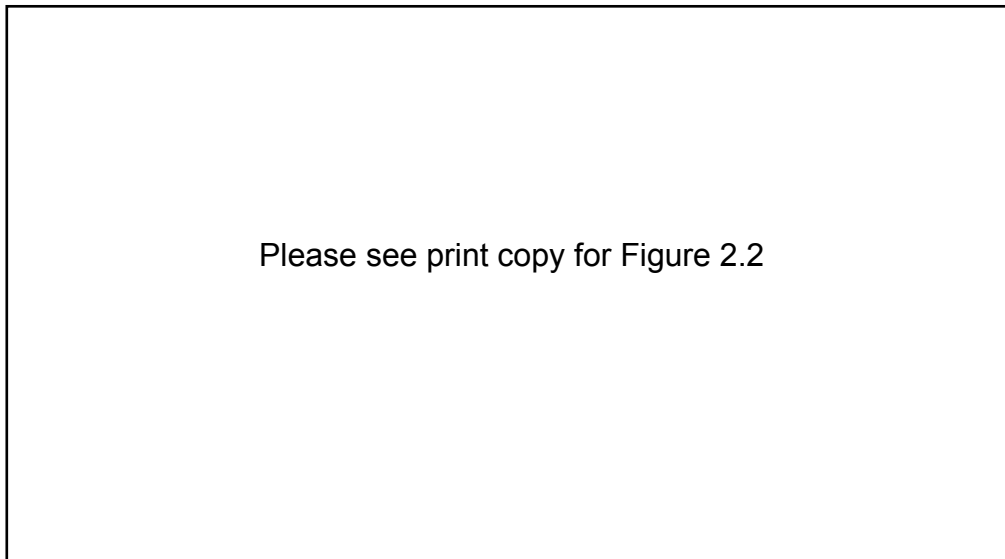
The kinds of jobs that involve complex communication (OECD, 2007) include being a leader or member of a team that improves organisation processes, a salesman assessing a customer's reaction, a coach motivating her team, a researcher explaining a new theory or an art director explaining the strategy for a campaign. The kinds of jobs that involve expert thinking or pattern recognition that is hard to computerize include jobs such as a doctor diagnosing an illness, a mechanic chasing down a fault in a machine, a web designer bringing together graphic and text elements into a unique design or a chef creating a unique dish from unusual ingredients.

The gap between what young people need and what teachers teach (Sierra, 2008) is shown in Figure 2.2. It is symptomatic of the focus on memorisation and reproduction rather than learning how to construct knowledge and apply it to new contexts. Sierra (2008) states:

If you studied math, science, or engineering at a four-year college in the US, much of what you learned is useless, forgotten, or obsolete. All that money, all that time, all that wasted talent. If all we lost were a few years, no big deal. But

the *really* scary part is that we never learned what matters most to true experts in math, science, and engineering. We never really learned how to DO math, science, and engineering. (p. 1)

Figure 2.2: Gap between required skills and what teachers teach. (Redrawn from Sierra, 2008)



Lord David Puttnam (The Guardian, 2007, May 8), former British advertising guru and chair of the British education innovation charity Futurelab, summarises the use of technology in the classroom when he quotes a young person of his acquaintance who said, “whenever I go into class, I have to power down,” which he says means:

What I do with digital technology outside school - at home, in my own free time - is on a completely different level to what I'm able to do at school. Outside school, I'm using much more advanced skills, doing many more interesting things, operating in a far more sophisticated way. School takes little notice of this and seems not to care. (p. 1)

Knowledge creation is now an essential skill

The critical skill required in the world of work is no longer the ability to accurately reproduce or apply knowledge, but to create new knowledge through engagement with others who each have partial and often different world views. Sadly, schools do not appear to have mastered the pedagogy for knowledge creation and re-creation (Windschitl, 1999) as anticipated by Downes et al. (2001, p. 16) in response to

the needs of employers for agile and flexible employees capable of working and learning in teams.

Knowledge creation or recreation is generally aligned with a pedagogical approach broadly referred to as social constructivism. The social constructivist model of teaching and learning, which is the focus of this study, has its origins in the thinking of theorists such as (Piaget, 1970), Vygotsky (1978), Bruner (1956) and Dewey (1933). It is the basis of activity theory, which contends that human activity is a dynamic process of learning and development mediated by tools such as language, symbols, signs and artifacts. Activity theory is explored more fully in chapter 3.

The main aim of constructivist learning practice is to build a bridge, using scaffolds, between what students know - no matter how scant, but has meaning and importance for them (Dewey, 1966) - and what they might possibly learn or discover. In the classroom setting, the role of the teacher is a guide, facilitator, provocateur and co-sense maker (Tobin, 1993).

The concept of scaffolding was developed by Bruner (1956) in the West as an instructional method in the 1950s, generally independently of Vygotsky (1978) who developed a similar concept in the 1930s in Russia, but whose ideas did not penetrate the Western psyche until the 1950s and 1960s. Vygotsky showed that guidance by an adult or a more capable peer could help children perform beyond what they could do unaided. Scaffolding strategies include modeling (Schoenfeld, 1985), prompting (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989), reflective thinking (Lin, Hmelo, Kinzer & Secules, 1999), questioning (Palincsar & Brown, 1984; King 1990), sequencing (Elliott, 1993a), and guided questioning (King, 1992; Findlay, 2005). Scaffolds help children to think simultaneously about each step of a process as well as the global problem (Elliott, 1993). Scaffolding is least beneficial when task instructions, roles and procedures are too highly structured (Cohen, 1994; King, 1997) and best when the quality of the support changes over a teaching session (Berk, 1996) or is progressively withdrawn to allow the learner to practice the new skills without support (Bruner, 1956).

Critics of constructivist methods argue that young people are unable to discover theoretical principles, concepts and processes for themselves without any support whatsoever (Kirschner, Sweller & Clark, 2007). They say that minimal guidance does not work because the ambiguity and lack of prior knowledge places such high demands on working memory that the learner becomes confused and may even regress. Some

strategies such as guided discovery are regarded as superior for struggling students (Mayer, 2004) because they provide support for the learner. The methods are usually contingent on the context and have proven difficult to formalize as a comprehensive and cohesive pedagogical approach that is easy to apply in the classroom (Windschitl, 1999). Some teachers have difficulty understanding constructivism and how to apply it or see constructivism as a toolbox of methods (Clements, 1997) while others simply balk because it requires more energy and forward planning than rote teaching (Darling-Hammond, 1996). Teachers need to practice the methods so they become an automatic part of their repertoire (Findlay, 2008). Vaughan, Klinger and Bryant (2001) found that turning control over learning to students is difficult for some teachers. For others, the procedures for facilitating peer-mediated learning is overwhelming and for others balancing this teaching strategy with content is difficult for teachers to monitor.

Constructivism is sometimes seen as generating the wrong answers because students develop scientifically unsound beliefs (Chi, Slotta & de Leeuw, 1994). Erroneous beliefs and incomplete conceptual structure can obstruct the development of further concepts dependent on the initial ideas (Hmelo, Najaran & Day, 2000). Weaker students may not have the appropriate prior knowledge as a foundation on which to build. Kirschner, Sweller and Clark (2007) argue that the required knowledge needs to be acquired by the student via instruction and that students with low prior domain knowledge have much greater difficulty solving new problems than those with high domain knowledge. Fensham, Gunstone & White (1994) contend that constructivist teaching does not give learners the right to claim their new knowledge is as good as scientific mainstream current knowledge; some meanings are superior to others and explanations should be elegant, parsimonious and connected with other phenomena as well as having intelligibility, plausibility and fruitfulness and be testable. Hayles (1994) proposes a model of "constrained constructivism" (p. 27) which accepts that whatever learners are able to develop is the best available until subsequently proven wrong and that there will always be concepts unknown or unimagined which are yet to be discovered or constructed.

Efforts to implement school-wide reforms based on constructivist principles has generally achieved poor results or ended in failure (Baumfield & Oberski, 1998). Reforms fail because they have little or no impact on teacher beliefs or their teaching practice (Niederhauser & Stoddart, 2001). Studies of teacher beliefs show that those who define themselves as traditional teachers are most likely to use instruction as their

main pedagogical practice (Joia, 2002). Such beliefs are generally associated with the idea that knowledge has an independent external existence and that learners are merely recipients of knowledge. Few see knowledge creation as a social process (Martinez, Sauleda & Huber, 2001). Student-centred constructivism and the teacher-centred classroom are sometimes seen as an either-or choices rather than a complementary approach (Matthews, 2003). Some teachers see the core philosophy of knowledge discovery or creation as being opposed to instruction (Hannafin, Hannafin, Land & Oliver, 1997) but in practice, constructivist teachers also rely on didactic methods to introduce students to concepts they may have not encountered or when they encounter difficulties.

Universities and other teacher training institutions are also part of the problem. They continue to employ self-study and lecture models of instruction while espousing a constructivist model of teaching and learning (Smith et al., 2003). Although new teachers acquire theoretical knowledge about constructivist practices they do not learn to perform this way, nor do their performances become automatic and routine. The paucity of authentic constructivist classroom learning experiences for pre-service teachers, particularly to observe activities making use of ICT (Elliott, 1999) contributes to the slow uptake of constructivist practices. In the prevailing risk-averse culture of schools, pre-service teachers are offered few opportunities to make mistakes, because mistakes are regarded as failure rather than a learning experience (Matusov, 2001). The employment conditions of lecturers is also an issue. Although lecturers may be employed to teach students, they are often employed on the basis of their research rather than their teaching skills (Lueddeke, 1999). The current shift to on-line learning also perpetuates the instructivist culture (Evans & Nation, 2000). Most on-line courses are designed to transmit knowledge to individuals rather than encourage its' discovery or creation although Pasciale and Fisher (1998) argue that British courses follow a more constructivist approach.

A worrying trend is that the instructivist culture has begun to permeate the world of kindergarten where, according to Resnik (2007) playful learning experiences were once the norm, but now:

Kindergarten is undergoing a dramatic change. For nearly 200 years, since the first kindergarten opened in 1837, kindergarten has been a time for telling stories, building castles, drawing pictures, and learning to share. But that is starting to change. Today, more and more kindergarten children are spending time filling out phonics worksheets and memorizing math flashcards [5]. In

short, kindergarten is becoming more like the rest of school. In my mind, exactly the opposite is needed: Instead of making kindergarten like the rest of school, we need to make the rest of school (indeed, the rest of life) more like kindergarten.
(p. 1)

The role of higher order thinking and metacognitive skills in learning

A current, but largely unrealised objective of school education is for learners to acquire thinking skills and in particular metacognitive thinking or thinking about thinking skills so they develop a helicopter view of themselves as learners and begin to recognise thinking methods and mental models as useful tools.

A metacognitive approach helps children organise complex sequences of thought or action and is effective for both high and low achieving students (Elliott, 1993). The teacher provides scaffolds to reduce the processing complexity to help develop new patterns of thinking and action. The teacher then selectively removes the scaffolds as the child acquires the ability to regulate his or her own activity. Zimmerman (1990) says that metacognitive knowledge and self-regulated learning are critical to academic success. According to Elliott (1993), a key strategy is to encourage children to talk about how they will go about solving a problem and to monitor or regulate their own actions and the actions of others. Elliott says they begin by determining the nature of the problem; then they learn to sequence the activity, trial the method, evaluate their progress, and finally improve the process. Part of the teacher's role is to link the learners' activity to both declarative and procedural knowledge, bringing together the theories of thinking with practice. In self-regulation children take an active role in controlling their own learning, particularly volitional control. They also learn how to deal with competing action tendencies, such as peer pressure or other activities that might seem more interesting or worthy of their attention. Elliott (1993) says children come to realise they must take an active role in their own learning although low achievers may still remain disengaged. Tasks are broken down into small sequential steps that lead to the learning goal. Progress is monitored so if the student leaves out a step or is unable to complete the task, the teacher provides cues about other approaches. Students are also encouraged to use mnemonics to guide their progress and praise is readily given by the teacher for progress made.

Improving metacognitive knowledge or control improves learning (Brown & Palincsar, 1989), helps performance in small groups (Schoenfeld, 1985), supports collaborative discussion (Lampert, 1990) and assists in cognitively guided instruction

such as guided questioning (King, 1994). Metacognitive knowledge comprises declarative, procedural and conditional knowledge (Brown 1987); if a person knows about thinking they have declarative knowledge, how to do things is procedural knowledge and conditional knowledge is when, where and why to use that knowledge. More knowledge leads to better metacognitive control and better control leads to the creation of new meta-cognitive knowledge (Schraw & Denison, 1994).

Metacognition improves in settings where the teachers model construction, then gradually remove the support (Moss, 1992), in peer learning with other students who are slightly more advanced (Rogoff, 1990), reciprocal teaching (Brown & Palincsar, 1989), and autonomous learning, where students discover strategies for themselves (Siegler & Jenkins, 1989), usually when they have relevant domain knowledge, are able to adapt strategies learned elsewhere and are able to deconstruct the problem they are working on or engage in self-directed reflection (Paris & Byrnes, 1989). Writing about the use of thinking skills and discussion with peers (Schraw & Denison, 1997) helps develop metacognitive skills as does using a check list to monitor performance (King, 1991) and self-talk during a difficult task (Pressley, El-Dinary, Gaskins, Schuder, Bergman, Almasi & Brown, 1992). However, to achieve stable acquisition and transfer of thinking skills repeated use of specific thinking skills in different contexts is necessary (Zohar, Weinberger & Tamir, 1994).

Arthur (2001) argues that a metacognitive approach to literacy, known as critical literacy, needs to be included in the list of standard literacy skills of reading, writing, speaking, viewing, drawing and critique. This approach helps students become aware of how they learn best and make optimal use of those methods but also to seek to improve their abilities where they feel less engaged or less proficient. The concept has been operationalised by Gardner (1993) whose multiple intelligences framework is based on the assumption that everyone is good at something, a strategy which helps to broadly legitimize “self esteem” for all. Gardner identified eight different kinds of intelligence: linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, intrapersonal, interpersonal and naturalist intelligence. The most effective strategy is for teachers to use a balanced mix of pedagogical techniques so students can learn predominantly through their preferred learning style but also gain experience with their less preferred methods as well (Felder, 1993).

Student access to higher level thinking skills also depends on the ability of teachers to frame questions, or to model the framing of questions, so students evolve or

expand upon ideas, rather than simply reproduce what they have been taught. Opportunities for students to practice higher order thinking skills are rare (Miettinen, 1999; King, 2002, Kutnick, Blatchford & Blaines, 2002) because teachers continue to ask mostly closed questions with a restricted range of solutions. Therefore, little has changed in the five decades since Bloom & Krathwohl (1956) showed that 95 percent of tests administered in college classrooms involve the least complex and lowest orders of thinking (Limbach & Waugh, 2005) and the recall of memorized information. Bloom's taxonomy categorizes cognitive activities or questions according to six types, generally in order of increasing cognitive complexity (Bloom & Krathwohl, 1965; Limbach & Waugh, 2000). I have used the taxonomy in this study to classify the questions presented by the team learning system to determine which kinds of questions attract attention, stimulate responses or result in elaboration. Limbach & Waugh (2005) describe the broad categories of Blooms' taxonomy. At the low end of the Bloom's scale are questions that test student recall of memorized *knowledge* such as facts, dates, figures and formulae. Next in terms of complexity are questions or activities that deal with *comprehension*, so students can demonstrate their understanding of what they know by explaining what it means; the *application* of knowledge according to a rule, principle or scheme in new situations; *analysis* which requires the students to explore how the parts of a system of concepts are connected; *synthesis* which involves the creation of new whole systems of ideas from other previously learned or developed ideas and *evaluation* which requires the learner to make judgments based on different value systems or criteria.

Thinking about thinking is a fuzzy concept for many teachers and is beyond their comprehension according to Zohar (1998) who found that teachers have declarative knowledge about thinking. They know the theories about thinking and can use a thinking process, but they are often unable to identify the steps in a process, name the parts or enunciate or derive the rules.

A major study of the introduction of a thinking skills program to schools in the United Kingdom found that teachers had difficulty incorporating discussion into their teaching practice (Baumfield & Oberski, 1998). Teachers wasted time completing routine administration tasks and maintaining order, had difficulty framing open-ended as opposed to closed questions, discovered that closed questions, with which they were most familiar, did not lead to dialogue or discussion and therefore defeated the purpose

of the activity, and struggled to complete the planned activities in a 60-minute timetabled period. Baumfield (2006) reported:

It is regrettable that pedagogy has not been a focus for either initial teacher education or continuing professional development in the UK (Mortimore, 1999). Appeals for a better understanding of that translation between the practice and theory (and theory and practice) of education which constitutes pedagogy recur and yet we struggle to achieve in the daily reality of the classroom the integration and application argued for since Dewey set out his plans for teacher education in the early 1900s. (p. 194)

There is also a widely held view in society that only a few are capable of complex, higher order thinking (Huck, 2001), especially in fields such as mathematics and science. This has not deterred advocates from developing latent talents in everyone, such as leading Australian educator Di Fleming (Fleming & Demkiw, 2008a) from creating collaborative software programs to teach any young person how to think like a genius, not just the “gifted and talented”. The program is based upon Michalko’s (1998) eight ways that geniuses think and act differently. According to Michalko, geniuses explore problems from many different viewpoints, make their thoughts visible, produce incessantly, create novel combinations, force relationships between previously unconnected concepts, think in opposites, think metaphorically and prepare themselves for chance. The software (Fleming & Demkiw, 2008b) is being trialled with high school students.

High-level thinking has been popularised by Edward de Bono (1992) via his thinking tools such as Six Thinking Hats, a problem solving method that is popular in British and Australian schools. De Bono also conceived the idea of parallel thinking to eliminate the confusion that arises when people use different kinds of thinking at the same time. Discussion becomes a muddle when some cite facts or express how they feel, while others describe the benefits or disadvantages and some jump to conclusions. When every member of the group does the same kind of thinking at the same time the discussion becomes better organized. Parallel thinking is a feature of the team learning system that is the subject of this study. De Bono also devised a range of CorT tools that capture and make available simple activity sequences that can be easily and reliably used by the learner, such as other people’s views (OPV), plus, minus, interesting points (PMI), first important priorities (FIP) and aims, goals and objectives (AGO) (Moseley, Baumfield, Elliott, Gregson, Higgins, Miller & Newton, 2005)

Teamwork and communications skill development at school

Most school learning is conducted in groups (Gavienas, 1997) but not the kinds of groups that are conducive to developing the teamwork, communication, leadership, negotiation, problem solving and persuasion skills required in the future world of work. Classrooms continue to be spaces where students sit alone at tables or desks, in pairs or in groups of four to six students in a large non-communicating group of 20-30 students under the direction of a teacher (Gavienas, 1997). They work on individuated tasks such as the practice of skills or revision of knowledge (Kutnick, Blatchford & Baines, 2002).

Classrooms have a culture of power that silences dialogue (Delpit, 1988; Cullingford, 2002) because most teachers are uncomfortable with allowing students to make decisions about topics or explore opinions that are a departure from the teacher's own views or curriculum (Florio-Ruane, 1990). The practice of silent working partly originates from the belief that the teachers role is to transmit knowledge (Florio-Ruane, 1990). Classroom discourse is unfamiliar territory for some teachers. Even in cooperative classrooms much of what occurs in small groups or pairs that is called peer learning is actually low level activity (King, 2002) involving the rehearsal of facts, learning words or checking each others' understanding of concepts.

Karp and Yoels (1987) found that classroom discussions generally involve very few students, a situation that still prevails. Four to five students account for 75 percent of all interactions in classes of less than 40 students, whereas two to three students dominate in classes of more than 40 students. In a study of middle and high school English classes Applebee, Langer, Nystrand and Gamoran (2003) found that general discussion lasted just 1.7 minutes per hour of time in the classroom, which was double the amount of discussion in an earlier Nystrand (1997) study of 8th grade literature and seven times that of 9th grade classes. Although teachers learn during their teacher training that a sense of competence, autonomy and relatedness motivates students, teachers continue to use pedagogical methods that have the opposite effect (Grolnick, Ryan & Deci, 1991). My point is that teachers may believe they encourage discussion, but a classroom discussion based on closed questioning of a few students, while the others remain silent, is not dialogue.

Much of what happens in school classrooms has less to do with learning, and more to do with teacher survival. Gavienas (1997) contends that British teachers arrange the seating in primary classrooms for social control and access to common resources but not for any pedagogical purpose. Although students are seated in groups, because

teachers fear students will engage in anti-social behaviour, they work on individual tasks and are discouraged from engaging in discussion. Ainley, Luntley and Jones (2004) found that teachers developed a repertoire of techniques to deal with unplanned student behaviour in order to survive in the classroom.

Classroom disruptions are an ever-present and persistent problem that consumes valuable class time. A meta-study of classroom behaviour by Beaman, Wheldall and Kemp (2007) shows that disruptive student behaviour increases as students go from primary to secondary school and is more prevalent among boys than girls. Most behaviour problems are innocuous and at the level of talking out-of-turn, not paying attention, forgetfulness and disrupting other children. Two thirds of all teachers say they experience the classroom disruptions and that dealing with such issues can consume as much as a quarter of class time. A study by Beaman and Wheldall (1997) shows that "the average classroom teacher can expect to find from two to nine students with some form of behaviour problem in his/her classroom of thirty students at any one time" (p. 47) which is consistent with the estimate that 10 percent of children in the general population experience emotional or behaviour problems (Mertin & Waysluk, 1994). As many as a third of teachers use sarcasm (Lewis, 2002) and put-downs (Whitted & Dupper, 2008) to maintain control. A study by Whitted and Dupper (2008) found that 9 of 10 students reports psychological maltreatment by an adult at school. Their worst school experience is twice as likely to have occurred during an interaction with an adult rather than a peer. Negative teacher behaviour such as ignoring requests for assistance, sarcasm and criticism is highly correlated with negative student behaviour (Beyda, Zentall, & Ferko, 2002). There is a gap between what teachers say they believe in and do and what actually happens in the classroom (Beare, 1991).

The adoption of knowledge telling-methods by teachers appears to originate in problematic early experiences as beginning teachers where the survival instinct overrides the idealised model of teaching learned in the lecture halls of universities and teacher training institutions (Smith et al., 2003). Wong Yuen-Fun (2003) gives an academic interpretation of her personal experience as a newly minted teacher:

...the administration and parents expect demonstrations of expertise comparable to those of a seasoned veteran (Howey and Bents, 1979). According to Brock and Grady (1995), "Teaching is one of the few careers in which the least experienced members face the greatest challenges and the most responsibilities" (p.1). Teaching in the 21st century has also become more demonstrably complex than it has ever been because of the challenges from the mega-trends in

technology, economic globalisation and social-political life (p. 1)... Beginning teachers report feeling overwhelmed and isolated (Camp and Heath-Camp, 1991; Lieberman and Miller, 1994) and feeling inadequate as teachers (Ryan, 1986; Veenman, 1984). Consequently, new teachers develop a survival mentality, and they learn they have to swim very quickly or sink (Bush, 1983). Research shows little professional growth occurs in the initial years of teaching (Howey and Bents, 1979; Langana, 1970; Shulman and Colbert, 1988; Zumwalt, 1984). Without support and guidance, beginning teachers have been found to adopt "coping survival strategies" which can actually prevent effective instruction from happening and unassisted beginners are also likely to develop negative teaching behaviours). Other beginning teachers become disillusioned and quit teaching after the first year (Gordon, 1991). (p. 2)

Teachers clearly have a large personal stake in stamping out discussion in a pre-emptive strike against widespread classroom disruption or insurrection. Nevertheless, learning outcomes are improved when students learn in groups rather than alone (Springer, Stanne & Donovan, 1999), are willing to plan, persist, retain an open mind and learn from mistakes (Halpern, 1989), ask useful questions (King, 1990), give and receive explanations (Webb, 1987), and act as provocateurs or challengers for group problem solving (Riesenmy, Ebel, Mitchell & Hudgins, 1991). Collaborative learning (King, 2002) involves a much higher level of cognitive processing. King (2002) shows that when students explain a concept to their peers this forces them to clarify their ideas. The ideas become richly connected to what they already know and the connections endure and remain memorable. Some teachers believe that low-achieving students have little to contribute to collaborative learning environments and that high-achieving students will be held back. Johnson & Johnson (1989) found that high-achieving students can benefit from exposure to diverse experiences and from peer tutoring; every student has something unique to offer.

Small group learning also has motivational benefits. A meta-analysis of small group learning by Springer, Stanne and Donovan (1999) found that most kinds of small group learning promote greater academic achievement, positive attitudes towards learning and more persistence in their studies. A similar meta-analysis by Kulik and Kulik (1979) found student discussion groups was more effective than lectures in promoting problem-solving skills and such students had a more enjoyable classroom experience than traditional lectures. Exposure to other points of view (Glaser & Bassock, 1989) can also challenge current understandings and motivate learning. However, some studies show that individual brainstorming produces ideas of better quality than those produced by groups (Diehl & Stroebe, 1987). Group discussion or

dialogue may be too artificial or constrained when the task instructions, roles and procedures are too structured, thereby reducing the potential for higher level thinking (Huck, 2001).

Small group work has clear benefits where the pedagogical strategy is to socialise the learner into a culture, such as in science, mathematics and languages. Crumbaugh (1998) found that even mathematicians need good social skills to engage in argument and disagreement, which are features of mathematics discourse. Approaching mathematics problems as thinking or writing exercises improves student involvement whereas mechanical or memorisation activities can be routine and boring (Martinez, Sauleda & Huber, 2001). Discourse helps students organize their thinking and explore the mathematical process. Similarly, peer-to-peer interaction is especially important in learning a language (Crago, 1992).

When students engage in peer-led tutoring they tend to remain on task for long periods without the teacher being present (Cracolice & Deming, 2001). However, group work is hampered by the search for correct answers (King, 2002) perhaps reflecting the cultural bias towards closed questioning. Sessions are much noisier than traditional classes (Johnson & Johnson, 1975) and this can be a problem for some administrators and fellow teachers who may equate noise with lack of teacher control.

There are also significant differences between two seemingly similar forms of group discourse, cooperative and collaborative learning (Springer, Stanne & Donovan, 1999). The proponents of collaborative learning argue that minimal structure is best because it gives groups the flexibility and freedom that results in more elaboration and cognitive restructuring (Nystrand, Gamoran & Heck, 1991; Cohen, 1994). The supporters of cooperative learning believe the best interactions and higher level discussion occurs when the teacher sets the tasks, defines the process and assigns roles to students (Johnson & Johnson, 1985). In the collaborative classroom, students are active participants in the creation of knowledge (Hansen & Stephens, 2000) and work independently of the teacher in small groups (Panitz, 1996) to solve ill-defined problems or problems with alternative solutions using whatever methods are at their disposal. Collaborative work is also related to high levels of critical thinking and limited rote memorisation (Smith, 1977). Process knowledge is often available as mental models, check lists and thinking methods such as Strengths-Weaknesses-Opportunity-Threats analysis (Wright & Rohrbaugh, 1999) and Six Hats Thinking (de Bono, 1992) so that even less capable learners are able to participate.

Researchers have developed a variety of socio-cognitive methods that combine thinking and relating, to facilitate small group discussions. The reciprocal teaching method (Palincsar & Brown, 1989) is a repeatable process that involves four stages - questioning, clarifying, summarising and predicting - that are easy for students to follow and subsequently use on their own. The *Jigsaw* method (Aronson, Blaney, Stephen, Sikes & Snapp, 1978) involves assigning different parts of a topic to each of several groups to learn, and then teach to others. Other socio-cognitive methods include *Think-Pair-Share* and *Think-Pair-Share-Square* from the cooperative learning stable (Kagan, 1992) and *Yes-and* and *Sound Ball* (Lobman, 2005) from the improvisational games genre. The main problem is that most schools are designed for students to work alone and the classroom structure and furniture is usually unsuitable for group work or performance. In order for students to engage in dialogue, the furniture needs to be rearranged so they can face each other (Cracolice & Deming, 2001) or move around. However, if students participate frequently in group discussions it becomes a normal way of learning rather than an occasional novelty (Matusov, 2001).

Support structures help teachers successfully adopt new pedagogies. Studies show that teachers benefit from peer advice and guidance (Arter & Busick, 2001; Vaughan, Klinger & Bryant, 2001) when they participate in learning communities that are supportive of the struggle and the necessary risk-taking (Putnam & Borko, 2000). Teachers who share the successes and difficulties (Arter & Busick, 2001) and plan how to improve their classroom performance are more successful than those that do not. However, joining a learning community is no guarantee teachers will use small group work in the classroom because they do not necessarily make the connection to their own learning experiences (Wood, 2007). Green & Hannon (2007) summarise the kind of role that teachers need to play when they say:

To really put children at the centre of their own learning, there needs to be a fundamental shift in the power relationships that govern the majority of interactions between students and teachers. Rather than thinking of themselves as only directors, teachers need to re-imagine themselves as facilitators. (p. 58)

Limitations to the use of 21st century technologies in the school classroom

Twenty-first century technologies may be different, but the teaching methods and the ways schools are organized remains essentially the same. The blackboard that was once the centerpiece of the school classroom in the United Kingdom has morphed into an electronic whiteboard. The whiteboard merely gives the classroom a window to a wider world. Most British classrooms now have a data projector and most teachers have a computer to connect to the projector to display information. However, the students continue to sit at desks arranged in rows facing the teacher and the teacher remains firmly in control at the centre of the classroom activities.

A survey of computer use in schools and at home by school students by BECTA, the British Educational Communications and Technology Agency (Kitchen, Finch & Sinclair, 2007) found that the ratio of students to computers in British primary schools has increased from 12.6 in 2000 to 6.2 in 2006, and in secondary schools from 7.9 to 3.6. According to Kitchen, Finch & Sinclair (2007), half of all primary schools and two thirds of secondary schools have laboratories where students can access software programs under the supervision of a teacher or teacher's aide, although a growing number of schools are distributing computers to classrooms. They say laptop use is increasing. Ninety percent of primary schools use laptops (an average of 14 per school) and 95 percent of secondary schools (77 per school) do too. Schools have installed wireless networks to support computers in the classroom. They say 42 percent of primary and 82 percent of secondary schools are equipped with wireless networks. Most schools have interactive whiteboards; primary schools have an average of eight and secondary schools an average of 22. Sixty percent of primary schools and all secondary schools have digital facilities for students to store their work including access from home; there is also a growing emphasis on e-portfolios. Virtual learning environments or learning management systems are becoming more popular although most schools report slow progress on implementation and adoption (Kitchen, Finch & Sinclair, 2007).

Sixty percent of British teachers say they use computers in class for learning tasks such as gathering information, analyzing information, being creative or solving problems, but rarely for discussion or dialogue (Becta, 2007). On the other hand, some 84 percent of secondary teachers and 75 percent of primary teachers say they rarely or never use computers to enable students to work together or communicate with each

other. Only 1-2 percent of primary teachers and 2-3 percent of secondary teachers frequently use computers for discussion. The Becta (2007) report states:

The main uses of ICT across the curriculum were word processing, internet access and presentations. Inspection data confirms that almost all schools had installed interactive whiteboards and more teachers were using them effectively to teach new skills, to provide good models and to introduce a broader range of source material directly from the internet. Teachers were adept in their use of interactive whiteboards and there was a general improvement in teachers' use and teaching of ICT (Ofsted, 2005a). However, relatively few teachers are using technology to support learning in a range of ways (Kitchen, Finch & Sinclair, 2007). Fairly limited numbers of teachers, for example, use ICT in lessons to support creativity and collaboration. (p. 26)

A review of a British program to issue teachers with a laptop or desktop computer conducted by Cunningham, Kerr, McEune, Smith & Harris (2004) found the main uses for the computer were email, administrative tasks such as maintaining the student roll and evaluating educational software that might be useful in the classroom. The main classroom use of laptops is to display slide show versions of lectures. Prensky (2007) offers these student reactions to the ubiquitous use of presentation software:

"Teachers make a PowerPoint and they think they're so awesome," says a high school girl (2006), typically. "Teachers make PowerPoints and think we're so excited to see them," says another in middle school (2006), "but it's just like writing on the blackboard." "And then they read them to us" says a third (2006). "Why should I have to go to hear it read?" (p. 41)

According to Prensky (2007), the main reasons teachers do not use technology and deal in such a cavalier fashion with the current generation of "digital natives" is they fear the loss of control:

Many teachers are highly fearful of the technologies that the students take for granted. While some teachers do embrace the kids' technological world, those teachers who are fearful of being unable to engage a generation of students used to technological advances often attribute their own failures, such as the loss of control implied in integrating tools that they know relatively little about, to untruths such as lack of attention span and Attention Deficit Disorder on the part of students. (p. 40)

Little has changed since the early days of computers in education, when students were taught how to use ICT although they often knew more than their teachers did (Budin, 1991), or when computers were used in classrooms for first order knowledge processing functions (Scardamalia & Bereiter, 1993) such as copying, entering, displaying and sending. A long-term study of The Apple Classrooms of Tomorrow

(Sandholtz, Ringstaff & Dwyer, 1997) that accumulated data from 1985 to 1997 continues to inform much of what we currently know about teacher use of technology in the classroom. The Apple study found that teachers vacillate between pedagogy that works for them in a technology-free world and the new methods that technology-rich classrooms require. Rowe (1996) argues that the ICT changes the classroom culture because it changes the way teachers and students interact, a shift from monologue to dialogue. Studies show that sustained computer use and engagement with the internet can lead to the development of constructivist teaching practices (Schofield, 1995; Becker & Ravitz, 1999). The effect may be similar to the instruction-less learning process identified by Shrager (1995) who found that as learners engage with a new tool – in this instance, a programmable toy - their theory of its' perceived behaviour changed and adoption followed. However, an in-depth case study by Windschitl & Sahl (2002) of teachers in laptops schools found no such change in their pedagogy.

Cuban (1997, 2001) argues that computers are incompatible with teaching yet major studies of computer use by teachers suggest otherwise (Mann, Shakeshaft, Becker & Kottkamp, 1999; Becker, 2000). According to Cuban (1997), teachers find it too hard to include computer use in their over-crowded classroom schedule. The computers fail and are hard to use. Cuban says that teachers believe they are immune to automation because their work is very different to types of work that have been previously automated. The new tools challenge the teacher's role and authority because they shift responsibility to the students, and in this way pose a threat rather than the promise of new pedagogical freedoms. Kerr's (1989) finding that teachers will adopt technology if it supports the role and authority of the teacher in the classroom explains the relative success of electronic whiteboards and presentation software in British schools because it allows them to remain centre stage as the content presenter except now they have "bells and whistles" that are more colourful.

Becker (2000) suggests that teachers can be willing adopters of technology if the conditions are right, especially when computers are seen as contributing to learning. He also says that only those teachers who value student-centred, constructivist learning are likely to adopt computers, and then, only when longer blocks of time are allocated and there is sufficient equipment available. In many schools, this is never achievable. Teaching with ICT requires teachers to learn, not only how to use a tool, but also to adopt new pedagogical techniques (Siegel, 1994). Teachers also find it difficult to link

computer use to the curriculum or use ICT in rooms designed for chalk and talk (Newhouse, 1999).

If schools are to successfully integrate technology into the classroom, they need to provide substantial professional development to teachers, restructure the school day into longer classes (Wenglinsky, 1998; Symonds, 2000; Garner, 2007), mix new users with teams of technologically knowledgeable teachers to help infuse the new tools (Dooley, Metcalf & Martinez, 1999) and allow time and opportunities for play (Rosen & Weil, 1994). Ertmer, Lane, Ross and Woods (1999) identify two kinds of barriers to the adoption of computers in the classroom. First order barriers include insufficient equipment for the activity, equipment failures, time off for professional development and lack of technical support, but these are diminishing in importance. Second order barriers include teacher beliefs, pedagogical practices and resistance to change, but these have proven more difficult to overcome. A major deterrent in teacher use of ICT is computer phobia (Selwyn, 1997) which is a complex mix of psychological, sociological and operational factors. Teachers are less likely than other professionals to use computers (Yildirim, 2000). Teachers fear they will lose control of the classroom (Selwyn, 1997; Sandholtz, Ringstaff & Dwyer, 1997) if the technology breaks down (Selwyn, 1997; Iding, Crosby & Speitel, 2002). They also fear a loss of self-esteem (Selwyn, 1997) if they do not appear fluent (Kortz, 2001) when using the computer in public. Fluent computer use (Kortz, 2001) is as difficult as learning a second language and users only gain sufficient skill and confidence after three to five years of experience. Teachers regard ICT as more trouble than they are worth as computers are often broken, out-of-date or unreliable (Iding, Crosby & Speitel, 2002). The public nature of computer classrooms and networks means the reliability of computers is unpredictable (Isenhour, Carroll, Neale, Rosson & Dunlap, 2000), which is a school version of a tragedy of the commons (Senge, 1992). The problem is exacerbated by classroom periods that are too short which shrink further if administration tasks consume some of the time available (Isenhour et al., 2000).

George, Sleeth and Pearce (1996) found that how teachers use technology falls into four categories: those unwilling to take risks, those with poor knowledge of technology but prepared to learn, those prepared to play, and those who are expert. According to Sandholtz, Ringstaff & Dwyer (1997), when teachers successfully change their teaching practice to accommodate technologies such as ICT, they appear to do so in five stages - frustration, adoption, adaptation, appropriation and invention. At the

start, there is considerable *frustration* and anxiety; most teachers endeavour to force the technology to fit traditional instruction and learning activities. In the *adoption* stage, teachers start to use the tools but remain focused on how to use them for traditional knowledge telling activities such as lectures and presentations. Then comes an *adaptation* phase where the focus shifts to how to engage the student, to grant them more responsibility and allow them to create activities similar to the teacher. The *appropriation* stage sees new learning patterns emerge with an emphasis on cross-disciplinary, project-based learning using new models of assessment and changes to the layout of the learning environment. Finally, during an *invention* stage, the learning environment is transformed and technology is now used flexibly.

Resistance to the use of technology is also caught up in teacher pedagogical beliefs (Sandholtz, Ringstaff & Dwyer, 1997; Himsworth, 2007). Teachers who have a constructivist view of learning are more likely to embrace computers in their teaching (Newhouse, 1999) while those with didactic views, are unlikely to adopt. Teachers who use a constructivist approach tend to use software with a student-centred focus (Niederhauser & Stoddart, 2001; Himsworth, 2007) while mainstream didactic teachers are primarily users of drill and practice software (Dwyer, 1994). Constructivist beliefs are most prevalent in early primary years and decline with each successive school year so that by secondary school it almost disappears (Niederhauser & Stoddart, 2001). Those who are risk averse and have a low tolerance for change see no compelling reasons to use technology (Geoghegan, 1995). Many of these teachers are characteristic of the teaching profession. The profession is generally middle-aged, female, and lacking in basic computer skills (Haag & Wienman, 1999). They find it hard to see a connection between computers and classroom learning (Ballard & Buchler, 1999).

Although there have been many studies of the use of technology and its effect on student outcomes, the results are mixed. A recent study by PISA (OECD, 2006a) found that students who have never used a computer perform well below the OECD average. Students with a computer at home perform half a grade higher than the average, whereas students who do not have a computer at home perform half a grade lower than the average. Students who have only just started to use computers are below the OECD average while students who have used computers both at home and at school or for five or more years perform well above the average. The reading performance of students who use computers the most frequently at school are generally lower than the OECD average. The poor performance of students who access computers at school may be

linked to how students engage with them. Previous OECD (2006a) surveys of upper secondary schools have shown “severe weaknesses” and “a lack of teacher know-how and time, along with scheduling difficulties” that hinder “the achievement by schools of their ICT development goals” (p. 69).

Most students know how to use computers for routine tasks without adult assistance (OECD, 2006a) and often have superior skills to their teachers. Nine out of ten 15-year olds can open, save or delete a file, play a computer game or draw a picture using a mouse. Eight out of ten students can create and edit a document, go to the internet and download files. Half can use a database to make a list of addresses, use a spreadsheet to make a graph. Two in five can create a website and one in five can write a software program.

A meta-analysis by Hattie (1999) of 31 meta-analysis, 17,952 studies and 352 effect-size studies of the effects on student achievement found that using computers in school had an effect size of .31 equal to a gain of three months or 15 percent compared with classes that did not use computers. Two thirds of the effects were positive and one third was zero or negative. Hattie (2003) found that other strategies had a greater effect. Teacher feedback has an effect size of 1.13, student prior cognitive ability (1.04), instructional quality (1.0) and direct instruction (.82). Remediation, the challenge of student goals, peer tutoring, mastery learning, parent involvement, homework, teacher style and questioning show above average effect sizes. Hattie (2003) also shows that 50 percent of the variance in achievement resides with students, their abilities and prior knowledge. Thirty percent of the variance is due to teachers and what they do, the relationships they have with students and how they work the classroom, 10 to 15 percent is contributed by the school, the size, facilities, culture and leadership, 5 to 10 percent is influenced by home life, particularly the encouragement students receive from parents while 5 to 10 percent of the variance is influenced by peers. Rowe (2004) supports Hattie’s contention that quality teaching is the most effective way to make schools better. However, this raises the question of what is meant by achievement and quality teaching. If achievement is measured in terms of knowledge at the expense of the complex thinking and relating skills required to equip young people with the skills necessary to participate in a Knowledge Age world, then we are using out-of-date measures of achievement. If quality teaching does not include the appropriate use of pedagogical approaches and technologies that will equip young people for a Knowledge Age society then our criteria for judging quality teaching is also out-of-date. It brings to

mind, a quotation attributed to Albert Einstein (The quotations page, 2008), “insanity (is) doing the same thing over and over again and expecting different results”.

Other significant studies of computer use are a meta-study by Waxman, Lin and Mitcho (2003) who found that teaching and learning with technology has a small positive effect on student performance compared to traditional teaching methods and a large U.S. wide study by Wenglinsky (1988) of the United States Testing Service found that computers in mathematics has a bigger impact on child development than either teacher professional development or reduced class size. Wenglinsky found that higher order thinking skills of eighth grade mathematics students improves by .42 grade levels when they use computers compared with .35 grade levels when the teachers undertake professional development, and .06 grade levels when class sizes are reduced. The grades of fourth grade mathematics students increase .58 grade levels when using computers whereas teacher development raises the performance by only .09 grade levels and there is no improvement as a result of reduced class sizes. Yet mathematics teachers continue to be the second most unlikely of all teaching professionals to adopt technology in their pedagogical practice. Only art teachers are more computer phobic (Becker, 2000).

It seems to me that teachers tend to adopt technologies that perpetuate the teacher-centric or traditional teaching model, which is reflected in courses to teach students how to use technology, reproduce information or engage in drill and practice exercises, none of which are particularly relevant to the 21st century world of work. Prensky (2007) suggests that students are now so far ahead of their teachers in the use of technology that they should accept this and not try to be the only person in the room who “knows everything”. Prensky says that teachers should work together with their students, and make use of their respective strengths:

Our students’ strengths lie in their ability to quickly master, use and apply technology, and in their fearlessness to try new things. Our teachers’ strengths lie (or should lie) in their ability to distil and teach lessons about and with technology, and to engage their students in discussions that help them see and understand issues that they are likely to miss on their own. In order to figure out ways to use the technologies in service of learning, both groups must work together, because today the ‘right answers’ and ‘best practices’ exist only as ideas and experiments, or do not exist at all. (p. 46)

The rich world of tools for participation and knowledge creation

In sharp contrast to the monological world of teachers is the highly interactive, multi-way and bi-directional world of young people. As I showed earlier, young people are no longer just listeners or viewers but active participants or *producers* (Bruns, 2008) whose opinions contribute to the mixing, combining and spread of ideas (Jenkins, 2006). It is the “always on”, Web 2.0 (O’Reilly, 2008) world of RSS feeds, wikis, blogs, social networking sites (Resnik, 2007) and on-line newspapers, video and audio “which improves as more people use it” (p. 1). Web 2.0 goes way beyond the “page view” model of Web 1.0. Young people are becoming both the entertainers and the entertained, political activists and electors, writers and readers, producers and the viewers. In real-time we can vote off unpopular Big Brother housemates or British Idol contestants who “can’t sing” or jointly write/read books at the website of Penguin, the paperback book publisher. We can publish movies and stories we have created but also evaluate the work of others. We can contribute to our friends’ narratives about their lives or with ideas gleaned from anywhere else in the world. It is a world swarming with ideas, all clamoring to be heard. It is the most contagious that attracts attention.

Web 2.0 tools are mostly asynchronous, which means that individual contributions are not necessarily visible to other participants until the artifact, idea or opinion has been posted to a website, but there is usually a time difference between posting and viewing (O’Reilly, 2008). Weblogs or blogs as they are more commonly known (Mayfield, 2006a) document projects and portfolios of work, provide a running commentary on issues or allow others to post their opinions about the original or intermediate contributions. Technorati, a website that records web log activity, was tracking “112.8 million blogs and over 250 million pieces of tagged social media” on March 11, 2008 (Technorati, 2008), when I last checked the state of play, and was growing by more than 1.5 million posts a day (Stephens, 2007). Wikis allow community interaction through co-production (Guth, 2007) where anyone who is a member can contribute changes to previous contributions, to assemble encyclopedia-size repositories of information that challenge conventional encyclopedias for usefulness and but not necessarily authenticity. Some budding authors use wikis to write on-line books or assemble projects. A problem with wikis is that generally only a very small percentage of the contributors do most of the work (Guth, 2007).

Web 2.0 is not only helping to create a generation of creator-consumers, but also a generation of auto-librarians. Text keyboards or tags as they are known, allow you to easily collect and categorize information on the internet, but also allow others to see how you have organised your collections (Mayfield, 2006a). Social book marking helps groups build a collection of shared resources such as useful websites, video, audio and images (Heymann, Koutrika & Garcia-Molina, 2008). Some collections take on a life of their own, because they eliminate the work involved in conducting a search for useful websites or pages. A trend amongst young people is to download podcasts, movies and audio files onto an MP3 player and other multi-media devices to be viewed later or more frequently (Abram, 2007). A short message service known as twittering (Stephens, 2007) has emerged as a favorite amongst closely connected groups who keep each other informed of their every move, their current location or mood sometimes in conjunction with geographical data provided by tools such as Google Earth (Mayfield, 2006a). RSS feeds allow information from news organisations, financial services and remote sensors to keep people informed of the latest gossip, the sports results or the status of appliances at home (Gooding, 2008). Many of these Web 2.0 tools are lightweight browser-based applets that can be acquired quickly off the internet. Anyone familiar with JavaScript and other web tools can extend the capability of their web browser and integrate modules in unique combinations to offer new integrated functionality in the form of Mashups that direct data from multiple sources into a single tool (Lackie & Terrio, 2007; Gordon-Murnane, 2008)

Figure 2.3: The power law of participation model (Redrawn from Mayfield, 2006a)

Please see print copy for Figure 2.3

The power law of participation model (Mayfield, 2006a) classifies tools according to the way people can interact in internet communities (see Figure 2.3) from the socially and cognitively distant to the socially and cognitively integrated. At the low end of the scale, characterized as collective intelligence, access to community is via a single click to read a page or to create a link to a favorite web site. Somewhat more socially intensive is the relatively disconnected act of commenting in a weblog or subscribing to a RSS feed that demands attention.

Moderately engaged activities include writing to or conversing with others. At the high end of the scale, characterised by Mayfield (2006a) as collaborative intelligence, is collaboration in the form of joint production, learning or decision-making, which includes activities such as moderating a bulletin board, facilitating a workshop or editing a wiki.

High-end computer tools, which Jonassen (1996) characterises as “mindtools” extend the cognitive capability for representing or creating new knowledge, facilitate higher order thinking and act as an intellectual partner (Mayes, 1992). Some productivity tools such search engines, spreadsheets, web browsers and databases can also be used as mindtools as can tools designed to support teachers such as learning management and portfolio systems (Kirschner & Woperis, 2003). Mindtools also include persuasive technologies that change human attitudes and behaviours and virtual environments for role-playing and simulations (King & Tester, 1999) as well as group decision support systems, expert systems, shared databases, and semantic networks.

Children lead the way in the use of remote synchronous tools such as Instant Messenger and chat rooms based on the Internet Relay Chat system (Isenhour et al., 2000). Although email is the most widely used internet communication medium (Sproull & Kiesler, 1991) it is asynchronous and children prefer the immediacy and social presence of instant messaging which they routinely use for communicating with friends all over the world (Prensky, 2007) but which teachers have banned from the classroom. Instant messaging applications have been augmented with Voice Over Internet Protocol (VOIP), file and application sharing, shared whiteboard and shared real-time video programs such as Skype (Bradbury, 2008). These tools attract tens of million of simultaneous users. Peer-to-peer file sharing of music has become so large it threatens the viability of the traditional music industry. Inadvertently, file sharing has boosted on-line sales of commercially available music and the popularity of user-

created music clips, movies and works of art (Silverthorn, 2003, June 21). Another popular synchronous group of applications is MUDS – multi-user domains (Curtis & Nichols, 1993) and MOOs that are object oriented MUDS (Spellman, Mosier, Deus & Carlson, 1997). These programs have evolved into sophisticated 3-D worlds such as Second Life where the denizens can create their own avatars that walk or fly through the world, create artifacts and structures and conduct financial exchanges using virtual money called Linden dollars. Young people even have their own version at Teen Second Life (Abram, 2007).

Computer and video games allow children to experience issues faced by professionals such as urban planners, businessmen, engineers and lawyers and in doing so develop strategy, problem solving and survival skills (Shaffer, 2006). School students, as young as elementary school age, can design their own games and interactive stories (Kafai, 1995) using tools such as *Scratch*, developed by the Massachusetts Institute of Technology's (MIT) Media Lab. They can also create their own toys using small programmable devices called *Crickets* into which “children can plug motors, lights sensors and other electronic blocks” to “make a wide range of imaginative creations...that spin, light up and play music” (Resnik, 2007, p. 2).

Despite their huge appeal, most Web 2.0 communications tools - instant messaging, MUDs, MOOs, chat and VOIP services - provide limited support for knowledge building and have proven difficult to use in learning settings. They are too unstructured to focus effort, achieve convergence on key issues, develop consensus, jointly generate a result (Romano, Nunamaker, Briggs & Vogel, 1998) or achieve learning outcomes (Oliver, 1999). Discussion or bulletin boards that are not moderated can result in either an avalanche of postings (Lawton & Whymark, 2003) where the sequence of the messages is difficult to follow or so few postings there is little to attract or maintain attention.

Learning to use and facilitate on-line meetings (Yoong & Gallupe, 2001) is a complex and difficult task. It is much more complex than conventional face-to-face meetings because it is difficult to achieve coordination and presence. Collis (1997) calls for a form of pedagogical re-engineering to design activities and incorporate features designed for the medium that would help make on-line collaboration more accessible.

The main difficulties encountered by people participating in synchronous on-line groups (Fisher, Phelps & Ellis, 2000) is the conflict with other commitments, lack of social feedback such as tone of voice or body language, the inability of participants to

use the technology, lack of group identity and failed log-ons or connections. Users may find it difficult to follow the thread of the conversation because postings can become out of order. For such tools to be used for teacher-led learning (Nipper, 1989) both the learners and their teachers need to develop a synchronous presence to mirror the sense of being together as occurs in the face-to-face environment. Facilitator or moderator skills cannot simply be transferred from the classroom to the on-line world. These tools demand more of the teacher's time for planning lessons (Ge, Yamashiro & Lee, 2000). A web-based chat room activity may require several hours of pre-planning for every hour on-line. Teachers must also change how they teach and must switch from being knowledge tellers and become the facilitators of participant discussion, criticism and reflection (Gustafon & Gibbs, 2000).

Group decision support systems for real-time human-to-human interactions

Group decision support systems (GDSSs) have been developed with human discourse in mind. These systems provide the structure, processes and tools for real-time human-to-human interactions that deal with the complexities of making sense and reaching agreement about abstract ideas, resolve conflicts and moderate the exercise of power that most web2.0 tools do not.

The team learning system that is the focus of this study (U.S. Patent No. 6,614,451) is a member of this software class and is one of only three GDSS software programs to have become commercialised, two of them from the U.S.A. and one from Australia. The tool is similar to but conceived separately from the GDSSs that were first developed in the U.S.A in the late 1980s and early 1990s (Stefik, Foster, Bobrow, Kahn, Lanning & Suchman, 1987; Dennis, George, Jessup, Nunamaker & Vogel, 1988; Kraemer & King, 1988; Nunamaker, Dennis, Valacich & Vogel, 1991). The American-designed systems are used mainly for large decision meetings of groups of 20 to 500 managers in the military, large government agencies and business. The team meeting system was developed in Australia mainly for small group community development, school education and business applications (Lewis & Newton, 1995).

A review of the literature on the use of the American GDSSs in educational settings reveals that such tools have been largely restricted to university teaching in business studies and information technology classes. Tullar, Kaiser & Balthazard (1998) suggest that the main barrier to uptake is the systems are expensive.

A meta-analysis of computer-mediated groups by Hollingshead & McGrath (1995) found computer-mediated groups took longer and had fewer exchanges than face-to-face groups, generated more ideas but were less able to solve problems, resolve conflicts or reach decisions. When groups use GDSSs to support meetings they take longer to reach consensus but are more candid, take more risks and generate more ideas (Nunamaker, Dennis, Valacich & Vogel, 1991). Although small conventional face-to-face groups are more effective than larger groups (Kiesler, 1986) larger GDSS groups generate more ideas and are more satisfied than smaller groups (Gallupe, Dennis, Cooper, Valacich, Nunamaker & Bastinanuti, 1991). GDSSs are particularly useful for complex tasks (Gallupe, DeSanctis & Dickson, 1988). Participants in GDSS meetings make better quality decisions but are less satisfied than their counterparts who participate in traditional meetings. The ability of participants to work in parallel accounts for most of the success of collaborative computer systems (Dennis & Valacich, 1993; Watson, Ho & Raman, 1994). Access to group memory and anonymity (Nunamaker, Dennis, Valacich & Vogel, 1991) also contribute. Joint attention may also have an effect, as groups tend to focus on the shared screen and address their comments to the screen rather than each other (Watson, Ho & Raman, 1994).

GDSSs increase the amount of information available but hinder the assimilation and acceptance of information (Marin, 1993). According to Yellen, Winniford and Sanford (1995), extroverts tend to speak more often and take up more airtime than introverts who pause longer between comments when they participate in conventional meetings. In the GDSS environment, introverts feel better able to contribute their ideas while the extroverts, who previously dominated the discussion, embellish ideas using other perspectives they are hearing for the first time. The structuring of the task plays a major part in the enhanced computer-mediated effects that may also be achievable in conventional groups without technology (Watson, 1991).

DeSanctis & Gallupe (1987) show that most GDSSs allow ideas to be contributed anonymously. Stripped of their social cues, ownership and emotion, the ideas are selected on merit rather than the power of the proponents or through compromise or satisficing (Simon, 1957). This results in improved decision quality in the case of creative, decision-making, cognitive conflict and mixed-motive tasks, but may result in no change with learning tasks. Anonymity (Jessup, Connelly & Galegher, 1990) encourages participants to generate more comments that are more critical and probing and more likely to be embellished by others. Anonymity changes the power

relationships within groups (Irving, 1976; Turoff & Hiltz, 1982), distributes power more evenly and prevents those with high-perceived power from exercising as much influence as they do in conventional settings.

Poole & DeSanctis (1990) report that face-to-face GDSS meetings lead to higher satisfaction than remote meetings. They contend that the more sophisticated the GDSS, especially its ability to deal with conflict, the more likely the system will be faithfully adopted, and the better understood the GDSS design, the more likely it will be appropriated by users. GDSS sessions increase idea generation and novelty by a combination of effective facilitation, anonymity and simultaneous input (Dennis, Valacich & Nunamaker, 1990). The overall superior performance of GDSS groups may also be due to the novelty (Kraemer & King, 1988), the critical role of the facilitator (Anson, 1990) or because the nature of GDSS forces users to design better meetings (Watson, 1991). The design of the agenda plays a critical role in the success of GDSSs (Antunes, Ho & Carrico, 1999). Sosik (1995) found that GDSS facilitators achieve improved group effectiveness by the appropriate use of transactional or transformational leadership styles.

Coordination can be a problem in collaborative environments. According to Stefik et al. (1987), participants work at different speeds, lose track of what they are doing, are uncertain whether others can see the same objects or activity, and because they share insertion points, they overwrite and eliminate each other's contributions. The number of ideas can grow so quickly people are unable to deal with the ideas, are unable to make sense of or integrate their contributions, go around in circles, do not finish, or finish prematurely. Dennis, Poootheri and Natarajan (1998) found that a critical mass of users is essential for successful use.

The findings by the American researchers that anonymity is essential for the effective use of GDSSs (Valacich, Dennis, Jessup & Nunamaker, 1992) is at odds with the research by Findlay (1996) which shows anonymity may inhibit the team formation process by requiring participants to work silently and alone. He shows that the elimination of discussion inhibits idea evolution, elaboration and integration and makes group ideas available very late in decision-making cycle thereby reducing the potential for consensus building through cross-fertilisation of ideas. Conventional GDSS decision-making processes often use voting to distinguish between ideas which Findlay (2001) says separates participants into cliques of competing interests, that then are often unable to broker agreement.

Poole & DeSanctis (1990) argue that for GDSSs to be effective they must employ formal decision-making processes such as Roberts Rules of Parliamentary Procedures and rule-writing tools. Findlay & Newman (2005) and Fitzgerald & Findlay (2006) show that the rules of debate limit the ways GDSS can be used. They say that the use of sequences of rich questions, that capture and make explicit even the most complex thinking or decision processes, is a more effective way to stimulate and integrate ideas. They also show that the use of a variety of rules of discourse, such as talk-type-read-review contributes to the result.

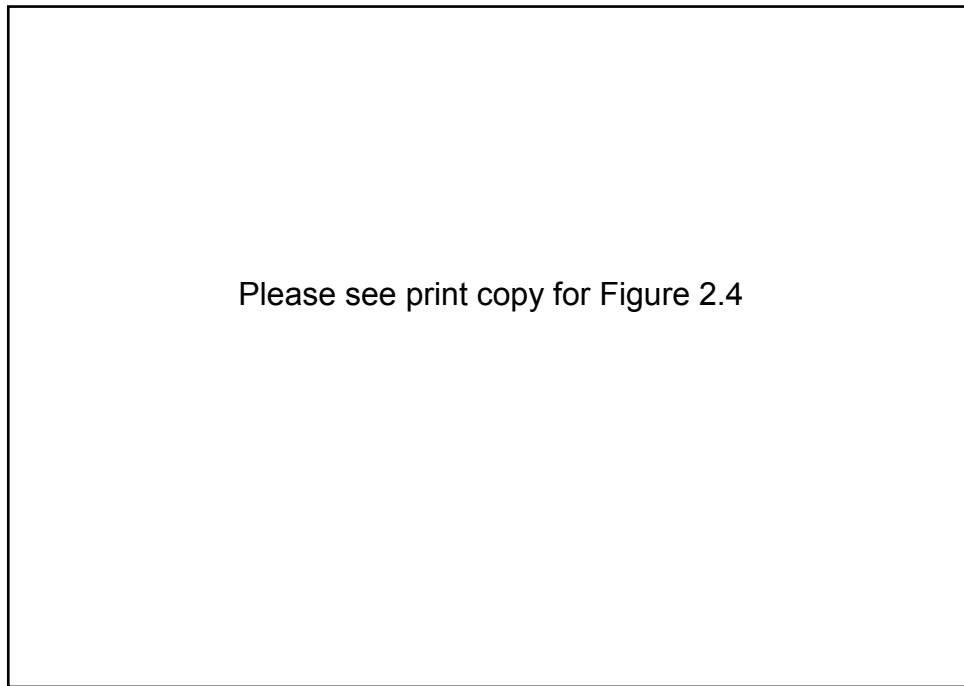
Research into the use of GDSSs for teaching and learning (Aiken, 1992; Brandt & Briggs, 1995; Walsh, Briggs & Ayoub, 1996; Leidner & Fuller, 1997; Gear, Jones & Read, 1999; Meloche, 2006) has generally been associated with teaching in higher education. The use of American GDSSs in school classrooms has been limited. One study by Brandt & Lonsdale (1996) found that students who used a GDSS at a Tucson high school surpassed their peers in cooperative and writing skills. One English class used the technology to answer lecture questions, write letters and dialogues and prepare a research paper. Another study by Pierce (1995) found that the use of GDSSs improved the quality of information sharing in a non-threatening environment, gave freedom of expression through anonymity and improved access for deaf and hearing participants alike.

Alavi (1994) found that GDSSs improve collaborative learning for college students by supporting teamwork, the sharing of information and providing structure for the learning process. Participants have a more positive experience than conventional groups who say their exposure to other perspectives makes it easier to create new mental models. Balthazard & Romani (1998) found that students are more motivated when using GDSSs than in traditional classroom settings. Most students feel equal because no one can dominate the activity (Walsh, Briggs, Ayoud, Vanderboom & Glynn, 1996). The use of GDSSs also leads to changes of behaviour (Hoxmeier & Kozar, 2000).

The Zing team learning system and its' history

The Zing team learning system employed in this study differs from other GDSSs in several important respects. The system provides a shared conceptual space where all participants are able to simultaneously view and contribute ideas as they are created (Lewis & Newton, 1995) (see Figure 2.4).

Figure 2.4: User interface of the team learning system: Year 8 feedback.



Users of the team learning system employs a facilitation model or “etiquette” which ensures novices can conduct sessions involving complex thinking or decision processes after only a short period of facilitator training (Findlay, 2005). The ability to view all the ideas as they are created brings them to the attention of all participants and promotes assimilation, orchestration and integration (Elliott, 2003b). Elliott (2003b) shows that “as learners’ thinking and narratives are shaped and revealed they become triggers or scaffolds for further ideas. In this sense the interrelatedness of the contextual supports frame aspects of self-regulated learning (p. 89).”

The team learning system has been applied to primary and secondary classroom learning (Elliott, 2003a; Waters & Callan, 2003; Findlay, 2003b; Young Foresight Institute, 2004; Dodd & McQuilten, 2007), consulting (Findlay, 1996; Meloche, 2006), organisation change (Lee & Crawford, 2002), information management (Lewis & Newton, 1995), professional development (Findlay, 1996), innovation (Buschman, 2007; Kobza, 2007), teacher education (Purnell, Callan & Munnerly, 2003), ethical dilemmas (Findlay & Newman, 2005), management education (Evans & Hunt, 2003), business process redesign (Alexander & Findlay, 2004), appreciative inquiry (Stratton-Berkessel, 2007), thinking skills (Fleming, 2003), research (Fitzgerald & Findlay, 2004; Caldwell, 2005b), focus groups (Ward & Hawkins, 2003; Moyle & Fitzgerald, 2008), and improvisation (Findlay, 2007b).

Figure 2.5: The team learning system is used in school classrooms. Clockwise from top left, Melbourne, Australia; Warsaw, Poland; New York, United States of America and Auckland, New Zealand. Source: Zing reseller kit (2008).

Please see print copy for Figure 2.5

Although the team learning system has been adopted in over 400 schools, concentrated mainly in the United Kingdom and Australia, it is used mainly for data collection and staff professional development. Waters and Callan (2003) point to the reluctance of teachers to use the technology in the classroom because they are often unable to perform as facilitators, are uncomfortable in this new role, or are unable to adapt to an interactive pedagogy (Purnell, Callan & Munnerley, 2003).

The team learning system supports guided reinvention. The architecture is similar to a team learning method developed by Korthagen and Kessels (1999) that encourages real-life practice of ideas and exploration of what works or does not. The tool can be used to create and present questions or tasks that would be asked by an expert teacher or consultant (Findlay, 2003b). Students learn a portfolio of thinking skills including how to design their own learning activities (Findlay, 2006; Findlay & Fitzgerald, 2006).

An earlier study by Findlay (1996) found that the team learning system supports what Isaacs and Senge (1999) define as *dialogue* that helps participants empathise with each other and develop shared goals or become supportive of each other and results in both increased performance and satisfaction. Recent studies (Findlay & Newman, 2005) have shown that participants become more open to each other and suspend judgment in the interests of creating new knowledge that simultaneously serves the group and individual interests. Findlay & Newman (2005) have also shown that the tool can support rich forms of discourse such *ethical dialectical discourse* (p. 1) that goes beyond the gold standard of dialogue. The questions incorporated into the tool place high ethical demands on the participants. The questions guide the participants through a process that resolves not only competing positions but also takes into account ethical considerations, particularly legal, professional and personal ethics that were derived from the Ethical Response Cycle (ERC), an ethical guidance tool developed by Newman & Pollnitz (2000). A team learning system version of the ERC known as Working Wisely (Findlay & Newman, 2005b) has since been developed for early childhood professionals.

The team learning system also accelerates group development and new knowledge formation. Findlay (1996) developed a phase-shift theory to explain the emergence of new kinds of group order under the influence of the tool. At some critical point, members of the group “click” into a new activity state and start to operate in unison, analogous to the change of phase in physical or chemical systems (Prigogne & Stengers, 1985). After the transition, the group becomes more highly organized and efficient. Findlay (1996) found that the participants’ ideas then resonate with the thoughts of others and their activity becomes more highly coordinated. Group satisfaction and performance improve simultaneously which is contrary to the findings of Turoff & Hiltz (1982) who argue that performance improves at the expense of satisfaction and vice versa. These contrary views of group development, may be a consequence of the discourse models upon which the system is based. The assumption that underlies the design of the American systems is that debate ensures the best ideas emerge, which can be characterised as zero-sum in which some people achieve their objectives at the expense of others. The Australian system is based on the assumption that knowledge is created via the resolution of the contradictions in viewpoints to the satisfaction of the proponents, which can be generally characterised as win-win (Findlay, 2001).

Facilitators can also use the tool differently at each stage of the team formation process (Findlay, 2005). The facilitator provides structure during the forming stage of team development and reduces support during the performing stage to allow the team to do it themselves, in the same manner that a constructivist teacher first provides, and then removes cognitive scaffolds. The tool provides scaffolds, not for cognition, but to learn how to use a discourse model, which, in effect, is a way of helping neophyte facilitators learn to become leaders.

Summary

The reforms to the British education system have achieved some notable successes. One third of each age cohort now graduates from university each year. However, despite the expenditure of billions of pounds in reforming the education system, one in six British students leaves school unable to read, write or count properly. This new underclass of unemployable young people is the harbinger of a new social and economic divide. The ICT revolution is not only contributing to the extinction of work that can be automated or relocated but is also responsible for the growth of new kinds of work that require novel problem solving and complex communication skills that demand higher levels of education. Even manual jobs now require minimal levels of computer, literacy, teamwork and thinking skills in order to record and interpret data, solve problems autonomously or work with others.

At home, the computer rivals the television as the primary form of entertainment for young people. They have access to a smorgasbord of lightweight browser-based Web 2.0 programs that are instantly accessible or downloadable in the form of games, web pages, simulations, video and audio clips, animation programs, software development programs and social networking tools. Young people are learning what it is to be a member of human society by engaging with this always-on world with other young people anywhere on the planet. They use the same tools for “edutainment” as they use to create more images, movies, music, web pages and collections of artifacts for the enjoyment of others. Increasingly, there is a convergence between the tools children use for entertainment and the tools adults use to create, store, display, share and reach agreement about knowledge.

Students enjoy or endure quite different social and technological experiences as they move between home and school. School classrooms continue to be places where students are expected to remain silent, listen to the teacher, copy from the blackboard

(or a more modern version, the electronic whiteboard) and work alone on exercises from textbooks or work sheets. The silent classroom is the antithesis of the noisy, energetic and random environment when young people engage in conversation, work in teams, use thinking, decision-making or relating processes and the creative activities that could prepare them for the new world of work (or perhaps innovative play). At school, students rarely use ICT for collective knowledge building activities that involve interaction. Students use computers four times as much at home for internet research and writing assignments as they do at school. Students from low socio-economic backgrounds with limited access to computers or the internet at home miss out twice, at home and at school.

The reasons for the slow uptake of technologies in schools are far from clear, but there are some suspects. Computer phobia, classroom disruption when the technology fails, and a lack of knowledge about how to teach using ICT, are likely contenders. Yet electronic whiteboards that allow teachers to continue to be centre stage have become very popular in British schools. At the same time, schools and teachers have been slow to adopt group work of any kind, not just computer-based group work. They are also reluctant to allow students to use computers in the classroom or even use computers themselves. With such minimal and impoverished use at school, it is understandable that the research shows only marginal improvements in learning outcomes from the use of ICT.

Schoolteachers are taught the theory of social constructivism, meta-cognitive thinking, scaffolding and thinking skills during their teacher training but they learn about these theories via a mix of self-study and broadcast models of learning. In the face of adversity, many seem to forget or be unable to apply what they know in the classroom. Nevertheless, there are many excellent teachers, some of whom succeed using didactic models or their best efforts at constructivist approaches.

A new class of tool that support group decision making and knowledge creation that embodies some of the practices of the ideal constructivist teacher, is becoming more widely adopted by schools for the professional development of teachers and for some classroom activities. This study will explore how such a tool is used by teachers and students in classroom and other settings, and in doing so, seek answers to these questions:

- How do teachers use a collaborative tool such as the team learning system in the classroom if they are already unprepared or unable to allow discussion or dialogue in their normal classroom?
- In what ways are the rules of the “school going” culture different from the rules associated with the collaborative tool?
- How does the team learning system modify, if at all, the way young people engage with each other, or how teachers engage with their students?
- In what ways does the team learning system support higher-order thinking or relating?
- What difficulties, if any, do teachers encounter when they seek to make the transition from their role as a teacher to the new role of facilitator?

CHAPTER 3

ACTIVITY THEORY: A “GENETIC” LAW OF HUMAN DEVELOPMENT

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Overview of the chapter

The key theme that emerges from the review of the literature on schools, learners, teaching, and technology is that schools and teachers are struggling to make use of current culturally relevant tools in the form of learning technologies and pedagogies. Instead, young people are engaging directly and increasingly with these very same tools in their private lives with little adult support, to not only learn how to participate in the adult world, but also to create a new and ever faster moving culture, even further removed from what adults know and enjoy. Busy parents have handed over *the* major role for acculturating young people into a rapidly changing world to educational institutions designed for another time.

A useful lens through which to explore this cultural gap is cultural historical activity theory (activity theory) which is a theoretical framework that has been widely applied to the study of human activity as mediated by social interaction, cultural tools, symbols and signs. Activity theory has its’ historical origins in three realms. It draws on classical German philosophy especially the works of Hegel (1985), the writings of Marx (2007) and Engels (Marx & Engels, 2002) as well as the voluminous works of a troika

of Russian psychologists Vygotsky (1978, 1986) and his two students Leont'ev (1978) and Luria (1973, 1976, 1979). Activity theory is also appealing because it has the potential to grow into a robust theory with broader explanatory power than its present “framework” status and in particular, to draw together and explain how tools can scaffold what it means to be human.

There are, however, some inconsistencies in activity theory that have been identified by Davydov (1999). He calls for a single, all encompassing theory, a better understanding of the separation of the social from the biological and instinctive, an improved model of change and transformation, a more robust explanation for the relationship between collective and individual activity, and a classification system for types of activity.

The first section of this chapter is a review of the historical development of activity theory that began as a theory of child development and has since become influential in education, research, sociology, psychology and cultural and technological change. Section two shows how human development follows learning and can occur both in collective play and when guided by an adult or more capable peer. The section also explores how teachers and the tools they use influence development. The question of whether negative or regressive influences should also be accommodated in activity theory is also considered. The third section explores the nature of activity and how humans use tools to achieve goals, initially for survival and more recently for a “better life”. This section also considers the differences between work, play and school-going and how the nomenclature associated with work activity may have contributed to the developmental delay of activity theory.

Section four reports on the contribution by Luria (1978) and Goldberg (2001) to our understanding of the human brain and, in particular, the way the frontal lobes are involved in imagining and planning new and different futures and the automation of speech and motor routines that make it possible for humans to perform more complex roles and adapt to novel contexts. Although this field is not strictly activity theory, Luria's work is inextricably interwoven with that of Vygotsky and Leont'ev, an understanding of this field is necessary to unravel some of the original assumptions about activity, particularly the assumption inherent in Leont'ev's (1978) triarchic structure of activity that places left frontal-lobe automatic operations at a lower level to conscious goal-directed activity and which I believe may need to be revised, in view of the latest findings from brain research.

The fifth section deals with the nature of the transformation of activity systems, especially the patterns within the development process at both individual and cultural scales, and the role genetic and memetic feedback each play in accelerating or moderating the rate of learning and development. It also considers whether the “spiral” metaphor for learning is still relevant or whether other analogies may be more appropriate. Section six considers how tools have evolved from gestures and simple language to complex physical, psychological and cultural artifacts and instruments. The section also examines how activity becomes automated or “concretized” by tools for later adaptation or adoption at a more advanced stage of human development. Section seven reviews how group development is understood by activity theory, the division of labour (or roles) that people play in society, the rules of engagement and the relationship between rules and discourse genres.

The search for a grand unified theory of human development

At the heart of activity theory are two core concepts, firstly, that humans are able to create their own future and secondly, that development proceeds via a dialectical struggle towards a higher level of human awakening (the ideal) by the constant synthesising of opposite ideas. Human learning and development occurs through a process of transforming the object of activity and at the same time, oneself and the community in which a person participates. As Marx remarks in *Capital* (2007):

A spider conducts operations that resemble those of a weaver, and a bee puts to shame many an architect in the construction of her cells. But what distinguishes the worst architect from the best of bees is this, that the architect raises his structure in imagination before he erects it in reality. At the end of every labour-process, we get a result that already existed in the imagination of the labourer at its commencement. (Chapter 7)

Activity theory began as a theory of childhood learning and development (Vygotsky, 1978, 1986) and the cognitive differences between people who developed in different cultural contexts (Luria, 1976, 1979). Activity theory has since become influential in education (Palincsar & Brown, 1984; Elliott, 1985; Engestrom, 1987; Rogoff, 1990; Palincsar, Brown & Campione, 1993; Brostrom, 1999; Hedegaard, 1999; Miettinen, 1999), children’s play (Hakkarainen, 1999; Verenikina & Herrington, 2006; Lobman & Lundquist, 2007), information systems (Kaptelinin, 1994; Nardi, 1996; Knutti, 1999; Tikhomirov, 1999; Jonassen, 2000), computer supported cooperative

work (Hasan & Gould, 2001), work design and organisation change (Engestrom, 2000), work teams (Engestrom, 1999b), knowledge management (Shariq, 1998), therapy (Koski-Jannes, 1999; Ryle, 1999; Holzman & Mendez, 2003), and performance (Newman & Holzman, 1996; Lobman, & Lundquist, 2007). Each field has drawn upon or expanded upon activity theory.

Vygotsky died in 1934 at the age of 37 (Wertsch, 1985, p. 3) but he left a legacy that endures largely because he was uniquely able to draw together into a single theory of human activity, what until then, were disparate ideas (p. 16). He was influenced in part by Piaget's theory of egocentric speech (p. 8), Darwin's theory of evolution (p. 20), Marx's dialectical materialism (Vygotsky, 1978, p. 54), Hegel's concept of mediated action (p. 54) and French psychiatrist Janet's theory (Wertsch, 1985, p. 92; Wertsch, 1991, p. 26) that memory and ideas such as space, time and number had a cultural origin and were not categories of mind.

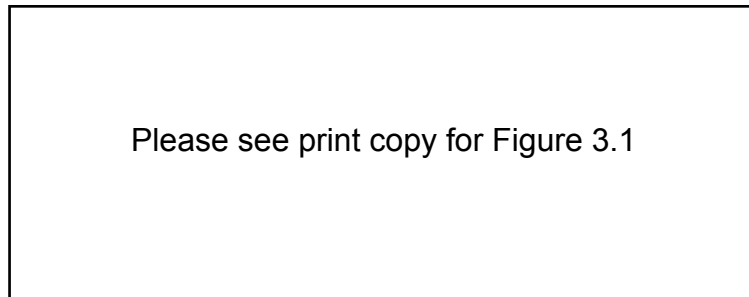
Vygotsky showed that humans have developed the ability to employ tools to evolve culturally via a process that Wertsch (1991) describes as a "genetic law of cultural development" (p. 26), in addition to, but interwoven with, the genetic developmental process that humans have in common with other forms of life. The process of socio-cultural historical change is different to the laws of evolution and Darwin's theory of natural selection (Wertsch, 1991). Knowledge is not simply discovered or transmitted but recreated by the child or person. The result is the internal transformation within the child or person and external change in the tool. The engagement with tools within the current cultural environment shapes a child's mental development as Vygotsky (1978) shows:

Within a general process of development, two qualitatively different lines of development, differing in origin, can be distinguished: the elementary processes, which are of biological origin, on the one hand, and the higher psychological functions, of socio-cultural origin, on the other. *The history of child behaviour is born from the interweaving of these two lines....the use of tools and human speech.* (p. 46)

The culture and the tools within the culture also evolve and so the historical development of an artifact is incorporated into the artifact itself (Vygotsky, 1978). Tool use becomes separated from the context and available for wider conceptual application via "the decontextualisation of mediational means" (Wertsch, 1985, p. 33) and "extends the operation of memory beyond the biological dimensions of the human nervous system" (Vygotsky, 1978, p. 39). Figure 3.1 illustrates the Vygotskian concept of

mediated action in which artifacts - symbols, language, signs and other tools - are employed by the subject to achieve their goals. The artifact and the subject are both transformed in the process.

Figure 3.1: Modern interpretation of Vygotsky's model of mediated action (Figure 1, Centre for Activity Theory and Developmental Work Research (2008a).



Vygotsky's (1978) initial research focus on child development was to distinguish between ape and human behaviour. He showed that development followed learning, contrary to the popular view, at the time, that learning followed development or maturation (Rosa & Montero, 1990). With the help of speech, children, unlike apes are able to be both the subjects and objects of their own behaviour and can create more possibilities than apes can through action alone. Speech ceases to accompany action and starts to organise behaviour. Children start to discuss with themselves what to do. They employ a form of "inner speech" (Vygotsky, 1978, p. 27) which initially follows action, and in due course, precedes and "guides action" (p. 28). Children begin to plan or think ahead and this dramatically expands their control of the world.

Vygotsky (1978, p. 54) shows there are four stages in the development of speech and mental operations in children; a primitive or natural stage from birth to two when the child is not capable of using signs to regulate behaviour; a naïve psychological stage where the child begins to use words to represent things but does not understand their symbolic function or grammatical logic; a period of external sign use accompanied by egocentric speech to accompany action and guide or plan action, and; a growth stage, where the egocentric speech becomes internalised. As a child develops within human culture through the interaction with other tool users as well as tools, his or her cultural development appears twice, initially externally in their social relationships with parents and teachers, and subsequently internally on the psychological plane, a process which is continually happening and continues to happen as humans make their way through life. What begins as externally directed speech, often in the struggle with an external artifact,

passes through a phase of egocentric speech, and then becomes internalised and automatic.

In this passage from an unpublished manuscript *Problema vozrasta*, Vygotsky likens the stages of child development to the ebb and flow of historical, biological and geological epochs (as cited in El'konin, 2008):

We may provisionally define psychological age as a specific epoch, cycle, or stage of development, as a definite, relatively self-contained period of development whose significance is determined by its place in the general developmental cycle and within each of which the general laws of development are expressed in a qualitatively distinct fashion. In this sense, we might compare age-levels in child development with the historical ages or eras in the development of mankind, with the evolutionary epochs in the development of organic life, or with geological epochs in the history of the earth's development. In the transition from one age-level to another we find the emergence of new structures that were absent in earlier periods; we can see a reorganisation and alteration of the very course of development. Thus the development of the child is but a continuous transition from one age-level to another, accompanied by developmental changes in the child's personality. The study of child development is the study of the child's transition from one age-level to another and the change in his personality within each age-period as these changes occur under concrete socio-historical conditions. (p. 6)

Vygotsky considered the then widely accepted stimulus-response theories of human behaviour as inadequate. He preferred the Hegelian concepts of “cunning” and “powerful” mediated action (Hegel, 1840, cited in Vygotsky, 1978, p. 54) which Marx describes as using “the mechanical, physical and chemical properties of objects to make them act as forces that affect other objects in order to fulfill his personal goals” (Marx, 1936 cited in Vygotsky, 1978, p. 54). Hegel regarded humans as capable of “becoming” and animals merely of “being” (Hegel, 1840, cited in Vygotsky, 1978, p. 17). People progress towards higher forms of freedom and “satisfaction” through the process of work (Kozulin, 1990, p. 16).

Vygotsky differentiated between the elementary mental functions or natural factors (Rogoff, 1990 p. 36) which humans are born with and have in common with animals and higher mental functions (Wertsch, 1985, p. 24) which are acquired culturally through teaching, learning and social interactions and include logical and abstract thinking, deliberate attention and memory, and mediated perception (Vialle, Lysaght & Verenikina, 2005). The higher mental functions become interwoven with the lower mental functions upon which they are dependent (Vialle, Lysaght & Verenikina, 2005).

Another member of the original troika was A.R. Luria, who made a substantial contribution to the field of brain research (Luria, 1979). Vygotsky and Luria planned to conduct a study of the influences of cultural change on the mental processes of illiterate Uzbek peasants and collective farm workers in Central Asia. The peasants were transported from a feudal society to a more modern society in a very short time. However, Vygotsky became ill and it was left to Luria (1973, 1976) to conduct the research. The results were much criticised. According to Engestrom (1999a), they proposed a theory of large-scale patterns of human development throughout history to explain the differences between cultures as well as the transition from apes to humans that could potentially rival Darwin's theory of evolution (pp. 19-20). I will revisit this approach to human development in this study, even though it could be regarded as a somewhat dangerous course in view of the criticism that Luria received. I have confidence in this approach for three reasons. Firstly, there appear to be some parallels between the way peasants and educated workers in Lurias' study and the student and teachers of this study were limited by their use of tools. Secondly, the tools humans use have developed spectacularly since use the early part of the 20th century when the studies were conducted, in a series of ever shorter waves, which could be best explained by a grand theory. Thirdly, new theoretical approaches, in particular complexity theory appears to offer a "grand theoretical" explanation for such longitudinal patterns of development in biological and economic systems and may be applicable to this context.

Vygotsky and Luria expected to find primitive ways of thinking among those who continued to live in traditional ways, similar to the thinking of very young children. They also expected to observe evidence of more advanced thinking in those who had attended school. Kozulin (1990) recounts:

The original idea of Vygotsky and Luria had been to study cognitive processes in primitive people as an approximation to studying mental process in people of a different historical epoch. The cultural historical approach aimed at discovering the changes in the social and cultural organisation of society. If implemented this approach could result in truly historical studies of the cognition of people in ancient, medieval or Renaissance times, with each type of cognition being put in correspondence to a specific form of material product and culture. (p. 132)

They found that literate subjects could use deductive reasoning and conceptual categorisation with only a brief experience of school whereas illiterate subjects could not. Luria (1976) reported that the peasants "were incapable of solving the simplest" (p.

120) hypothetical problems because they could not separate the conditions of the problem from their practical experience or had little experience and were not prepared to even make a guess. The peasants could solve narrow but simple numerical problems as long as they were familiar and concrete (Luria, 1976, p. 130). A quarter of the subjects were able to answer the questions after they were made more specific. When asked to frame hypothetical questions, which involves creative rather than reproductive imagination, the peasants were unable or refused to do so (Luria, 1976, p. 136). They said they lacked the “necessary knowledge” or practical experience (Luria, 1976, p. 139). Some were able to formulate questions about practical situations, as could 80 percent of those who had completed a literacy program. About 90 percent of children who completed two years of schooling were able to formulate such questions more broadly. School goers also “categorized objects, accepted premises and derived conclusions strictly on the basis of linguistic means” whereas their illiterate counterparts “invoked non-linguistic, practical experiences in their reasoning” (Wertsch, 1985, p.35). Luria found that very few peasants were able to analyse their own personal qualities (Luria, 1976, p. 151); most refused to perform the task. A transitional group was able to describe the traits of others more capably than they could themselves, perhaps when the new way of thinking became routine. With more schooling or more experience with group interactions, the peasants were more able to be self-reflective.

The search by Luria and Vygotsky for a grand unified theory of human development is akin to the search for the elusive grand unified theory of physics to unite the four main forces that explain gravity, electromagnetic waves and the structure of atoms. Their theory and their results encountered considerable opposition. Cole points out in a foreword to Luria’s account of the research (Luria, 1976, p. xiv) that Luria’s results were not well received and were seen by some as an insult to his research subjects. In Russia, say Rosa and Montero (1990), “the results were labeled pseudoscientific, reactionary, anti-Marxist and anti-proletariat, and conducive to the notion that the USSR was governed by a class that was incapable of abstract thought” (p. 71). Even latter-day researchers continue to reject the findings. Engestrom (1999a) describes “the ”grand theories” type of thinking and writing” approach of the Russians as “heavy ballast” (p. 27).

In an attempt to untangle schooled and cultural effects, Scribner and Cole’s (1978) study of the Vai culture in Liberia, where literacy was acquired without attending school, cast doubt on Luria’s findings. Scribner and Cole argue that the

development of abstract thought in children does not necessarily have to occur in educational settings. Cole (1976, p. 103) contends that Luria's study really measured the uptake of an introduced cultural approach and ignored other possible locally developed learning processes. Cole (1976, p. 107) is skeptical of generally applying developmental theories across different cultures and that the learning system for each culture evolves in its own way. He argues that the forced adoption of formal schooling in developing countries by powerful outsiders as a panacea for access to Western wealth "has been a source of disruption and human misery".

In this thesis I will argue that Vygotsky and Luria were on the right track, and that there is a pattern to human cultural development, but such a theory would not be able to explain the rise and fall of civilisations. Instead, as I will show in chapter 4, there is a pattern of tool speciations and extinctions that has occurred over the past 10,000 years since humans first settled down to an agrarian lifestyle and that the transitions from one cultural epoch to the next is mirrored in the structure and complexity of the tool system and of the tools themselves. I will also argue that the rate of tool development has far surpassed the rate of human genetic evolution, and that at different times throughout human history, the conditions for tool development and adoption have been optimal for some populations, and at other times, even within the same society, tool development and adoption has stagnated or suffered reversals.

Luria (1973) also made a significant contribution to the psychological sciences with a highly detailed model of the way the brain functions, which is discussed in this chapter (see pages 91 to 96). The Lurian model of brain function is of considerable interest to this study, particularly because it explains how the human brain evolves, which I will show is important to an understanding of incremental and transformational change. This section also examines the dual role that the frontal lobes play in firstly, consciously attending to and dealing with novel situations, and secondly, once cognitive routines are automated, unconsciously managing multiple streams of activity, and how these functions relate to activity theory.

The third member of the troika was Leont'ev, who like Luria, was also a student of Vygotsky. Leont'ev took a considerable interest in unconscious activity unlike his two colleagues (Vocate, 1987) who saw rational consciousness as "the highest form of mental activity" (p. 145) and who relegated the sub-conscious to a lesser role.

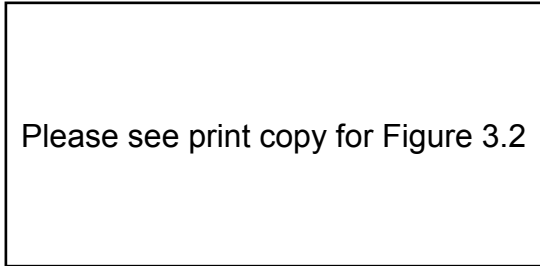
Leont'ev regarded activity as a self-developing system (Davydov, 1981, p. 10) in which humans engage with an objective world and in doing so proceed towards an

ideal world. Leont'ev (1975) viewed needs as “a state of necessity of an individual that in itself is not capable of giving rise to any specifically directed activity” which are satisfied through an “encounter” with the object of activity and direct and regulate the activity (p. 87). Leont'ev showed that automatic or unconscious operations eventually become “concretised” as tools and thus become available to contribute further to human development. Leont'ev (1978) described consciousness as a partnership between the mind and the tools humans create:

Consciousness is co-knowing, but only in that sense that individual consciousness may exist only in the presence of social consciousness and of language that is its real substrate. In the process of material production, people also produce language, and this serves not only as a means of information but also as a carrier of the socially developed meanings fixed in it. (Chapter 3)

Leont'ev's main contribution to activity theory is the triarchic structure of activity as shown in Figure 3.2 that illustrates how transformations occur constantly and dialectically (Hasan & Gould, 2001). Activities are determined by their motive, actions by goals and operations are based on the conditions for carrying out the action (Verenikina & Gould, 2003).

Figure 3.2: Leont'ev's triarchic structure of activity (Redrawn from Hasan & Gould, 2001, p. 81)



Please see print copy for Figure 3.2

Initially there is a conscious action, which may become an automatic operation, when internalised and learned, such as happens when people learn to use a new tool (Hasan & Gould, 2001). Jonassen (2000) shows that “creating a new action out of previously automated operations may, after some time of applying it, start automating that action, which then becomes an operation, but at a higher level of organisation” (p. 12).

What is initially a conscious struggle becomes routine and below the level of conscious awareness. The totality of an activity, using the computer as the example, comprises many actions – manipulating the mouse, typing on the keyboard, following

the commands or buttons (Findlay, 2003a). Each action has its own goal. The goal for manipulating the mouse may be to select functions. The goal for typing on the keyboard may be to input data to the software program. The motive for learning, in this case to use the computer and software is directly related to the activity and may be to improve communications with others or reduce the effort required to search for information. A single action can be related to several different activities; for example, using a keyboard to write an email, fill out an on-line form, or edit a document.

The process by which actions are automated and become operations that require little conscious mental effort (Jonassen, 2000) is of considerable interest to this study because it may help explain the difficulty teachers encounter when they endeavour to add new, complex speech and motor routines to their repertoire. In doing so teachers may need to override, or perhaps overlay, earlier and deeply entrenched routines. This may require more than just a few minutes preparation. I suspect it may be as difficult as learning to drive a motor car. Also of interest is whether inner speech may interfere with or inhibit the ability of teachers, instructors or presenters to give clear instructions or convey accurate information when performing in public or using a shared tool. Verenikina & Gould (2005) explain that the process of inner speech is not confined to children:

People often talk silently to themselves in their mind for the purposes of thinking, self-direction and self-control (Vygotsky, 1978). When people face a difficult task or they have problems performing a task because they feel tired, they start talking aloud to themselves. It helps them to keep their attention on task and to self direct their actions. (p. 164)

The cultural transmission and transformation of human knowledge

According to activity theory, those who have gone before in society induct the next generation into human culture and in humankind's knowledgeable ways, particularly the roles that people play within families, communities and organisations.

Before children go to school, they learn a wide variety of skills - how to speak, the names of objects and the qualities and quantities of things - through their interactions with parents, siblings and playmates. Learning occurs in many different ways but primarily through imitation, by asking questions and following instructions. Students can often do much more with adult assistance or collectively in play through imitation than they can do on their own (Vygotsky, 1978). In present times, children arrive at school with some skills that may not have been acquired by engaging with a

human but via socially mediated technologies found in the home such as the television, telephones, computers, the internet and electronic games.

Vygotsky (1978) showed that learning and development did not necessarily coincide and there is considerable variability between what children can do independently and with support. He devised a diagnostic for use by psychologists and educators known as the zone of proximal development (ZPD) to measure the progress that learners make towards independence and to “take into account...not only the cycles and maturation processes that have already been completed, but also those currently in a state of formation” (p. 87). Vygotsky (1978) defined the ZPD as:

The distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (p. 86)

The concept of the ZPD has become more broadly interpreted with the widespread adoption of activity theory. New interpretations of the ZPD include the equal interactive participation of people in their own development both as learners and teachers or parents (Rogoff, 1990), the co-creation of culture and cognition (Cole, 1985), reciprocal teaching (Palincsar & Brown, 1984), engagement with significant others (Forman & McPhail, 1993), non-verbal communication as well as speech (Rogoff, 1990), interaction with a computer as an equivalent of a more capable peer (Pea, 1993; Salomon, Globerson & Guterman, 1989) or a community of learners created through overlapping ZPDs (Brown, Metz and Campione, 1996).

A dynamic view of the ZPD is described by Engestrom, Brown, Christopher & Gregory (1997) as “an invisible battleground” or “terrain of constant ambivalence, struggle and surprises” between an existing activity, possible expanded activities and possible contracted activities (p. 36-37). Communian and Gielen (cited in Reiman, 1999) propose an advanced form of the ZPD known as a “zone of proximal reflection” to take into account a dynamic that elevates the support role to that of a minimally interventionist facilitator, a role that is now popular within corporate life, but less so in school settings and which this study will closely examine. In such instances, the facilitator does not provide the actual support, but fosters or creates the initial conditions that is self-supporting such as occurs in mentoring (Reiman & Thies-Springhall, 1984), the creation of a playful environment (Lobman, 2005), or the use of journals for self-reflection (Reiman, 1999). In this respect, Cole and Griffin (1984) suggest that adult

support is inversely proportional to the child's competence and that the child's "development is circumscribed by the adults achieved wisdom" (p. 62).

Computers and digital media as well as tertiary or super-symbolic tools such as organisation rules, processes and procedures also appear to have a role to play in supporting the performance of learners through the ZPD (Pea, 1993; Salomon, Globerson & Guterman, 1989). Of particular interest to this study is whether and how the team learning system plays a "role" equivalent to human functions such as question asking that might be performed by a teacher, or coordinating the group in an equivalent manner to a leader or facilitator. Another issue is whether the presence of tools developed at a later stage in human history, compared with the equivalent tools developed at an earlier period, makes a difference. Blonskiy (1934) suggests that the speed of cultural development has an impact on the rate of child development:

Modern man, under social conditions favourable for his development, develops further and more rapidly than the human being of earlier historical epochs. Hence childhood is not an eternal, immutable phenomenon: it is different at each different stage of evolution in the animal world, and it is different also at each different stage of mankind's own historical development. The more favourable the economic and cultural conditions of development, the faster its pace. (p. 326)

In much of the literature, development seems to occur only in a future direction. For example, Griffen and Cole, (1984) see the child's development through the ZPD as a series of stepped transitions from one ontogenetically dominant activity to another, from play to formal learning, formal learning to peer-to-peer activity, and from peer activity to work.

This raises the question of whether activity theory should account for development in which there is no progress, restricted progress or negative progress. Vygotsky (1978), for example, briefly states that only "good learning" is that which precedes development (p. 89). According to Tudge (1990), "Adult-child interaction and peer collaboration in which the more competent partner is also more confident are not typical of all interaction, and that peer collaboration can lead to regression as well as development" (p. 167). Leont'ev (1978) frequently refers to "economic alienation", whereby a class-based or capitalist society denies most citizens access to the material and intellectual riches accessible to a few, "which leads to alienation and to disintegration of human consciousness" (Chapter 3). Engestrom (1999a) also contemplates a form of retarded development, as part of his definition of the ZPD as an "expansive cycle" (p. 35) of development. He says that an expansive cycle involves the

creation of something new, such as a new work process, new roles or new tools by resolving contradictions in the preceding activity system(s), develops new theories and leads to an expanded activity but, if internal contradictions are not addressed and eliminated, the cycle will be “non-expansive” (p. 35) Another researcher to consider the possibility of negative development is Ryle (1999) who shows that maladapted intersubjective relations in the early stages of child development often leads to the development of neurotic and personality disorders.

The issue of negative development is raised indirectly by Hedegaard (2005) in her research into how schools and teachers have difficulty understanding and dealing with cross-cultural differences between teachers, raised in a civil society, and students who grew up in a war zone. Hedegaard (2005) shows that teachers misinterpret such children’s attitudes to learning as behavioural difficulties. She shows that boys from refugee camps in Lebanon and Palestine who had “developed strategies for surviving and protecting themselves and their families...created problems in the Danish school” system and “from the school’s perspective...were learning disabled children” (p. 5). Hedegaard (2005) says that the students had:

....difficulties concentrating in school and after 4-6 years they had not learned the elementary skills of reading and writing and other school competencies....they were seen as obstructive...and as having behavioural problems. Their social motive of caring for friends was not seen as positive and this was interpreted as gang activity that aimed at protecting each other from authorities. From the children’s perspective their problem was not a learning problem but a problem of finding strategies to survive in a new social context. They had learned in the war zone to mistrust authorities and see them as enemies. (p. 5-6)

Other than these brief accounts of negative development or perceived negative development, there seem to be no mechanisms in activity theory to deal with restrictions placed on others to limit their ability to reach their potential, especially in the context of an accelerating cultural context.

The spectrum of activities that is activity

At their core, humans are animals endowed with an almost insatiable curiosity who are attracted to the future. We are adapted to search for something that does not yet physically exist (Davydov & Zinchenko, 1982), which for some is survival, but for many is “a better life” for ourselves and our children, utopia, nirvana or Hegel’s

spiritual liberation. To go there we engage in various types of activity. According to Davydov (1979) “the ideal is the existence of an object in the phase of its formation in the subject’s activity manifesting itself as a need and a goal” (p. 50). Activity emerges firstly as a felt need which is the need state, followed by a way of resolving the need, which is motive formation, followed by the transformation or resolution of the need through activity (Bratus & Lishen, 1983). Needs alone are “not capable of giving rise to any specifically directed activity” (Davydov, 1979, p. 50).

Thus, the link between the imagined world of the ideal and the practical as-lived world of day-to-day existence is *activity*; the separate realms of materialism and idealism is bridged or transcended by activity, in the movement from:

Experienced material world ↔ Activity ↔ Ideal

Tolman (1999) contends that humans have evolved beyond animals because we have created a sustaining web of activity at a higher quantum state. Tolman says, “survival in the strictest sense is impossible for individual members of our species on their absolute own” because we rely on “knowledge that is accumulated by society in the course of its’ history and that we receive from others” and the means of surviving in the world “is not carried in our biotic genes but in our social institutions” (p. 72).

Four types of activity dominate the literature - work, play, school-going and learning – although learning, like development, is generally regarded as an intrinsic part of activity. Each has its own unique signature. Work activity is expressed in terms of economic language. Play activity is couched in the language of early childhood. School-going is framed in the language of a highly persistent Industrial Age model of one-to-many teaching. Each form of activity is bound up in the language of its discipline and in some sense is a prisoner of that world.

Work activity. Work activity has its origins in the Marxist concepts of alienated labour where concrete work submits to abstract work and the production of surplus value (Engestrom, 1987). Humans pursue needs that are not sought by other animals nor are the needs biological in nature. The new needs are explained says Leont’ev (1978), “by the fact that in human society needed objects are produced” which in turn produces new needs.

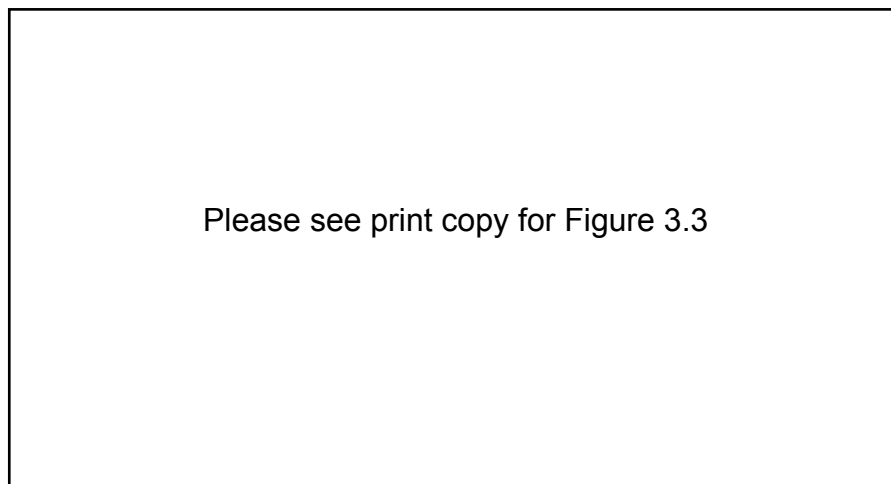
Leont’ev (1978) makes the point that consciousness is a symbiotic relationship between the human mind and tools. What the human mind-tool partnership produces, co-creates the other. Leont’ev (1978) states:

Consciousness is not a manifestation of some kind of mystical capability of the human brain to generate a “light of consciousness” under the influence of things impinging on it - stimuli - but a product of those special - that is, social - relations into which people enter and which are realized only by means of their brains, their organs of feeling, and their organs of action. The processes evoked by these relations also lead to the acceptance of objects in the form of their subjective images in the head of man, in the form of consciousness. (Chap. 1)

Leont’ev’s concept of activity has a meaning equivalent to the German word *Tätigkeit* meaning work, job, function, business, trade and doing rather than *Aktivität* which includes effort, eagerness, engagement, difference and restlessness (Roth & Lee, 2007, p. 197).

Says Leont’ev (1978), “the activity of every individual man depends on his place in society, on the conditions that are his lot and on how this lot is worked out in unique, individual circumstances” (Chapter 3). This translates into the way work is differentiated and how surplus goods and capacity is produced and becomes available for exchange with others. The Engestrom (1987, p. 78) triangle, that represents the structure of collective work activity (see Figure 3.3) captures these essential elements. The model incorporates three kinds of mediation; the traditional model of tool mediation plus two additional types, rule mediation and division of labour mediation, with which I have a difficulty, as roles seem to be determined by how humans use tools.

Figure 3.3: Structure of human activity. (Figure 3. Centre for Activity Theory and Developmental Work Research (2008, adapted from Engestrom, 1987, p. 78))



Engestrom completes the triangle with vectors couched in the language of economics which shows the fruits of each type of mediation. Tool mediation is concerned with production, division of labour mediation involves exchange and rule mediation determines how production is distributed. The entire activity system involves

consumption. Activity theory “suffers from its persistent focus on the formal “industrial” structure of goal-directed activity, which is considered unchanging and timeless” (Hayrynen, 1999, p. 116) mainly to honour its’ historical roots. Some of the criticism levelled at activity theory says Letorsky (1999, p. 65) is “justified to a degree” including notions that it is a “totalitarian ideology” corresponding to “command socialism” in which people are portrayed as implementers of “plans, orders and standards imposed from outside.” Letorsky argues that activity theory “should not be repudiated” but “developed in new directions”. Perhaps, if the nomenclature of activity theory could be ameliorated by the adoption of more culturally neutral and less convoluted language, then activity theory could become more accessible and generally useful.

Play activity. Play as activity has been studied in considerable depth (Piaget, 1962; Elliott, 1985; Vygotsky, 1978; Rogoff, 1990; Elliott, 1990; Elliott, 1995; Tudge, Lee & Putnam, 1998; Lobman, 2005; Holzman, 2005). Play is unique because the motive of play is the process of play itself (Brostrom, 1999; El’konin, 2008), which means it is intrinsic or internally rewarding (Hakkarainen, 1999, p. 247).

Play is a way for children to explore being an adult and actively create for themselves, by themselves, their own knowledge in a safe and fun way. Play evolves as the child matures. Piaget (1962) shows that in early infancy, the child engages in practice or sensorimotor play, and then, prior to going to school, symbolic play emerges in the child, where things represent real artifacts. By middle childhood, play is conducted as games with rules. At age six, or thereabouts, the child become conscious of his or her own activity and is able to organise games independently of adults (Brostrom, 1999, p. 254). Brostrom points out that the child explores novel ideas and worlds it does not initially comprehend, absorbing what they are prepared for. Increasingly during the teenage years, young people are socialised out of play and into study, which is a form of work. In the senior years at school, the main remaining form of play is rule-based school sports.

Various researchers have identified within play some of the features of self-developing systems, whereby new order emerges that is due to the activity rather than any conscious goal seeking. Vygotsky shows that through a process that begins with imitation of adult activity, children are able to explore collectively what they cannot do alone. Vygotsky (1978) states:

In play, a child always behaves beyond his average age, above his daily behaviour; in play, it is as though he were a head taller than himself. As in the focus of a magnifying glass, play combined all the developmental tendencies in a condensed form and is itself a major source of development (p. 102)

Brostrom (1999, p. 250-251) points out that all three necessary mediating factors – tools, signs and other people – are present in play so that children are able, via cooperation to “raise the demand on themselves and with that bring themselves into the *zone of proximal development*” and thereby master ideas they cannot achieve in non-play settings. Children participate in play of their own free will but “if you try to force play, children will stop playing... The motive of play is the process itself, in the context of the action, not in the result” (Brostrom, 1999, p. 250). “The child’s “make-believe gives new meaning to actions and objects” as well as new uses for tools and artifacts. In play, children act out new roles according to an imagined or observed set of rules (Hakkarainen, 1999). Children also use *props* to represent something other than the artifact, such as a stick for a sword or a chair for a house, around which are built larger scale events or simulations known as *scripts* such as “playing doctors” or “playing house” which are generalised events (Elliott, 1990, p. 15). A script is created from a sequence of play actions (Bretherton, 1984). Hakkarainen (1999) points out that “play brings joy and satisfaction and this is why people play” (p. 232) but “once the play is over, nothing is left; the players pack up and go” (Cohen & MacKeith, 1991, p. 11). Play also results in “a movement from unconscious motives to more conscious ones” (El’konin cited in Brostrom, 1999, p. 253) and a “gradual movement from unconscious and impulsive actions to conscious willful actions.” The order in which activity occurs changes from action-speech-thought to the reverse order of thought-speech-action (Brostrom, 1999, p. 253). Learning activity, as opposed to school-going, has similar features to play, because it has no formal outcome and allows people to collectively go exploring (Bruner, 1985).

Some activity theory researchers have likened individual play to the optimal experience of flow (Csikszentmihalyi, 1995) where the activity is its own reward and actions are guided, not by conscious thought, but by the process itself. Engestrom (1987) gives examples of musicians and mountain climbers who behave in an “unbridled manner” and in the process change from being a person who rationally thinks and plans an action to one who just lives the moment and knows intuitively what to do. A state that is similar to flow is described by Eisenberg (1990) as “jamming

experiences” (p. 139) which are unplanned, meaningful, often ecstatic “moments of fit” that occur between people. Bartlett (1958) describes the feeling as “something outside himself” which “has taken charge and is now settling everything that happens” (p. 192). Zinchenko (1985) talks about “liberated or unloosed actions” (p. 114) and Bateson (1978) writes about the loss of self when one develops high level learning capacities. Shotter (1982, p. 48) says that when playing games it is not uncommon for people to experience, if only briefly, the sense of “losing themselves in the game” or “playing out of their minds....In such a state, players are clearly not unconscious as such, but they do not have to try to do what is required of them, they.... know it in the course of doing it”. Engstrom (1987, p. 29) comments that in this special state “the new actions produce richer results than expected” which is an interesting outcome for an activity that is not consciously planned or controlled. This aspect of play is considered in relation to flow experiences (Csikszentmihalyi, 1997) in chapter 4 (see pages 177-183), to explore a possible link between unconscious automatic operations and the moderate emotion of enjoyment associated with flow, and equally the more extreme emotions of boredom and anxiety experienced in non-flow situations and conscious right frontal lobe functions.

Play in its more adult guise of creativity and innovation (Brooks & Bowker, 2002) is now an important function within organisations of all kinds – schools, business and government agencies - keen to become competitive by re-inventing themselves. Serious play (Heracleous & Jacobs, 2005) offers the means to bring previously unconnected ideas together and to explore their hidden potential in a kind of rehearsal for reality but without any dangerous consequences, such as the use of simulations, which Jacobs & Statler (2006) describe as a “technology of foolishness” (p. 77). Collective play, in the form of brainstorming session, roles plays and simulations, offers organisation the ability to tap into the creativity of their people in order to invent new products and services, or try out a new strategy (Landry, 2000). Many of these new opportunities are beyond their visible horizon, sometimes described in the business and management literature as the fourth quadrant of the Johari window (Luft & Wingham, 1955). The Johari window is a tool that classifies knowledge according to its accessibility and the fourth quadrant is what you do not know you do not know, in the unpredictable future outside the realm of current algorithms. Business also uses play to generate complex scenarios about how they might engage in competitive and collaborative activities that makes visible the likely outcomes before making difficult

strategic choices. The tool that is the subject of this study is used by business and government organisations (Findlay, 1997; Findlay, 2001) and the military (Lewis & Newton, 1995) to generate and evaluate scenarios. In this sense, play as creativity or innovation “aims at the mastery of mastering” (Hakkarainen, 1999, p. 234) of what was not there before. Imagining a new future and forming new goals, or transforming unmet needs into goals is a prerequisite of creativity (Tikhomirov, 1999).

It seems that the transformative process of collective play has some of the features of a phase transition, and is therefore of interest to this study. Such shifts appear to occur spontaneously, outside human control. Some unidentified component or process in human activity seems to act as a catalyst and drives the transformation. This aspect of collective development is largely ignored in activity theory but has been more thoroughly researched in the management and positive psychology literature that is reviewed in chapter 4 (see pages 169-177).

School-going activity. In most school settings, an unusual form of activity has become endemic and impervious to change known as *school learning* or *school-going* activity (Engestrom, 1987, p. 101). “School-going activity” is unusual because the object of activity and the tool are reversed (Engestrom, 1987, p. 101). The object of school-going is to reproduce the mediating tool, which is the text and the purpose of reproducing the text is to “succeed in examinations and to get high grades” which has the social purpose of sorting people into different occupations (Miettinen, 1999, p. 326).

The classroom prepares students for the kind of obedient roles and relationships they can expect in the “hierarchical power relations in work life and society”(Miettinen, 1999, p. 328). In school classrooms, closed questions are used by teachers as an instrument of control rather than as a learning device as Miettinen (1999) states:

Studies over the past 30 years have demonstrated the unique inertia and conformity of classroom teaching and interaction. Lecturing and the question-answer method still seem to be the dominant forms of work in classrooms. Teacher talk dominates, and student activity is largely limited to answering questions formulated by the teacher....In ordinary oral language, questions are asked to request information and action. In schools, questions are asked to which the teacher already knows the answer. (p. 327)

Since compulsory school attendance was introduced in the 19th century, little has changed to the underlying design of school. School continues to be about mastering masses of prior human knowledge and the further development of knowledge is not encouraged (Engestrom, 1987). The main primary (physical) tools in school learning are

pencils, notebooks, and desks, and the secondary tools (psychological) are the lecture and formal study. School lessons are fraught with difficulty and failure for many students, and what is easily mastered as commonsense outside of school is found to be incredibly difficult when served up in its academic guise. In many traditional classrooms, students automatically take up roles as the *good student* and the *disruptive student* (Danish & Enyedy, 2005) and their subsequent learning trajectory towards success or failure becomes a self-fulfilling prophecy.

Schools became necessary (Engestrom, 1987) when people started reading and writing as a means of recording transactions about exchanges of goods and labour. Informal workshops soon become schools for writers. Those attending learned not only how to read and write but acquired current knowledge (Fichtner, 1985). From the middle Ages onward, from about the time of the invention of the printing press, mastery of knowledge was synonymous with understanding texts. Text was king. Reality became what experts wrote and memorised, reciting aloud the main means of knowledge transmission to the illiterate, and religious texts and textbooks were presented as factual accounts (Ong, 1982).

This kind of approach to education is characteristic of the Industrial Age and its locus of control at the apex of the organisation whereas the Knowledge Age conception of the world regards students and people as being able to think and act autonomously (Oblinger, 2004).

The consequences of school-going, which is also referred to by the legendary educationalist, John Dewey, as “book school” (Dewey & Childs, 1933, p. 51), is the slavish dependence on books and the separation from the original socially-constructed meaning of concepts. When knowledge is taken out of context and mode of use it becomes inert or dead (Whitehead, 1929) and makes little sense to the learner, because students find it difficult to connect what they learn, to some useful purpose. Ideas become technical and abstract. In this sense, school-going is not the same as learning (Miettinen, 1999). Dewey’s (1923) criticisms of the “book school” culture remain just as relevant today as they were in 1923:

How many lost the impetus to learn because of the way in which learning was experienced by them? How many acquired special skills by means of automatic drill so that their power of judgment and capacity to act intelligently in new situations was limited? How many came to associate the learning process with ennui and boredom? How many found what they did learn so foreign to the situation of life outside the school as to give them no power or control over the

latter? How many came to associate books with dull drudgery, so that they were “conditioned” to all but flashy reading matter? (pp. 26-27)

The knowledge acquired in school merely helps students progress at school and is often irrelevant to careers or community life (Gardner 1990, p. 93). Pedagogies that schools use ignore the way the human brain works and how people live in the real world. Goldberg (2001) states:

Most real life acts of memory recall involve deciding what type of information is useful to me at the moment.... Memory based on ever changing, fluid decision, selection and switches is guided by the frontal lobes and is called *working memory*.... To access it is like an instantaneous finding of a needle in a haystack, and it is nothing short of astounding.... (p. 73)

In school we are given a problem and must find the correct answer. Only one correct answer usually exists. The answer is hidden. The question is clear-cut. But most real-life situations, outside of the narrow technical problems, are inherently ambiguous. The answer is hidden and so is the question. (p. 77-78)

The widespread use of monologue by teachers to the exclusion of discussion or dialogue also stunts the potential development of young people. Carpay and Van Oers (1999) make the point that discourse is central to both social development and education as an activity. In some ways, young people face a form of dispossession not all that different to the oppressed workers of the 18th and 19th centuries, which Hargreaves (1994) describes as a cross between “the factory, the asylum and the prison” (p. 43). Marx wrote and lectured at a time when the world was in upheaval, having just dispensed with oppressors in the form of kings, princes and lords of the manor. Marx (2007) observed, that the world had swapped feudal rule for a new ruling class – the capitalists - whose power was exercised by making profits from the labour of their workers and generating even more capital to become even more powerful. In some ways, school children are the new oppressed.

Learning activity. Some researchers regard learning as a unique form of activity (Lompscher, 1999) that can be planned and analysed as a separate kind (Roth & Lee, 2007). Others such as (Scribner, 1985) regard learning, like development, as an intrinsic part of (work) activity, and that the Vygotskian childhood model of learning and development should instead be regarded as a lifelong process.

Although all activity involves learning and development, except perhaps for the regressive kind, some types of learning have become professionalised into unique specialisations such as training, lecturing, research and knowledge management. Some

of the more recently developed types of learning treat the learners as autonomous creators or recreators of knowledge. Learning by attending lectures regards the learner as dependent, whereas “learner as researcher” (Fitzgerald & Findlay, 2005, p. 1205) regards the learner as autonomous.

Central to the activity theory model is the expert teacher who acts as a guide and scaffolds the learning of the student, a concept that emerged in both Russia and the West about the same time (Wood, Bruner & Ross, 1976). The Russian version of scaffolding owes its’ origins in part to the work Gal’perin (Haenan, 2001) a colleague of Leont’ev and a devotee of Vygotsky. Gal’perin developed a new teaching strategy based on the theoretical principles of mediated activity and internalisation. At the start of a classroom activity, the learners receive an advanced package of both the action and the goal. The method provides a structure for the thinking or learning process and a mental model of what is to be learned. Gal’perin’s method is an important forerunner to small group work and cooperative learning (Haenan, 2001, p. 161) in which “working together, thinking aloud and elaborating explanations” forms an important part of the internalisation process. After speaking aloud about what the learner is doing – the action – the learner has a discussion with himself or herself and records what he or she has been discussing. It is also a forerunner to reciprocal teaching in which students formulate and ask each other questions (Palincsar, Brown & Campione, 1993) or engage in journal writing after discussion (Haenan, 2001).

By contrast to the “traditional classroom with its control and management, its’ drills and worksheets” (Moll, Tapier & Whitmore, 1991) is the “living knowledge” (p. 148) of Mexican-American classrooms where the students draw on the resources of teachers, materials, and each other to shape and direct their academic activities. They say, “the teachers role is to help children learn how to exploit the resources in their environment, how to become conscious users of the cultural resources available for thinking be it a book, their bilingualism, the library, or other children” (p. 161). This less controlling and directive model that guides learners and grants them autonomy is much closer to the concepts of *teacher as facilitator* or *learner as facilitator* that will be explored in this study.

Engestrom (1987) shows that learning is central to all activity and gives the process the key role in his “learning by expanding” model. He classifies learning activity based on learner autonomy, whether the task is predetermined or constrained, whether the group has control over its learning process, the outcomes that are achieved,

and the relative power of the tools at the group's disposal. Engestrom's four types of learning comprise *craft*, which is a localized activity of an individual or small group making use of their tacit knowledge and simple tools; *rationalized*, in which management decides what to do within constraints; *humanized*, where semi-autonomous groups make decisions within a predetermined framework and *consciously or theoretically mastered* learning via a whole cycle of expansion, such as autonomous groups using advanced tools who are capable of implementing what they learn. It appears to me that the Engestrom learning by expanding model is actually a hierarchy of discourse types that determine how the collective object is transformed and is all about the negotiation of power. Whereas the craft learner is able to exercise very little power relative to the manager, teacher or the organisation, the theoretically mastered learner exercises considerable relative power.

In the same way that work activity has a bias towards an Industrial Age form of existence, with an emphasis on the economic, especially the concept of the alienated worker, learning activity, as it is characterised in activity theory, is skewed towards the requirements of the same period, and emphasizes memorisation (Goldberg 2001) and knowledge transmission. A learning activity model that is based on the innate ability of the frontal lobes to deal with novelty and create new, what Luria calls, "kinetic melodies" (Luria, 1987, p. 31), for evolving contexts deserves closer examination.

I argue that if activity is the bridge between perceptions of material existence and the ideal or imagined world then logically there should be activity types that span the entire spectrum of human experience from the best to the worst, from the most oppressed or victimised to the most spiritual experiences. Activity clearly spans not just work, play and learning, but the most basic forms of existence, where goals are thwarted by nature or over-ridden by authoritarian rule to the most idealistic form of existence, where lofty intentions may be realised via spiritual experiences. Such a wider view of activity is held by Davydov (1993, p. 46) who argues that activity may comprise any psychic process that involves thinking, imagining, perceiving and remembering. It is this broader view of activity and its many types that I will seek to categorise in this study.

Novelty, automatic operations and the human brain

At the heart of everything that is human is our very large brain. However, it is not the size of our brain that is all-important, but the additional structure and features.

The frontal lobes have expanded in both size and capability during the four million years since we separated genetically from our nearest primate relatives. The frontal lobes play a role in the regulation of conscious activity that occurs with the “close participation of speech” (Luria, 1976, p. 93). In this section I will set the scene for the analysis of what teachers do and say in order to use the team learning system in the classroom, and/or to co-ordinate group learning activities by referring to the basic structure of the brain as understood by Luria (1976) and his student Goldberg (2001) in relation to the production of speech and orchestration of motor activities.

According to Goldberg (2001), changes in brain organisation from the lower primates to humans is a shift from the central brain system or thalamic to the cortical, a shift from the modular to the distributed, from the instinctive to the flexible and conditional. Goldberg (2001) describes the role the frontal lobes play in human and cultural development:

Human cognition is forward-looking, proactive rather than reactive. It is driven by goals, plans, aspirations, ambition and dreams all of which pertain to the future and not to the past. These cognitive powers depend on the frontal lobes and evolve with them. In a broad sense, the frontal lobes are the organism’s mechanism of liberating itself from the past and projecting into the future. The frontal lobes endow the organism with the ability to create neural models of things as a pre-requisite for making things happen, models of something that do not yet exist but which you want to bring into existence. (p. 24)

It can be argued that the whole history of human civilisation has been characterized by a relative shift of the cognitive emphasis from the right hemisphere to the left hemisphere owing to the accumulation of ready-made cognitive “templates” of various kinds. These cognitive templates are stored externally through various cultural means, including language, and are internalized by individuals in the course of learning as cognitive “prefabricates” of sorts. Any attempt to translate Vygotskian cultural-historical psychology into neuroanatomical terms will inevitably lead to this conclusion. (p. 52)

The frontal lobes are one of three main units of the brain described by Luria (1973, p. 43). Conscious activity operates as a “complex functional system” and involves all three main units concertedly working together in a combined way. One unit maintains the cortical tone and the waking state of the brain. The second unit acquires, processes and stores information received via the senses – sight, hearing, smell, taste and touch. The third unit is responsible for programming, regulating and verifying mental activity.

The first unit (Luria, 1973, p. 45-46) is the reticular formation, which is involved in arousal. The brain “wakes up” when new and significant sensory input arrives from the spinal cord about muscular functions, from the medulla about sensory function, and from the mid-brain, which deals with limbic functions. The highest level of the reticular formation is the cortex and is connected to the lower parts of the reticular formation, both ascending and descending. It is a two-way, self-regulating system, influenced by the “outside world” of the body and the environment and the “internal world” of the brain. When confronted with novelty, much of the cortex “light up”. There are three kinds of activation or inhibition. *Metabolic* processes are associated with changes in digestion and respiration and instinctive food-getting or sexual behaviour; *stimuli* from the outside world are manifested in the *orienting reflex* and compare the stimulus with previously encountered stimuli, in order to determine whether the stimulus is novel and requires attention or not and the *regulatory influence* of the cortex is responsible for planning and intentions to modify the cortical tone so as to co-opt the “lower systems of the reticular formation of the thalamus and brain stem” or “old brain” (p. 45) to make possible complex forms of conscious activity and to exercise control over emotions and instinctive reactions.

The second unit is a system (Luria, 1973, pp.73-77) for the reception, coding and storage of information located at the posterior region of the neocortex including the auditory, visual and general sensory regions. This region of the cortex comprises a very large number of neurons with widely differentiated functions. The system has a primary area for receiving and analysis of information into its basic components, a secondary area for coding or synthesis and organisation of these components and a tertiary zone for producing symbolic schemas. The main function of the primary zone is to convert impulses from the senses – concrete perception - and convert the impulses, through spatial reorganisation, into schemes of abstract thought, and in the process form memories of both uncoded information and symbolic forms. With the hands freed for use instead of locomotion, right-handedness in tool use, has resulted in the lateralisation of some cortical functions to the left hand side of the brain in most humans (some being left handed) and has become associated closely with speech. Lateralisation occurs at the tertiary and to a lesser extent at the secondary level of the anterior cortex, but not at the primary receptor levels where the right brain-left body, left brain-right body connection is maintained. Animals do not exhibit such lateralisation (p. 77).

The third unit, the left and right frontal lobes (Luria, 1973, p. 79), plays a role in planning, problem solving and complex decision-making or meta-cognition, adapting to new situations and orchestrating complex actions such as playing a piano or driving a motor car. The frontal lobes “perform the function of synthesis of external stimuli, preparation for action, and the formation of programmes” and in doing so provide “executive control” (p. 93) The frontal lobes are richly connected to the descending activating reticular formation (p. 94). They are more highly developed in humans than in other primates and play a much greater role in organising, controlling and regulating conscious activity.

Luria (1973, pp. 30-31) employs the metaphor of a “kinetic melody” to describe the process by which the frontal lobes initially orchestrate the performance of a new motor skill involving the other functional units, and which, with practice, becomes automated. Speech is also controlled this way, being the coordination of movements of the lungs, lips, tongue, muscles around the mouth and larynx to produce sounds with variations in pitch and intensity. (p. 320). Once a new pattern that deals with novel situations becomes established, the frontal lobes offload the responsibility to other parts of the brain. Luria also shows that damage to the left pre-motor cortex makes it difficult for patients to sequence actions into a new “kinetic melody”. Luria (1973) states:

The development of any type of complex conscious activity at first is expanded in character and requires a number of external aids for its performance, and not until later does it gradually become condensed into an automatic motor skill. In the initial stages, for example, writing depends on memorising the graphic form of every letter. It takes place through a chain of isolated motor impulses, each of which is responsible for the performance of only one element of the graphic structure; with practice, the structure of the process is radically altered and writing is converted into a single “kinetic melody”, no longer requiring the memorization of each isolated letter or individual motor impulse for making every stroke....Similar changes take place also during the development of other higher psychological processes....In the course of such development it is not only the functional structure of the process which changes, but also its cerebral “organization”. The participation of the auditory and visual area of the cortex, essential in the early stages of the formation of the activity, no longer is necessary in its later stages, and the activity starts to depend on a different system of concertedly working zones. (pp. 30-31)

Luria (1973, p. 73) describes two distinct types of cognitive processing; the first of these forms is the integration of the individual stimuli arriving in the brain into

simultaneous, and primarily spatial groups, and the second is the integration of individual stimuli arriving consecutively in the brain *into temporally organized successive series*. Simultaneous processing involves the ordering of events such as reading, speech and writing and is associated with conscious thought. Successive processing such as verbal ability and the literal understanding of texts is associated with unconscious automatic operations (Elliott, 1990). Vocate (1987) states:

Simultaneous synthesis brings together the visual, kinetic and vestibular systems... that orient the body in space” and “successive synthesis is produced via the “motor and acoustic systems” which are linked to spoken language. (p. 138)

I suspect it is the reliance by teachers on a general ability to make use of simultaneously process skills and inventively develop solutions to presenting problems at the expense of automating critically important speech and motor routines that demand near perfect sequencing that may be at the heart of the reluctance to promote collaborative interaction or use technologies that require complex explanations and demonstrations prior to use in the classroom.

The right hemisphere is associated with novel cognitive function, the left deals more with routine (Goldberg, 2001, p. 43) and there is a shift from right to left as development proceeds. The frontal lobes are also involved in what Goldberg (2001) describes as “long-distance communication” (p. 144) to coordinate the many different parts of the brain. When humans face a novel situation the frontal lobes, especially the right hemisphere of the cortex, “light up” (Goldberg, 2001, p. 111). Goldberg says that as a task becomes automated, control of the performance shifts from the frontal left to the posterior areas of the cortex, and what was once novel becomes routine (see also Chapter 4, pages 161-169). Goldberg (2001, p. 47-51) cites a series of studies of brain scans which show clear evidence of an association between the right hemisphere and novelty and the left hemisphere and automatic operations as well as a shift from the left to right frontal lobes (Haier, Siegel, MacLachlan, Soderling, Lottenberg & Buchsbaum, 1992; Raichle, Fiez, Videen, MacLeod, Pardo, Fox & Petersen, 1994; Gold, Berman, Randolph, Goldberg & Weinberger, 1996; Shadmehr & Holcomb, 1997; Berns, Cohen & Mintun, 1997; Martin, Wiggs & Weisberg, 1997; Henson, Shallice & Dolan, 2000).

Goldberg (2001) explains how human behaviour is adapted to the context, whereas instinctive behaviour results in the same response to a triggering stimulus during the lifetime of the organism:

Unlike instinctive behaviour, learning by definition, is change. The organism encounters a situation for which it has no ready-made effective response. With repeated exposures to similar situations over time, appropriate response strategies emerge. The length of time, or the number of exposures, required for the emergence of effective solutions, is vastly variable. The process is somewhat condensed in a single exposure, the so-called Aha! reaction. But invariably, the transition is from an absence of effective behaviour to the emergence of effective behaviour. This process is called “learning”....At an early stage of every learning process the organism is faced with “novelty” and at the end-stage of the learning process can be thought of as “routinisation” or “familiarity”. The transition from novelty to routinisation is the universal cycle of our inner world. (p. 44)

Goldberg (2001) points out the front lobes are the equivalent of a leadership function within the brain, which is capable of making sense out of ambiguity and developing strategies to meeting new, unusual or complex situations:

The prefrontal cortex is central to such decision making since it is the only part of the brain where the inputs from within the organism converge with the inputs from the outside world (p. 78)....the majority of our mental processes are effortless and automatic, conducted as if it were on autopilot. By contrast, the effortful and consciously controlled cognitive tasks represent only a minor portion of our mental life. (p. 54)

Goldberg (2001, p. 226) also draws a parallel between the stages of development of man-made computing devices and the evolution of the brain and society and shows that the frontal lobes, like search engines, deliver instant access to memory. Goldberg (2001) asks the question, which is central to this study:

Do the invariant laws of evolution shared by the brain, society and digital computing devices reflect the only intrinsically possible or optimal path of development? Or do humans recapitulate, consciously or unconsciously, their own internal organization in man-made devices and social structures? (p. 224)

Change, development and transformation in activity systems

Change, development and transformation are often used interchangeably and ambiguously throughout the activity theory literature. One of the main problems is that although all activity is movement and change, not all change is transformation, and it may be possible that some kinds of change are dialectical, and involve a change in the structure, composition and relationships of all the aspects of an activity system, or some

other simpler and perhaps serial trajectory. The issue revolves around the reconstruction of the object of activity, which in itself is regarded as a dialectical process. This occurs usually via a dual process of internal cognitive change in the subject(s) and changes in the external activity, as Davydov (1999) states:

Most frequently, transformation is understood as changing the object. But careful examination shows that not every change is transformation. Many changes of natural and social reality carried out by people affect the object externally without changing it internally. Such changes can hardly be called transformations....Transformation means changing an object internally, making evident its essence and altering it. (p. 42)

The issues raised by Davydov involve not just the problem of unresolved contradictions between the internal and external aspects of the object of activity, but other dimensions of activity as well. Sometimes, as Engestrom points out, contradictions develop, when there are differences between the participants in collective activity. What is not clear is whether and under what circumstances the main components of an activity system – the roles, rules, tools and the community - change their character and whether these changes occur *incrementally* or *discontinuously*, whether the changes occur always in response to goal-directed action alone, which is a core assumption of activity theory, or whether some changes occur as a consequence of the state of the system. Another issue is whether all activity is dialectical. Much of what humans do collectively falls far short of what is possible, and although dialectical transformation may represent the ideal process of change, cruder forms of human interaction, such as monologue or discussion, may simply reinforce the existing power relations, and result in incremental change, no change or even regressive change instead.

In analysing the differences between types of change in an activity system, my starting point is to clarify the meaning of dialectical, in the context of dialectical processes of change. For Hegel (1985), dialectical thinking is not about incremental adjustment by individuals, but a collective qualitative change in society, in which the negative becomes part of the positive and in turn transforms itself. Marx (2007) saw it as the resolution of the conflict of opposing forces, whereby a given contradiction is characterized by a primary and a secondary aspect, the secondary succumbs to the primary, which is then transformed into a new entity. According to Roth & Lee (2007) a dialectical entity, concept or germ cell “presupposes all other parts” like a series of related wholes such as a thread, its’ strands and fibre (p. 196). Dialectical entities

contain their theoretical opposites, variants or contradictions. Roth and Lee (2007) use the example of light, which can be regarded as both a wave and a particle and is often represented as wave/particle where the relationship between the parts of the dialectical entity “corresponds to the NAND operation in classical Boolean algebra that creates statements that are always true when it involves non-identical terms of the same entity” (p. 197).

Davydov’s issue with transformation is that formal logic is often inappropriately applied to the transformation of the object of activity, which results in the promotion of the object to an overarching concept that embraces the initial concept, such as occurs in the relationship between shoe and footwear, or the concept of dog extracted from poodles and labradors. The correct approach, according to Davydov, is to use dialectical logic to explore the relationship between the internal and external aspects of the object of activity which involves the development or expansion of the activity, for example, the shift from knowledge telling (Scardamalia & Bereiter, 1993) to facilitation (Findlay & Fitzgerald, 2004) to learning activity design (Findlay & Fitzgerald, 2006) or to co-performance (Holzman, 2005), where each higher concept presupposes and incorporates elements of the lower, but is richer and more elaborate, and I suspect, more powerful.

Kaptelinin (2002) draws attention to the confusion between object as a thing, object as motive, object as goal, object as outcome and individual vs. collective objects. The confusion is caused by a lack of shared definitions and different assumptions about activity theory, especially in relation to the motive, as a single object may have motives that correspond to several simultaneous needs and because the object of activity is a conceptual tool, its’ use may vary according to the context. Kaptelinin says that objects of activity can serve as “powerful sensemakers” (p. 187) and be used for setting or describing priorities and goals, making commitments, developing plans, coordinating efforts and make sense of data.

Objects arise from a human motive, need or desire. The nature of the object determines and informs the character of the activity (Leont’ev, 1978). The object appears to presuppose some modern elements used frequently in the business literature such as problem space, vision, mission, goals and objectives and action plans, each of which describes a lesser or greater purpose in the overall human scheme of proposed or felt future action. Learning is the theoretical and internal reconstruction of the object in which the object is challenged by a new or improved model, which then influences what the external object, will become (Davydov, 1999). Human activity grows constantly

richer and progresses towards increased subjectivity (Engestrom, 1987) and with that a dialectical increase in the number and interconnection of activities and widening of the object landscape of those activities. The web of interactions expands in the same way that products and services dynamically and interdependently persist in market space with complementary products and services. Jonassen (2000) explains object-oriented activity:

All activity is object-oriented. Objects of activity systems are artifacts that are produced by the system. Whether physical, mental, or symbolic, they are the product that is acted on by the subject. The transformation of the object into the outcome represents the purpose or intention of the activity. Just as the object is transformed during the production process, the subject may also be transformed by the object. As individuals engage in activity systems, they are changed by those systems. Despite the intended object of activity, the form and function of that object is likely to be modified as the activity unfolds. For instance, students in the classroom may become devotees of romantic poetry, or they gain avoidance, time management, or other skills and knowledge. (p. 7)

Russell (1997) defines the object in terms of the motive or direction of the activity in relation to an individual or collective subject:

The object/motive refers to the raw material or problem space on which the subject(s) brings to bear various tools in ongoing interaction with another person(s). The object is shaped and changed over time to produce some outcome. This is the object of study of some discipline (e.g., cells in cytology, literary works in literary criticism). The object or focus of activity implies an overall direction of that activity, a (provisionally) shared purpose or motive (e.g., analyzing cells, analyzing literary works). (p. 5)

Kaptelinin and Nardi (1997) explain how the *object* motivates activity, giving it a specific direction. In one sense, the object or artifact is like a problem descriptor or problem space, for example “make people well”, “learn to dance” or “conduct a lesson with a team learning system.” Kaptelinin and Nardi (1997) explain the relationship between internal and external aspects of the object in the following terms:

Activity Theory differentiates between internal and external activities. It emphasizes that internal activities cannot be understood if they are analysed separately from external activities, because they transform into each other. Internalization is the transformation of external activities into internal ones. Internalization provides a means for people to try potential interactions with reality without performing actual manipulation with real objects (mental simulations, imaginings, considering alternative plans, etc.). Externalization transforms internal activities into external ones. Externalization is often necessary when an internalized action needs to be "repaired," or scaled. It is also important when a collaboration between several people requires their activities to be performed externally in order to be coordinated. (p. 3)

The Kaptelinin and Nardi (1997) explanation may work in an ideal world, but most situations in the classroom or the workplace are from ideal. There are frequently significant power and cultural differences between the collective subjects and their leaders, managers or teachers. What if some students quickly decipher what their teachers are communicating and others do not? I argue that if all the students learn a new concept and/or how to apply the concept, the object is transformed both internally and externally? But what if a teacher comes to the classroom with tools from an earlier cultural frame, rather than more modern tools for which the students have a demonstrated competence, and the teacher demands the students use older, slower, more complex methods than the ones they already know, what internal development can be considered to have taken place if the students are expected to “learn” to use and apply a more primitive tool, which requires them to be less than they already have become, and in what ways is the object of activity transformed either internally or externally? Another question is whether change always proceeds in the same manner of Darwin’s gradualism (Corning, 2002) by the accumulation of a large number of small errors or adjustments, or if, during the transition to a new kind of order, the process simply speeds up? Does a phase transition (Prigogne & Stengers, 1985) involve numerous small changes, or is there some other process at work, perhaps in the form of a procedural jump, to a new kind of order as occurs with the formation of a quasi-periodic crystal? Penrose (1990) explains that five-fold symmetry quasi-periodic crystals come into existence, not via a serial process as occurs with conventional crystals such as snowflakes, but via a process of “intelligent groping” (p. 564), as if the pieces know where they had to fit, which is similar to the way that proteins and DNA interact.

Throughout the activity theory literature, human progress is often treated as having a uniform rate and direction in all learning situations and in all cultures, which is commensurate with what Dawkins (1996) refers to as “constant speedism”(p. 228) in biological evolution and which he demonstrates is an impossibility. He replaces the notion with “variable speedism” (p. 229) to account for brief periods of transformational change that are followed by a long period of incremental change. If the revolutionary transformations in child development identified by Vygotsky are dialectical, what is the relationship, if any, between dialectical processes and phase transitions?

Activity theory acknowledges four different strands of development, which proceed over different time scales (Wertsch, 1991, p. 20). Wertsch describes the strands

as *ontogenesis*, which is the development of individuals and occurs over a human lifetime, *microgenesis*, the moment-by-moment psychological changes through engagement with tools, *culturogenesis*, the evolution of cultures, which is said to be driven by learning activity, whereas *phylogenesis* is the evolution of races or species, occurs via natural selection and depends on a vast number of chance mutations over millions of years for significant change to occur. Kauffman (1995) shows that this idea is wrong and that phylogenesis is *also* determined by the spontaneous emergence of new order within systems as a consequence of the stage of development of the system. He describes the combined process as “co-evolution” (p. 8). This aspect of transformative change will be explored more fully in Chapter 4 (see pages 141-152).

What appears to be missing from this hierarchy, although touched on by some researchers (Wartofsky, 1979), is a kind of *technogenesis* or longitudinal process of tool evolution that goes beyond the basic mechanisms of tool formation. Wartofsky (1979) suggests, “the artifact is to cultural evolution what the gene is to biological evolution” (p.205). Wertsch (1985) puts forward the possibility that some of the biological changes that have occurred in humans over the past four million years may have co-developed in “response to cultural pressures” (p. 30). Thus, selective pressures may have favoured those who became more capable of survival through the growing of crops and the storing of water, thereby increasing the chances of their own survival, and the survival of their offspring, during extended extreme weather patterns or natural disasters, and at the same time guaranteed the survival of the tools they had developed.

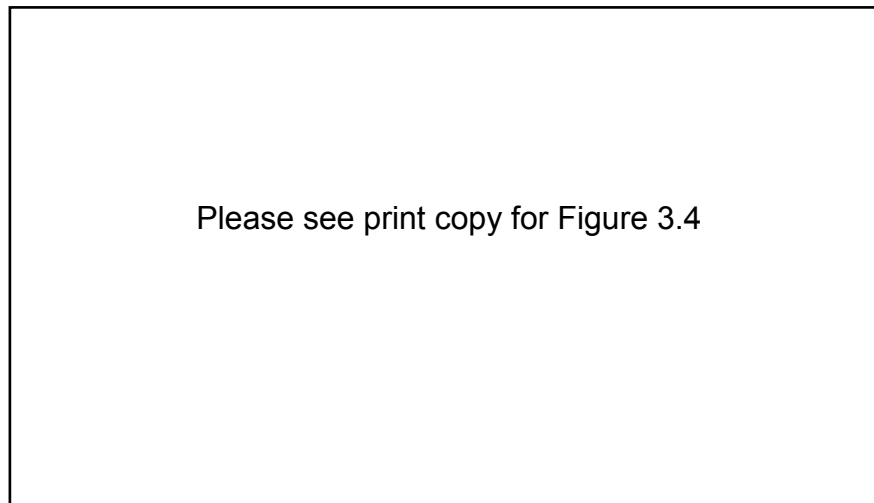
Some researchers regard activity as one continuous but cyclical process consistent with the original Vygotskian (1978) view of development which proceeds “not in a circle but in a spiral passing through the same point at each new revolution while advancing to a higher level” (p. 56). Piaget (1962) also saw development as an upwardly expanding spiral. This concept continues to dominate the literature. Engestrom’s (2000) stepwise cycles of expansive learning, Shariq’s (1998) knowledgescapes and Nonaka and Takeuchi’s (1995) continuous, self-transcending process or spiral of knowledge creation all have the topology of a spiral.

In an attempt to discern the inner working of activity (Engestrom, 1999b) created a less serial model of transformation in his “cycles of expansive learning” (p. 382). But deep within this process, the spiral remains, although each cycle or re-arrangement of activity begins as a deviation from what was previously the norm. Engestrom says the method is based on “the dialectics of ascending from the concrete to

the abstract” and in the process resolves the inner contradictions within the existing activity system starting with an initial “germ cell” and transforming “the initial simple idea” into “a complex object, a new form of practice” (p. 382). A developmental work research method devised by Engestrom as a practical implementation of the expansive learning model is used by “change” facilitators to help make visible, “what is not there yet”, an imagined future state which potentially expands the activity (Engestrom, 1991, p. 270). The process involves questioning the accepted practice, analysing the situation, particularly its’ inner systemic relations, developing a new model that could resolve any problems, examining the model to ensure it fits with the new situation, and implementing it.

The Engestrom (1999) model of activity considers there are four kinds of contradictions, each being associated with an aspect of activity – instruments (tools), roles, objects, culture and subject – as shown in the Engestrom triangle (see Figure 3.6).

Figure 3.4: Contradictions in activity systems, (Figure 6, Centre for Activity Theory and Developmental Work Research (2008).



Conflicts between exchange value and use value are *primary contradictions*. *Secondary contradictions* exist where expectations or needs cannot be met from within the existing activity system. *Tertiary contradictions* are present when a culturally advanced object (or motive) is introduced and is resisted or rejected by the incumbents. *Quaternary contradictions* are said to develop when people from different cultures come together and their tool use and cultural practices are in conflict or are not understood by each other. A question that needs to be asked is whether Engestrom’s model of contradictions would survive Ockham’s razor, which awards the competition between competing theories to the simplest, but most complete.

Engestrom (2000) also employs a concept as “knotworking” to describe a process of organisation-wide change that involves temporary teams of customers, staff, and other stakeholders who focus on new need states and the new tools that might satisfy those needs. Knots of activity form, develop contradictions, dissolve, and then reform in new configurations. A simpler way of representing the gap between the present activity and future states of the activity system is needed.

There are also some researchers, particularly Engestrom (1987, 1999b), Goldberg (2001), Tobach (1999) and Tolman (1999) who flirt with the possibility that occasionally, change in an activity system can also occur autocatalytically and beyond human control. Bifurcation, a key concept from complexity theory was introduced by Foot (2002) to describe the transformation of an object into a bifurcated object, which occurs when attempts are made to remediate contradictions in an activity system and the system splits into two or more streams of activity. At times, Engestrom (1999b, p. 22) argues that transformations in activity systems occur as a result of deliberate goal-directed action, and at other times he offers the possibility that activity systems can be self-organising. Engestrom (1999b, p. 33) also observes that “the trajectory of an activity system moving through such an expansive cycle seems to go through phases of “far from equilibrium” conditions”, which is consistent with emergence. Engestrom cites Prigogne and Stengers (1984), two of the pioneers in the complex systems field, as his inspiration. At other times, Engestrom clearly regards development of an activity system as a deliberately planned process when he and Cole (Cole & Engestrom, 1991) say:

The new activity structure does not emerge out of the blue. It requires reflective analysis of the existing activity structure – participants must learn to know and understand what they want to transcend. (p. 40)

An approach that integrates activity theory with the theory of integrative levels (Needham, 1937) is proposed by Tobach (1999) to explain how many small evolutionary changes, punctuated occasionally by revolutionary transformations result in the emergence of new structures and processes at a higher level of organisation. The theory of integrative levels (Needham, 1937; Greenberg, Partridge, Pisula & Weiss, 2004) is based on the idea that complexity increases with time and as thresholds are reached, very small changes lead to a dramatic shift in the way the system is organized; change is non-linear and discontinuous. In the Tobach (1999) interpretation, all matter, both inanimate and animate, becomes differentiated into “dynamically interacting

levels” (p. 134), in an ascending hierarchy from the atomic through molecular biochemical, cellular, histological, physiological, and the psychological. New levels arise when internal contradictions within a level become so great it can no longer adjust internally, and the tension is resolved by the eruption of a new level. Changes at high levels feed back to lower levels, and vice versa (p. 136). This concept of change is consistent with the view of Greenberg et al. (2004) that there is a “directional trend in evolution” known as avagenesis “which reflects change from the simple to the complex” (pp. 3-4). Saunders and Ho (1976) suggest that “increasing complexity is a second law of evolution after natural selection” (pp. 3-4).

Vygotsky’s observation in his unpublished work *Problema vozrasta* (cited in El’konin, 2008) that child development has a “perfectly regular and distinct pattern” involving “ages of stability are interrupted by ages of crisis...in which the transition from one stage to the next occurs not through evolution, but through revolution” (p. 34), bears a close resemblance to Tobach’s (1999) theory of integrative levels and the theory of complex systems (Kauffman, 1995). The stages of development are characterised by long quiet periods of stability punctuated by short periods of chaos followed by a new period of stability but at a higher level of organisation.

Mahn and John-Steiner (1996) point to parallels between phase transitions and the Vygotskian and Lurian view of the internal and external interactions in the development of mind, and in particular, the changes that take place in the mind between childhood and adolescence. With each new transformation, what was previously abstract for a person becomes more concrete and available as tools for use in the next stage of development. In this way the mind is reorganised for higher-level functioning, and so is the outside world.

It is this fractal, self-similar, model of emergence that informs this study, not only as a consequence of goal seeking, but as consequences of interactions that occur spontaneously within a system, at certain stages of its’ development. Such changes may include the eruption of new levels in the neural wiring of the brain associated with the formation of “kinetic melodies” (Luria, 1987, p. 31), large-scale rearrangements of neural connections in the brain associated with the stages of child development, and disruptive cultural changes in society associated with the evolution of the tools use. A detailed exploration of this model of emergent order in relation to tools, pedagogy and culture is reviewed in chapter 5 (see pages 134-141).

How tools evolve in a symbiotic relationship with humans

Of particular interest to this study is how, over time, tools become more complex or adopt more human-like features or affordances (Norman, 1988) and thereby contribute to further human development and cultural evolution.

Tool use is one of the subtle differences between humans and other animals, with the exception of some of our fellow primates. Humans are said to be able to use reason and use language while other animals behave instinctively (Klix, 1982; Davydov, 1999; Tolman, 1999; Goldberg, 2001) although we now know this is not the entire story. Humans not only use tools, but we create them (Mead, 1934; Keiler, 1981) in a symbiotic relationship with the tools themselves. Over many millennia, we have been sustained in a complex web of social relationships that is facilitated by the common bond of tools such as language and cultural artifacts (Davydov, 1999; Tolman, 1999; McNeil, 2005) which allows humans to construct rather than adapt to the environment. Researchers originally believed that what separated humans from other species was our unique use of signs, instruments and tools (Mead, 1934; Keiler, 1981). We now know this is not correct, but there are major differences. Keiler (1981, p. 153) argues that apes and dolphins, despite their complex relationships, do not show productive or systematic use of tools. Says Pepperberg (2007), “detailed observation and careful experimentation have repeatedly demonstrated that nonhumans often possess abilities thought to belong only to humans. Humans for example are not the only tool-using species, nor the only tool-making species, nor the only species to act cooperatively” (p. 11). There is evidence that chimpanzees make their own weapons and consistently use them to hunt other mammals (Chimps make weapons, 2007), whales learn courting songs from each other, monkeys learn to wash potatoes in the same manner as their predecessors and birds copy the song of other birds (Podos, Huber & Taft, 2004; Laland & Janik; 2006; Pepperberg, 2007). These are all forms of cultural transmission yet such findings remain controversial simply because many researchers do not accept there is a cognitive continuum or that other animals may have an emotional life.

Sustained attention also helps separate humans from other animals with perhaps the exception of primates. Although both apes and dogs are capable of sustained attention, apes and dogs exhibit quite different subsequent behaviours (Goldberg, 2001). The ape will resume what it was doing; the dog will not. Although only partially

developed in the ape, it is this ability to maintain sustained intention that is at the core of being human. Goldberg (2001) says:

To conjure up an internal representation of the future, the brain must have an ability to take certain elements of prior experiences and reconfigure them in such a way that in its totality does not correspond to any actual past experience.....One of the most fundamental distinguishing features of human cognition, systematic tool making, may be said to depend on this ability. (p. 25)

Unlike instinctive behaviour, learning by definition, is change. The organism encounters a situation for which it has no ready-made effective response. With repeated exposures to similar situations over time, appropriate response strategies emerge. The length of time, or the number of exposures, required for the emergence of effective solutions, is vastly variable....But invariably, the transition is from an absence of effective behaviour to the emergence of effective behaviour. This process is called “learning”...At an early stage of every learning process the organism is faced with “novelty” and at the end-stage of the learning process can be thought of as “routinization” or “familiarity”. (p. 44)

The differences between humans and animals may not be quite as abrupt as originally thought, but humans continue to be the only species on the planet that drives and rides in cars, flies jumbo jets, writes books, generates electricity, composes and plays music and sends its young to school for a quarter of their lives to learn how to participate in the culture.

For some researchers, the human hand (Mead, 1934, p. 363) is the fundamental basis for tools, and other tools are merely an extension to the hand. Significant or conscious gestures were supposedly found only among humans (Mead, 1934, p. 81) and occurred in early evolutionary stages, but the use of gestures and signs has since been demonstrated in the great apes (Savage-Rumbaugh, Rumbaugh, & McDonald, 1985). The origin of verbal gestures is thought to be mouth open, mouth closed reactions used in fear and anger (Rizzolatti, Fadiga, Gallese & Fogassi, 1996) and this has led to a more complex social life in a partnership between language, symbols, gestures and signs (McNeill, 2005). Gestures evolved into symbols and further evolved into language (Mead, 1934, p. 77). Says Davydov (1999, p. 48), “the biological basis of animal behavior and the societal basis of human activity create two radically different types of existence”; a break occurred in human development when “human beings lost their instincts” and the means of satisfying them” (p. 49). Animals and humans learn differently. Animal learning occurs via conditioning including habituation, conditional reflex and operant conditioning and interacting directly with the environment, whereas

human reasoning or cognitive learning occurs via hypothesis formation, induction, deduction, analogy and rule learning otherwise known as heuristics as well as interacting with concepts, relationship and procedures (Klix, 1982).

Since Vygotsky's day the concept of tools has expanded from gestures, signs and language to include physical and systemic entities. The present classification derives from Wartofsky's (1979) three level hierarchy. *Primary* tools are used for production. They include machines such as computers or motor cars and artifacts such as knives or needles. *Secondary* tools are symbolic or psychological and include language, signs, concepts, methods, procedures and mental models. *Tertiary* tools are cultures and systems (Hasan & Gould, 2001) as well as imaginative worlds in which people can play and which help to change current practices (Wartofsky, 1979, p. 208).

Primary tools are concretised from automatic operations, having started out as an action, associated with a motor skill. Says Leont'ev, (1978) "it is generally the fate of operations that sooner or later they become the function of a machine" (p. 66). Leont'ev explains that in order to travel in a motor car at variable speeds many individual conscious actions are required to change from one gear to another, but once learned, become a seamless unconscious automatic operation. Later on, and via another process entirely, this automatic operation was concretized by the invention of the automatic transmission. The invention and creation of a primary tool such as an automatic transmission makes use of a complex blend of primary, secondary and tertiary tools. The primary tool starts out as a theory or two, followed by plans of action and a series of manufacturing activity steps. A recent inventive step in the history of the automatic transmission which elevates tools to the cognitive realm, is a computer or program control, exemplified in airport trains that whisk passengers from a remote terminal to the arrivals lobby, that controls the speed of travel according to a pre-determined pattern, or sets of road rules and contexts. The computer replaces the human driver; it controls starting, acceleration, deceleration and stopping at predetermined times and places. It is this process of automating human labour and displacing earlier generations of tools, and the roles the tools support, that is of particular interest to this study in respect of the higher cognitive functions provided by the team learning system such as rich question asking. What is also of interest is whether the pattern of historical development of tools can be shown to parallel cultural development or child development, or perhaps both.

Secondary or psychological tools arise through the internalisation of ideas and concepts as mental models. These tools are manipulated in the “internal plane of action” (Hasan & Gould, 2001, p. 80) whereby subjects are able to play with an internal representation or model of the external world before starting actions with these objects in reality. As a cognitive or psychological tool, the computer extends the internal plane of action (Kaptelinin, 1994; Hasan & Gould, 2001). Computers offer considerable potential to transform human activity, not just for routine functions such as word processing or maintaining financial records, but also for a higher purpose such as offering higher-level thinking and meta-cognitive-like guidance. Tikhomirov (1999, p. 355) makes the interesting observation that “dialogue between human and computer is characterized by the emerging personification of the computer” and interaction between the human operator and the computer “takes on more and more traits of joint activity”. (Salomon, Globerson & Guterman, 1989) found that the computer tool behaved as a more capable peer when used as a reading partner. It is this aspect of tools as a learning guide that is of interest in this study, in particular, the way in which a tool makes it easier for a facilitator to organise, what otherwise might be a very complex group discussion, thinking, or learning process.

Tertiary tools are complex amalgamations of either, or both, primary and secondary tools such as games and simulations, as well as governance, transportation, and logistics systems, whole-of-organisation cultural change methodologies, movie production methods, science fiction and virtual reality software (Hasan & Gould, 2001). For example, much emergent creative activity is mediated by the use of cultural artifacts that may be any combination or even constellations of rule-based, role-based, symbol-based, cognition-based, discourse-based, process-based and technology-based tools (Jenlink, 2001). Some very complex tertiary tools that allow people to imagine and simulate different futures, are being concretised as primary tools and allow users to exercise the considerable powers that were once available only to political leaders. One such tertiary tool is the military machine (Toffler, 1990; De Landa, 1991) which is employed by governments or a powerful few individuals, such as dictators, to exert power at a distance by terminating and replacing existing and competing governance systems with models of their own liking. Such wars are increasingly being fought using software and hardware systems that are equivalent to computer games or simulations. An operator on one continent controls one or more remotely-controlled weapons such as pilot-less aircraft and fires rockets at targets on another continent at the press of a key or

click of a mouse, so that the actions become increasingly isolated from the object of the activity and play and work activity become blurred. The boundaries between humans and tools are becoming intimately blurred, which leads to the possibility of a quaternary tool category of pseudo-cyborg. According to Mitchell (1995), the first tools to span the “carbon-silicon divide” have now been developed and make use of physical connections such as “interchangeable, snap-in organs connected by axon nerves” to “sensory receptors and muscles”. Humans are on the verge of becoming “reconfigurable, infinitely extensible cyborgs” where “the border between interiority and exteriority is destabilised” (pp. 28-29). Also, under development are giant scale complex tools such as cooperative buildings (Streitz, Geissler & Holmer, 1998) that use shared, aware, responsive ICT to promote human-human interaction, artificial intelligence systems for advanced courses that can teach or tutor almost as effectively as their human equivalents (Lajoie & Derry, 1993) and knowledge discovery systems whose ancestors are inquiry systems which incorporate validation mechanisms (Marcum 2001). Some of the new systems belong to the Johari window class of tools that go beyond any existing systems because the outcome is invisible, unknown, uncertain, evolving or a moving target, and the purpose of the tool is to discover order in uncertainty (Scott Kelso, 1995). Clark (2007) even goes so far as to suggest the cyborgs have already arrived, and they are our left frontal lobes, the “quick thinking zombie” (p. 273) inside every one of us. He makes the point that the human frontal lobes have automated a wide variety of very complex activities so that much of what humans do is unconscious rather than conscious and can decide our fate before we become consciously aware of what we have done

No specific pattern to tool development or *technogenesis* has been identified in activity theory nor has it been the subject of research. However, a more evolutionary and distributed view of tools has been realised in a related field of study known as *Actor-Network theory* which was developed originally by Latour (1998). Latour regards tools as forming complex webs of relationships with their human users. Social relations are embedded in artifacts or tools and remain stable as long as the tools are put to use. Humans, tools and the natural world are all equivalent. Actors do things to achieve their objectives and grow in power as the networks, of which they are part, grow in size as they co-opt and align more and more actors. They also become more stable with size and influence. Actors and networks constantly redefine each other. The greater the diversity in a network the greater the stability, because to become disconnected from a

network, many links may need to be severed. The main criticism of Actor-Network theory is that it regards humans and tools as equivalents.

Another theoretical field that is closely related to activity theory is *distributed cognition*, which considers tools as external extensions of the mind. The processing load can be reduced by offloading some of the functions to the surround, which may be what the team learning system does to support thinking and relating processes. Artifacts such as to-do lists, mnemonics, calculating devices and software reduce mental effort or prevent the occurrence of errors (Pea, 1993). A special form of distributed cognition involves shifting executive control, or the process of organising thinking, to the surround. In formal education learners often abdicate the executive or cognitive control function (Perkins, 1993) to the teacher, whether they like it or not, who makes many of the decisions about what steps will be performed by the subject and in what order. According to Olson and Astington (cited in Perkins, 1993) teachers frequently offload the executive control function to textbooks, which contain activities to perform but rarely refer to higher order thinking processes, and to software, which can provide access to higher order numerical, algebraic, reasoning and artistic skills. In such highly scaffolded situations the underlying decision-making processes are invisible to the learner. Perkins (1993) gives examples of contracts, assembly instructions and juries as a way that allows humans to “freeze certain patterns of decision making” (p. 94) and make them available to others. Many learning situations leave students, especially weaker students, floundering, by not providing “enough executive function” within the artifacts they use” (p. 98). This may explain the variability of open-ended learning, particularly involving computers, because teachers are not skilled in scaffolding learners. “Misconceptions in mathematics and science can be traced in part to the lack of higher-order knowledge” (p. 101). Learners “regain control” when they master knowledge and skills, but in highly controlled or scaffolded settings, students are often unable to regain control because they have not practiced the necessary skills without support (p. 99). Salomon (1993) contends that “higher order knowledge in the form of heuristics, patterns of explanations and modes of inquiry...cannot become distributed” (p. xvii) to the surround because they are used across many contexts or situations and so must be available anywhere and everywhere and this cannot easily be achieved. Findlay and Newman (2005) show that, contrary to Salamons’ (1993) argument, complex ethical decision processes, involving a series of conditional steps, can be captured in sequences of questions and incorporated into a team learning system for application in a

variety of contexts, An interesting question is whether student users of a team learning system, are able to design, capture, and improve their own thinking processes.

New knowledge and tool creating processes

Tacit knowledge that is acquired outside school by engaging with the world is often regarded by teachers as having little or less value than the *scientific* knowledge acquired at school. Of particular interest is whether making *tacit* knowledge explicit and accessible either alone or in combination with *scientific* knowledge can usefully contribute to student learning and development. Both kinds of knowledge are relevant to the process of tool development by first articulating a concept, theory or model and then creating an artifact that makes the knowledge available as an extension of human functioning. Also of interest is how conceptual labels direct attention and assist in the retrieval and recombination of “rememberings” (Gabora, 1998, p. 3) that contribute to the making of new meanings.

Tacit knowledge, or what people know from their own experiences, was not very highly regarded until recently, compared with centuries-old formal logic (Shariq, 1999). The problem with tacit knowledge (Nonaka, Toyama & Konno, 2000) is that it is rooted in action, procedures, routines, commitments, ideals, values and emotions. It is hard to communicate because it is an analogue process that requires simultaneous processing (Nonaka, Toyama & Konno, 2000). Tacit knowledge is fragile and subject to decay (Shariq, 1999) and may be difficult or impossible to recreate once lost or extinct. (McKenzie, 1996, p. 216). Tacit knowledge leaves organisations when people retire or resign or when work groups are abandoned, but is vital for their success. The situation in school settings is even more problematic, say Scardamalia and Bereiter (1984):

Informal or tacit knowledge - both the kind that students bring in with them and the kind that they will need in order to function expertly - is generally ignored in school curricula. The result, frequently, is inert knowledge, unconnected to the knowledge that actually informs thought and behavior. (p. 266)

Tacit knowledge has similarities with *common sense* knowledge and praxis (Colucci, 1999, p. 149), a “spontaneous philosophy” of Gramsci (cited in Colucci 1999) unconsciously held by all people. Knowledge, codified in one context may be meaningless or misunderstood in another (Shariq, 1999), which is the same problem scientists encounter when attempting to recreate an extinct animal from the remnants of its’ DNA. The recipe is available but the ecology or web of interdependencies that guide

development is not. Sensemaking (Weick, 1979), which involves searching for and discovering patterns in collections of ideas, is the process for creating new explicit knowledge from tacit knowledge, in the form of prototypical concepts, models, rules, methods and theories.

Scientific concepts are learned mainly through instruction rather than spontaneously, but to be useful to the learner, may need to be easily accessible and comprehensible. For many students, concept formation is not a trivial task as many are “quite adept at inventing scientific misconceptions” when left to their own devices (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993, p. 206). Scientific concepts flow from the general to the specific, everyday concepts flow from the specific to the scientific, and the concepts penetrate, transform and inform the other (Engestrom, 1987).

The difference between everyday concepts and scientific concepts is most evident in educational settings (Carpay & Van Oers, 1999), where academic knowledge has authority and tacit knowledge is undervalued. This dichotomy has its origins in the period when knowledge was tightly held by the church or the state and universities were originally established to provide training for the clergy (Wertheim, 1996), whereas in the 21st century, knowledge is widely distributed, and the role of the universities is to provide training for a much broader professional class. Students are often able to perform complex arithmetical processes in everyday activities such as shopping, but are unable to engage with or comprehend the equivalent abstract concept in the classroom (Lave, 1985).

Concepts are general ideas that are inferred from specific instances of other ideas or concepts. Knowledge of a word is acquired through its’ use in many situations (Malinowski, 1923) so as to know its boundaries and connections. Labels create a boundary that *detaches* its meaning from everything else, acts as a *label* for something we can recognise, and acts as a *vehicle* for the concept to be re-used in other contexts (Dewey cited in Prawat, 2002). Concepts develop in interdependent webs of concepts, which Wittgenstein (1999) describes as language games. Each concept in the set contributes meanings to other concepts. Embedded within the meanings are shared social practices including the rules for how we humans engage with each other and our collective tools.

Children acquire concepts by generally applying a word they have learned in a two-way movement from the general to the particular or the particular to the general at

the same time (Vygotsky, 1978). They further develop the concept in relation to other concepts. Concepts are also identified by the role they play in theories (Carey, 1985). Carey says the explanation that a theory offers is different from conceptual structures such as scripts or methods, although Murphy and Medin (1985) say scripts are also theories, as they may contain the theory of the relationships between the parts. Engestrom (1987) contends that models are not theories, but prototypical components, and when fully elaborated into a new and more complex form, become a theory (Wartofsky, 1979). According to Engestrom (1987), an initial germ of a whole theory in all its complexity lies at the heart of a genuine scientific-theoretical concept, which performs much the same function as a metaphor. Limon (2001) sees conceptual change is a gradual process, not all or nothing and that most models of conceptual change are linear, similar to the process of speciation in evolution, whereby, through a gradual process, a single species divides into two or more species that are so different they can no longer mate.

Conceptual tools have a quality known as reflexive embodiment (Wartofsky, 1979) which are models of action or practice that can be then used instead of the original action or practice to routinely do the same things repeatedly in the same or other contexts, so that a theoretical model starts to be used as if it was the real thing. Conceptual models give direction to activity or in Gal'perin's words provide a "scheme of a complete orienting basis of an action" (Haenan, 2001, p. 162), a kind of cheat sheet in the form of charts, displays, maps or drawings that depict the concept. Models generate complete descriptions of how the parts of a system are connected and what states are possible (Rouse & Morris, 1985).

Of particular interest is how an unusually potent kind of concept, the metaphor, helps to construct new possibilities, perhaps extending to the fourth quadrant of the Johari window, which is what we do not know we do not know. Metaphors help you to imagine new concepts and derive subsidiary concepts that flow from the exchange of labels at the intersection of the concepts, which helps to create new, previously unimagined, worlds. According to Engestrom (1987), metaphors can control the development of an activity system from a single conceptual source and thus have some of the functions of a gene, or what Engestrom (1991) calls a "germ cell" and Dawkins (1976) calls a meme (p. 382). Fichtner (1999) explains that metaphors allow you to "see something as something else" (p. 314), to model ideas and construct "visual images" (p. 315). Says Fichtner, metaphors "do not change reality but they make it changeable" (p.

315). Metaphors expand experience and allow you to discover new systemic relationships by interrogating the target concept using labels associated with the donor concept, and vice versa. Metaphors are both “objective and subjective at the same time” (p. 319) and play a role in the creation of “theoretical arguments, modeling ideas and procedures” (p. 321). The metaphorical process is “an imaginative act” which “mediates between the object and the subject” and connects “emotion to cognition, seeing to thinking and insight to intuition” (p. 323).

An example of the use of metaphor is Edward de Bono’s (1992) random word generator that helps people see existing situations in new ways. The word *bottle* might be randomly selected to help think about the concept *traffic*. The features of the bottle help the learner see traffic problem unconstrained by present understandings, for example “overcome bottlenecks” or “make the problem transparent”.

Deutscher (2005) shows how metaphors have become deeply embedded in everyday language and play such a major role in the transformation of language that we are oblivious to the origin of the complex meaning of words. Deutscher (2005) states:

Even in the most commonplace discourse, it is hardly possible to venture a few steps without treading on dozens of metaphors. For metaphors are everywhere, not only in language, but in mind. Far from being a rare spark of poetic genius, the marvellous gift of a precious few, metaphor is an indispensable element in the thought-processes of every one of us....we use metaphors not because of any literary leanings or artistic ambitions, but quite simply because metaphor is the chief mechanism through which we can describe and even grasp abstraction. (p. 117)

Metaphors, says Deutscher (2005), become “bleached of their original vitality” and are turned into “pale lifeless terms for abstract concepts” which are laid down layer by layer as the foundations for emergent language “as a reef of dead metaphors” (p. 118), for example:

At the cabinet meeting, *ground-breaking* plans were put forward by the minister for *tough* new legislation to *curb* the power of the unions. It was *clear* that the unions would never *go along* with these suggestions and the conflict *erupted* as soon as the news of the plan was *leaked* to the press. (p. 119)

In this example Deutscher (2005, p. 119) shows that “ground breaking” is done by shovels, “tough” is a quality of materials such as fabrics, “put forward” is an act of pushing something, a “curb” is a metal device inserted in a horse’s mouth to slow it down, glass is “clear”, volcanoes “erupt” and taps “leak”.

Metaphors do not transfer meaning but provoke dialogue, in much the same way that a tai-chi apprentice re-interprets the master when he/she achieves proficiency (Arendt, 2002). When the metaphor is combined with theory, the parts decompose into their interlocking logical components (Engestrom, 1987). Metaphors can also be visual images, word pictures (Schon, 1983) or image-laden rich questions (Fleming, 2003) that direct attention to the possibilities within a concept or model. Reasoning by analogy has important similarities with deciding categories and concepts (Ramscar & Pain, 1996). Metaphor is thus often used to assist in the formulation, development and explanation of theories (Miller, 1984).

Of particular interest to this study is how sequences of questions can scaffold the formation of new knowledge by students, or at least, what for them is new knowledge. This kind of problem, says Prawat (1999) “has vexed educators and learning theorists for years, the so called learning paradox” (p. 36). Prawat asks how can new knowledge be “fashioned out of prior, less complex knowledge” using the “processes of deduction or induction” (p. 36). Prawat says that a metaphorical process known as abduction offers a full explanation for how this can occur. He cites Peirce (1934) to explain that whereas “deduction proves that something must be,” and “induction shows that something is actually operative,” abduction creates new possibilities and “suggests that something may be” (p. 90). Abductive thinking (Prawat, 1999), “involves reasoning from the known (rule) to the new or unknown (case) by way of a metaphoric leap or projection” (p. 62). The process begins by conceiving of a new set of conceptual relations, that explores the consequences of the new relationship and establishes whether the new constellation of ideas is a good explanation or fit with the observed facts.

Intersubjective relations and coordination models

One of the fundamentals of activity theory is that all activity is collective. Although the transformation of a collective object has been thoroughly studied, the processes by which group development occurs, has not (Springer, Stanne & Donovan, 1999), nor has the relationship between the different kinds of joint activity and types of discourse (Wells, 2007). There are four aspects to group development which will be considered in this section; the formal understanding within activity theory of intersubjective relations, the role of the frontal lobes in social intercourse, the nature and

evolution of roles in group interactions and the rules of engagement embedded in different types of discourse.

Intersubjectivity is the aspect of activity theory that explains group development but it is little more than a formal definition of communication relations between people and does not purport to be a theory. Trevarthen (1980) defines intersubjectivity as the “recognition and control of cooperative intentions and joint patterns of awareness” (p. 530). At least three types of intersubjectivity have been identified and described. In developmental terms, *primary intersubjectivity* (Trevarthen, 1979; Rogoff, 1990) is a form of communication where the focus of attention is between only those people who are involved, as occurs in mother-child interactions or in face-to-face dialogue between partners. Primary intersubjectivity may also be regarded as a special case of tool use, when, for example, infants employ adults as tools to reach their own goals (Mosier & Rogoff, 1994). *Secondary intersubjectivity* is where the focus of joint attention is on other people or things, for example, when a mother draws attention to a thing or event, or distracts the child from a current pattern of behaviour (Trevarthen, 1979). Secondary intersubjectivity develops at about nine months when infants deliberately begin to share their experiences of events and includes relations such as a teacher engaging with a learner (Rogoff, 1990, p. 78). Tomasello, Kruger and Ratner (1993) suggests that a third kind of intersubjective relations is necessary – tertiary intersubjectivity – to describe how a group focuses on others as they approach a problem together, and in the process, create culture.

According to Fichtner (1984), intersubjectivity also has three features - coordination, cooperation and reflective communication - that in ascending order of complexity is said to correspond with operations, actions and activity. Fichtner (1984) explains that *coordination* involves individuals acting on a common object but who behave as separate individuals as occurs in a poorly formed group, *cooperation* is conscious, goal directed interactions that result in the successful joint completion of tasks or joint solution of a problem and the individual balances his actions and outcomes with those of a partner or colleague, and *reflective communication* occurs when individuals engage in collective cognitive activity using shared instruments and where the interaction system “becomes the focus of reflection and self-regulation” (p. 217). (Fichtner 1984 argues that the developmental forms of intersubjectivity are merely “phases of any cycle of genuine learning activity rather than ontogenetic development” (p. 217). Each expansive transition is a movement from the individual to the collective

or from coordination to reflective communication (Engestrom, 1987). I have some difficulties with the marrying of coordination with operations, simply because coordination of activity requires a conscious alignment of interests, whereas operations are essentially an automatic response. It would make more sense if the term involuntary alignment were used.

Opinions are divided on whether intersubjectivity is innate or learned. Those who regard intersubjectivity as innate argue that infants are born with the ability to share attention with a partner (Trevvarthen, Hubley & Sheeran, 1975; Luria, 1987). Certainly, other animals such as monkeys (Harlow, 1963) are able to focus on the same things as their mothers and mimic what they do soon after birth. An alternative view held by Kaye (1982) is that mothers act as if their infants were communicating, and over many cycles, the child's non-social actions become elevated to dialogue. Tobach (1999) even suggests that intersubjectivity has its origins in sexual reproduction, because all species are social in the sense that they "must at some stage in their lifecycle history mix their gametes" (p. 137) although the case for intersubjectivity could also be regarded as originating from the competition between species for resources.

Another model of group development offered by Lave & Wenger (1991) suggests that learning occurs by engaging in a *community of practice*. Novices are acculturated into existing communities of practice via a kind of apprenticeship to professions, trades or academic specialties (Brown, Collins & Duiguid, 1989) and give up their existing speech habits for the language of the discipline (O'Connor, 1991). The community of practice model (Brown, Ash, Rutherford, Nakagawa, Gordon & Campione, 1993) involves "learning how to learn" perhaps as a "lifelong learner" (p. 190) and learning how to acquire the body of knowledge produced by the profession or trade. Brown et al. (1993) show that schools are vehicles for the professional practice of teaching rather than the professional practice of being a mathematician, historian, scientist or artist, and because teachers do not participate in the creation of new knowledge or the application of existing knowledge, it lacks real meaning.

Some researchers see group development as a process of knowledge creation or of the coordination of individual goals. Salomon (1993) says that when people work or learn in groups, they "appear to think in conjunction or partnership with others and the whole system learns; even the tools and artifacts can become smarter. The cognition is distributed across the system" (p. xiii). Nickerson, Perkins and Smith (1991) regard collective activity as a novelty creating process where new insights and discoveries

contribute to the knowledge of the group. Valsiner (2002) suggests that group development is the coordination of individual goal orientations by the participants, which “orchestrates” the transformation of meaning by “changing the fields of personal sense” (p. 112).

When people work or learn in groups, the interactions can become very complex. Goldberg (2001, p. 107) shows that intersubjective or social relations relies on each person having an internal representation of what others may be thinking as well as a representation of their own performance. Even when people work alone, such as writing an email or novel, they craft their “written speech” against a backdrop of how the audience may receive or respond to what they write or say. Goldberg (2001) states:

The ability to form an internal representation of a different person’s mind is linked to another fundamental cognitive ability; the concept of mental self and mental non-self differentiation. The sense of self is fundamental to our mental life and it would appear that no complex cognition can exist without it. Yet scientific evidence suggests that the sense of self emerges late in evolution and is linked to the development of the frontal lobes....When subjects are asked to focus on their own mental states, as opposed to external reality, medial prefrontal cortex lights up...The pre-frontal cortex is the closest there is to the neural substrate of social being. (pp. 110-111)

Nesbit (2000) says the process of creating something new involves the integration of different kinds of knowledge held by people and is acquired through empathy and trust. He notes that when individuals are able to think meta-cognitively, to take other people’s perspectives and live in their world, this is the world of the connected knower, in which a kind of respectful co-creation occurs. Nesbit also observes that both Vygotsky and Piaget held the view that a new concept is enhanced when a previously learned concept is connected to it, thereby evolving it. Engestrom (1991b) says it is important that learning in groups be moderated by some form of facilitated process involving “critical questioning” (p. 397) or “constructive controversy” (Tjosvold & Tjosvold, 1994, in Engestrom 1991b, p. 397) which helps develop teamwork and a shared object.

Actor-Network theory introduces a concept known as a boundary object (Star & Griesemer, 1989; Feldman, Khademian, Ingram & Schneider, 1999) which has crossed over into activity theory to explain how groups from differing cultural or social backgrounds encounter each other and deal with differing viewpoints and use artifacts. Boundary objects are a special case of object that mediates between overlapping activity

systems (Wenger, 1991). Feldman, Khademian, Ingram and Schneider (1999) offer this explanation:

Boundary objects are physical objects that enable people to understand other perspectives ... An "effective boundary object facilitates a process where individuals can jointly transform their knowledge" ... or jointly translate ideas and information. Many things can serve as boundary objects, but a boundary object must provide a common focus for different ways of knowing. Pictures, prototypes, graphs, building blocks, research reports, grants, even text can serve the purpose of crossing the boundaries between different ways of knowing....focusing on a boundary object can expose associations that are continuously renewed in different ways of knowing, suggest alternative associations that facilitate the joint translation of information and ideas, and enable the inclusion of different actants, potentially leading to the creation of new associations.

Rules and discourse models. Rules are one of the elements of the activity theory collective model developed by Engestrom (1999a) and are said to mediate the relations, interactions or communications between the subject(s) of an activity system and the community. They can include assumptions, norms, etiquette, principles, ethics, values, procedures, methods, processes, regulations, conventions and laws (p. 31).

Discourse, is thus the process by which collective objects of decision-making and learning groups are transformed both internally and externally. This means that the quality of the communication, and not just the content of the communication influences whether the object of activity will evolve incrementally, remain the same or be transformed (Carpay & Van Oers, 1999). The relationship between the rules of the system and the transformation of activity is explained by Engestrom (1999a) when he states:

An activity system is by definition a multi-voiced formation. An expansive cycle is a reorchestration of those voices of the different viewpoints and approaches of the various participants. (p. 35)

The rules of communication are embedded in types of discourse or the object of activity. For example, (Wegerif, 2002) shows that dialogue contains implicit rules such as respect for others, active empathy, a sense of fairness, tolerance for diversity and the use of persuasive argument in place of coercive force, whereas monologue contains the implicit assumption that what one person has to say is more important than the views of others, at least briefly. In some situations, the rules are incorporated in the activity system in such a way that they are largely invisible to the participants. Often the rules do

not have to be made explicit. For example, children learning in groups know the rules intuitively (Wegerif, 2002).

Although it is clear that human discourse, can take many forms, Jenlink (2001) points to six primary kinds of discourse that exhibit varying degrees of empathy, attention and engagement. These are monologue, discussion, dialectic, dialogue and ethical discourse. The discourse that dominates the school classroom is *monologue*, a polite type of conversation that is rule following (Isaacs & Senge 1999) and does not necessarily disclose what people really think. The lecture, the rant and the soliloquy are monologues, whereas *discussion* is a form of random discourse, which is rule revealing, and viewpoints are often presented in adversarial and non-negotiable terms as participants seek to defend or establish a position. *Dialogue* is both reflective and generative, which is respectively rule reflecting and rule generating (Isaacs & Senge, 1996). Participants are empathetic and prepared to be open to each other's ideas, needs or future opportunities. During dialogue, judgment, beliefs and assumptions are suspended in the interests of creating new knowledge that simultaneously serves the group and individual interests (Jenlink, 2001). *Dialectical* discourse is a form of disciplined inquiry based on rational argument, often presented as truth and which is equally rule revealing and adversarial during which all aspects are resolved into a higher level concept which bridges the initial position (Findlay & Newman, 2005). Dialectical discourse can also be conducted as a formal process of arriving at the truth by the exchange of logical arguments which involves stating a thesis, developing a contradictory antithesis and combining and resolving them into a coherent synthesis. *Ethical discourse* (Banathy, 1996) is determined by social rules such as morals, values and ethical guidelines and is especially valued in cross-cultural communication where there may be many value systems in play. *Post-formal* (Horn, 1999) is a transcendental form of discourse about power and the consequences of the discourse.

Discourse also has its variants in the form of combinations with gesture and signs. Of particular interest to this study is "written speech", a form of discourse that allows humans to record or store information or send messages to people in different places and different times (Moro, 1999, p. 165). During the early 2000s written speech in the form of emails, telephone text messages, journal entries and the twittering short message service, has become a common feature of 21st century life, particularly for young people who are connected by their computers and mobile phones. This form of speech is of particular interest to this study because it is the main way that ideas

discussed locally by small groups are shared instantly with the entire community present at the meeting or workshop when they use the team learning system.

Written speech began as messages and records of transactions for trade, and has evolved into complex forms such as instruction manuals, novels, academic papers and software programs (Moro, 1999), and has thereby become the main pathway to the creation of new primary tools via the writing of plans and procedures. Moro explains that written speech can be used either as a tool for transmitting information devoid of context, or for very rich communication, as in the multi-voicedness of literary works such as poetry, novels, songs, movies and opera, which begin in a written form, and are capable of enriching human cognition. Moro (1999) says that writing results in “decontextualisation” (p. 172) with many of the cultural clues that give the message meaning, absent from the message. Nevertheless, much of the original context can be retained through definitions and webs of associations or heteroglossia that help the receiver understand much more of the sender’s intentions. Written speech can, for example, communicate a rich polyphony of voices as occurs in the writing or reading of a novel (Bakhtin, 1982), that brings the characters and rich tapestry of their interactions to life.

According to Wertsch (1991, p. 51), Bakhtin created the concept of utterance to take into account the idea that speech is always delivered from a viewpoint, set of intentions or world view, interwoven with what others are saying, and who are evaluating what they see and hear. Speech can only be understood in a situation of dialogue. Words or sentences used out-of-context are linguistic abstractions. Moro (1999) describes Bakhtin’s concept of utterances and how they transform each other:

An utterance emerges as a “voice” with the speaker’s expression and intonation....Utterances interact and penetrate each other....When producing utterances, active interlocutors are not only responding to each other’s utterances but also evaluating and judging them and developing a valuative attitude towards them. Speakers are judging whether the utterances are true or false, good or bad, and beautiful or not....This living dialectical synthesis is constantly taking place again and again. (p. 169)

In ordinary discourse the spoken subject and real subject are the same but this does not apply in writing activity where the speaking subjects – as created by the writer – may differ from those the writer has created (Moro, 1999). Just as there are speech genres, there are written speech genres. Computer mediated communication, which this study explores, has the features of both written and oral speech (Bjorck, 2002) and

because multiple participants can be involved at the same time, and may either reveal their true identity or play a role, the collective output has some of the multi-voicedness of the novel or play, and may become dissociated from the author. In addition, the ideas are generally communicated sequentially and because the participants may not be able to see each other, responses can be contributed out of turn and lose the meaning associated with the original context. People respond in a way instructed by the framework of the software, in much the same way (Moro, 1999) that children “adopt the genre of the classroom journal” which is a form of “secondary speech” (p. 172). They also become aware of a story teller viewpoint by writing stories and reflecting on each other’s stories.

Intonation, emphasis and accompanying gestures radically change meaning (Bakhtin, 1982; McNeil, 2005) and can significantly influence both the process and the outcome of group interactions. For example, in a Dostoevsky work cited by Vygotsky (1986), six drunks all utter the same swear word, but in a different way to express contempt, doubt, intrusive anger, restraining anger, joy, and revenge (Shotter, 1992). Says Shotter, written speech is thus often devoid of the body language or gestural component of communication which can either lead to greater acceptance of ideas, or even greater misinterpretation of otherwise innocent conveyed meanings. McNeil (2005) points out that gestures generally accompany spoken communication and can be regarded as “co-expressive” (p. 23), but can also be a complete language in their own right, as occurs with sign language for the hearing impaired, or used instead of speech when it is not possible to speak or be heard.

There appear to be gestural equivalents for each form of discourse. For example, striking another person or embarking upon a course of unilateral action in war can be regarded as the gestural equivalent of monologue, whereas a warm embrace has the empathic elements of dialogue. A rich source of communication rules that have both gestural and spoken elements are the improvisational performances based on the learning games developed by Spolin (1963) for students who were unable to learn effectively in traditional educational settings. Typical improvisational routines include Yes-and, where participants serially and positively develop a collective story, sound-ball, where participants shape an imaginary ball and receive a sound in the manner it was sent, then send a new sound to a new recipient, and the Gregorian chant, where participants chant scripts they have collectively created using written speech (Lobman & Lindquist, 2007).

Roles and performance. Also of interest to this study are the roles that teachers and students adopt in the classroom in the context of the tools that are introduced. However, what is not clear is which comes first, the new roles, the relationships, the new rules of engagement or the tool. There appears to be an in-built assumption within activity theory that some people are regarded as more knowledgeable than others and that tasks may be divided on the basis of relative expertise, capability or power which results in natural divisions of labour between managers and the workers as well as teachers and their students. Such differences in the exercise of power are not the natural order of human existence, but assumptions about how work or schoolwork should ideally be organised. This bias may be connected to the undue emphasis on work as activity, with its historical origins in Marx's alienated labour but also due to the reverence for Vygotsky and his writings who according to (Hayrynen, 1999) "did not pay much attention to the conflicts that emerge *between* learners and teachers or instructors in formal education" (p. 119) and tended to deal with an idealised model of teaching rather than the practical realities of the classroom in which the teacher has epistemic authority and social distance from the students (Cole, 1976; Puolimatka, 1999).

Another underlying assumption is that activity is determined wholly by human goal-seeking, but this view tends to obscure what I call the spontaneous coordination paradox. Although most theoretically ideal groups become organized, either formally or informally, theoretically or practically, via some form of leadership or managerial control, ranging from the anarchic to the authoritarian, not all coordination is due to leadership. Tolman (1999, p. 72) argues that the contrary actions in joint activity, such as the role of the beater in Leont'ev's collective hunt, who herds the prey in the direction opposite to an immediate meal only makes sense if activity is consciously planned beforehand, but birds flock and fish shoal, without previously deciding to do so. Jadbabaie, Lin & Morse (2003) show that fish and birds follow one or more contextual rules, such as remaining a certain distance from others and pointing in an average direction, which is lacking in a collective intention, and may merely be an instinctive response. The high levels of apparently spontaneous coordination by children when engaged in collective play, may simply be achieved by following contextual rules that evolve during play, or which are embedded in the activity they imitate, in what complexity theorists understand to be "initial conditions" (Guastello, 1995, p. 18). This may also explain why much of what constitutes collective human activity in families,

community and workplaces, which is informal, unplanned, or poorly planned and loosely organised, can nevertheless result in the emergence of orchestrated order. In such spontaneously organised collective activity, what is conscious, unconsciously automatic or instinctive? In addition, how is labour divided, and what roles do individuals play in the collective performance?

I also prefer to use the term “roles” instead of “division of labour” as conceived by Engestrom (1993, p. 31) for his triangular model of collective activity, to signify how tasks are divided between members of a community. The term roles comes without the baggage of alienated labour and more readily fits with other types of activity.

Jonassen (2000) offers a useful definition of division of labour (roles):

Organizations vary in terms of the flexibility with which their divisions of labor are administered. In some organizations, those divisions are negotiated on an activity-by-activity basis, whereas in other more vertical organizations, divisions are mandated from the top down....How flexibly any work organization can adapt to circumstances will determine the ability of the activity system to engage in different activities. That is, how work is distributed throughout the organization determines to some degree the nature of the work culture and the climate for those involved in any activity system. Classroom activity systems are seldom flexible enough to assume activities that are not traditionally associated with classroom learning (listening to the teacher, studying, taking tests, etc.) (p. 9-10)

There appears to be shift underway to a more humanized view of work. This trend began with the development of socio-technical theories (Trist & Bamforth, 1951; Emery, 1959) according to Knutti (1999), where the key idea is to motivate workers by “giving them more control over their work” but, in practice, “autonomy is restricted to the work process” and “workers have no influence on product design and many other matters” (pp. 368-369). Although authoritarian control of work is no longer officially popular, much shop floor work is still of this type and management still acts as a controller. Knutti (1999) states “the objectified knowledge is embodied many times over in machines and detailed instruction and a well known problem of such *rationalized work* is alienation” (p. 368). In these settings, organisation control is still maintained by managers.

Computer supported cooperative work (CSCW), as considered in this study, is a closer approximation to the new type of “semi-autonomous work” expected in democratic organisations (Knutti, 1999, p. 371) such as learning or knowledge creating organisations (Shariq, 1998). There has been a shift towards leadership, as opposed to

management, as a way of engaging with groups. The role of the leader covers a broad spectrum. The roles include being a collector of information for the group, the coordinator of the group to ensure its smooth functioning (Nocon, 2002) or the simplifier of complexity for the group (Star & Strauss, 1999). There appear to be some parallels between autonomous work and young people participating in collective play, where the workers learn by reflecting on their individual and collective performances. There is also some evidence that young people can learn somewhat independently of either their teachers or their superiors, often by collaborating with other young people, via social technologies (Elliott, 2003b; Findlay & Fitzgerald, 2006), and in the process become creators of new knowledge (Sefton-Green, 2005; Malmberg, Njord & Svingby, 2005), design new artifacts such as software, websites, movies, and other multimedia materials (Zimmerman, 2005; Lynch & Fleming, 2006), design their own learning processes (Shimada, 2005; Findlay & Fitzgerald, 2006) and act as independent researchers (Fitzgerald & Findlay, 2006; Roth & Lee, 2007). These new forms of liberated activity, characteristic of writers, scholars and artists, is now within the reach of almost anyone engaged in modern production or service (Kozulin, 1999). Young people are routinely learning software programming, web design, illustration, and movie production by engaging with virtual or imagined communities who are interested in these topics via their websites, databases and chat rooms accessible via the Internet (Mayfield, 2006a). Knowledge, which took centuries to be developed by geniuses, is routinely acquired by children at school (Buerdon & Smith, 2000). Children are now routinely able to learn, think, and perform like geniuses (Lynch & Fleming, 2006). In such settings, the learner is far more autonomous than in traditional classrooms.

A quite different “performance” or “role” based view of teaching and learning that builds on Vygotsky’s (1978) original observation that in play children perform “as if they were a head taller” (p. 102) is articulated by Lobman (2005) who makes the point that:

Teachers who respond directly to play, and who elaborate and expand on children’s activities have a positive impact on children’s learning and development... However, many childhood teachers are not skilled at playing with children. This is not surprising, because while teacher education programs teach prospective teachers about the importance of play for children’s development they do not teach them how to play collectively with children... They are unaware of the importance of participating responsively to children’s play. They have been trained as facilitators and observers, not co-

participants. Teachers are taught to be experts on the subject of play, not creative players. (p. 327)

This performance model has much to commend it. The existing model of dividing tasks between experts and novices perpetuates the historical divisions between aristocracy and peasant, management and labour, teachers and students. Performing is what humans do to “create themselves as changers of their worlds” in a process of being both “who we are” and “who we are becoming/who we are not” (Holzman, 2005, p. 326). It is this more equitable role as a participant in one’s own development, with minimal guidance by a facilitator that is of interest to this study, which has been more extensively studied by small group and management researchers and is explored more fully in chapter 6.

Summary

Activity theory derives from the ideas of Vygotsky (1978) and his students Luria (1976) and Leont’ev (1978) who almost a century ago showed that humans use tools - language, gestures, symbols and signs - to reinvent themselves and their tools in a dialectical process of joint activity. The theory offers a useful lens through which to consider the differences between teachers and students when they use a computer-based tool to support discourse for the first time. However there are some aspects of activity theory that are in need of reinvention in order for it to become a more robust theory of learning and development as envisaged by Davydov (1999) and of greater use to this study.

Learning and development occurs in childhood in a series of both evolutionary and revolutionary stages, as Vygotsky shows, but also continues throughout life. Vygotsky and Luria tried to find a similar pattern in the progress of human culture when they studied the cognitive differences between peasants and recently educated farm workers in central Asia. Although the duo received considerable criticism for their findings in this particular work by other researchers and the Russian state, the remainder of Vygotsky’s research into child development and Luria’s brain research, is otherwise highly regarded (Cole, 1976; Wertsch, 1985; Engestrom, 1987; Goldberg, 2001) and seen as farsighted.

Vygotsky showed that children learn with guidance from an adult or a more capable peer, until eventually they acquire sufficient skills and knowledge to become

independent learners. However, the boundary between independence and dependence is somewhat blurred, even to the extent that learners can be both experts and neophytes, and experts can be learners. Learners use speech, not only as a means of communication but also to “program” their own brains. A new capability is first practiced externally using tools, often via a form of silent speech or by talking to themselves aloud. The new capability then becomes internalized and available for use in other contexts. Vygotsky also showed that children learn autonomously through collective play by appropriating artifacts to represent other things and other people and by imitating others. This type of activity appears to have some of the features of self-organisation (Kauffman, 1995), which I will explore in more detail in chapter 4.

What separates humans from other animals is the unique ability to not only use tools, but also to further develop them, so the tools become more complex and powerful (Mead, 1934; Keiler, 1981). The key to this additional capability is the frontal lobes that are more developed in humans than in other animals and give humans the unique ability to deal with novelty and complexity and to orchestrate many specialised functions from distant parts of the brain (Goldberg, 2001). Each time humans respond to a radically new situation our right frontal lobes help us plan or problem solve our way out of trouble and with practice, create new speech and motor routines that Luria (1973) called “kinetic melodies”. Then, conveniently, our left frontal lobes take over control, so that when we are confronted with the same or similar situations some time later, we respond automatically, and can juggle many routines simultaneously, without consciously thinking about them.

Over the same period that humans acquired additional powers from making use of the tools, the tools “themselves” have become even richer and more complex, and a significant advance over the physical and cognitive tools used by the peasants or their more educated brothers and sisters studied by Vygotsky and Luria (1976) in central Asia. Tools extend the capability of not only our minds, but also our bodies. I contend that tools are like exoskeletons, so that when we fly as a passenger in a plane, or ride in a motor car, the pilot or driver is merely allowing us to take a ride in their extended body. The playwright uses the services of actors to extend his or her mind, so that the narrative becomes visible to others. The leaders of countries deploy armies to extend their power and influence at a distance. The new roles we play are achieved by appropriating a new tool and automating its use.

As Leont'ev (1998) shows, automatic operations ultimately become tools. I would argue, that many of our additional physical and psychological powers have developed from the integration or blurring of the boundaries between “kinetic melodies” (Luria, 1973) for gestures and vocalisations, and their transformation into “written speech” that allow humans to go “time travelling”, to recall the past and to project ourselves into the future. As McNeill (2005) points out, not only are speech and gesture temporally linked, but also the motor and speech circuits are physically adjacent in the brain (McNeill, 2005). Whereas speech and gesture persist for a fleeting moment and are difficult to transmit from one generation to the next, written speech affords us the opportunity to maintain records that survive for millennia, to critique what happened yesterday, to convey to others very complex instructions or ideas, or to remind ourselves of what to do tomorrow. Written speech also plays a vital role in the development of plans, procedures, models and theories that become regarded as the real thing, or lead to the development of more complex tools. In modern times, written speech has been used to communicate a rich polyphony of voices in a novel or a play or remove all the social cues, as in on-line communication to gain wider adoption of ideas by a community. There also appears to be a democratisation effect. As I showed in chapter 2, many young people are now both the creators and consumers of artifacts. These skills and other complex skills such as driving a motor car or using a computer are capable of being performed, not only by an elite few, but also by almost anyone. As the technology changes, we are constantly having to learn new skills, and in the process, the “plastic brain” adapts to the new set of conditions. This raises the question of whether the original assumptions that placed automatic operations in a subservient role to goal-directed actions in Leont'ev's triarchic model of activity can be sustained in the light of new knowledge about brain plasticity (Goldberg, 2001; Lewis, 2005) which I will review in chapter 4.

From time to time, various researchers including Vygotsky (1978) and Engestrom (1987) have considered learning and development to have the topology of a progressively rising spiral. Occasionally, some theorists flirt with a new, ecological model of activity. Engestrom (1987) cites Prigogne and Stenger's (1985) “theory of instability”, the forerunner to chaos theory and complexity theory, as a source of renewal and Tobach (1999) shows that the theory of integrated levels explains how new kinds of order may erupt out of a lower level of order when the contradictions pile up. My view is that the Vygotskian stages of child development look suspiciously like self-

organisation (Kauffman, 1995). It is this aspect of activity that has received little attention, and which may explain the patterns of development in activity. A critical issue is whether, after each transition, the structure and the components of the system – the brain, the tool system, the relations with others in a group, or human culture – remain qualitatively the same, or do the structures and the components develop different characteristics? For example, is the cluster of brain cells that fires off to perform the “kinetic melody” (Luria, 1973) for the role of teacher qualitatively different from the cluster that fires off to perform the “kinetic melody” for the role of facilitator? Are the interdependent tools that make up the ancient Roman transportation culture of the chariot, horse, roads, stable and farrier, qualitatively different from the tools of the motor car, engine, freeways, garage and the mechanic? When a disorganised group becomes so perfectly coordinated during a game of football that they win the game against all odds, what makes the difference, and are the changes structural or relational?

Another aspect of activity theory that requires re-examination is the way in which humans jointly use tools. Engestrom’s (1987, p.78) model of the structure of human activity which richly expands on Vygotsky’s original concept of tool mediation, has proven to be a useful tool for explaining activity in collective terms, how we divide tasks, the rules of engagement in activity and the relationships we have with the community. However, the economic language of the Industrial Age - consumption, distribution and exchange – keeps the model rooted in the past. The role of leadership in group development and the negotiation of power in groups, with perhaps the unique exception of Vygotsky’s ideal teacher are also weakly developed by comparison to the small group and management literature, and will be explored more fully in chapter 4. Although communication is clearly the process by which people negotiate collective activity, what is not evident is the role that different kinds of discourse play in transforming the object. The internal and external reconstruction of collective activity, which is said to be a dialectical process, appears to be “heavy ballast”, to use some of Engestrom’s own words that he applied to Vygotsky and Luria’s discredited grand unified theories of human development. The concept appears to suffer from idealism, because not all collective activity is dialectical. Discourse can be as disconnected as monologue, as unengaged as discussion, as respectfully embracing as dialogue or transformative as dialectical discourse. Discourse also has its gestural equivalents. For example a jet aircraft flown into the World Trade Centre could be regarded as a form of monologue, whereas the same passenger aircraft used for transporting passengers is

dialectical, because it integrates the interests of the pilot, the passengers and the airline. The use of a tool for a baser purpose can thereby regarded as more primitive in the context of activity being a movement from the material world to the ideal. A further confusion is the use of concept of “dialectical” change in the broad Marxist sense, versus Plato’s much narrower use of dialectics as a form of collective reasoning, as a way of resolving or combining different viewpoints into an overarching explanation. The role of leadership in group development is also skirted over. Not all participants in collective activity are able to benefit from a leader like Vygotsky’s ideal teacher who guides you through the zone of proximal development. Some of us have to put up with dictators, managers or anarchy. Others are lucky enough to have a teacher who not only knows the theory of play, but also knows how to play with others (Holzman, 2005) and can scaffold their learning so they discover new ideas for themselves.

Further consideration needs to be given to the role that abductive (metaphorical) reasoning or discourse (Prawat, 1999) plays in helping humans invent and populate new conceptual worlds, first in our imaginations, then in reality. I suspect that by arranging certain types of question or activities in a particular sequence that the conditions are established for abductive, “what might be” type thinking, which is the way questions are presented by the team learning system. Similarly, the process by which tacit knowledge can be fashioned into scientific knowledge needs to be explored further, as does the manner by which concepts may spark a search for further concepts or how the simple act of placing two different concepts in close proximity helps catalyse other concepts that reside, as Wittgenstein (1999) shows, in complex interdependent webs.

Although activity theory has become widely adopted and is generally accepted as a useful framework for examining learning and development using technology in education settings, the theory is in need of pruning, clarification and some amplification in the following ways:

- Clarify the process of internal and external transformation of the object of activity, and in particular, eliminate the confusion about the relationship between individual and collective activity;
- Determine what constitutes incremental and transformational change in activity;
- Review the spiral metaphor for the process of learning and development to see whether it is still relevant and descriptive, particularly of development;

- Establish what role the right and left frontal lobes of the human brain play in the processes of incremental and transformational change;
- Consider whether there is an underlying pattern to tool development or *technogenesis* by which tools themselves undergo both evolutionary and revolutionary development;
- Explore whether there is also a pattern or stages in cultural or tool development that may parallel the stages of child development;
- Determine whether the process of group development also has stages;
- If possible, develop a classification system for work, play, school-going and other types of activity and determine whether there is a relationship between different types of activity and discourse models, types of intersubjectivity, co-ordination mechanisms or power relationships between participants in collective activity.

CHAPTER 4

COMPLEXITY AND OTHER THEORIES OF DEVELOPMENT

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Overview of the chapter

Although activity theory offers a useful explanation for how humans use tools to transform themselves, their tools and society, researchers in the field have largely ignored the obvious possibility that culture and tools may follow an evolutionary path of their own. Researchers appear to have avoided straying into this theoretical “no-mans land” in order to avoid the same kind of treatment received by two of the fathers of activity theory, Vygotsky and Luria. Both were criticised by the Russian state and their peers for revealing cultural and cognitive differences between educated workers and uneducated peasants in their quest for an overarching theory of human development. If two of the leaders in the field should suffer such a fate, why should any lesser mortal consider straying into this obvious minefield?

However, there are now clear indications that recent discoveries in related theories of development, particularly the work of Kauffman (1995) in the field of complexity theory, reveal a pattern of extinctions and emergence of species in the biological record and tools in the human cultural record that could be the missing piece of the jigsaw.

It is for this reason that I revive the search for a grand-unified theory of human development and begin this chapter by asking the hypothetical question, *If Vygotsky was alive today what other theories of development would have attracted his interest, and how would he have incorporated these ideas into his theory?*

This chapter also explores the possibility that a unified theory of human development could offer a superior, overarching explanation for the group, cognitive and cultural phenomena explained by activity theory taken together with management, small group, and innovation theories that currently only offer partial explanations.

The central concept from complexity theory that could enhance activity theory is that new order spontaneously emerges in all kinds of systems – biological, human, technological and economic - when they reach a critical stage of development. Elements within a system cross-catalyse other elements to create new “order for free” (Kauffman, 1995, p. 71). Kauffman (1995) shows that random variation, which is the key mechanism in Darwin’s theory of natural selection, fails to account for the large-scale speciations and extinctions that have occurred from time-to-time during the hundreds of millions of years of biological development which are also apparent in the cultural record.

Kauffman (1995) says that complexity theory offers a necessary second law of evolution in partnership with natural selection:

If biologists have ignored self-organization it is not because self-organization is not pervasive and profound. It is because we biologists have yet to think about systems governed by two sources of order. (p. 112)

Section one of this chapter considers how the transformations in activity systems at an individual, group and cultural level may be explained by Kauffman’s (1995) ideas about emergence. These ideas have already found favour amongst some activity theory researchers, particularly Letorsky (1999) and Engestrom (1999a) who both suspected that Prigogne and Stengers’ (1985) “theory of instability”, a forerunner to complexity theory, was a useful line of inquiry. The section also considers other types of self-organisation by which systems become synchronized or entrained.

Section two sets out a brief chronology of human cultural and genetic changes over the past 10,000 years to show that the human brain has changed very little in comparison to the extraordinary changes that have occurred in language and other tools. This section also explores the science and labour statistics literature to consider how human work undergoes periodic spontaneous transitions as ever-more powerful technological species drive earlier tools and jobs out of existence.

The third section looks at the way new ideas and tools are adopted by people and their organisations. It consider how the new disciplines of organisational development and knowledge management deal with persistent cultures that are slow to adapt in the

face of accelerating social and technological change. The section also explores a model of culture that considers power and other differences between people, which may contribute to an improved theory of activity.

Section four discusses the brain as a self-developing system in the light of new theories about brain plasticity and synaptic growth and pruning. It also considers the role that “mirror neurons” play in activity, how the right frontal lobes deal with novelty and the left with automatic operations, and how this is related to the role that early mother-child interactions play in the development of emotional feedback mechanisms and frontal lobe functioning. The section also explores an autocatalytic view of brain development that identifies the shift from episodic to memetic memories as a turning point for human development. It focuses on how human brains have developed in a symbiotic partnership with tools. In the process, tools progressively “reprogram” brains to become more capable and in return, brains invent and develop new more complex and powerful tools.

The fifth section is a review of theories of group development, intra-group communication, coordination and leadership from the business and small group literature that may benefit activity theory. The section also offers some evidence for autocatalytic emergence in groups and the role that entrainment plays in maintaining group norms. I show that the group process is a means by which new knowledge is created for subsequent wider adoption, further development or application.

Section six examines the flow theory literature and how the attention to and achievement of tasks that are just beyond an individual’s capability engenders feelings of enjoyment, and may confer an adaptive advantage. The section also considers how the principles of flow theory as applied to video and computer game design could inform theories of learning and development.

Self-organisation as an explanation for transformation

Over the past three decades theories of self-organisation – which encompass chaos theory (Gleick, 1988), complexity theory (Cohen & Stewart, 1994; Kauffman, 1995), and dynamical systems theory (Forrester, 1987; Schein, 1988; Senge, 1992) – have been applied to the study of complex system to understand how new forms of higher-level order emerge spontaneously from lower-order systems. Related fields include theories of self-similarity or fractals (Mandelbrot, 1977), dissipative systems (Prigogne & Stengers, 1984) and the theory of the structure of scientific revolutions

(Kuhn, 1962). Self-organisation can be found in the interactions of many aspects of the world - atoms and molecules in a fluid or gas, cells and organisms, neurons and the brain, organisms and ecosystems, people and society, and buyers and sellers in a market (Kauffman, 1995).

Prigogne and Stengers (1984) showed that order could spontaneously arise in systems whose stability depends on a flow of matter or energy through the system, known as dissipation, as occurs with hurricanes and ecologies. All free-living cellular life is a dissipative system. Organisms perform work using the energy and matter that flows through the system to sustain themselves in a web of connections with other organisms. Although the organisms may pursue individual goals, new order emerges as a consequence of their activity, and any apparent deliberate collective purpose, may be just an illusion. In a sense, discourse is the flow of energy in the form of information or ideas through a human social system, and will be treated as such in this study.

Although the theory of natural selection, as an explanation of 1000 million years of biological development, has survived a century of challenges (Dennett, 1995), it no longer provides an adequate explanation for the large-scale speciation and extinction events that are evident from both the geological record (Gould, 1989; Kauffman, 1995) and discontinuities that we observe occurring today (Cohen & Stewart, 1994).

Darwin believed that nature evolved incrementally and that species grow apart through numerous small changes (Corning, 2002). At the level of the organism, mutations in the genetic code result in changes in the form and function of an organism. Errors in replication produce mutations, some of which confer an adaptive advantage. Species best able to adapt to a changing environment survive while others less well adapted die out. Raup (1991) estimates that over 99 percent of all species that have ever existed on earth are now extinct.

However, as Kauffman (1995) demonstrates, species do not live in isolation but in interconnected food webs, where some are predators and others prey. If the prey increases in numbers, the size of the predator population that can be supported increases, often to unsustainable levels, which then leads to a crash in the predator population and a resurgence in prey numbers. Such systems settle down into a stable pattern that remains dynamically stable for a time. However, random variations in the genetic code of one or more of the species in a food web can contribute to a change in the dynamics of the entire system. Complex systems are sensitive to initial conditions (Guastello, 1995, p. 18) a discovery made by Edward Lorenz in 1963 when he was

researching weather patterns. Slight changes or perturbations can significantly alter the long-term activity of the system, also known as the “butterfly effect”, that a butterfly flapping its wings in Brazil can initiate a hurricane in the Caribbean. Such processes are non-linear, discontinuous (Greenberg et al., 2004) and co-dependent (Kauffman, 2000) and involve macro and micro-level changes that have a feedback influence over the other. Higher order elements change the way lower-order constituents interact, and at the same time, lower-order elements influence changes in the higher order elements (Haken, 1987).

In the biological sphere, say Huxley and Huxley (cited in Corning 2002), it is the intersection of genetic variation and self-organisation of species webs that periodically results in “a sudden rapid passage to a totally new and more comprehensive type of organisation with quite new emergent properties, and involving quite new methods of further evolution” (p. 120). The war on bacteria using antibiotics may have eliminated some organisms from a local ecological niche to save the life of a patient, but globally this vendetta has ensured that adapted and more resistant forms of organisms such as golden staph, *staphylococcus aureus* have survived. Highly resistant golden staph now lurks in hospitals ready to infect unsuspecting patients, and like tuberculosis, where the “war” seemed to have been won, has been able to survive and is now difficult to fight (Huber, 2008). Mutations of influenza strains, such as the “spanish flu” which killed 2.5 to 5 percent of the world’s population (Garrett, 1994), become more virulent and dangerous from time to time, and alter the structure of the ecosystem they inhabit. Before international air travel, mutations in a virus or bacterial vector could remain contained in a local population, but in modern times myriads of new connection pathways, allow new, more deadly forms, to spread in days and weeks, rather than millennia (Garrett, 1994). For example, the AIDS virus has altered the dynamics of most of the populations it has infected. Deaths in the gay community, which AIDS first attacked, resulted in disproportionate losses to the creative arts field. The gay community reacted by becoming more sexually conservative in order to avoid the virus, at least for a time. Sexually active heterosexual adult populations in sub-Saharan Africa have been decimated and many families are now being raised by surviving children (UNAIDS, 2007). Thus, small changes in a system can quickly result in large-scale discontinuities or abrupt extinctions and the emergence of new behaviours or new species with new characteristics and relationships (Eldredge & Gould, 1972).

When a system becomes sufficiently dense and connected (Kauffman, 1995, p. 57) new order emerges spontaneously at which point a self-sustaining network arises and the separate components become an integrated whole with a life of its own. This is similar to Leont'ev's concept of "self-developing systems" (Davydov, 1979, p. 87) or "gestalt" events (Marmgren, 2001), in which a "collective, cumulative" advance (or retreat) occurs (Beninger, 1986, p. 10). The new state of the system involves the re-arrangement of the components of a system that occupies a new phase space (Prigogne & Stengers, 1984). Substance is found not in the parts but in the organisation or relationships between the parts (Waldrop, 1992). The connections give rise to apparent substance. Systems may begin with "many degrees of freedom" but "become more deterministic" and "more fully specified, with fewer degrees of freedom, as they develop" and so are "much more sensitive to perturbations early in their history than later" (Lewis, 2000, p. 39). Says Lewis, "the more order that has accumulated over time, the greater the push that is necessary to shift the system's trajectory" (p. 39), which may explain why education systems are so resistant to change.

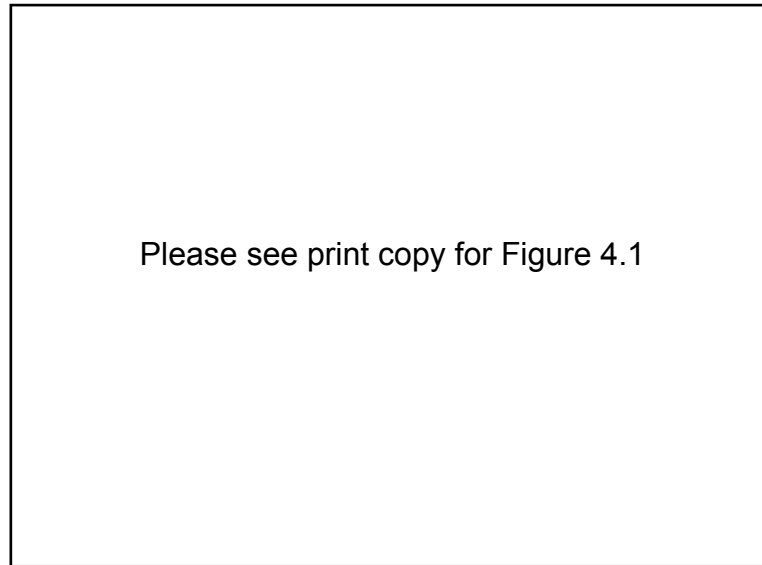
For such transformations to be self-sustaining a critical number of interconnected components or constituents that are capable of cross-catalysing each other is needed, as occurs with a chemical reaction or a new ecology (Kauffman, 1995). A catalyst lowers the threshold at which events are initiated. The web of co-dependent components, organisms or processes feed off each other or cross-catalyse each other, so that outputs from one kind of process are inputs for others. Says Kauffman (2008):

As the diversity of molecules in the system increases, the ratio of reactions among the molecules to the molecules increases, and therefore the number of catalysts in the system for the reactions among the molecules gradually rises above a threshold at which the likelihood of collectively autocatalytic sets in the system becomes nearly certain. (p. 60)

For every molecule in the set whose formation requires catalysis, there is a molecule in the set that carries it out. (p. 57)

Kauffman (1995, p. 54-57) uses the example of random graphs (Erdos & Renyi, 1959) to illustrate the principles by which a phase transition occurs. Random graphs are nodes or *vertices* or *nodes* ("buttons") connected by links or *edges* ("threads"). He explains the principles by asking the reader to imagine a large number of buttons, say 10,000 lying on a floor (see Figure 4.1).

Figure 4.1: Formation of large component by linking nodes and edges (Kauffman, 1995, p. 55)

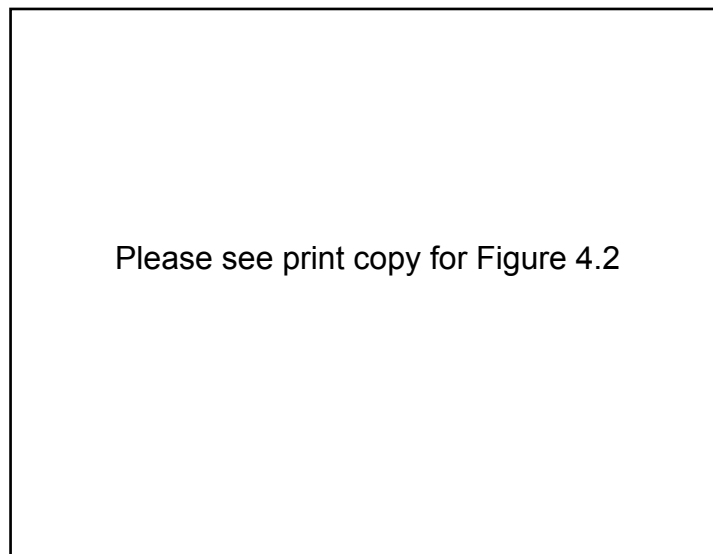


The buttons are randomly connected in pairs, two at a time. Pick up any thread when there are few threads connected and you are likely to pick up a new pair of buttons every time. Pick up any threads or buttons near the transition point and you are likely to pick up most of the buttons, in a complete assemblage. Says Kaufman (1995) “as the ratio of threads to buttons in a random graph exceeds .5, the size of the connected cluster slowly increases until it reaches a phase transition” (p. 57). Directed graphs are used in this study to analyse the patterns of discourse in the team learning system classroom to determine whether the new order that emerges is consistent with the formation of a large component.

One of the deep underlying “simplicities” (Cohen & Stewart, 1994, p. 228-230) within emergent systems is the Feigenbaum number, 4.669. The Feigenbaum constant, mathematically expresses the onset of order or bifurcation points within seemingly chaotic systems, which may be apparent in the development of tools, and which in turn may also influence cognitive and cultural development. It is the limit ratio of each bifurcation interval to the next in a period doubling cascade (see Figure 4.2). The Feigenbaum constant is as fundamental to self-organising systems as the constant Π (Pi) is to circles. Rossi (1998) shows that social, psychological and cognitive processes that involve feedback with iteration can exhibit the period doubling cascade pattern, and obey the rules of the Feigenbaum constant. Rossi argues that there is a limit to human cognitive processing associated with the fourth period doubling in which chaos reigns,

at which point “infinite choices create a situation in which freedom has no more meaning” (Merry, 1995). Rossi says, “the sense of reality teeters off the edge of comprehension or rationality.” Rossi uses the argument to explain why humans have difficulty remembering more than seven (plus or minus two) digits or manipulating seven or so factors at the same time. Findlay and Fitzgerald (2005) suggest that the automation of work by tools in successive waves of cultural change is a period doubling cascade consistent with the Feigenbaum ratio. They show that the limit to the ratio of the duration of successive ages, that is, the ratio of the length in years of the Agricultural Age to the length of the Hunter-gatherer Age, and the subsequent three transitions, generally approaches the Feigenbaum number.

Figure 4.2: Period doubling cascade and definition of the Feigenbaum number (Berland, 2005)



Kauffman (1995) demonstrates there are parallels between biological and technological developmental processes. The history of biological development involves long periods of incremental change punctuated by short bursts of extinctions, followed by speciation events that occur on the rebound. Kauffman cites the Permian Age extinctions of 245 million years ago when 96 percent of the planet’s species died out (Kauffman, 1995, p. 13). Similarly, in an economic web, when a new technology that is better adapted to the marketplace displaces old technologies and starts to form a new ecology of interdependent products and services, it acquires market and mind share, thereby depriving existing products and services of an ecological niche. Extinctions are

accelerated when the dependent products and services fail to adapt and also crash.

Kauffman states (1995):

...life...unrolls in an unending procession of change, with small and large bursts of speciations and small and large bursts of extinctions...Over the next 100 million years, the average diversity of species increased to a kind of steady state. But that level was and persistently is, perturbed by small and large avalanches of extinctions.... Similar small avalanches occur in evolving cultural systems...The very struggle to survive may ultimately drive some species to extinction while creating novel niches for others... Each new good or service affords a niche or two for other goods or services whose providers thereby make a living. (p. 14-16)

Gladwell (2000) calls these inflection points the “tipping point” (p. 9) at which time very small events can make the difference between expansion of the system or its decay. The transformation process often has the characteristics of an epidemic. Crime waves, diseases, fashion trends and the adoption of new products or technologies all have tipping points. Gladwell (2000) identifies three “contagiousness” (p. 29) factors that contribute to the sudden spread of a population or its’ equally dramatic collapse. The first factor is the *degree of connectedness* within and without a system. The second factor is the *stickiness* of the system, which is an attribute of the population itself and how fast information travels through the system. The third factor is the *power of the context*, which determines whether the environment or ecological niche is conducive to the survival of the population (p. 29). Gladwell (2000) also identifies three roles that contribute to the spread of an idea; the *salesman* who generates or initially promotes a new idea, the *connector* who helps spread an idea and the *maven* who acknowledges and gives support to a new idea (p. 34). Such role types may be difficult to identify in a traditional classroom where activity is constrained by the rules of silence and tight control by the teacher, but may be more evident in a classroom where dialogue or discussion is encouraged and will be explored in this study.

Greenberg et al. (2004) show that complex adaptive systems exhibit three distinct kinds of behaviour. At low levels of interconnectivity, systems exhibit chaotic behaviour with no inherent order or stability. A second state is complete connectivity when the system becomes “frozen” into a static system. A third state is where the system is locally unstable, but globally stable at a critical ratio of connections, such as an ecology that is in dynamic equilibrium. They say that systems settle into a pattern of activity in phase space defined by attractors. The types of attractors include a *single*

point attractor such a heart that has stopped beating; a *circular* attractor also called a limit cycle which oscillates between two states, such as a predator-prey system in which a reduction in predators results in an increase in prey, which allows an increase in predators, and reduces the number of prey; *quasi-periodic* attractors in the shape of a torus, and a *strange* attractor which exhibits aperiodic (non-repeating) behaviour but nevertheless occupies a clearly defined area of phase space with well-defined shape and structure (Greenberg et al., 2004).

According to Corning (2000, p. 22), some systems become more ordered due to synergies between components of the system rather than by autocatalytic activity. Corning cites examples such as Velcro which has hooks and loops that create a strong mutual bond, coral reefs whose polyps have a mutually beneficial relationship with an algae, Leont'ev's hunt where the hunters all perform different activities but achieve a common result, and the assembly of a motor car from parts in a particular order to produce a more powerful tool than any of the separate parts. Entrainment is another form of self-organisation that occurs when two or more oscillating systems interact (Pikovsky, Rosenblum & Kurths, 2001) such as when sleep patterns align to the 24-hour rotation of earth (Pittendrigh, 1981), when the swing of pendulum clocks standing along the same wall become aligned, clapping crowds (Pikovsky, Rosenblum & Kurths, 2001), neural oscillations that recruit other neuron assemblies (Lakatos, 2008), and the way groups interact when people meet (McGrath, 1990). Often the system reflects a pattern that persists within one of the parts of the systems. Although interacting systems may begin with different periodicities, there is a transfer of energy between them, so that one catches up to the other and one falls behind until they have the same periodicity or synchrony, or beat with the same period, but in opposite phase.

One of the issues I will consider in this thesis is whether the emergence that occurs in learning and development, cultural development, tool development and team formation is due to autocatalytic effects or synchronised self-organisation.

The rapid co-evolution of tools with slowly evolving humans

Ever since “stone-age” man settled down to an agrarian lifestyle about 10,000 years ago, our genetic make-up has changed little, but the tools that we have created and give us greater powers, have become an evolutionary juggernaut in our stead. We may have begun with grunts, gestures, rudimentary language, flints, baskets, stone axes and

spears (Galor & Moav, 2002), but we have since learned how to bake cakes, plough fields, store grain, write books, fly planes, teach classes, and transform these psychological “methods” tools into physical tools.

Our scientists have harnessed the atom, flown us to the moon, replicated life and developed the ability to destroy millions of lives in a moment or power millions of homes for a generation, that were once physical force of a fist or the flame of a fire. As Toth & Schick (2007) show:

The record of human technological development begins with the appearance of the earliest stone artifacts approximately 2.6 million years ago and continues with a primary emphasis on use of stone for tools for most of the ensuing time. The transition to other tools – e.g. widespread use of ceramics, use of metals, development of writing, concerted harnessing of various forms of energy (animals, mechanical devices, machines, electronics, nuclear, etc.) – is relatively recent across the planet, emerging only since the end of the last Ice Age, or within the last 10,000 years or so (somewhat earlier or later in different places depending on local resources, geography, ecology, and contacts between populations). (p. ix-x)

Since the last major out-of-Africa expansion about 40,000-50,000 years ago (Paabo, 2003; Stix, 2008) the human genome has drifted less than .1 percent (U.S. National Human Genome Research Institute, 1997). Says Stix (2008), “DNA furnishes an ever clearer picture of the multimillennial trek from Africa all the way to the tip of South America....Almost all three billion “letters” or nucleotides that make up the human genome – is the same from person to person” (p. 38). Yet the genetic difference between humans and our nearest primate cousin, the chimpanzee is 120 times greater at 1.2 percent on average (Chen & Li, 2001; Paabo, 2003). Although humans as a species are linguistically, culturally and ethnically diverse, we continue to be a single interbreeding species so that any two people of opposite gender on the planet alive today are able to mate and produce offspring, including the descendants of people who separated geographically some 160,000 to 200,000 generations ago. The US National Human Genome Research Institute (1997) states:

No two humans, save identical twins, ever have been or will be genetically identical. Between any two humans, the amount of genetic variation— biochemical individuality—is about .1 percent. This means that about one base pair out of every 1,000 will be different between any two individuals. Any two (diploid) people have about 6×10^6 base pairs that are different....research results consistently demonstrate that about 85 percent of all human genetic variation exists *within* human populations, whereas about only 15 percent of variation

exists *between* populations. That is, research reveals that *Homo sapiens* are one continuously variable, interbreeding species.

What this means is that most of the difference between human brains and the brains of our primate cousins, the growth especially in the frontal lobes, occurred during the four million years before we became agriculturalists. Humans living anywhere on the planet have essentially the same “body plans”, even though their ancestors separated 10,000 years ago. In a sense, humans today have “stone age” brains.

So how have humans become more capable? While our genes have been replicating and mutating at a modestly gradual rate, our brains have been extraordinarily busy, working symbiotically with tools, to create more complex and powerful varieties or tools in a headlong rush to the future. Our journey has occurred, not in a single continuous development, but with periodic large-scale technological and social rearrangements associated with critically important inventions such as fire, electricity and electronics. According to Iberall (1983) the first transition occurred around 8,000 B.C. when several *food-collecting* societies became *food-producing* societies by inventing tools to support the tilling of the land, the sowing of crops and the storage of grain and water. The Hunter-Gatherer Age and the Agricultural Age respectively, were the forerunners of a further technological (and employment) discontinuity that began in the 1700s known generally as the Industrial Age, which was based on a newfound ability to design and make machines that automated the work of humans and animals. None of the transitions was smooth. Each transition involved massive and chaotic economic, social and political dislocations that persisted for decades (Jones, 1990) involving not only extinctions of the tools, but most of the work performed by the users of those tools.

The Labour Market Division of the British Office of National Statistics (2003) describes some of the changes to the types of work that have swept through the British economic system:

Before the Industrial Revolution most people.....worked in agricultural industries. The eighteenth and nineteenth centuries saw that change as technological innovations began to improve the productivity of agricultural workers, starting with Jethro Tull's (1674-1741) mechanical seed sower in 1701. These developments meant that more agricultural produce could be provided by fewer workers and consequently the numbers employed in the primary sector began to fall. However, at the same time, technology such as the steam engine triggered the Industrial Revolution. The decline in employment in agriculture was more than offset by the increase in the new manufacturing and mining

sectors. Similarly, the twentieth century saw ongoing improvements in technology which improved efficiency in the manufacturing sector, for example computers and automation. This in turn freed up resources to work in the burgeoning services sector. Moreover, each revolution also helped fuel the next: improved efficiency in agriculture raised living standards and wealth which increased the demand for manufactured goods; similarly, rising living standards and leisure in the twentieth century helped increase the demand for services.

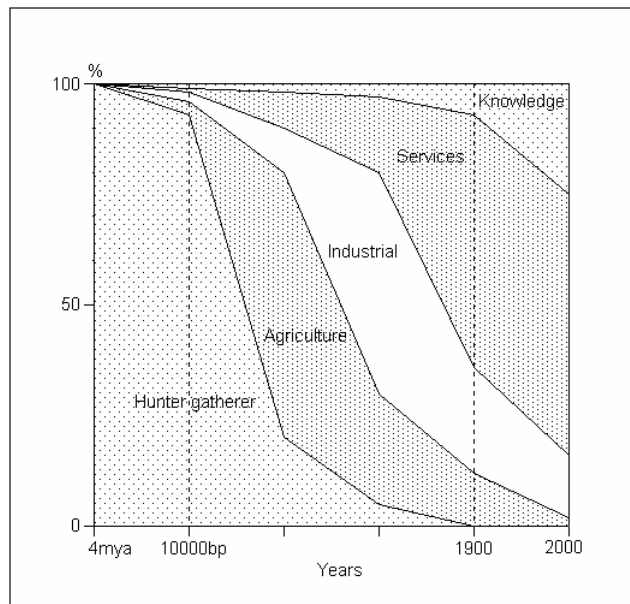
The British National Statistics (2003) illustrate the extent of the changes in types of employment that occurred in the 20th century. Between 1900 and 2000 the British workforce expanded from 17 to 28 million people. More women entered the workforce, rising from 29 percent to 46 percent of all workers. Agricultural employment declined sharply from 11 percent to 2 percent of the workforce and manufacturing work fell from 24 percent to 14 percent of all work. At the same time, services workers (including knowledge workers) increased from 50 per cent to 75 percent of the workforce. A similar pattern occurred in the United States of America during the same period according to a U.S. Department of Labour (2001) report. The U.S. workforce expanded from 24 million to 139 million people and the proportion of women in the workforce from 19 percent to 60 percent. Employment in agriculture declined from 38 percent of the workforce in 1900 to 3 percent in 1999, while employment in mining, manufacturing, and construction decreased from 31 percent to 19 percent. Service workers (including knowledge workers), rose from 34 percent of employees in 1900 to 70 percent in 2000, largely associated with the growth in information processing and process control technologies that required armies of data entry operators, clerks and secretaries to process the management information to support distributed or globalised organisations. This period, which is generally characterised as the Information Age (Naisbett, 1982; Beninger, 1986; Drucker, 1999), began in the early 1940s, and is often associated with the invention of the mainframe computer and distributed data processing.

Towards the end of the 20th Century, a new but equally large-scale technological and social revolution has emerged which has been characterised as the Knowledge Age (Toffler, 1990; OECD, 2001). The period is associated with the widespread adoption of distributed electronics, such as the personal computer, the photocopier and the mobile phone, to support complex forms of work that demand high levels of personal cognitive functions known as knowledge work (Levy & Murnane, 2004). Knowledge work involves the creation of new ideas, the production of

knowledge or the provision of expert opinion not easily transferable to others such the work of engineers, consultants, scientists or computer specialists (OECD, 2001). Between 1900 and 2005, knowledge work grew to 43 percent of all jobs in 2000 (Economic and Social Research Council, 2008) from a base of about 10 percent in 1900, an estimate by Machlup (1962) of equivalent growth in the U.S. component of knowledge work in the absence of British data. This is consistent with the growth in British employment of people employed as managers, administrators, professionals and employers which rose from 7.5 percent to 37.5 percent of the workforce between 1911 and 1991 (Gallie, 2001).

Figure 4.3 summarises the changes in employment generally described by the data for 1900 and 2000 taken together with hypothetical “employment” estimates for the Hunter-gatherer-Agricultural Age and the Agricultural-Industrial Age transitions. It shows the continuing rise of knowledge work, the slump in agricultural work, a continuing decline in manufacturing work and the plateauing of services work.

Figure 4.3: Percentage of population employed in key sectors – 4mya to present.



In the same way that humans have a genetic lineage, tools appear to have historical connections to antecedents. New tools are created, says Kauffman (1995), by combining the features of previously developed tools in novel ways in a web of new dependencies. Most new tools depend on prior inventions. Burke (1996) gives examples of how a ball valve device, that regulated the flow of water to English gardens, was the

precursor to the float valve in the carburetor of the motor car and how the first typewriters borrowed the concept of keys from pianos. Says Kauffman (1999):

Consider, for example, the Wright brothers' airplane. It is a recombination of four technological facts: an airfoil, a light gas engine, bicycle wheels and a propeller. The more diversity that exists in the technological community, the more diversity of novel combinations of existing elements are (sic) present that might prove useful in some context. Thus, 200,000 years ago the diversity of the economic web was severely limited. Today it is vast. Two hundred thousand years ago, finding a technological novelty with the stone and bone implements was hard. Today, with millions of artifacts in existence, the generation of novel ones is easy. In short, memes do not just descend with modifications. A rich web of conceptual interactions is at work as humans happen upon, design and implement a combinatorially exploding diversity of new goods and services. (p. 1)

Many degrees of freedom are available to new inventions at the start of a new era. The developers of new technologies try out new combinations of features, but over time, as competition for market share becomes intense, products with the best or more powerful features tend to be selected and inferior products die out (Foster, 1987). Designers incorporate competing features in their products in order to compete, so that eventually most products and processes acquire similar features. According to Kauffman (1999), evolution attempts to "optimise systems riddled with conflicting constraints" (p. 179), but there are only a few ideal ways in which the parts of the new organism or technology can be assembled, that deliver maximum performance, for each of the ways it will be used. Kauffman (1999) gives the analogy of assembling a jet aircraft to explain that the constraints imposed on the ideal location of wings, tanks, wheels, engines, passengers and pilot, limits where they can be placed, which determines the overall design.

The rate of improvement slows as a species moves uphill on a "fitness landscape" (Kauffman, 1999, p. 163). The peaks represent the highest fitness. As the species moves upwards it faces an exponentially reducing number of degrees of freedom. This slowing is a common feature of adaptive systems and explains why selection alone does not work. On random landscapes, with numerous fitness peaks, mutated species remain "trapped forever in the region it started in (and)...unable to search long distances for higher peaks" (Kauffman, 1995, p. 183). The species runs into an "error catastrophe" where all "accumulated useful traits melt away" (p. 183).

Each new wave of technology depends for its existence on advances in theoretical knowledge. Scientists first develop a theory and engineers or designers then

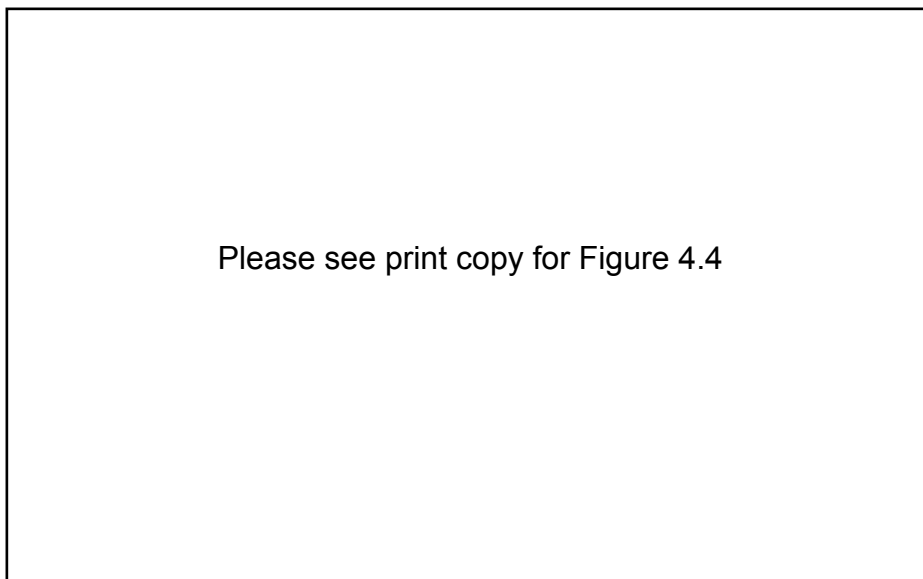
develop a way to apply the knowledge to real situations. Theories also have a shelf life. Kuhn (1962) showed that as contradictions in theories accumulate over a long period, new and better explanations suddenly emerge and the theoretical landscape becomes transformed in a quantum leap. Kuhn's (1962) theory of scientific revolutions is topologically equivalent to Kauffman's model of biological and technological development. Long periods of acceptance of a particular theory are punctuated by the emergence of a new theory that explains more than the previous theory, and is a better fit with the emerging "knowledgescape" (Shariq, 1999, p. 243). New theories face the same uphill battle for mindshare as do new technologies, and for all practical purposes become extinct, when they fail to gain acceptance. However, some people continue to believe a theory that has been abandoned by the mainstream, so pockets of old beliefs persist. For example, some people still drive horses and buggies and others believe the earth was created in seven days. Schools and universities continue to teach a variety of different theories of the physical universe such as Newton's laws of motion, quantum dynamics and string theory side-by-side. Psychology and business studies students learn a myriad of theories to explain their respective worlds, although many offer a poor explanation for human behaviour.

Influenced by Kuhn's theory of scientific revolutions, Foster (1987, p. 20) recognized the discontinuous nature of human technological progress. He proposed the S-curve theory (p. 31) of technology adoption to explain the birth, growth and maturation of technologies. The theory also explains the waves of emergence and extinction of products as diverse as data processing machines, computer components, sailing ships, automobile wheels and medical imaging technologies in the 21st century. According to Foster, new technologies arrive when existing technologies have run their course. At the end of a technological lifetime, there are few remaining opportunities for incremental improvements. The attacking technology usually displaces several classes of technologies at the same time. When the photocopier displaced carbon paper for making copies of typed documents, it also attacked small offset printing, and with help from the personal computers, which was popularised about the same time, eliminated the work of armies of typists. The new product is usually many times more efficient or productive than the products it attacks. It is faster, smaller, has more features, and is more robust or simpler. Some technologies have effects across all sectors. For example, electricity became a universal tool for powering machines and labour saving devices and freed up people for other kinds of work. In 1900 only 5 percent of America's

factories used electricity but by 2000 electric power was universal (U.S. Department of Labour, 2001). Only 10 percent of homes in 1900 had electric power, but by the end of the century electricity was in virtually every U.S. home, an invention that has spread to most parts of the world. Similarly, the reciprocating engine, which gave people power they could carry around with them, led to a vast global ecology of freeways, fast food stores, shopping malls and service stations.

Foster (2003, p. 102) shows that pairs of successive S-curves (or Gompertz curves), for each technological discontinuity (see Figure 4.4.1) exhibit the features of a phase-transition where the trajectory of the emerging or attacking product briefly overlaps the trajectory of the existing or defending product which generally becomes extinct, or is no longer ubiquitous. The curve flattens as both the population of possible adopters declines and the density of risk-averse or pessimistic people increases (Young, 2005). Foster (2003) gives the example of the switch from bias tyres to radial tyres in the 1970s and 1980s to illustrate the dynamics of a discontinuity, as shown in Figure 4.4.2. Bias tyres reigned supreme for 21 of the 23 years of the encounter then lost 70 percent of the market share in the last two years.

Figure 4.4: S-curve model of innovation (Redrawn from Foster, 1987, pp. 102 and 162)



Such extinctions also have a knock-on effect, and extinguish entire ecologies of complementary tools, but also the jobs that accompany the tools as explained by Kauffman (1995):

What applies to organisms may apply to artifacts...both also *coevolve*....With the horse went the buggy, the buggy whip, the smithy. The saddlery and the harness maker. With the car came the oil and gasoline industry, motels, paved roads, traffic courts, suburbs, shopping malls and fast food restaurants... Organisms speciate and then live in the niches created by other species. When one goes extinct it alters the niche it helped create and may drive its neighbours extinct. Goods and services live in an economy in the niches afforded by other goods and services. (p. 240)

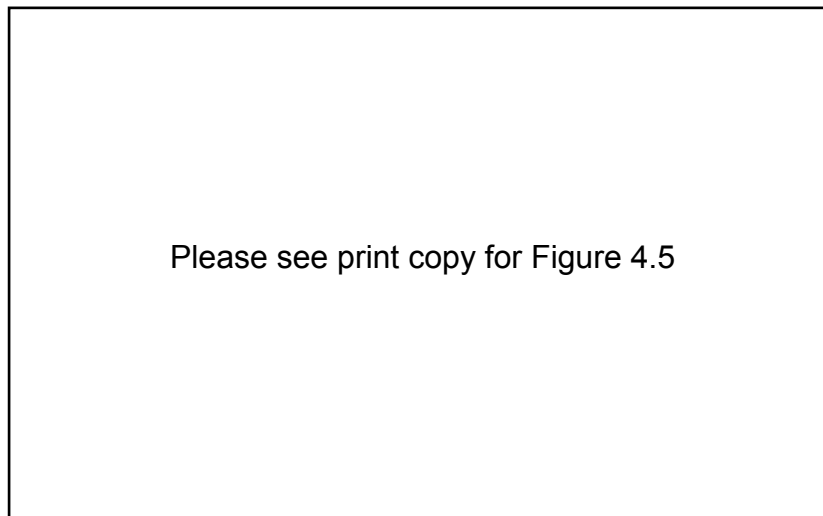
A model developed by Findlay, Crawford and Lee (2002) and further refined by Findlay and Fitzgerald (2006) conceptualises tool evolution as a series of discontinuous S-curves of successively shorter period, but not to scale, in which the capabilities of tools are a multifold advance over the tools of the previous period (see Figure 4.5). Each period is associated with a form of work and a pedagogical approach that is consistent with the dominant culture at the time. Findlay and Fitzgerald (2006) base the categories of the cultural periods on the emerging type of work and describe a pedagogical approach for each cultural period:

- Hunter-Gatherer Age (pre-8,000 BC). The main new activity is food seeking. Cultural knowledge is passed on to a new generation directly by parents to children and through dance, song and rituals with other members of the tribe.
- Agricultural Age (8,000 BC – 1700 AD). The main new activity is farming. Some members of the community such as tribal leaders and priests begin to specialize in the storing and transmission of knowledge from one generation to the next, in the form of clay tablets, scrolls, glass windows, paintings and the first books. Informal learning continues but the experts are consulted when higher level thinking is required.
- Industrial Age (1700-1940). The main new activity is manufacturing. The dominant learning strategy is instruction on a large scale, such as school classes. Organisation control systems are top-down, a model that has persisted well beyond the Industrial Age.
- Information Age (1940-1990). The main new activity is data collection and information processing. Accelerating change and decentralisation of business operations on national and international scales demands new kind of workers, in particular, people who can think and act autonomously, who are able to reconstruct and apply knowledge and contribute to a process of continuous improvement.
- Knowledge Age (1990-2000). With globalisation and rapidly transforming markets, processes and technologies, a new breed of knowledge workers identified by Levy and Murnane (2004) has become essential to corporate

survival. This new form of work and tools is characterized by knowledge creation and re-creation, sensemaking and real-time model or theory building.

- Wisdom Age model (2000+). The main new activity is the wise application of knowledge. Chaotic and indeterminate market conditions require most employees to be capable of inventing not only their own knowledge, but also to be able to explore possible new scenarios similar to the evolving capability of the Web 2.0 world described in chapter 2. Learners are “producers”.

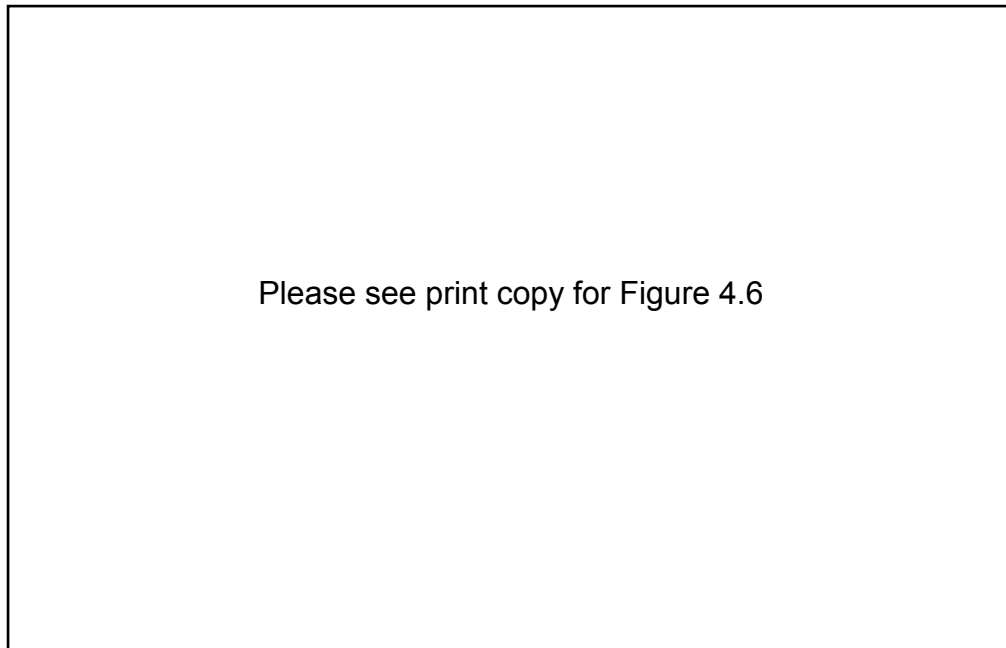
Figure 4.5: Sequence of S-curves in tool evolution (Redrawn from Findlay & Fitzgerald (2005b)).



The stages proposed by Findlay & Fitzgerald is similar to a model of the stages of development of tools for the mediation of human communication (see Figure 4.6) developed by Pea and Wallis, cited in National Science Foundation (2008) report on cyberlearning. At the lowest level is face-to-face interactions requiring no tools, followed by a second stage of symbols such as numbers, characters and symbols. The third stage is the radio, telephone and television, followed by a fourth wave involving networked personal computers, which has led to a fifth wave of hypercomplex forms of social networking and sensemaking. In the Vygotskian model, the lowest level of human tools is mediation by language and gestures. I contend that as tools are becoming more powerful and complex and automate more of what it means to be human, there is a democratisation effect. More and more people gain access to ever more powerful tools that they learn to use automatically “without thinking”. However, the level of education required to design, make and maintain tools increases. Thus, young people may be able to learn independently of their parents and teachers but still require a “scientific”

education to participate fully in society. Another possibility is that the pattern of child development may mirror in some way the growing complexity of language and tools.

Figure 4.6: Mediation model. Redrawn from Figure 1. *Advances in Communication and Information Resources for Human Interaction* (Roy Pea & Jillian Wallis), National Science Foundation (2008), page 11.



Evidence for progressive cultural development independent of the education system is to be found in the trend towards higher intelligence scores in 21st Century children compared with their parents, but remains controversial. There is even a greater shift when compared with their grandparents. Although Flynn (2007, p. 30) contends that gains in Ravens and Full Scale IQ scores “suggests that our parents are some nine to 15 points duller than we are and that our children are nine to 10 points brighter” the findings may merely reflect changes in acculturation. Flynn argues that our ancestors were not less intelligent but IQ scores reflect changes in approaches to abstract reasoning by young people as a consequence of their exposure to more complex cultural tools such as video and electronic games or TV soaps. These artifacts that once required minimal cognitive effort to follow a simple story line, now have so many characters and story lines, they require higher levels of cognitive processing to enjoy them. He also shows that the ability of young people to cope with everyday practical living has diminished particularly in terms of obsolete items in the Daily Living Skills test such as

“sews or hems clothes.” This is consistent with Blonskiy (1934) view that each stage of cultural development accelerates the rate of child development.

Barriers to change, innovation and the tools for transformation

Lewis (2000) shows that as order within dynamical systems becomes more “concretized” it takes considerably more effort to initiate changes and even more to perturbate the system to a new state. In effect, the system becomes dynamically stable, locked into interdependent webs of relationships with other parts. In this section, I will explore the dynamics of change in economic systems and how successful businesses deal with challenges from lithe competitors with faster, more productive or efficient technologies. I also explore how the new psychological tools developed in the past two or three decades to leverage organisation learning may be relevant to schools.

Young (2000) describes three innovation diffusion models, each of which is determined by the way new ideas are communicated and adopted. People adopt immediately through contact with others if the spread is *contagious*. If there is a *social threshold*, then people only adopt when a critical mass has adopted. If people only adopt when they see the advantages, this is called *social learning*.

Rogers’ (1983) shows there are six reasons why new ideas are adopted. Tools are adopted if they perform a similar task better than others do, if the tools are easy to use, if the tools will enhance the user’s social status, if potential users can try before they buy or use, and if there is a good fit between new tools and the user’s beliefs, needs and experiences. It is this last characteristic that is the Achilles heel of most new technologies introduced into the school classroom and offers an explanation why teachers in British schools have been willing adopters of electronic whiteboards. Whiteboards allow teachers to continue to practice a knowledge telling pedagogy that places the teacher, rather than the student, at the centre of the classroom.

The adoption cycle is related to people’s attitudes to change. Kirton (1976) shows that some people prefer certainty and others prefer novelty. Each technology adoption cycle begins with the curious, highly connected and visionary risk takers who are excited by novelty and are willing to experiment, followed by the progressively more risk averse and conservative. According to Rogers (1983) the adoption cycle has five stages starting with the innovators (2-3% of all people), followed by early adopters (10%), the early majority (30-40%), the late majority (40%) and finally the laggards (10%). The laggards rarely adopt the new technology. There is a stage in the adoption

process when the process either stalls or takes off. This occurs at the “tipping point” (Gladwell, 2000), a critical point between the early adoption and the early majority stage. If the early adopters embrace the new technology, the adoption process usually becomes self-sustaining, but not always. The innovation process closely parallels Foster’s (1987) S-curve model, Kuhn’s (1962) scientific model of scientific revolutions and Engestrom’s (2000) introduction of a culturally advanced artifact to a cycle of expansive learning.

According to Zaltman, Duncan and Holbek (1973) there are two stages of the innovation process. The first stage is focused on creativity; the second stage is focused on innovation. *Creativity* is the generation of new and unique concepts often associated with divergent thinking (Brown, Tumeo, Larey & Paulus, 1998) and *innovation* is the implementation of the idea (West, 1990) and is often associated with entrepreneurship or invention (Kanter, 1983) and frame-breaking change (Leavy & Jacobson, 1998) that requires a high degree of obsession or determination to see the idea through to realisation (Peters, 1990). In the context of the present school system, there is little need for creativity or innovation because the system is constrained by an externally devised curriculum that controls what teachers must teach. This means that any attempt to change teacher practices challenges teachers’ underlying fear of loss of control, and will be self-defeating.

The innovation process in organisations usually follows a pattern of long periods of slow evolution followed by short bursts of radical or frame-breaking change (Tushman & Anderson, 1986). Innovation may involve creative imitation (Linsu, 2001) through the acquisition of externally created knowledge (Bolton, 1993) or creative accumulation (Orsenigo, 1997) via the absorption of existing knowledge into leaner, more efficient structures and processes (Hamel & Prahalad, 1994) usually involving creative destruction (Schumpeter, 1912) which is equivalent to Kauffman’s (1995) extinctions. Competency enhancing is to be found in new sectors of the economy and competency destroying is associated with decaying technologies (Tushman & Anderson, 1986). Innovation depends as much on the ability to mobilise systems-wide learning and implementation as it does genius; it requires competition in the development of ideas and cooperation for their implementation (Leavy & Jacobson, 1998). Innovation is usually incremental when pursued with an internal organisation focus and radical when the focus is on external concerns, although most radical innovation originates in new entrants to a field (Foster, 1987). Foster (1987) shows that

seven of ten technology attacks from new entrants are successful, which should serve as a warning to incumbents determined to ignore signals from the external world, which teachers and schools have been doing for the greater part of a century since Dewey first warned of the impending crisis in education. Learning seems to be accelerated by crisis (Starbuck, Greve & Hedburg, 1978). Organisations facing emerging competition sometimes begin pooling their resources with others. They create alliances to exploit opportunities and link their systems in partnerships, particularly with suppliers to fend off attacks (Kanter, 1989). Large organisations buy up small innovative ones, rather than attempt to become more innovative, which also allows the spread of new tools beyond a small niche. In the school context, there are no competitors to threaten the status quo (Foster, 1987).

The core capability of an individual or firm can easily become a core rigidity (Leonard-Barton, 1992) otherwise known as a competence trap (Levitt & March, 1998). Highly valued organisation practices such as the teacher-centred classroom acquire the status of “rationalized myths” (Meyer & Rowan, 1977, p. 346). They become regarded as the only solution possible for a particular outcome based not on empirical evidence but on shared beliefs and tradition. If the professional identity of people is strongly bound up with a set of organisation practices they generally become very resistant to change (Jaffee, 1998).

In an early stage of an industry, innovation occurs in the creation of new products and services and these are matched to customer needs. As an industry matures, its’ innovation is focused on saving costs and improving performance (Kanter, 1983). Each stage of the innovation process requires a different kind of thinking (Roberts & Fusfeld, 1981) and the most versatile organisations use both analytical-serial and systemic ways of thinking. Roberts & Fusfeld show that the process begins with idea generation and progresses through entrepreneurship or championing of the new ideas, leading projects, gate-keeping and sponsoring/coaching, unfreezing and creating new models, winning support for an implementing the new models and refreezing to create a stable system capable of surviving.

The barrier to uptake of new technology, says Geoghegan (1995), is not so much an aversion to the technology, but aversion to the risks associated with its use. Early adopters may be poor role models and ineffective change agents and thereby alienate the next generation of potential users. To succeed, organisations must be able to innovate internally and engage in participative decision-making, power sharing and

collaboration in order to create and disseminate new knowledge. They must also be able to grow new external webs of relationships and win the hearts and minds of the fearful, in order to help people deal with the unpredictable and the unforeseen (Hurley & Hult, 1998).

Shareef (1997) argues that innovation in organisations now happens so quickly that Kuhn's theory of scientific revolutions does not offer a sufficiently robust explanation. He argues instead for a concept of revolution in permanence (Popper, 1972). In doing so, he ignores the core of the argument he cites from Kanter (1983) that, when an industry matures, its' innovation becomes focused on cost savings and performance improvement. Companies abandon innovation, to introduce certainty and control based on what they already know rather than what they do not know. Such approaches to innovation fail (Foster, 1987) because other organisations become better at theory building in the context of the emergent environment they are collectively creating. The new entrants change the market ecology and create revolutionary products that are a better fit with emergent customer needs than the old products. The attackers create new webs of relationships that so transform the market ecology, that even small inroads into market share destabilise the supplier network of the incumbent, create uncertainty, and drive up costs (Foster, 1987).

Each new wave of technologies has at its core, new theoretical understandings, which over time, become concretised as tools. Sterman (1985) argues that scientific revolutions occur when the metaphor at the heart of the current paradigm becomes exhausted and that scientists live simultaneously in two worlds, the old discredited science, and the new science they do not yet fully comprehend. Sterman says theories gain support when they explain many of the anomalies in the previous theories' representation of phenomena, or when the new tools they engender, displace the older kinds of tools. Confidence in the theory grows as the number of solved puzzles increases or shows promise that more will be solved. Any new theory has a halcyon period when the majority of scientists defect to the new theory which Kuhn called normal science. A crisis in confidence follows as the number of anomalies grows and puzzle solving slows due to their inherent difficulty or complexity.

Popper (1972) argues that the growth of pre-scientific human knowledge occurred by the elimination of those who believed hypotheses that are a poor fit with what is observed:

While animal knowledge and pre-scientific knowledge grow mainly through the elimination of those holding unfit hypothesis, scientific criticism often makes our theories perish in our stead eliminating our mistaken beliefs before such beliefs lead to our own elimination. (p. 261)

Popper's view (1972) is that knowledge expands because of a process of continual problem solving of ever-increasing depth and complexity and that truth is determined by eliminating hypotheses that are unfit, similar to Darwin's theory of natural selection. The Popperian process of hypothesis testing and elimination does not occur in isolation. In partnership with a process of "creative destruction" (p. 222) there must also be a process of creative construction which is an integrative or dialectical-style method that brings new concepts into alignment that were previously opposed or contradictory. Teachers and schools are saved from their erroneous beliefs by a system that, in most instances, is controlled by the state, and which forces the attendance of students for a compulsory period so that the school-going system is self-perpetuating.

Currently it is fashionable, some say necessary, for organisations to become more flexible, by capturing and managing the tacit knowledge (Shariq, 1999; Nonaka, Toyama & Konno, 2000) that is held personally by individuals and make this more widely available in procedures, models and prototype theories, which is one of the functions of the team learning system that is the subject of this study. Others argue that knowledge management is only part of what is now required for success, and that organisations should engage in knowledge creation in order to develop their knowledge capital and remain ahead of competitors (Sveiby, 1997). Such knowledge management or knowledge creation processes are now being adopted, albeit slowly, by the school education system (Hargreaves, 1997). At present, schools have little influence over the content of their knowledge capital because the content of the curriculum is imported from other knowledge creators. Schools also miss out on opportunities to capitalize on the rich tacit knowledge that children bring to school every day as a consequence of their engagement with the world, and in particular how to use Web 2.0 technologies, not merely for information gathering, but for knowledge creation.

The barriers between disciplines and organisations have been dissolving over the past two or three decades, in recognition of the vulnerability of organizations and society to problems that are difficult to foresee. The solution of small-scale problems frequently makes use of available knowledge from a single discipline (Argyris & Schon, 1978) whereas large-scale problems require cross-discipline input from across

organisation levels, disciplines and boundaries. Complex problems require frame-breaking thinking such as *double loop learning* (Argyris & Schon, 1974) which involves stepping outside the current paradigm rather than traditional *single loop learning* that involves thinking and working within the current paradigm. Double loop learning involves working across the boundaries of disciplines. It is a cognitive and an interactionist method, because different points of view need to be reconciled.

A model from the knowledge management world that could help inform this study is the data-information-knowledge-wisdom chain (Ackoff, 1989) that explains the differences and the relationship between each stage of information processing. What begins as data is transformed into information and subsequently knowledge that can then be wisely or unwisely applied (Ackoff, 1989; Thow-Yick, 1995; Prewitt, 2002). It is only when data is woven into a stream of connected themes that it becomes rich, interesting and available as information (Salamon & Perkins, 1996). Information becomes most useful when it is converted into theories or models and thus can be translated into tools for widespread application. The denser the connections or web of information, the more interesting or meaningful it becomes. A critical problem for organisations is knowing whether the existing knowledge base is relevant to the presenting problem, or whether the context has changed and new solutions need to be found or created. Individuals and corporations tend to apply existing knowledge to new circumstances, which hinders the search for new knowledge (March, 1991). Ringland, Edwards, Hammond, Heinzen, Rendell, Sparrow, & White (1999) say that failures arise from believing what we want to believe. The most difficult new ideas are those that fit the category of what we do not know we do not know (Luft & Wingham, 1955). Bower & Morrow, (1990) state:

We build mental models that represent significant aspects of our physical and social world, and we manipulate elements of those models when we think, plan and try to explain events of that world. The ability to construct and manipulate valid models of reality provides humans with our distinctive adaptive advantage: it must be considered one of the crowning achievements of the human intellect. (p. 44)

An emergent view of knowledge creation is presented by Gordon (2000) who points out that the “aha” or “eureka” experience or epiphany comes about when thought, emotions and sensation converge in a gestalt kind of experience. The process involves identifying the patterns in the information. The ideas put forward are merely prototypes

to be considered which lead to the development of knowledge whereas what becomes knowledge must be justified to ensure its survival.

A key stage in any decision-making or knowledge-creating process is sensemaking (Weick, 1979) which is one of the features of the team learning system that is the subject of this study. Sensemaking is a process of seeking patterns in ideas, and converting the ideas into a model. It involves gaining insight and understanding in relation to the contextual framework (Shariq, 1998) and finding a model that helps the individual or the organisation deal with perceived threats (Russell, Stefik, Pilolli & Card, 1993). Models comprise component parts, features or variables which describe how the parts interact, state the boundaries of the region of the universe they represent, define the states that can exist and describe the logic of the model (Dubin, 1978). Perception (Massaro, 1997) is a close relative of sensemaking and has three stages – feature evaluation, feature integration and decision. The best solution usually offers the perfect fit when compared with alternatives. The new knowledge is created in a discontinuous and integrative process of social negotiations that resolve differences between individual understandings (Savery & Duffy, 1995).

Knowledge creation as a discipline is frequently seen as something fuzzy and complex, which only experts such as consultants, senior managers or academics and geniuses do. Increasingly, thinking and decision tools are becoming more readily available and accessible for anyone in an organisation to use. Some methods are even learned by children at school. It is these kinds of processes the team learning system, that is the subject of this study, captures in the form of open ended question sequences.

The tools include de Bono's Six thinking Hats and directed attention tools (de Bono, 1992), nominal group technique (Delbecq, Van de Ven & Gustafon, 1975; Bartunek & Murningham, 1984), Delphi technique (Dalkey, 1968), Devil's Advocacy (Schweiger & Finger, 1989), problem solving (Guzzo, 1982), action research (Zuber-Skerrit, 1993), SWOT analysis (Mintzberg, 1991a), TRIZ (Altshuller, 1994), quality function deployment (Hunt & Xavier, 2003), business process redesign (Alexander & Findlay, 2004), multi-criteria decision-making (Phillips, 2007), appreciative inquiry (Cooperrider, Barrett & Srivastva, 1995), reciprocal learning (Palincsar & Brown, 1984), inquiry learning (Barab, Schatz & Scheckler, 2004) and cognitive acceleration (Shayer, 1999). One of the primary purposes of the team learning system is to capture these kinds of secondary tools and make them available for everyday use as a primary tool.

Increasingly, organisations have come to rely on groups to perform their knowledge creation and dissemination function. Large-scale formal organisation systems and computers have the same practical functions (Beninger, 1990). Like computers, organisations perform a control function. They exist as a tool for management to manipulate the system, to collect and process data using formal rules and to control processes to achieve the organisation's goals. Before the computer, the formal organisation and its armies of clerks were the only way to perform this function on a large scale, but now that the clerical armies have departed, each new task expected of ICT is directed at greater control by the organisation over production, distribution or the marketplace (Beninger, 1986).

Functional groups of people with specialised skills are also used by management as tools for achieving their goals in competition or collaboration with other organisations. This is not a new concept. The military has long been regarded as a tool of government policy. The language of the military turns human flesh into extensions of the military mind (De Landa, 1991). Perhaps this is why concepts such as "rearguard action," "fighting machine" and "cannon fodder" refer not to physical equipment but to people and the ways they are deployed permeate the English language.

Cultural change or change management as a process of organisation re-invention is widely used to help staff articulate shared assumptions about the current health of the organisation (Deshpande & Webster, 1989) as well as suggest new ways to develop organisation capability or functions (Day 1994) that are a better fit with the emerging context. Such change processes are driven by the need for organisations to remain competitive in the face of external threats and internal inefficiencies or capacity constraints. These are the tools that schools must adopt in order to transform their role from knowledge transmitters to knowledge co-creators.

Organisation improvement programs come in many forms. They are designed to achieve some kind of change, ranging from the incremental to the transformational. The methods include organisation development (Schein, 1985; Weissbord, 1992; Burke, 2002), continuous improvement (Zangwill & Cantor, 1998), business process improvement (Hammer & Champy, 1993; Smith, 2007), six sigma (Kumar, 2006; Wedgwood, 2007), quality (Deming, 1986; Davids, 1989; Juran, 1989) total quality management (Ross & Perry, 1989), quality function deployment (Hunt & Xavier, 2003) and more recently knowledge management (Sveiby, 1997; Shariq, 1998; Nonaka, Toyama & Konno, 2000). Most of these methods have been captured in the team

learning system and are used in the corporate world (Alexander & Findlay, 2004) and some in school learning (Findlay & Fitzgerald, 2006).

Transforming organisations is difficult. Only one in three attempts are effective (McKinsey, 2008) often because the efforts encounter resistance. Argyris (1990) shows that all organisations, communities and groups have a defence pattern, a kind of skilled incompetence, to protect the organisation from embarrassment or threat and characterised by cover-ups and bypassing issues resulting in cynicism, hopelessness, distancing and blaming others. Senge (1992) says that new insights fail to be adopted because they conflict with strongly held, unconscious mental models. Little or no cultural change occurs (Dowling, 1996) when staff do not trust the originators of a change, the need for change is not obvious or the process is drawn out. Landry (2000) contends that organisations have had to learn how to be playful in order to constantly re-invent themselves by tapping into the creativity of their staff, customers and suppliers.

Although cultures are constantly evolving, they are also enduring (Hofstede, 2001) and slow to change. Myriads of interconnections between parts of the system sustain the system. Galloway (1992) says that culture gives its' members a shared identity and a way for choosing, creating and interpreting the world in a consistent manner. Hofstede (2001) views culture as the organisation or collective equivalent of personality. He identifies four dimensions of culture or values - *power distance*, *individualism*, *uncertainty avoidance* and *materialism* – which have parallels with the rules of activity systems, because they describe how people engage with each other. The *power distance* dimension is how inequality between people is managed or facilitated. *Individualism* is the relationship between individuals and groups or communities, and their relative autonomy. The *uncertainty avoidance* dimension explains how people deal with the risks inherent in the future. *Materialism* reflects the balance between spiritual or material pursuits, which also has parallels with activity theory, in that activity is the link between the experience of the material world and the ideal. At one end of the *power distance* scale, people expect to conform to well-defined roles bound by duty, as occurs in paternalistic or hierarchical communities and at the other end of the scale, where equality flourishes, people have rights. On the *individualism* scale of Hofstede's (2001) model, the individual centered view is that success comes from personal struggle and that people have the power to control their environment in which only the fit survive. The collective end of the individualism scale regards people as embedded in a web of relationships where individuals have little or no power over their lives. At the low end

of the *risk avoidance* scale some seek stability and security above all else and so the existing culture endures, whereas at the other end of the scale, people are more future oriented and prepared to take risks, and so the culture evolves. At one end of the *materialism* scale people see work as a means of gaining wealth, possessions, fame or success dimension ranges and at the other end of the scale, living a life, perhaps an uncomplicated life, uncluttered by possessions is what counts. It is this more complex interpretation of rules that I believe should be explored in activity theory.

Deeply embedded assumptions within a culture can lead to incremental models of future making. Gaddis (1997) says that the idea that an organisation can plan its' way to a known future is implausible and the ability of people within a system to see failures is equally problematic. The rules of the current cultural paradigm blind the learner or observer to hidden or difficult-to-see order within the system or other ways of seeing the system (Bohm & Peat, 1987). In some ways, this is the situation that prevails in schools, where teachers see themselves as restricted by the rules of the system over which they have limited influence.

The brain as a self-organising system in symbiosis with tools

Self-organisation as a concept has become an important area of study in psychology, particularly developmental psychology (Lewis & Granic, 2000) because it offers a way to explain emergent phenomena. Various aspects of cognitive and emotional life have been shown to be self-organising or emergent systems (Freeman, 2000; Lewis, 2005). Cognitive self-organisation has its origins in the work of Ashby (1952) and von Neumann (1958) who discovered patterns in electronic circuits. Their findings have developed into the field of neural networking, a form of computing that learns through experience. Whereas much of the earliest research into brains concerned people with damage and was based on what people could not do, recent research on healthy brains has given scientists a dynamic, three-dimensional, but broad-brush view of neural excitation using non-invasive neuroimaging devices such as magnetic resonance imaging (MRI), positron emission tomography (PET) and single photon emission computerized tomography (SPECT) machines. However, these methods “do not measure neural activity directly” but related factors, such as blood flow and glucose metabolism (Goldberg, 2001, p. 54).

It is the self-organising aspects of brain development, especially in relation to tool use as well as the unique ability of brain cells to represent “other cells” (Damasio,

2002), and by extension other things such as tools, that makes it possible for humans to learn and develop culturally as well as genetically that is of particular interest to this study. Collectively, brain cells have evolved to represent external action internally as well as internal events, through a close link between language and gesture, both of which are motor activities. In a sense, the words and gestures we use, which become more complex physical and psychological tools, are not objects but dynamically evolving systems or processes in the form of extensions to or amplifications of “kinetic melodies” (Luria, 1973).

We now know that the human brain comprises hundreds of billions of cells - neurons - that are highly connected, some of which are local or adjacent, but many are distant (Goldberg, 2000) and glial cells which nourish and support the brain functions but do not transmit impulses. Every neuron is connected to a huge number of other neurons. Learning occurs as the strength of the pattern of interconnection increases when structural connections are made chemically. Sporns (2003) says only one in every million neurons are connected, although in local groups such as cortical columns, the connectivity can be much higher. The cortex in human brains has some 8.3×10^9 neurons and 6.7×10^{13} connections but “despite this massive connectivity, cortical networks are exceedingly sparse” (p. 56). Ten percent of all neurons have instant connections (Freeman, 2000) not just to the cortex, but also to all parts of the brain.

The developing brain is plastic; it evolves (Vargha-Khadem, Gadian, Watkins, Connelly, van Paesschen & Mishkin, 1997). Synapses are strengthened with use (Goldberg, 2001), and the more they are used, the stronger the connections become. Synaptic pruning eliminates the least-used or obsolete synapses, so the strongest synapses become even more dominant and establish a learning pattern. Neurons grow axons to the neurons from which they receive information, both locally to nearby neurons and to distant locations. Neurons also recruit their neighbours through feedback loops that amplify small changes. As more constellations of neurons are recruited for a particular pattern of processing, they exert “a stabilizing influence on each other” (Lewis, 2005, p. 261). Emotional events promote synaptic change and at the same time maintain synaptic connections (Lewis, 2005). The neurological structure of the brain also changes during a lifetime. Just after birth, there is a significant spurt in the number of neuronal connections, a process common to most mammals. The development of the cortex anticipates a surge in the storage of information by the overproduction of synaptic connections to accommodate the learning necessary for survival outside the

womb (Black, 1998), but if blocked can lead to abnormal development and behaviour. As humans approach about 10 years of age the brain prunes a large number of neuronal connections, usually the least used circuits. Brains also prune neuronal connections when people become depressed which plunges the brain into deeper depression (Harkness & Tucker, 2000). The effectiveness of the neurons is also affected by the degree of myelination. Each neuron is covered with myelin, a fatty tissue that acts as an insulator. It is not until around 18 years of age, when people reach maturity, that the “long distance communication” neurons (Goldberg, 2001, p. 144) that connect to just about every part of the brain become fully myelinated. Axonal growth also occurs as a result of learning (Renfrew & Scaree, 1998) such as demonstrated by MRI studies of London taxi drivers who were found they have larger hippocampus than age-matched controls of the general population (Maguire, Spiers, Good, Hartley, Frackowiak & Burgess, 2003). Their brain size increased in proportion to the time spent driving.

Lewis (2005) shows that emotions play a major role in the development of synaptic strength. In normal synaptic transmission, neurotransmitters are produced locally in the cells. But local firing rates are also modulated by neurotransmitters and neuropeptides produced in the brain stem and hypothalamus and are released all over the brain during minor and major crises confronting the individual. Lewis says:

Critically, these neuromodulatory effects are often triggered by emotional associations or perceptions mediated by limbic and paralimbic structures. For example, amygdala responses mediating emotional associations send activation down “descending” pathways to brainstem and hypothalamic centers, which in turn produce their global effects through “ascending” fibers to these and other brain regions. In this way, emotions greatly affect information processing throughout the entire brain. (p. 258)

The right frontal lobes tend to deal with extreme emotional states that are “far-from-equilibrium” both strong (high) and weak (low) (Schore, 2000) such as “terror, excitement and elation and low such as shame” whereas the left hemisphere is more involved in moderate emotional states such as “anxiety, interest, enjoyment and guilt” (p. 178). Schore (2000b) shows that mother child face-to-face transactions in early infancy, including the processing of faces and early language development, play a big part in developing the wiring of the frontal lobes with other areas of the brain and in particular, the feedback loop between the cortex and the limbic system. Schore (2000b) shows that the right frontal lobe “is deeply connected into the autonomic nervous system and the arousal-generating reticular formation...is the only cortical structure with direct

connections” which plays a major role in the regulation of “autonomic responses to social stimuli...and modulates “instinctual behaviour” (p. 31). The wiring of the young brain occurs mainly between the seventh and fifteenth months.

The brain starts off life with unlimited degrees of freedom. Synaptic pruning eliminates the least connected fibres and strongly establishes learning patterns by reducing the degrees of freedom. Says Lewis (2005, p. 261), “prolonged stress in infancy” leads to “excessive glucocorticoid activity, resulting in synaptic reduction and even cell death in the hippocampus and other structures”. Such “decrements in self-regulation, memory, positive mood and other functions can never be completely undone” (p. 261) and can subsequently limit the child’s developmental possibilities at high school, university or throughout life.

A poor socio-cognitive start to life can lead to further decline as a result of negative school experiences. In school settings, the role that emotion plays in shaping learning is generally ignored by teachers who mostly focus on the cognitive aspects of learning (Immordino & Damasio, 2007). As a result, many students leave school unable to apply what they have learned to real-life. Immordino and Damasio (2007) explain that the inability of students to apply their learning in social and work contexts has parallels with patients with ventromedial prefrontal lobe damage whose “social behaviour is compromised, making them oblivious to the consequences of their actions, insensitive to others emotions and unable to learn from their mistakes” (p. 4) yet their cognitive skills such as memory and logic remain intact.

Those who most suffer from such a disadvantage are children who arrive at school with impoverished language skills, with reduced opportunities to “program” their brains for the 21st century. Hart and Risley (1995) found that the effective use of language correlates positively with higher IQ and academic success. They show that intellectual development is stimulated by the progressive use of longer sentence and richer discussions using complex, abstract concepts rather than simple words. Hearing few words and receiving many discouragements impacts negatively on IQ. Hart and Risley (1995) reported that by age three, the children of professional parents have a vocabulary of 1000 words and an average IQ of 117, whereas the children whose parents survive on welfare have a vocabulary of 525 words and an average IQ of 79. They also found that by age three the children of professionals have received 400,000 positive interactions and 80,000 negative ones. Welfare children were exposed to the opposite treatment; 75,000 encouragements and 200,000 discouragements. Many then

encounter further barriers to development in school settings that enforce rigid and punitive behaviour control or limit opportunities to develop language skills via discussion or dialogue in social settings. Early language development is a predictor of future academic performance and success or failure in life (Elliott, 2008) and that by the end of 12 years of schooling, the differences between the highest and lowest performing students may be as much as six school years. What is perplexing is why do some teachers continue to use pedagogical strategies that widen rather than close this gap?

Strong emotions such as fear narrow the perceptual field, demand attention to the threat and ways to avoid or escape the threat and render an individual incapable. This inhibits exploring or pursuing new possibilities (Izard, Ackerman, Schoff & Fine, 2000) whereas the activation of another emotion, such as curiosity increases ways of dealing with a complex situation. Izard et al., (2000) show that when a person confronts a fearful situation, impulses from the sense organs travel to the thalamus, neocortex and amygdala. The amygdala establishes whether the danger is significant, and if so, triggers an autonomic system response, such as increased heart rate and increased blood flow to the muscles, to prepare the body for fight, freezing or flight. It also wakes up the frontal lobes, which, although slower to react, may subsequently over-ride the instinctive response. Fear, and its' associated but learned emotion of shame, that are part of the teacher's arsenal to maintain classroom control, can become self-perpetuating. Shame is rooted in early parent-child relations, and although it occurs mainly in relations, can also be felt when alone. Boys, for example, learn to feel ashamed of showing they are afraid. Fear and shame are closely coupled and feeling shame can activate fear. Shame also pairs with anger, and if the shaming persists, can lead to violence. But anger can also diminish the shame experience when it acts as a defence to prevent further shaming. Fear-shame-anger together in a cycle can lead to the suppressed anger of alienation (Lewis, 2005) that is exhibited by some students. Shame involves a loss of control (defeat, alienation, indignity) and involves a heightened sense of self-awareness. It is a cognitive rather than an instinctive process. The person feels belittled or an object of contempt.

Human beings are biased towards the negative because negative emotions and expectations (Seligman, Rashid & Parks, 2006) have their origins in survival. Depressed moods and narrow thinking reinforce each other, resulting in a downward spiral. Frederickson (1998) has shown that positive emotions can reverse the effects of negative emotions so people can become healthier and more creative by adopting a

positive attitude. Positive emotions and a broader thought-action repertoire amplify the other (Frederickson & Joiner, 2002; Seligman, Rashid & Parks, 2006).

If you give a person an interesting task the whole brain lights up, but attack or insult the person, and they switch off (Abbott, 1997). When a person successfully masters an activity, the signal strength falls away so that, according to Goldberg (2000), “highly automatic, effortless, easy” (p. 54) tasks associated with the left frontal lobes generate no detectable signal. Rizzolatti et al. (1996) found that the same neurons fire in the brains of humans and monkeys when they watch an action being performed and when they perform the action. “Mirror neurons” (Jeannerod, 1994, p. 2) are responsible for forming an image of the motor action are the same neurons that are activated for planning the action. They are located in Broca’s area which lies adjacent to the motor neuron area where, says McNeil (2005) “inputs from the right hemisphere, the frontal areas and the posterior regions of the left hemisphere...converge” (p. 234). McNeil (2005) contends that:

Without gestures...some of the brain circuits required for language (Broca's area including mirror neurons and possibly others) could not have evolved in the way they have in the human brain, whereby thought and language orchestrates them directly via a thought-language hand (and vocal) link. (p. 233)

In this way, gesture is not merely a remnant of past dominant ways of communicating, but an integral and inseparable part of language and action involving tools. McNeill (2005) says, “the evolutionary step is co-opting the action orchestration areas by things (sic) other than the actions themselves” (p. 250). McNeil (2005) argues that “mirror neurons complete Mead’s loop in the part of the brain where action sequences are organized – the two kinds of sequential actions, speech and gesture, converging....” (p. 250-251) and that the “gesture and language centres are side-by-side” (p. 256). It is damage to this part of the brain that makes it difficult to sequence actions into a new “kinetic melody” for the “orchestration of movement” (Luria, 1973, p. 234). It is therefore quite likely otherwise intelligent and capable people, such as teachers, who know the theory of play or facilitation are unable to sequence and integrate complex speech and motor actions and thereby make the shift from the cognitive role of teaching to the embodied role of facilitating, without considerable rehearsal. Attempting to use and explain new technology in public before the speech and motor routines have become automatic can be a recipe for failure. You cannot learn

to be a great Kung Fu master or a brilliant opera singer without practicing ‘the moves’ so they are as readily accessible as instinctive responses.

Language, as a component of communication, is a relatively recent phenomenon, having developed in the past 100,000 to 200,000 years (Corballis, 2003). Language has adapted to fit the ecological niche of the human brain. It has been described in turn as a parasite that confers and adaptive advantage (Christiansen, 1994), a symbiant which has become co-adapted with its human host (Christiansen & Chater, 2007), a virus (Deacon, 1997), organism (Pennock, 1999) and a meme (van Drien, 2005). Although humans could survive without language, language needs humans for its’ survival. Christiansen and Chater (2007) show that language has a “vanishingly small” (p. 10) probability that it could have developed through natural selection, having changed far too rapidly to enable natural selection to operate. Modern languages derive mostly or completely from a single language spoken in East Africa about 100,000 years ago (Cavalli-Sforza & Feldman, 2003, p. 273) and wide syntactic diversity in the Indo-European group from a common ancestor perhaps 10,000 years ago (Gray & Atkinson, 2003). In some parts of the world, language has mutated rapidly. In Papua New Guinea, which was settled in the past 50,000 years, an estimated one quarter of the world’s languages are spoken (Diamond, 1992).

Christiansen and Chater (2007) show that language co-evolves as a “complex and interdependent ‘organism’ under selectional pressures” (p. 1) (see Figure 4.7) due to the survival of those members of the human species who use language to adapt to new circumstances

Figure 4.7: Language adaptation under selective pressure (Redrawn from Christiansen & Chater, 2007, p. 12, originally Figure 2(b)).

Please see print copy for Figure 4.7

Christiansen and Chater offer mathematical proof that rejects Chomsky's theory that humans are born with a universal grammar that is biologically determined. They show that rate of change of languages is much faster than the genetic changes necessary for language to develop. They show the spread of new human capabilities via tools occurs, not only through the use of the tool, but also via the names given to the tools and their parts, and contributes to the enrichment, evolution and lexical magnitude of meanings.

Many of the inventions of the past century, and their associations, are easily recognisable, such as air planes and airports, spreadsheets and word processors, automobiles and autobahns, radio and airwaves, to name a few. In this way, what was once a theoretical backwater, can become adopted more widely by society. At the same time a lexicon is developed to name the parts of the tools and to explain their use to novices, which contributes to the further development and the spread of the language associated with the tool. Also, what begins as a concept grows up into a theory or a model and becomes a psychological tool that can be used initially by a limited expert or professional few, but at a later stage of development by novices, who become familiar with the language.

A novel argument for an autocatalytic theory of mind that originates in the evolution of language and gesture is proposed by Gabora (1998) to explain the shift from episodic to mimetic culture and from short-term memory to long-term associations. According to Gabora, language learning is the result of selection processes of many generations of prior learners who have contributed to the evolution of the language towards the attractor of the most popular guesses of prior learners (p. 26). Gabora (1998) states:

Language provides a means for individuals to mutually enrich one another's worldviews and to test their worldviews against each other. The bottom line is: culture as we know it with its explosive array of meaningful gesture, languages and artifact depends on both intra-individual and inter-individual meme replication. The advantages of a stream of thought would be largely lost on non-human animals because they neither have the vocal apparatus nor the manual dexterity and freedom of upper limbs to implement creative ideas. As worldviews become more complex, the artifacts we put into the world become more complex, which necessitates even more complex world-view, thus a positive feedback cycle sets in.... Memes act as memory pointers to other memory locations.... Correlated memes get stored in overlapping locations. Much as polymer A brings polymer B into existence by catalyzing its formation, meme A brings meme B into conscious awareness by evoking it from memory.... A retrieval can be a reminding, a redescription of something in light of new

contextual information or a creative blend or reconstruction of many stored memes....Reminding events increase meme density by triggering symbolic abstraction which in turn increases the frequency of reminders....As episodes accumulated in....memory occasionally it happened that an instant of experience was so similar some stored episode that a retrieval process occurred...and kept this stream of thought going long enough to refine a concept or perspective, or invent a novel artifact. (p. 3)

In a lively debate, conducted via an internet discussion board with Gabora and others, Kauffman (1999), one of the leading researchers in the field of complexity theory, concurs with Gabora's autocatalytic model of brain development. He also poses the questions about whether the long quiet periods of tool development punctuated by short periods of rapid change, might also be apparent in the stages of development of child development. Kauffman (1999) states:

As the capacity for abstract thought increases "the pathways of reminders are far richer, ramifying and recurrent....The emergence of autocatalytic reminders, as abstraction increases becomes the wellspring and driver of the emergence of coherent world views.... Do small children recapitulate this sequence? Are there corollaries in artifact diversity that can be found in the Paleolithic and Neolithic records? What of technological diversity and the development of vocabulary in ancient Egyptian and other early written records? (p. 1)

Therefore, it seems likely that conceptual groupings are autocatalytic sets, and act on each other when mixed in the cognitive equivalent of the reaction flask. As Wittgenstein points out, concepts do not exist alone, but in mutually defined sets that are "jointly needed for each other" (Kauffman, 2008, p. 77). Multiple reminders (Gabora, 1998) serve to reinforce the group's belief in the validity of the concepts. If this is so, then this may help explain how the team learning system works. Perhaps the questions initiate the process of concept formation, which asks the group to explore aspects of Concept A that then reminds Amy of concept B. Concept B reminds Betty of concept C. Concept C reminds Chris of Concept B and so on.

The dynamics of small groups and the subtle role of leadership

Group development has been extensively studied and is represented in both the management and small group literature, but remains undeveloped in activity theory. The critical issue faced by groups is how they negotiate the use of shared tools, including how to coordinate their activities in order to achieve a collective outcome, such as winning a game, making decisions, performing a complex and multilayered task or

creating new knowledge. At one end of the coordination spectrum is the anarchic group where there are no rules, no leadership and utter chaos. At the other end of the spectrum is the military platoon with rigid rules, clear leadership and precision. In the middle is the way that most people live and work.

Newly formed groups whose members come from even slightly different cultures often have no history, nor norms that give the members guidance about how to interact with each other. Each person forms a “theory of mind” (Goldberg, 2001) of the other members of the group and what they might be thinking in order to anticipate their actions or reactions. Thus any “theory of mind” about another person, requires for completeness, a mental representation of a person’s performance relative to another individual and what they might be thinking about what you are thinking. The range of potential interactions and reactions are enormously complex, but research shows there are clear patterns to how members of groups engage with each other. For people who work with large groups such as facilitators and teachers, the potential interactions are staggeringly complex, and similar to the anarchic state that groups face when they meet for the first time.

The dynamics of small groups have been explored by researchers such as Shaw (1932) who showed that groups can solve problems more successfully and faster than individuals can. The group dynamics field is very broad and covers the sociology of groups (Lewin, 1947), small group interaction analysis (Bales (1950), group problem solving (Bales & Strodbeck, 1951), organisation development (Schein, 1988; Argyris, 1990; Schein, 1997), team learning (Senge, 1992), team formation (Tuckman, 1965; McGrath, 1990), computer support for interacting groups (DeSanctis & Gallupe, 1987; Nunamaker et al., 1991; DeSanctis, Poole & Desharnis, 1991; Cole & Nast-Cole, 1992; Gallupe & Cooper, 1993), learning communities (Scardamalia & Bereiter, 1993), and communities of practice (Lave & Wenger, 1991).

Throughout the literature, there are occasional references to a state of team development (Schein, 1988; McGrath, 1990; Senge, 1992; Losada, 1999) that has the hallmarks of a phase transition. What is not clear is whether this new state develops via a process of self-organisation (Losada, 1999) or by the close temporal coordination of “entrainment” (McGrath, 1990, p. 23).

The conditions under which groups transform into highly performing teams and develop new knowledge and meet individual and group needs include clear goals, feedback, creativity, trust and distributed leadership (Schein, 1988), focus on the task

(Schein, 1988; Losada, 1999), enthusiasm for the task (Losada, 1999), a sense of time transformation (Senge, 1992; Findlay & Fitzgerald, 2005a) and the orchestration of activity (Senge, 1992). Other factors include time spent together which increases bonds through friendship (Thomas & Fink, 1963; Lott & Lott, 1965; Insko & Wilson 1977) or if a group is threatened by external forces and coalesces to protect the group's interests (Stein, 1976). Group size is also a factor; small groups are more productive and reach consensus more readily (Mintzberg & Quinn, 1991a) as there are more communication links than larger groups. Schein (1998) shows that effective groups are prepared to share leadership, seek novel and improved methods, consider all aspects of issues prior to taking action, remain open to each other views and are candid with each other. Members of ineffective groups exhibit divergent or conflicting goals and engage passively, aggressively or withdraw. One or two people dominate poorly performing groups; members mistrust each other, jump to conclusions or avoid making decisions and are rigid in the way they think and act. When groups meet for the first time the participants develop a tentative structure; they try out variations of the arrangements before the group settles into a relatively stable state (Parsons & Bales, 1955) which Arrow, Henry, Scott Poole, Wheelan & Moreland (2005) consider to be an early form of self-organisation.

Poole, Van de Ven, Dooley and Holmes (2000) offer a model of four types of change in groups – life cycle, teleological, dialectical and evolutionary –some of which are deterministic and others exhibit features of self-organisation and emergence. The pattern of development occurs either through the unfolding of predetermined change (life cycle), movement towards a goal with feedback that results in improvements (teleological), change that involves opposing forces whose positions are synthesized and new cycles begin (dialectical) or cycles are determined by variation and selection (evolutionary change).

According to McGrath (1990), the state of peak development of a group is when the activity becomes so highly coordinated that a form of social entrainment or synchrony is established. McGrath's theory has some of the elements of Hutchins and Hazelhurst's (1992) theory of distributed cognition where individual activity in a group becomes so finely coordinated that a resonance sets in and the activity becomes entrained through the shared use of common artifacts and the adoption of common rules. Examples of shared physical environments and rules which lead to entrainment of activity are public highways and the driving code designed to prevent car crashes, the

shared use of a library where the rules of borrowing determine access to books, and football ovals, goalposts and ball where the rules determine how players can win the game.

Senge (1992) offers an example of spontaneous emergence by which collective activity becomes synchronised:

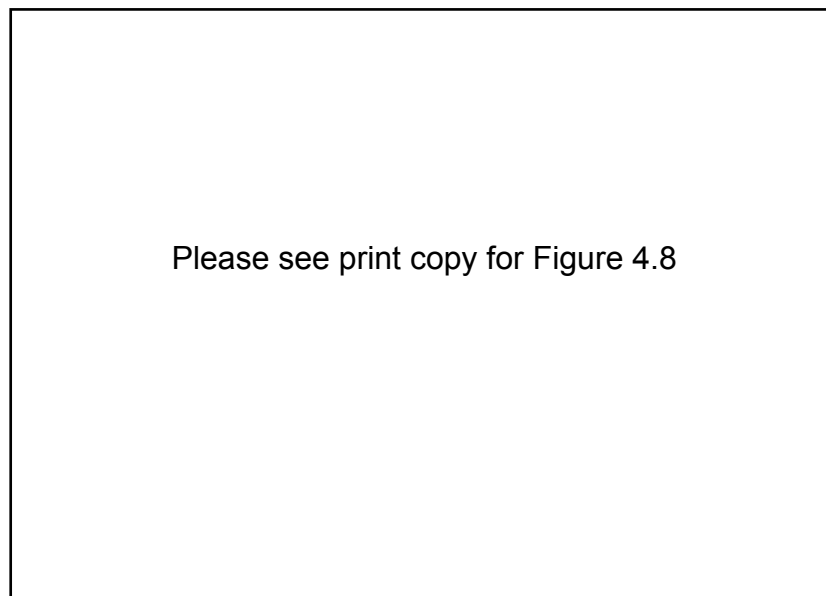
Basketball player, Bill Russel, wrote of the Boston Celtics, “Every so often a Celtic game would heat up so that it became more than a physical or mental game and would be magical. When it happened I could feel my play rising to a new level...all sorts of odd things happened,...the game would move so fast that every fake cut and pass would be surprising....it was almost as if we were playing in slow motion....During those spells, I could almost sense how the next play would develop and where the next shot would be taken....To me, the key was that both teams had to be playing at their peaks. (p. 234)

In contrast to McGrath’s (1990) entrainment model, which explains team development as a temporal alignment of activities, Losada (1999) makes an important connection between team development and complexity theory, which explains the change in terms of a shift to a new relationship and structure. Using complexity theory as a research model, he shows that peak team performance is highly correlated with group connectivity as measured by the number and strength of speech acts between the members of the group. Group performance declines as the number of connections becomes smaller and weaker. High performance teams create new opportunities and the emotional connections including trust, sharing, mutual support and engagement. Poorly performing teams exhibit little enthusiasm for their tasks, do not trust each other, and become cynical. Losada shows that connections between members of highly connected groups exhibit a quasi-periodic cycle, which usually represents two or more unaligned limit cycles at work within a system, whereas poorly connected groups exhibit much simpler dynamics in the form of point attractors that are equivalent to stasis.

Tuckman’s (1965) group development model also exhibits some of the features of a phase transition. Groups progress from a poorly organised state through a chaotic or disassociated state to a highly orchestrated or organised state in five stages - forming, storming, norming, performing and adjourning – as shown in Figure 4.8. Each stage of the process, says Findlay (2003a) “is related to the degree of interconnectedness, alignment between the interests, and coordination between the members of a group” (p. 52). Thus, when numerous individuals engage with a shared tool such as a group decision support system, library, football field or a freeway the various individual

objects are transformed into a common object, which transcends the previous objects – a kind of advanced complex object. This is quite different to the unstable or chaotic group dynamics that are evident when the goal is mandated or the tasks are proscribed by a person in authority such as a manager or when the subjects speak simultaneously with many voices as occurs with anarchy, or when separate coalitions form within a group antagonistic towards each other.

Figure 4.8 Stages of team development and phase-shifts (based on Findlay, 1997, p. 10)



Mintzberg (1991a) contends that small groups of 6-7 people are the most productive as they offer opportunities for emotional development and ease of managing relationships. As the number of participants in a meeting increases, the available communications channels “increases exponentially” (p. 752). As group membership increases consensus becomes harder to achieve and affective ties with other team members decline. Mintzberg (1984) also developed a model of classifying organisation types according to their type, tensions, their structure, socio-technical design parameters, and contingency factors such as age, size and power. These aspects of organisation design are of interest to this study because they direct attention to the different kinds of structure that are determined by the types of discourse each employs. The five organisation types are the *adhocracy* such as advertising agents or think tanks, *entrepreneurial* such as start-ups, *machine* organisations such as large bureaucracies, *professional* such as hospitals or legal firms, the *political* including regulatory authorities, and the *religious* such as the kibbutz or al Qaida; the tensions on the

organisations of which there are also five – efficiency, concentration, direction, innovation, competition and cooperation and the five methods for coordinating activity which comprise mutual adjustment, direct supervision, work process standardisation, output-standardisation and skill and knowledge standardisation.

Group development is influenced not only by the way the members approach the establishment of joint goals and the process by which they are socialised as a group, but also by their core beliefs. The *ten schools of thought* model developed by Mintzberg (1990) explains some of the different approaches to strategy formation and the wide spectrum of outcomes that may be possible. Each school of thought relies upon a different combination of role-based, rule-based and theoretical model-based approach to discourse with potentially different outcomes for both the members of the group and either the formal or emergent leader, manager or facilitator. The *design* school sees strategy development or goal setting as a process of conception, with architecture as the metaphor. The *planning* school develops strategy by way of a formal process informed by systems theory or town planning. The *positioning* school concerns itself only with analysis and facts. The *entrepreneurial* school regards strategy as an envisioning process that is grounded in economics. The *cognitive* school sees strategy as a mental process which has its roots in psychology. The *education* school does strategy as an emergent process informed by political science. The *power* school develops strategy as a process of negotiation in such a way that it is everyone for themselves. The *cultural* school embarks on strategy formation as a collective process informed by anthropology or human development. The *environmental* school engages in strategy formation as a reactive process using biology as the metaphor. The *configuration* school uses strategy as a process of transformation, which depends entirely on the context. When the ten schools of thought are interpreted through the tentative complexity-activity theoretical model, each can be shown to exercise power in a unique way determined by a set of rules for the conduct of discourse that offers fertile ground for the expansion of the range of discourse models developed by Jenlink (2001).

Team performance improves when groups acquire an optimal mix of skills and capabilities (Belbin, 1993) and when individuals are assigned or assume roles. Belbin (1993) suggests that members contribute in two ways to the overall group performance - a functional role based on the professional or technical knowledge and a social role based on how they relate to others. Self-knowledge and an appropriate mix of roles can improve team performance. Belbin operationalised his theory by creating a tool known

as *Belbin's team roles* (Belbin, 1993) but very little research has been carried out on its efficacy. The roles comprise the *plant*, who is imaginative and generates solutions to problems; the *resource investigator*, who finds opportunities and makes new contacts; the *coordinator*, who clarifies goals and promotes decision-making; the *shaper*, who has the drive to overcome obstacles; the *monitor-evaluator*, who judges the accuracy of things; the *team worker*, who listens, works and avoids friction; the *implementer*, who reliably makes things happen; the *completer-finisher*, who is painstaking, detects errors and corrects omissions and the *specialist*, who is a self-starting type who supplies services in short supply. Belbin contends there are two critical roles, the person who stimulates new thinking in a group and the encourager who praises or warmly accepts the thinking of others. The combined roles are similar to Vygotsky's idealised teacher. One study by Prichard & Stanton (1999) found that consistent with Belbin's theory, mixed role groups perform better than a team consisting of one type – shapers – alone. In a separate line of study, Mintzberg (1975) argued that a successful team also requires a mix of roles including figurehead, disturbance handler, liaison, disseminator, entrepreneur, resource allocator, leader, monitor, spokesperson and negotiator. Similarly, Dalton's (1985) cooperative learning model assigns individual students a role as a reporter, devil's advocate, questioner, teller, praiser, summariser or linker.

A new type of leadership role – the facilitator - has emerged from this multiplicity of roles (Findlay, 2002) to support the activities of conventional face-to-face groups as well as people who meet on-line. The role combines aspects of many of the roles envisaged or identified by Belbin (1993), Mintzberg (1975) and Dalton (1985). The facilitator keeps time, asks the appropriate or difficult questions, encourages the group members, maintains a record of the process including what they collectively think or mean, and points to possible linkages between ideas and keeps the group on track or task (Findlay, 2005). The facilitator is seen as an expert in a multiplicity of fields including conflict resolution and cross-cultural communications (Camacho, 2001), managing meetings, adult learning and motivation, group dynamics, problem solving, decision-making and conflict management (Sisco, 1993). Heider (1997) shows that groups perform best when the facilitator adopts such a light but firm touch that the group believes "We did it ourselves!" (p. 33).

Quinn (1998) sees the facilitator as playing many of the roles of a leader who deals with the political, rational, consensual and empirical aspects of group needs. As a broker or innovation leader (Wright & Rohrbaugh, 1999), the job of the facilitator is to

help acquire resources and improve group flexibility; as a producer or director, the job is to identify goals and achieve them efficiently; as a mentor or mediator, the job is to build group cohesion and develop people and as a coordinator or monitor, the job is to manage information and to keep the activities on track. In recent years, community development work has shifted its' focus from the therapeutic or "sickness" consulting model to an asset-based facilitation model (Kretzman & McKnight, 1993). Instead of bringing in experts and resources from outside to deal with deficits and tell them what to do, the facilitator helps the community focus on their existing abilities, Capece and Schantz (2000) argue that under the therapy model, programs collapse when the expert withdraws. The asset-based model ensures the community develops ownership of what it has created for itself. The role of the facilitator is like a mediator who helps guide the way the discussion takes place so the participants attack the problem and not each other. A similar change has occurred in the on-line environment where facilitators need to have process rather than content skills. In the on-line learning context, the facilitator's role is to encourage student discussion, criticism and reflection (Gustafon & Gibbs, 2000), act as a neutral servant of a group who is clear about their role, insist on workable agendas using open-ended questions, get agreement about and manage the process, stay out of the limelight, avoid being the expert. (Smith, 2000) and have some expertise in the design of activities and the theories of conversation (Thorpe, 2002). The appreciative inquiry mode of facilitation takes this affirmative approach further and builds on positive aspects of people's lives (Cooperrider, Barrett & Srivastva, 1995). A variation is the positive psychological model (Seligman, 2002) and the strengths-based approach (Frederickson, 2003; Frederickson & Losada, 2005), which encourages people to expand on existing capabilities, skills, resources or personal characteristics about which they feel positive.

Overall, there has been a trend away from leadership concentrated in a single individual to leadership distributed throughout the group, or to neutral leadership. Of particular interest in this study, is what type of role the facilitator plays when using the team learning system and what difference the software facilities such as the multiple active windows, the etiquette, the question asking process and the sense making tools contribute to the result. As I showed in chapter 2, schools generally continue to employ a coordination model that concentrates power in the hands of the teacher at a time in human history when society requires more flexible and less intrusive models of coordination. Employers, for example, expect young people to be able to use a variety

of discourse, relating and coordination models such as brainstorming, planning and problem solving and possess leadership, managerial, teamwork and presentation skills. The exertion of authority or epistemic power, which many teachers believe is necessary, to maintain classroom control, causes the members of the student group to “circle the wagons” in a defensive movement, against the teacher, who is perceived as the enemy. Another issue is that support for the introduction of new, more efficient work methods that help organizations survive rapidly changing times can not be achieved by simply telling educated staff, what to do and think. The overuse of authority power builds resistance, yet teachers continue to employ this outmoded model.

The role of novelty, play and attention in transformation

A theme that runs through the activity theory and the complexity theory literature is that change, both incremental and transformational, appears to be a state for which humans have a genetic, cognitive or cultural predisposition. There is no doubt that a very large pair of frontal lobes sets humans apart from other animals, and that the right frontal lobes especially, are always ready to create new “kinetic melodies” (Luria, 1973) to deal with fear provoking novelty and the dangerous. Then, when new routines are handed-off to the left frontal lobes to manage new orchestrated actions automatically in the background, moderate emotions come into play.

A theory that has some potential to explain this love for change is flow. Flow is a theory of optimal experience developed by (Csikszentmihalyi, 1975) to explain how humans are bored by inaction, are fearful of giant leaps and get a buzz out of modest achievements. During the flow experience an individual’s whole body, mind, and consciousness becomes ordered and harmoniously directed, action and awareness merge, feelings of indecision and anxiety disappear and self-consciousness and worries recede (Csikszentmihalyi, 1975). Csikszentmihalyi shows that flow only seems to happen when the task or activity is within the capability of the individual, and when there are clearly established rules for action. Although flow is usually commonly regarded as a personal experience the phenomena seems to also occur in group settings or when people use a tool that captures their complete attention. The close match between the challenge and the skills generates rapid feedback that engenders the flow state, in which the participant becomes deeply absorbed and oblivious to the world around them (Kubey & Larson, 1990). Flow experiences are so rewarding in terms of fun and enjoyment that they become self-justifying, which is the same experience that

children have in collective play (Vygotsky, 1978) when they act beyond their usual capabilities.

Eight characteristics of flow have been identified by Csikszentmihalyi (1997) who says that:

Being an engineer or a carpenter is not in itself enjoyable, but if one does things a certain way, then they become intrinsically rewarding. Flow is an almost effortless yet highly focused state of consciousness and the descriptions do not vary much by culture, gender or age. In interviews, people repeatedly mention certain key elements in their impressions of this enjoyable experience: 1. There are clear goals every step of the way. 2. There is immediate feedback to one's actions. 3. There is a balance between challenges and skills. 4. Action and awareness merged. 5. Distractions are excluded from consciousness. 6. There is no worry of failure. 7. Self-consciousness disappears. 8. The sense of time becomes distorted. 9. The activity becomes an end in itself. (p. 1)

Flow occurs in many kinds of activities, usually games, play and creative activities (Csikszentmihalyi, 1997), when playing chess, dancing and climbing rock formations (Csikszentmihalyi, 1975), when competing in sports (Jackson & Csikszentmihalyi, 1999), while browsing the web (Chen, Wigand & Nilan, 2000; Novak, Hoffman & Duhachek, 2003; Chen 2006), playing computer games (Kubey & Csikszentmihalyi, 1990) and when engaged in other computer tasks (Woszczynski, Roth & Segars, 2002; Pilke, 2004). Interviews conducted by Csikszentmihalyi (1977) over twenty years with people from all walks of life - engineers, chemists, writers, musicians, historians and sociologists – found that they choose to work in their respective fields because it is fun or involves discovery.

A major study by Kubey & Csikszentmihalyi (1990) of several thousand people conducted randomly through each day over several weeks found that flow occurred most often when people were engaged in their favourite activities – playing sport, working, playing games or socialising. Of 16 common daily activities, lovemaking tops the list followed in order by socialising, talking, eating, playing sport, shopping and cooking, well above watching television or reading. Flow occurs frequently at work, generally when eating with others or in conversation about non-work topics. Work-related conversation is more enjoyable than other work. Flow is least likely to be experienced during passive activities such as watching television or relaxing.

According to Csikszentmihalyi (1997), teenagers experience flow three times more often when they play sport or games (44%) than when they watch TV (13%), but they also experience flow when they are involved in hobbies (34%). In classroom

settings, Csikszentmihalyi and Larson (1984) found that students are bored when the teacher is lecturing and most bored when other students act in the role of the expert presenter. They also found that the most positive student experiences involved interactive activities especially class discussions and group work. The least positive experiences were in classes dealing with abstract subjects. Flow is more likely when students feel they control their learning (Boyer, 1996). A study by Custodero (1997), of 4-year old and 5-year old children who were learning music, found flow in most musical activities. Flow develops when children play video games that become more difficult as players acquire new skills (Kubey & Csikszentmihalyi, 1990). Flow also occurs in group activities including 60 percent of the time when interacting with family and 6 percent with friends (Kubey, 1984). People enjoy talking the most (Kubey & Csikszentmihalyi, 1990).

A study of flow in high school students by Shernoff, Csikszentmihalyi, Schneider & Shernoff (2003) shows that students participate mostly in passive activities including working alone (23%), lectures (21%), copying or making notes (10%), homework and studying (7%) and very little time interactively engaged such as discussion (9%), group or work in a laboratory (6%), and talking to the teacher (1%). The study found that individual work can be as engaging as group work. Students who regard their skills as high report they are highly engaged only if the task is challenging. The students feel more engaged when the tasks are relevant and they have more control. Concentration is highest during examinations (83%), individual work (78%), group work (75%) and least while listening to a lecture (65%) or watching TV or a video (57%). Art and computer science are the most engaging lessons while history, English and social studies are the least interesting. Although students are highly engaged in examinations, they are the least motivational learning activity. Marks (2000) found that small group work is regarded by students as student-controlled whereas whole group teaching is seen as teacher-controlled. Shernoff, Csikszentmihalyi, Schneider & Shernoff (2003) state:

The abundance of lectures, taking notes, and watching videos makes for a narrow range of classroom activities that leaves little room for active engagement. An interesting question becomes how students can be expected to reach adult goals of participation, belongingness, and identification with school (Finn, 1989) when active and meaningful participation is not consistently invited in classrooms... student disengagement may stem from a lack of challenge or meaning, which was reported to typically occur in the lecture format (i.e., teacher-initiated instruction). (p. 171)

Flow is frequently reported by users of computers and players of computer and video games (Ghani & Deshpande, 1994; Webster, Trevino & Ryan, 2003; Weibel, Wissmath, Kronrad, Filip & Hoffmann, 2003; Green, Brock & Kaufman, 2004; Voiskounsky, Mitina & Avetisova, 2004; Hu & Chang, 2007; Habegger, Steiner & Groner, in press). Although play is widely recognized as being vital to the development of young children, playing computer or video games is often dismissed by educators as having little value (Roussou, 2004). Ghani and Deshpande (1994) found that workers, who used trial and error to learn how to use computers experienced flow, feel in control and enjoy the challenge. This approach to learning also relates to expanded computer use. Malone and Lepper (1987) show that games provide seven kinds of intrinsic motivations – challenging tasks, curiosity about what comes next, control over one’s destiny, immersion in fantasy, competition with other player or against a nominal other, cooperation with others in multi-player gaming situations, and recognition for progress through the game. When playing games on computers, gamers who play against a real person report stronger flow experiences than those who play only against the computer (Weibel et al., in press). Massively parallel gaming that has become extremely popular with “children” of all ages has proven to be not only highly engaging but the design principles have been adapted for new learning technologies (Hu & Chang, 2007) so as to attract the interest of students who are turned off by the boredom of conventional classrooms. Museums, for example, have learned that the creation of interactive exhibits is not only popular with young patrons but maintains their attention (Roussou, 2004). The shift to immersive exhibits and activities has reinvigorated attendance.

Sweeter and Wyeth (2005) have developed a model for evaluating player enjoyment of computer games which could be used as a basis for transforming classroom learning. I suspect that a sequence of questions which guides learners from what they know to what they could know and invites them to consolidate what they have collectively created after each set of responses, performs a similar function to a game, because the process delivers an intrinsic reward at each step. The model, which has its basis in flow theory, shows that enjoyment is the main reason people play games. They say games work best if they quickly attract and keep a player’s attention for hours, and then progressively increase the player’s perceptual, cognitive and memory workload. Games become enjoyable when they are challenging so players want to keep playing and achieving. However, the tasks should not be so challenging the game far

exceeds a player's ability that they become anxious or be too easy so the game is boring and not worth doing. Games should progress so that as a player masters one level, more complex and difficult tasks remain. Sweeter and Wyeth (2005) say players should learn as they play, receive rewards for making progress and, if they get into serious difficulties, receive hints or be able to read a simple on-line manual. Ideally, the cues should be present in the game. The controls and interface should be simple and have analogies in the real world. Players should feel as if they are having an impact on the game world and be able to make decisions that change whether they win or lose. Games should also have a clear goal and goals within each level. As the game progresses, players need frequent feedback about their performance, usually via a progress score. If they lose at any stage in the game, they need to know whether they are making progress overall. Flow is thus a moment-to-moment experience and an overly difficult or irrelevant task can change the mood and level of engagement (Sweeter & Wyeth, 2005).

Pearce, Ainley and Howard (2005) show that flow can be regarded as a process rather than a state. Their study of student engagement with an on-line simulation found that perceptions of flow change over time depending upon the match between task difficulty and acquired skills. This study will consider whether any of these features are incorporated into the team learning system, and if so, to what effect.

Chen, Wigand and Nilan (2000) consider the flow experience as the link between individual or group activity and cultural evolution. They say flow is as "an engine of evolution propelling human beings to a higher level of complexity and to an improved psychological wellbeing." In order to continue to experience flow, individuals may need to pursue greater challenges and in doing so increase their skills and knowledge, which may thereby confer an adaptive advantage compared with other people whose brains are rarely challenged or who suffer from excessive anxiety and retreat from new experiences. Csikszentmihalyi (1997) shares this view. He presents the argument that humans evolved from ancestors who survived because they became skilled at inventing and exploring and were thus able to deal more successfully with the unpredictable. He says that the discovery of novelty engages the brain and evokes a pleasurable experience and that without the motivation for enjoyment there would be no evolution of culture. Csikszentmihalyi (1997) also regards the evolutionary aspects of flow in terms of energy seeking behaviour through two contrary processes that can be broadly translated as cooperation and competition. The cooperative approach to energy seeking, symbiosis, leads towards harmony and increasing complexity and with this an

increase in diversity that is observed in languages, rituals and cultural tools as well as the integration of interests and diverse opinions necessary to bring new ideas to fruition.

At a cognitive level, research into flow and brain functioning has been inconclusive, although flow has characteristics in common with team formation (Schein, 1988; Losada, 1999) and collective play (Vygotsky, 1978). Flow does not appear to have a unique signature than can be attributed to a particular neurological event (Marr, 2006) although Ashby, Isen and Turken (1999) have shown that rapid attention set-shifting correlates to feelings of elation and satisfaction consistent with the release of the neurotransmitter dopamine which engenders pleasant feelings but also “stabilizes active neural representations in the pre-frontal cortex” (p. 529).

Goldberg (2001) shows that attention, an important aspect of flow and critical to learner engagement, is “a loop-like process involving complex interactions among the pre-frontal cortex, ventral brain stem and posterior” (p. 171).

The frontal lobes play a key role in motivation and attention (Goldberg, 2001, p. 4) which are fundamental to flow. The twin epidemics of attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD) have their origins in minor malfunctions of the frontal lobes or their connections elsewhere in the brain. Dysfunction of the frontal lobes is also involved in dementia, schizophrenia and head trauma as well as Tourette’s syndrome and obsessive compulsive disorder. Goldberg (2001) says, “attention deficit disorder is often selective and is present only in the “uninteresting” activities but absent in “interesting” activities (p. 173).

Differences in brain chemistry between the lobes may account for the link between novelty and pleasurable feelings. The neurotransmitter dopamine is more frequent in the left, norepinephrine in the right (Goldberg, 2001, p. 42) and neurohormonal estrogen receptors are more pervasive in the right hemisphere. According to Schore (2000), the frontal lobes tend to deal with extreme emotional states that are “far-from-equilibrium” both high and low such as “terror, excitement and elation and low such as shame” whereas the left hemisphere is more involved in moderate emotional states such “anxiety, interest, enjoyment and guilt” (p. 178). Thus, flow can be shown to be a useful measure of attention and engagement, but it may also be a way of assessing whether control has been transferred from the right frontal lobes to the left and if development is in train.

Summary

This chapter began by asking what theories Vygotsky would have considered if he was alive today in order to deal with contradictions that have developed in activity theory over the past century. The review has traversed the fields of complexity theory as well as recent developments in brain science, genetics, innovation, organisation development, small group theory and flow theory in order to consider what ideas might fill in the gaps.

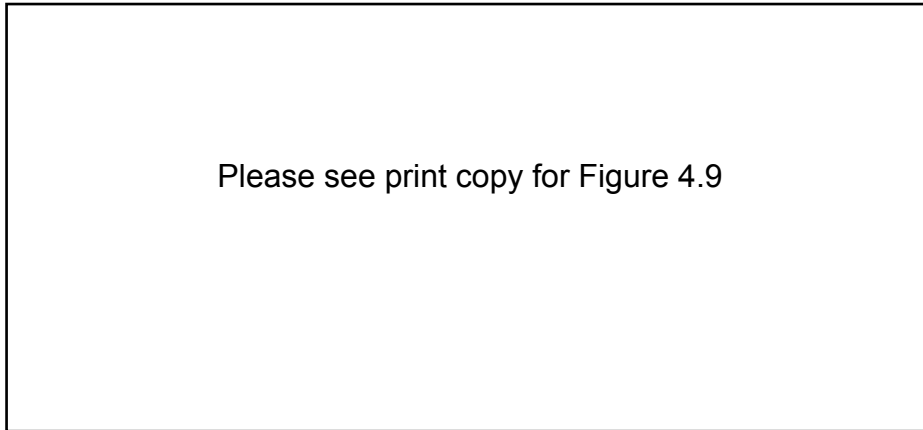
Much has been made of the differences between human brains and the brains of other species, particularly our fellow primates. Our large frontal lobes set us apart. As a single interbreeding species that dispersed geographically 40,000 to 50,000 years ago, we remain very similar genetically to our “stone-age” ancestors, just one sixth of .1 per cent, compared to 1.2 per cent difference to our nearest primate relatives. In what has clearly become a symbiotic partnership between our “stone-age” brain and our ever more powerful tools, humans have learned to perform an ever-widening spectrum of roles as well as roles that are increasingly more powerful.

Activity theory has long held that human activity is primarily goal-directed and that automatic operations have a subservient role. I consider this emphasis on right frontal lobe thinking to be misplaced. We now know that brains are plastic. They evolve. What begins as automatic operations and becomes concretised as tools, appears to undergo its’ own discontinuous development path, via a process of self-organisation, which then influences the structural re-organisation of the human brain, so that the brain operates at a higher level of order. For example, the shift from thinking-acting like a “knowledge telling” teacher to a “question asking” facilitator requires a substantial rewiring of the brain. The synaptic connections which were strengthened to support the automatic activity of teaching need to be undone or overlaid with new, and stronger synaptic connections that support facilitating. This is not a trivial exercise.

A reading of Vygotsky’s writings about child development revealed a pattern that is typical of self-organising systems - long periods of incremental change punctuated by short periods of rapid development. What we learn to do when we are very young is overlaid by progressively more complex automated routines as development proceeds. Self-organisation is also evident in collective play and in the cultural record. As Kauffman shows, large-scale speciations and extinctions, which occur from time-to-time, in not only the biological record but also in the technological

record, have a powerful influence on what we do. When our new ideas create new tools, the old tools die out, and with them, old forms of work. As the old jobs die out, we humans need to “reprogram” our brains to be able to use the new tools that emerge at the same time.

Figure 4.9: Modified model of language and tool evolution (Findlay, in press), based on Christiansen and Chater (2007), see page 167.



In a sense, tools are “concretised” motor and speech routines. The model of the how human brains have co-evolved with language as depicted by Christiansen and Chater (2007) would be more complete if the model included a feedback loop that takes into account the co-evolution with the psychological and physical tools that have evolved out of language (see Figure 4.9)

The pattern of tool speciations and extinctions, and the accompanying job extinctions, appear to follow a pattern of a period doubling cascade, typical of self-organising systems, which is reflected in the stages of cultural development, the elusive pattern that Vygotsky and Luria hoped to discover in central Asia. The ratio of the length of one cultural period to the next appears to proceed towards a limit, which generally approximates to the Feigenbaum constant, a pattern found in all kinds of complex systems. Culture appears to have evolved according to the following pattern:

Hunter-gatherer Age: (pre 8,000BC)
Agricultural Age: (8,000BC – 1700AD)
Industrial Age: (1700 – 1940)
Information Age: (1940 – 1990)
Knowledge Age: (1990 – 2000)
Wisdom Age: (2000+)

What is not clear from the review is which systems - brain, cultures, teams or tools - are self-organising or whether there is a single source and the other systems are synchronised with the primary system. Gabora's argument that concepts act as catalysts by stimulating "rememberings" of other concepts, which in the context of Wittgenstein's (1999) language games of constellations of concepts, seems to be the underlying process. There is some evidence however, that brains are also self-organising, through a process of synaptic pruning of the least used connections (extinctions) and strengthening of the most used connections (speciations). The brain research also shows that if negative emotions such as blame, shame and guilt which develop in right brain to right brain communication between mothers and their young babies come to dominate a life, then a second kind of synaptic pruning, which occurs when people become depressed, reduces the possibility that people will engage in the very activities that will help them "reprogram" their brains. On the other hand, the pleasurable experience known as flow that occurs when humans engage in activities within their capabilities, but just beyond their previous achievements, may explain why humans are attracted to the future, and dislike boredom and anxiety. If a situation is familiar, even if slightly novel, the left frontal lobe simply plays an automatic "kinetic melody" (Luria, 1973) and dopamine flows and with it pleasurable associations. If the activity is too boring, the incoming signals simply fail to jolt the frontal lobes into action. If the situation is anxiety or fear inducing, we may act instinctively, as do other animals and the flight or fight reaction follows, or the right frontal lobes may break the cycle, and override instincts to consciously plan or problem solve our way out of a situation. Thus, selection based on having fun, which is what children do in play, may have worked to favour of brains that enjoy dealing with moderate amounts of novelty and change.

Similarly, the process by which groups become highly orchestrated teams is not clear, but there is evidence from Losada (1999) that peak group development occurs when speech acts between participants is rich and vibrant. On the other hand, McGrath (1990) shows that groups become temporally aligned when members follow the rules of the system, whether they are the rules of the road, playing a game of football or the rules for taking a book out of the library. The jury is out on whether group development is autocatalytic. Such collective activity is the main way that humans create new knowledge, through a process of resolving differences between competing views. On this subject, activity theory appears to have a somewhat idealistic view, and considers

all activity to be dialectical. However, as the management literature shows, change can be extraordinarily slow and incremental. Most deliberate changes at an organisation level to transform collective activity fail, usually because differences of opinions, and diverse goals and needs can not be easily integrated or resolved.

The management and small group literature reveals a trend towards group leadership roles that are less autocratic and more respectful of the participants' views and capabilities, in order to bring more and richer ideas and capacities to brokered solutions. The trend appears to be in response to the democratisation of capability in humans and distribution of cognitive capacity throughout organisations in order to deal with accelerating change. As our tools have become more ubiquitous and more powerful, more and more people are educated to much higher levels so they are able to perform the work that was once the exclusive preserve of senior management, academics and consultants.

As human society works its way through a scientific revolution there are some who quickly adopt and make use of the new knowledge and others who are slow to do so. The adoption of any new tool or technology appears to follow a cycle in which the curious, well-connected visionary risk takers begin the process of invention and adoption. The innovators are followed, at a greater distance, by the progressively more conservative and risk averse. This mechanism could explain how human systems transition from one stable state to another. I suspect that when society approaches the end of a technological epoch and most people have adopted a new tool, the innovators in their midst who earn a living from creating new tools – the equivalent of 21st century consultants and entrepreneurs – have no way to earn a living and face starvation. In order to survive, they invent new tools that fit a new world beyond what people know. The innovators who saved the seeds and stored water for next year, and lived to produce more offspring and carry the tools forward as part of their culture are our ancestors, whereas the non-adopters of the new methods died out.

The literature review provokes a series of questions that this study will seek to answer:

- In what ways does the assumption that the relationship between humans and tools is symbiotic inform, and perhaps change, the activity theoretical model?
- How does the focused conscious functioning of the right frontal lobes and the automatic unconscious functioning of the left frontal lobes relate to incremental and transformational change in human activity?

- What aspects of human activity serve as autocatalytic agents in child, cultural, tool, group and cognitive development?
- Which aspects of human activity, if any, are primary sources of spontaneous emergence, and which, if any are due to entrainment?
- What roles do different kinds of discourse play in the mediation of the object of activity? In addition, what are the gestural equivalents of discourse?
- In what ways do the intrinsic rewards in collective play and flow influence development?

CHAPTER 5

THE COMPLEXITY-ACTIVITY MODEL AND RESEARCH QUESTION

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Overview of the chapter

In Chapter 3, I showed that although activity theory offers a useful framework for exploring the cultural differences between teachers and student users of a collaborative tool in the context of accelerating change, the theory has some gaps and contradictions which are in need of resolution. The review of theories of self-organisation and development reported in this chapter, chapter 4, has identified some possible explanations for the differences between incremental and transformational change, the relationship between the internal and external change of the object in collective activity, and how language and other tools might evolve under selective pressure from brains.

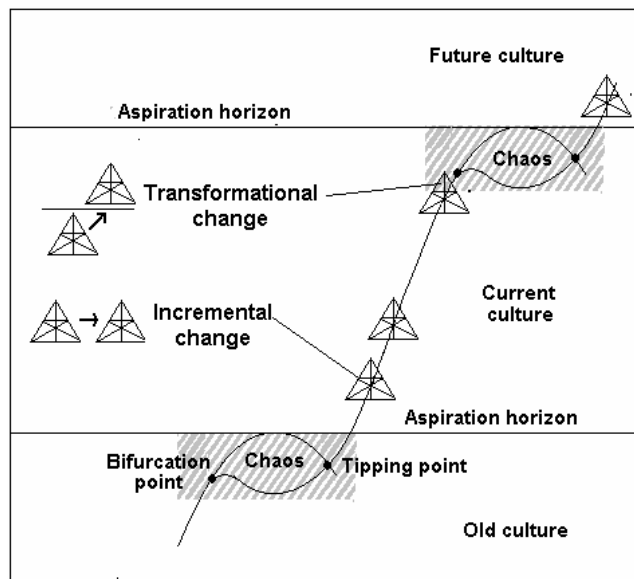
This chapter draws together the two theoretical strands into a tentative complexity-activity model for further evaluation by the study. The chapter concludes with the framing of the research question.

A tentative complexity-activity theoretical model

I have developed a complexity-activity model which considers human activity as a trajectory from the past to an unknown future that is both self-organising and goal-directed. Drawing on the literature review, the model contends that tools are symbiotic extensions of humans and that brains and tools co-evolve. What began as rudimentary speech, gestures and signs has evolved into highly interlinked ecologies of concepts, theories, models, plans, methods, processes and their physical instantiations.

Self-organisation: Transformational changes in activity occur spontaneously and outside human conscious control when the tool-brain system undergoes structural reorganisation associated with the use of radically new types of tools. I have used Engestrom’s activity triangle (see Figure 5.1) to show how activity systems undergo two main kinds of cultural development, *incremental change* where there is sub-optimal reconstruction of the object of activity and minimal or no internal change in the subjects and *transformational change*, where there is both internal and external reconstruction of the object of activity, so that a new structural form emerges in the activity system.

Figure 5.1: Model of incremental and transformational change in activity

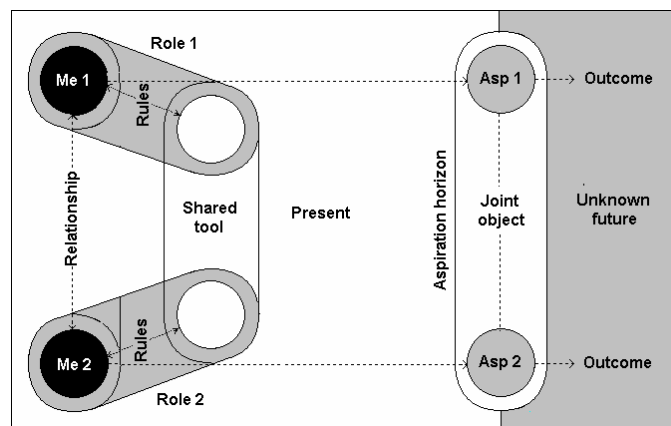


Each stage of cultural development is associated with progressively more complex types of tools, more complex forms of activity, and more richly connected neuronal structures in the brain. Existential threats lead to the development, usually by chance, but not always, of successful tool adaptations and associated “work” practices that deviate from the cultural mainstream. This occurs at the bifurcation point. Other deviant tools and practices emerge, by either chance or imitation, and become more widely adopted, mutually supportive and autocatalytic. This meta-process is usually unconscious and outside human control, at least until humans learn to “surf discontinuities”. The overall process or progressive cultural change involves ever-shorter waves in the form of period-doubling cascades, which commenced with the Hunter-Gatherer Age (Pre 8000 BC) and is currently extant as the Knowledge Age (1990-). At a cognitive scale, the process of automating “kinetic melodies” (Luria, 1973) is autocatalytic, as is the further development of automatic speech and motor

routines which results in synaptic strengthening of the most frequently used circuits of multiple associated routines (speciations) and synaptic pruning (extinctions) as old patterns of work/action are abandoned.

Goal-directed activity. The second type of human activity is goal-directed, generally as understood by activity theory with some variations. The complexity – activity model draws on the categories of Engestrom’s (1987) activity triangle (see Figure 5.2). It sets out to explain activity in terms of the relationship between individual subjects (me) and the collective subject (we), jointly using a tool, often in different ways and according to different rules in pursuit of different needs or different aspirations. The individual aspirations, when considered together, are the equivalent of the object in activity.

Figure 5.2: Joint model of activity where tools are symbiotic extensions

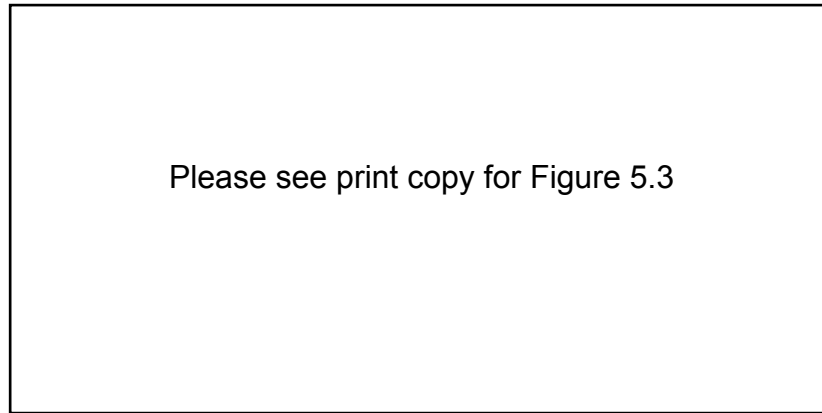


I have moved away from Vygotsky’s original assumption that activity is mediated by tools and have adopted a view that tools are symbiotic (Christiansen & Chater, 1997) extensions of humans (Damasio, 1999). When the relationship between tools and humans is regarded this way, it is the rules (or modes) of communication between participants in collective activity that ultimately determines the function of a tool, whether a stick will simply be a stick, or firewood to be collected, or a weapon to be wielded, or to symbolise some other “thing” in play. As Damasio (1999) points out, brain cells are different to all other cells, because they are not only themselves, but they represent other cells, and become unified with the “tools” you hold in your hand, or say with your larynx, or type with your fingers.

Throughout the remainder of the thesis I will mostly use the revised complexity-activity theoretical model and the concept of *aspiration horizon* as an alternative to *object* in order to expand the original concept beyond its general meaning of *artifact to be transformed, the motive or problem space*, such as play inspirational music, drive sports cars or understand calculus. *Aspiration* contains the sense of an attractor, a concept from complexity theory that describes the organising principle to which the participants in a collective activity system gravitate. It reflects the notion that human activity is about movement towards some new ideal(s) – the aspiration horizon - to which a person, group, organisation or society is attracted or aspires. It retains the original concept of object as a statement of the *artifact to be transformed/problem/opportunity/motive space* but also allows consideration of both positive and negative aspects of development. I have also used the concept of *relationship* instead of *community* to describe the quality of the connections with others that develops from joint activity. The concept of relationship is the same type as tools, roles and rules – an aspect of human capability - whereas community is of a different type, being a member of the class of “subjects” including individual, dyad, group, family, organisation, community group and society as a whole. Aspiration also overcomes the inherent contradiction in the Engestrom triangle whereby community is employed twice when referring to group subjects, both as a subject to which the activity systems relates and one of the mediating means. The concept of *role* is used as an alternative to the *division of labour*, which is a more relevant descriptor of a person’s status in other kinds of activity such as play and school-going without losing any of its interpretive power. The elimination of this kind of Industrial Age cultural bias in activity theory and severing of its historical connection to a conflict between alienated labour and the owners of capital will free activity theory for broader application. By definition, role is what happens when humans partner with one or more tools, to acquire powers beyond what they acquired genetically at conception. Role is simply not an abstract characteristic of a human engaging in activity, but human + tools, including gestures, signs, symbols, language, methods or physical tools. Role is thereby an extension to the human body and mind, akin to Sigourney Weaver wearing a powered exoskeleton (see Figure 5.3) in the movie *Aliens* (Cameron, 1986). When we “strap on” a tool, we gain the power to play different roles. If we have a sword in our hand, we can be a soldier. When we hold a doll, we can play being a mother. When we use our hands, arms and fingers to slide a bow across the strings of a violin, we are a musician. When

we speak with great eloquence and communicate ideas that resonate, we become an orator.

Figure 5.3: Tools as exoskeletons: Sigourney Weaver in Aliens (Cameron, 1986)



Each new tool we adopt or adapt opens up new degrees of freedom for expanded roles, power and influence and changes the relationship with others. A role is determined not only by the tool, but how we use the tool. Differences in tool use are the equivalent of Engestrom's contradictions, when two or more participants jointly use the same tool, but use it according to different rules, as shown in the Figure 5.4.

Figure 5.4: Revised definition of role in relation to tools

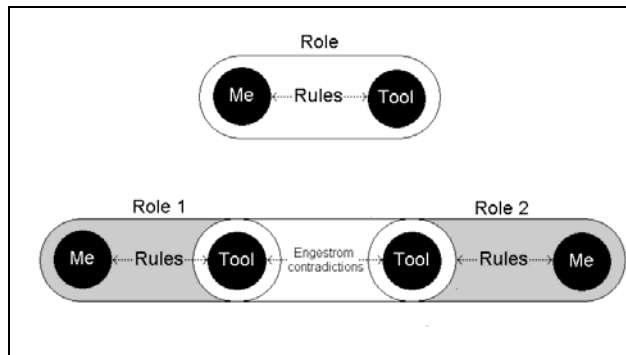
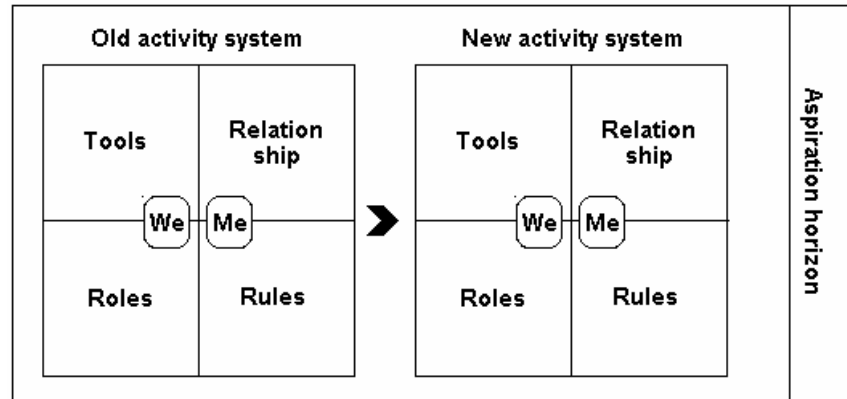


Figure 5.5 is diagram that is intended to be used as an analytical tool to record and illustrate the respective roles of participants in an activity while jointly using a tool as illustrated in the new model of activity as shown in Figure 5.1 and Figure 2. The diagram represents the intersection of the relationship between an individual “me” and the group “we” as a subject makes choices or movement towards a new imagined future, the aspiration horizon.

Figure 5.5: Analytical tool to explore change in activity systems



The research question

We know what schools must do to prepare young people for a more complex and chaotic world in which all kinds of tools – knowledge, technologies and methods – will continue to undergo accelerating transformation. To participate in modern society, young people need to learn how to work in teams, develop empathetic interpersonal relationships, use thinking skills, design and manage projects and engage in new kinds of creativity. It is all frontal lobe mental activity. Yet our teachers persist in employing methods and transmitted “facts” that bore the frontal lobes to bits. The reluctance of teachers to adopt new pedagogies in ways that are more appropriate to the needs of today’s students has confounded researchers for almost a century. If we were to adopt a Rogers (1983) approach to innovation, any new technology we introduce to schools would always fail the sixth condition for adoption – it would not fit with teacher beliefs. From an Engestromian (1987) perspective the “school-going” culture in which teachers are immersed has a powerful hold which ensures change occurs slowly or until perhaps there is a bloody revolution, similar to the one that engulfed the kings and queens and the aristocracy of Europe who ignored the signals of a new paradigm. I suspect that teachers have been acculturated into earlier stages of societal development. Teacher’s “kinetic melodies” (Luria, 1973) for speech and motor action appear to be deeply patterned or “programmed” to perform in quite different ways to their students who have been immersed in a Knowledge Age culture from birth, with its attendant web of more complex connections.

But unlike their hunter gatherer ancestors, teachers do not have to face starvation if their beliefs are a poor fit with a life threatening context. For the past hundred years

the state has removed many of the connections between the feedback mechanisms of society and teacher pay and conditions. The persistence of the system can perhaps be explained by regarding the system of schools and teachers as a dissipative system in which the money that flows through the system sustains it. On the other hand, one would expect that rational teachers acting in the interests of their students would willingly embrace a new technology that simultaneously is a good fit with the ideal forms of pedagogy for the present times, helps students develop teamwork, leadership, thinking and knowledge construction skills required for their future careers and is the type of tool that students enthusiastically use in their home lives. But on the other hand they may not, perhaps out of fear, cultural entrainment or because the equipment failed on the day. It is against this backdrop and using this revised complexity-activity model that I ask this research question:

How do the cultural differences between teachers and students and the historical development of tools explain their use of a tool for collective knowledge creation and how can this be translated into new models of learning consistent with a more robust theory of activity?

The purpose of this study is therefore to explore this tentative model for human learning and development from a synthesis of activity theory and complexity theory and confirm it through the analysis of a series of case studies of learner and teacher facilitated classroom activities supported by a mix of research methods. A secondary goal is to develop the tentative model so that it may be capable of making reliable predictions (Penrose, 1990, p. 197) about learning and development.

CHAPTER 6

RESEARCH DESIGN

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Overview of the chapter

The purpose of this chapter is to explain the research method, the data collection and analysis processes and the theory development procedures in order to answer the research question established at the conclusion of Chapter 5.

In chapter 2, I showed that at school, young people have limited access to two of the most important tools for 21st century work, ICT that in their private lives gives them access to an “always on” Web 2.0 world and high-level discourse tools that Vygotsky demonstrated are central to learning and development. I also showed how the Zing team learning system, a collaborative computer-based tool that is the subject of this study, incorporates the thinking, relating and discourse skills that teachers are reluctant to use, and thus provides a unique laboratory in which to investigate why teachers and learners use tools so differently.

In chapter 3, I considered activity theory as a lens through which to explore these differences. Although activity theory allows researchers to explore the development of people and communities in a social and historical context, it does not adequately deal with several aspects of activity that are vital to this study, especially the relationship between individual and collective activity and the processes of incremental and transformational change.

In chapter 4, I showed that complexity theory, in particular, and other theories of development, appear to fill some of the gaps in activity theory, by offering a possible explanation for the spontaneous emergence of new kinds of order in three aspects of human activity, the cognitive, the collective and the cultural.

The literature review led to the development in chapter 5 of a tentative complexity-activity theoretical model, to rationalise the contradictions between the various theoretical models. This new model contends that human learning and development is determined not only by human goal-directed activity, a central concept in activity theory, but also occurs through a process of autocatalytic transformations, in which the tools we use in our daily lives undergo large-scale transformations, as partners with humans along a new kind of “evolutionary” pathway. The new model regards tools as extensions to the human body and brain, and like exoskeletons, give us the capacity to become more than we would otherwise be. The new model may also be able to explain the relationship between discontinuities in child and cultural development and the process by which speech and motor routines become automated.

The purpose of the study is to assess this model. The findings are reported in chapters 7, 8 and 9.

Methodological considerations

The study is primarily informed by activity theory (Vygotsky, 1978; Luria, 1976, Leont'ev, 1998; Engestrom 1987) and its dialectical nature but is also informed by complexity theory (Kauffman, 1995) and its autocatalytic nature.

The principal unit of analysis used throughout the study is activity as understood by activity theory (Nardi, 1992, p. 35). At the local scale, the focus of the research is on the change that takes place in the activity of the teachers and the students especially what they say and do, their aspirations, the rules of engagement, their roles and relationships, and the developmental changes in the tools that they use. At a collective or intersubjective scale, the focus of the research is on the discourse between participants in activity, how concepts develop and relationships change, and the structural arrangements that develop within a group. At a global level, the study examines how the local changes fit with the large-scale societal, cultural and technological changes reflected in the changes in the fundamental nature of human activity and tool webs. The analysis also considers this new aspect from complexity theory, the possibility that new order may emerge spontaneously and outside of conscious human control (Kauffman, 1995), as a consequence of the interactions between the participants, in the shape of new knowledge (clusters of concepts) and new relationships (high alignment of interests) exemplified by the formation of a large component (Newman, 2002).

In order to allow new concepts and ideas to emerge, an exploratory approach akin to grounded theory (Glaser, 1992) has been adopted so that the data and inputs, such as the literature review, as well as questions and hunches, are all regarded as usable inputs. The literature plays a key role in the study, as a lens through which to conduct the research but also as an input to the formation of a new theory (Kerlinger, 1973):

...and its set of interrelated constructs, definitions and propositions that presents a systematic view of phenomenon by specifying relations among variables with the purpose of explaining and predicting phenomenon.

A central plank of activity theory is that researchers and the participants in the activity are all agents of change, and that it is not possible to separate the observer/researcher from the activity. The act of observing changes the activity (Eisenberg, 1930). In this study, the participants are not merely the subjects of the study,

but are also observers of their own activity and thereby contribute to the theory building process. The team learning system tool is not merely a subject of the study, but a means of collecting data. It is also a “participant” in the sense that some of its’ features appear to support how humans ask sequences of rich questions, assist in the provision of leadership and use higher level forms of discourse.

The design, objectives and methodology of the study have also been influenced by a desire to make a difference to school education so that our young people are no longer bored or alienated by their teachers. The study also seeks to identify ways to achieve a better outcome from school education, perhaps in the manner suggested by Caldwell (2005b) when he borrows from Drucker, the idea of “organized abandonment” (Drucker, 1999) to argue that schools must be reinvented from scratch:

Starting afresh, we must toss out the artifacts, which were designed for past conditions, even if they were successful then. (The school day, the school week, formulaic school holidays, and end-of-year examinations conducted en masse are candidates for abandonment.) Next, progressively abandon whatever has a limited shelf life and is likely to have outworn its efficacy in five to 10 years. (On this criterion, some technologies, some teaching modes, some of the physical plant will thereby be phased out.) And thirdly, remodel any functions or processes which will continue to be necessary but which use resources prodigally. (A lot of the ways we recruit, use, deploy, organize and remunerate the educator staff are prime candidates for radical rethinking.) (p. 4).

Case studies. The main findings from the student and teacher feedback are presented as a series of explanatory case studies, in which the data are accumulated via categorical aggregation (Stake, 1995) and interpreted according to specific theoretical understandings (Yin, 1994). The case study is the preferred method of inquiry where “how”, “who”, “why” or “what” questions are being pursued (Burns, 1997) or where there are multiple streams of intersecting activity, such as occurs with the evolution of a discussion or when social relationships develop over time (Neuman, 2003), which are features of this research. Generalisations are not attributed to populations, but to theory (Yin, 1994). For multiple-case studies, the evidence can be more compelling if patterns can be shown to occur on a variety of scales and across disparate situations (Yin, 1994; Burns, 1997) especially where the influence of the many variables is largely unknown but may be explored with a common set of data collection methods and analysis tools, and the interpretation relies on all the evidence. The strength of conclusions does not necessarily depend on the number of cases. One or two thoroughly researched cases

may provide sufficient compelling evidence from which to draw reliable conclusions (Yin, 1994).

In Chapter 7, ten case studies are presented which report on the teachers and the student experiences with the team learning system. The cases are explored through the complexity-activity theory lens – roles, rules, tools, aspiration, culture and the type of change. The cases focus on the activity of the students of four classes - Year 7 textiles, Year 8 textiles, Year 9 history and Year 12 history, four teachers, a group of seniors students and the facilitators group which comprised the teachers and students who trained as facilitators. The case studies are constructed from a mixture of the transcripts of classroom and student and teacher feedback activities collected using the tool and via a concept analysis, video record and pre- and post- participant reports supported by quantitative measures of participant engagement and interest. Four case studies are presented in chapter 8 that analyse the speech used by the facilitators – the researcher, two teachers and two students – and how their speech assisted or interfered with their performance. This analysis is conducted through a lens of four speech types, previously learned speech routines, the ideal facilitator speech, inner speech, which assists in learning how to use tools, and authority speech used by teachers to maintain control. The case study approach is adopted in chapter 9 to identify interaction patterns in the “written speech” of the participants, to understand the process of concept development and explore whether and how questions and ideas may catalyse further ideas. This analysis also considers whether any of the interactions are consistent with the formation of a large component (Newman, 2002), indicative of a change of state.

Mixed methods approach. The study draws upon a mix of quantitative and qualitative research methods, including discourse analysis, social network analysis and statistical analysis to assist in the presentation of the case studies. An advantage of the mixed-methods approach is that emerging results can alert the researcher to opportunities to explore the data more deeply using alternative methods or to deal successfully with discrepancies in the data (Tashakkori & Teddlie, 1992). It may also offer greater validity of results by triangulation across methods in much the same way that triangulation across multiple cases can improve reliability. Of the two main mixed-method approaches, pragmatic or dialectical, (Tashakkori & Teddlie, 1998, p. 596) the dialectical approach was seen as the best fit for this study as it allowed the opportunistic repurposing of the data to explore issues more deeply, whereas the pragmatic approach

with its pre-planned sequences of qualitative and quantitative steps would have introduced unnecessary rigidity to the study.

The mixed-methods approach also deals successfully with an underlying contradiction between the constructivist aspects of activity theory and emergent aspects of complexity theory but which offers the possibility that the competing theories and philosophies can be reconciled through the study. One of the central tenets of activity theory is that humans create their own reality through goal-directed activity mediated by tools. On the other hand, complexity theory, with which activity theory shares a common ancestry in Darwin's theory of evolution contends, that all systems, including human activity systems, undergo transformative changes outside of human control, under certain conditions. Researchers such as Engestrom (1999) and Goldberg (2001) have skirted around the possibility of autocatalytic emergence, but have been unable to fully embrace the concept or suggest how it could be integrated with activity theory. The need to entertain the possibility that human activity systems may be subject to free will at a conscious level and determinism at an unconscious level has made it necessary to go beyond either a qualitative or constructivist approach and embrace both.

Other methodological considerations. Other research designs were considered. A purely experimental method using quantitative data was ruled out because of the exploratory nature of the study and the lack of a sufficiently well developed hypothesis for testing. In some ways, the study has key elements of an action research approach (Dick & Dalmau, 1999) which offers the advantage of involving the participants as co-developers of a new theoretical model. Although action research, is in keeping with the nature of the tool being studied and shared a common ancestor in the search conference (Emery, 1999), the action research approach lacks the necessary rigor to be used exclusively as the research method. Some aspects of action research are adopted for the feedback sessions with the teachers and the students, who played a major part as informants in the theory building process. A phenomenological approach (Husserl, 1931; Schutz, 1967; Marton, 1981) was considered because it would have allowed many competing views of reality to be considered. While this may have been a useful way to explore cross-cultural effects and knowledge building at a group level, the method would have meant starting theory building from the outset rather than expanding upon a useful existing theoretical framework. Also considered was an ethnographic approach (Geertz, 1973; Burns, 1997) which literally means "writing about people" (Burns, 1973, p. 297) but was also discounted because observation alone would have provided very

few opportunities for theory building compared with methods that are more diverse. However, some of the principles of the ethnographic approach are included in the overall design.

Ethical considerations

Ethics approval was obtained through the University of Wollongong. A consideration of the ethics approval was that the researcher distance himself from the data collection activity as much as possible, in view of his ownership of the company that makes the team learning system that is the subject of this study. After the initial training delivered by the researcher, the teachers were asked to be responsible for the data collection for the sessions they facilitated. Later, after the initial teacher-led workshops, the researcher conducted a series of sessions to collect feedback from the teachers and two groups of students about the first experiences with the tool. The school sought and obtained releases from the students and the teachers. Participation was voluntary and the teachers and the children were free to withdraw at any time. The children who participated in the study did so under informed parental consent. The information sheet and consent form is shown in Appendix IX, page 451.

It should be noted that the researcher has a business relationship with the head teacher of the school, which existed prior to the study and continues to this day. The head teacher is a distributor of Zing products in the school education sector in the United Kingdom. The head teacher has expanded the breadth of his advisory relationship with a number of British educational institutions as a result of using the tool. He is also in demand as a consultant to assist failing schools and uses the tools in this work, a practice that has been adopted by other consultants. The head teacher's expanding career trajectory into the field of facilitated events is one consequence of his participation in the study and was an unanticipated outcome of the research. Thus, the head teacher's and the researcher's story is recorded and analyzed in this study as discreetly as possible and for completeness, because it is instructive to the research outcome.

Selection of the study group

The study was undertaken at a co-educational secondary school east of London in the United Kingdom that serves as a teacher training facility for regional schools. Eighty-five students (43 female, 42 male) and seven teachers (4 male, 3 female)

participated in the study (see Table 6.1). The school is a moderate performer in terms of student outcomes. The school has over 1,500 students and 100 staff. In 2004, 84 percent of students achieved five or more GCSE A*-C (General certificate secondary education passes at the A to C levels) compared with the national average of 53 percent. The school is a Technology College with a specialisation in information and communication technologies (ICT).

Table 6.1: Composition of the study population

Group	Students		Teachers	
	Male	Female	Male	Female
Seniors	7	5	1	1
Facilitators	3	4	2	1
Year 7	10	10		
Year 8	9	12		
Year 9	7	7		
Year 12	6	5		
Teachers			2	2
Total	42	43	4*	3*

* Several teachers present in both the facilitators and teachers group

The main considerations for selecting the school for the study were a willingness to participate, the availability of a team learning system that was purchased three years before and rarely used, some familiarity with the tool, and the facilities to allow video recording of sessions. Prior to the commencement of the study, only three teachers at the school had received training in how to use the team learning system. The school planned to expand the use of the tool and wished to train additional teacher facilitators. It also wished to train student facilitators so they were able to design and facilitate learning activities with their peers. The prior relationship with the head teacher was both a strength and a weakness. The head teacher was able to ensure the study proceeded smoothly and remained on track. However, the relationship introduced an element of a conflict of interest and the potential for bias which needed to be made visible and managed.

Research procedures

The original intention of the researcher was to conduct the study in three stages:

- a training session for teachers and students,
- the teacher and student activities, and
- feedback sessions with the teachers and students.

The research activity became extended, partly because the researcher lives in Australia and visited England only occasionally, and because the teachers found it difficult to fit the research into their busy classroom teaching schedules.

Table 6.2: Types of data collected by source

Group	Session video	Feedback video	Participant feedback Form	Session transcript	Feedback transcript
Facilitators			Yes	Yes	
Teachers			Yes		Yes
Year 7			Yes	Yes	
Year 8	Yes	Yes	Yes	Yes	Yes
Year 9			Yes	Yes	
Year 12	Yes	Yes	Yes	Yes	Yes
Seniors	Yes			Yes	

Five types of data were collected; a videotape of five sessions, participants questionnaires from six groups and session transcripts from nine sessions as shown in Table 6.2. The researcher remained in touch with the teachers who participated in the study by paying a series of visits to the school up to four years after the initial data collection.

The study was conducted in five stages over a two-year period beginning with a training day in August 2003 attended by three teachers and seven Year 12 students who had agreed to participate and learn how to use the tool. The researcher delivered the training using a standard set of procedures provided by the Zing training manual (Findlay, 2005), which is described more fully in Chapter 7 (see pages 274-275). In a second stage of data collection, two of the teachers and two of the students conducted classroom activities with students during August, September and October 2003. A third round of data collection was undertaken in February 2004 when the researcher facilitated two learning activities to benchmark the trainee facilitator activity and obtained feedback from two of the classes of students about their initial experiences

with the team learning system. A fourth round of data was collected during July 2004 when two teachers facilitated further sessions with students. The final round of data collection was conducted in September 2005 with five teachers. The teachers were invited to reflect on their experiences and to engage in a tentative theory building activity with the researcher. Three of the teachers trained with the researcher and two learned to facilitate by observing the facilitator.

Introducing the teacher and student facilitator's to the study. A group of teacher and student facilitators was selected by the school to participate in the study and to undergo the facilitator training. The facilitators learned how to prepare and facilitate a session, design question sequences for a learning method, select questions from a menu and practice what to say and do to coordinate the participants' joint activity.

The facilitator's role is to sequence the questions and to keep time using the talk-type-read-review etiquette to remind participants when to discuss the question, type their ideas, read the ideas aloud and summarise the ideas. The successful use of the tool is dependent on the facilitator's ability to integrate complex technical, communication and leadership skills in a fluent manner (Findlay, 2005, p. 54). The facilitator introduces new participants to the etiquette via three introductory or "warm up questions" so it becomes routine. The level of difficulty is about the same as learning to drive a car. If the facilitator adheres closely to the procedure (see Table 8.2, page 274) for introducing new participants to the tool, they quickly learn what to do and the meetings become very easy for the facilitator to lead. If the facilitator omits steps or the order of certain steps, the activity can become chaotic.

The training day was conducted in three parts. The day began with a model session delivered by the researcher. This was followed by a series of three scripted sessions in which the participants practiced their technical role, their leadership role (the etiquette and what they had to say and do) and a final session where each person facilitated a meeting for the entire training group using the required "warm up questions" that new facilitators are trained to use when they first meet with a group (see page 274) and their own sequence of questions. The model session comprised three distinct sets of questions – an orientation or socialisation sequence, a thinking process and a feedback process that are learned during the facilitator training program (Findlay, 2005) to socialise participants into the use of the tool. The trainee facilitators were expected to employ orientation questions each time they used the tool with a neophyte group, so the participants could quickly learn how to use it. The first question invites

participants to type anything they like to become familiar with their place on the screen and how to use the keyboards. The second question, which asks participants to describe a story they had read and enjoyed, introduces the talk-type-read-review etiquette. The third question invites participants to imagine what kind of television, cartoon, movie or fairytale character they might be and what it would be like to live with the character. This question is designed to reinforce the etiquette and the process for sharing the work of reading the ideas aloud.

During the model session, the participants experienced a complete learning or meeting activity. At the conclusion of the model session, the participants were asked to record their observations of how the meeting differed from conventional face-to-face meetings, and what the facilitator did and said to conduct the session. The technical and the scripted leadership rehearsal sessions were practiced with a peer. Each person took turns to be the trainee facilitator while the other provided the instructions of what to do and/or say from the training manual. Each student or teacher facilitator then created a classroom learning activity, which comprised a sequence of 7-12 questions together with attachments such as images or web pages. At the conclusion of the training session, the trainee facilitators delivered their first performance using the required socialisation questions and set of their own questions. The participants and the researcher offered hints about what to say or do next. Before undertaking the activity the participants were asked to complete a survey (see Appendix I, see page 431) that identified, the activity, participant name and the participant's expectations of the session. Each participant completed a 10-question flow inventory (Novak et al, 2001) to assess his or her level of engagement before the activity and an innovation inventory (Kirton, 1994) to determine the participant's preference for novelty or certainty. After the session, the participants were asked to complete a second flow inventory to assess the participant's level of engagement during the activity.

Introducing the students to the tool and the study. The teachers conducted their first meetings within one month of the training session so that the facilitation method was still "top of mind." The teachers and student facilitators began their sessions with a series of questions that introduced the tool to the class in the same or a similar manner to the procedures learned during the training session. This preliminary activity was followed by a series of "learning activity" questions designed by the teachers. Before undertaking the activity, the participants were asked to complete a survey (see Appendix I, see page 431) comprising a flow inventory (see page 208),

innovation inventory (see page 209) and pre-session questions about their expectations of the session. At the conclusion of the session, the participants completed a new flow inventory and post-session questions about what they had learned during the session.

Data collection

Data were obtained from transcripts of sessions, observations, questionnaires, inventories and focus groups of teachers and students.

Transcripts of the initial training activity. A record of the contributions to the initial training activity was automatically created by the team learning system software. Feedback was collected about what the participants saw as the differences between the session and a conventional meeting or learning activity as well as the observations of what the facilitator said or did to conduct the meeting. The teachers and students teachers were identified in the record by name. In the final report, first names of the students were changed and teachers were identified by their first names to preserve a level of anonymity.

Transcripts of classroom activities. Ideas contributed by students of Years 7, 8, 9 and 12 to learning activities designed and facilitated by their teachers were recorded automatically. The students logged onto their session using an alias, or if they were working in groups, logged on with a group alias. The teachers supplied a list of the students and their aliases, so the meeting record data could be compared with other data. The computer record of all the ideas for all sessions was published in a word document in chronological order with the name of the contributor. A record was also produced of the themes that are summaries of the key concepts observed by the participants and recorded by the facilitator at the end of the discussion cycle, for most, but not all of the questions.

Transcripts of student feedback sessions. Feedback about the Year 8 and Year 12 students' experiences was captured during a team learning system workshop facilitated by the researcher six months after the initial activity during a subsequent visit to the United Kingdom. The students were asked to type their name before they made a contribution so their opinions could be tabulated and analyzed in the context of other factors including age, sex, year, learning and personal interests. Twenty questions were asked which are listed in Appendix II (see page 435). The questions were presented to each group to record their opinions about what they liked or disliked about their initial sessions, their assessment of the teachers' performances, the rules or culture of the

normal classroom versus the rules that applied in the classroom when using the team learning system and their use of ICT in school and at home. Students were also asked questions about their personal learning styles, academic or learning interests, social interests and future career intentions. The researcher was unable to collect feedback data from Years 7 and 9 about their initial experiences because the sessions were conducted near the end of the school year, and the students were dispersed to different class groups the next year, making it difficult for them to reconvene.

Teacher feedback workshop. A workshop was conducted by the researcher with four of the five teachers (Mr. David, Mr. James, Ms. Debbie and Ms. Zoe) who participated in the research project to obtain feedback about their experiences with the team learning system. A brief interview was conducted with one teacher, Mr. Mike, who attended the initial training program but did not subsequently use the team learning system with any groups and was unavailable for the workshop. Twenty-one questions were asked. The questions are listed in Appendix III (see page 437). The teachers were asked how they used the team learning system, how they learned to use the tool and what they saw as the main differences between meetings or learning activities conducted using the tool and normal activities. The teachers were also asked to describe the facilitator's role in the activity and in what ways the participant activity changed the facilitator activity, the barriers to use, at what stage and under what circumstances the tool became easier to use and what the facilitator had to do to ensure its' successful activity. The teachers were also prompted to think about how the features of the team learning system contributed to successful use including the etiquette, parallel thinking, reading ideas aloud, dyadic discourse, theme identification, open-ended questions and the simultaneous viewing and contribution of ideas. Opinions were also sought about how the use of the tool changed the classroom activity, how the students acted when using the tool and the relationship of the tool to the culture of the school and youth culture.

Pre- and post- session reports. Prior to the start of each teacher-led session, participants were asked to describe what they knew about the topic and their expectations of the session. These questions are described in Appendix I (see pages 433-434). At the conclusion of the activity, the participants were asked to record what they had learned during the session, what they liked or disliked about the session and what their new learning or other goals would be as a consequence of participating in the

session. These reports were used to inform the narrative for each of the facilitators group and Years 7, 8, 9 and 12 case studies.

Video record. In order to understand how the teachers and students who were trained as facilitators performed in their new roles, and whether this was any different to a traditional teaching or meeting chairperson role, a videotape record was made with three groups led by the teachers - Year 8, Year 9, and the senior's group. Two sessions conducted by the researcher – Year 8 cloning and Year 12 cloning - were also videotaped to benchmark the teachers' sessions. Although the school and the researcher planned to videotape the initial training sessions, the room with the videotape recording system was unavailable on the training day due to an industrial accident at the school. The videotapes were recorded by an operator located in a control room at the rear of a special classroom equipped with a one-way observation mirror, three independently movable cameras with zoom lens mounted in the ceiling and microphones located at the teacher table. The videotape was initially recorded onto hard disk and then transferred to compact disk.

Survey of the flow experiences. In order to determine whether there was a change during the workshops in the level of student engagement, enjoyment and satisfaction, a flow survey (Csikszentmihalyi, 1975, p. 38) was undertaken using an inventory adapted from Novak, Hoffman and Duhachek (2001) both before and after each teacher led activity and the feedback activities facilitated by the researcher (see Appendix I, page 431-432). The inventory comprised eight propositions, each relating to a dimension of flow. The participants were asked to assign a number 1 to 5 to indicate to what degree they were certain about the task, enjoyed the activity or felt connected to the task, connected to other people, a sense of being in control and a sense of time transformation such as the rapid passing of time and a sense that the task was within the participant's capability. The facilitators group and students from Years 7, 8, 9 and 12 who participated in the teacher-led classroom activities completed paper versions of the inventory in which each person was required to assign a number from 1 to 5 to indicate agreement to a bi-polar proposition at each end of a semantic differential scale. The Year 8 and Year 12 students who participated in the feedback sessions facilitated by the researcher completed a software-based version of the flow questionnaire. The 10 propositions were presented as a single positive statement with a Yes or No response required. The data were rescaled using SPSS (Carver & Nash, 2005).

Innovation inventory questionnaire. In order to determine whether some students, more than others, were responsible for the generation or the adoption of ideas, a questionnaire adapted from the Kirton Innovation-Adaptation Inventory (Kirton, 1994) was used to ascertain the participant's interest or goals in relation to change or certainty (see Appendix I, page 433). The Kirton adaptation-innovation theory (1976) is based upon the assumption that people deal with change, creativity and problem solving and decision-making in different ways, generally categorized as *Adapters* and *Innovators*. The inventory employs a bipolar scale so that no position is more advantageous. *Adapters* prefer to be precise, reliable, efficient and conformist and seek to solve problems in conventional, proven ways. They are able to deal with boredom and can remain accurate over extended periods. *Innovators* prefer to think more randomly and flexibly, try methods that go off at a tangent, and seek solutions which may jump or bridge cultural barriers, but are unable to focus on minute details for very long. The approach of *Innovators* is poorly understood by *Adapters*.

The inventory has the following dimensions: accepts-challenges problem definition, does things better-differently, likes solving-finding problems, questions-accepts assumptions, uses existing-invents new ways to solve problems, methodical, thorough and precise vs. ingenious, original and unconventional, capable of routine work vs. takes control and is an authority. Each participant responded to a proposition by recording a number from 1 to 5 to indicate agreement to propositions at opposing ends of a semantic differential scale. **Student academic ability data.** In order to determine whether some students more than others, particularly those with a positive attitude to learning and strong verbal, quantitative and non-verbal abilities, participated more actively in the workshops, data were obtained from the teachers for Year 8 and Year 12 students. The attitude to learning ranking provided by the school gives an overall assessment of the student classroom performance. The score is the mean of subjective scores given by every teacher in the student's current year from 1 to 9 (1 = very poor attitude, 10 = very good attitude to learning) and is generally consistent with the student's overall academic achievement. The verbal, quantitative and non-verbal reasoning skills scores were collected by the school using the Cognitive Abilities test (nferNelson, April 2007) administered in Year 7. The verbal test uses words, the quantitative test uses numbers and symbols and the non-verbal test employs shapes and figures and requires no knowledge of English language but is useful for assessing students who think in terms of images rather than words or numbers.

Data analysis

The study involved three sets of analyses. The first set, reported in chapter 7, assembled the data into a series of 10 cases, the four teachers, the facilitators group and the four groups of students who participated in classroom activities. The analyses considered whether the data was broadly consistent with the revised complexity-activity theoretical model. The second set of analyses, reported in chapter 8, examined the transcript of the video record in the context of the revised complexity-activity theory and how the facilitator performances were influenced by previously learned automatic speech routines or “kinetic melodies” (Luria, 1973) or emergent automatic routines and inner speech (Vygotsky, 1978) as well as the use of language that exhibited either a person-centric or group-centred approach. The third set of analyses, reported in chapter 9, examined the participants’ performances in terms of frequency and consistency of idea generation and concept evolution. A detailed analysis of the 140 question cycles explored whether there was a pattern to the interactions consistent a change in the activity state. The analysis also considered whether any of these changes were related to specific participant characteristics, such the order in which participants generated ideas, preference for change or certainty, as well as verbal, non-verbal and quantitative academic ability. This analysis is both exploratory and opportunistic in nature.

Analysis of the session transcripts. Ten case studies were prepared using direct quotations from the participant feedback. The narrative reported on the changes that occurred in the participant activity during the course of each session in terms of the participants’ **roles**, their **relationships** with each other, the **rules** of engagement, **tool** use, the object of the activity (or the participant’s **aspirations**) and whether these changes were incremental or transformational resulting in a change in the **culture**. There was no feedback from the seniors session and two of the feedback from the Year 12 history students pertained to two sessions.

The teacher and student feedback transcripts were also subjected to a key word analysis and a concept analysis using Leximancer 3.6 (Smith & Humphreys, 2006), a software program that automatically identifies the key concepts in text, clusters the concepts by the frequency of their relationships to other concepts, and displays the results on a concept cluster map and a frequency table. The strength of the relationships between concepts is indicated by the brightness of the text. Concepts that are most closely related are displayed in close proximity to other concepts.

Analysis of the video transcript. A transcript was produced from the videotape recordings of five of the 12 sessions – the seniors session, Year 12 cloning, Year 12 feedback, Year 12 history, Year 8 textiles and Year 8 cloning. The transcript reported on what the teachers said and did to introduce and coordinate the team learning activities, including the physical actions, such as selecting a new question, as well as intelligible responses such as laughter or body language such as embarrassment. A sample of the video transcript is shown at Appendix VIII (see page 448).

The record was then examined to identify how the facilitators used speech to provide instructions to the participants, and the extent to which these instructions were interrupted by other “speech acts” in particular previously learned and inappropriate speech routines, inner speech used by the facilitator to guide how to use the tool and other uses of speech, in particular the extent to which the facilitator used speech to maintain control of student behaviour. The time stamp feature of the video record was used to calculate the length of time devoted to each stage of the discussion cycle including the time spent asking the questions, introducing the topic, discussing, typing, reading the ideas aloud and recording the themes.

Further use was made of video transcripts to determine whether the reported change in the relationship between the teachers and the students was reflected in how the teachers addressed the students. A word count of “I/we” and “you” was undertaken for the “warm up” question cycles, which all four facilitators completed, to determine whether the ratio of collective to personal pronouns changed during the activity.

Analysis of participant idea generation. The computer transcripts of 12 sessions was analysed to determine the productivity of the participants, the consistency of engagement and the order in which they contributed the ideas. A sample of the computer transcripts is shown in Appendix VIII (see page 447). The regularity of the sessions was measured by the frequency of ideas generated per person for each discussion cycle for each activity. A word count was also performed to establish the extent to which participants elaborated or extended ideas. The idea and word count excluded contributions that were not relevant to the discussion, for example “Skool sucks”, “Fun” or “Hello Tom.” Three voting sessions in the human cloning sessions that did not involve idea generation were also excluded from the idea generation analysis.

A series of analyses were performed on the data to determine the rate of idea generation per person per discussion cycle, the rate of idea generation per minute of elapsed time (obtained from the videotape analysis for five of the sessions) as well as a

Pearson correlation analysis of the relationship between the length of ideas and the frequency of the ideas for each cycle using SPSS software (Carver & Nash, 2005).

Analysis of concept order. The conceptual content of all the contributions from five sessions was analysed to identify which participants were responsible for initiating concepts which Gladwell (2004, p. 41) refers to as salesmen who fashion the ideas, and which I have termed *mavericks* and to determine which participants acknowledged or adopted concepts that Gladwell terms *mavens* from the Yiddish word for knowledge acquirer. Each instance of a concept within an idea was then recorded in a spreadsheet and assigned a number (1, 2, 3 etc.) to indicate the order in which the concept was contributed and by which participant.

The definition of the relationship between ideas and concepts is given as:

$$\text{Idea} = \text{Concept 1} + \dots + \text{Concept}_n$$

where each concept is a self-contained element and more than one concept may be included in an idea contributed by a participant, for example, “clones are exact copies of an organism” or “Dolly the sheep, the first animal to be cloned”, “the cloning process is risky/unproven”.

Whenever participants were the sole user of a keyboard, one instance of a concept was recorded. This occurred in the Year 12 history, Year 12 feedback, Year 12 cloning, the facilitators group, the seniors and teachers’ feedback sessions. In some session, participants shared a keyboard, and an additional instance of the concept was recorded for each person who shared the keyboard. This occurred in Year 8 textiles, Year 7 textiles and Year 8 history. In some sessions, students who shared keyboards were asked to type their name as part of their contribution, so that individual data was obtained, even though keyboards were shared. This occurred in Year 8 feedback and Year 8 cloning. The concept order was then used to calculate the number of concepts generated by each participant. These were defined as (see Figure 6.1) *unique concepts* contributed by only one person or group sharing a keyboard, *first concepts*, if a participant was the first to generate a concept, *total concepts* contributed by a participant, *maverick concepts* which were the first concept in a cluster of three or more contributed by each participant, and *maven concepts* which were the presence of a participant’s concept in a cluster of three or more concepts where support for a concept was developing. An Excel spreadsheet was used to record concepts generated by the participants in response to a question.

Figure 6.1: Definition of unique, first, total, maverick and maven concepts

Participant	Concept 1	Concept 2	Concept 3
Alicia	1		4
Brad		1	
Diane			2
Emma			4
Helen			5
James			
Jane		2	
Mike			3
Tom			
Zoe			

Social network analysis of contributions and concept order. Five of the sessions where individual data was available – the facilitator group, Year 12 history, Year 12 cloning, Year 8 feedback and Year 8 cloning – were selected to explore how concepts were generated and transmitted or replicated through each group and the extent to which participants were connected by shared concepts. The analysis considered three aspects of connectivity; whether there was evidence for the emergence of new order in the group in the form of clusters of concepts, clusters of clusters or a “large component” indicative of a phase-shift (Freeman, 2002); whether there was any discernible patterns to concept development; and, whether there were any differences in the way participants contributed to the discussion, for example, did some students or teachers participate more frequently in the generation of concepts than others?

Although individual data was not available, the Year 8 textiles session was also subjected to a social network analysis, to establish whether a possible pattern of emergence that reported by the students and the teachers in their feedback, was evident in the discourse pattern.

2-mode social network analysis. The record of concept generation was used to produce a series of 2-mode social network graphs for the six sessions selected for social network analysis to make visible the connections between participants via their links to common concepts. 2-mode networks display the connections between two variables using non-directional ties. The graphs were then analysed using a case-study method to explore the relationship between the type of question (open-ended, closed and Bloom’s level) and the network pattern and whether there was evidence of cross-connections between cliques. The data was coded using the Ucinet software program (Borgatti,

Everett & Freeman, 2002) in the form of a matrix. The x-axis of the matrix represents the concepts in the order in which they were contributed by the participants and were assigned the numbers 1, 2, 3...etc. The y-axis of the matrix represents the participants listed by name in alphabetical order (Mr. James, Mr. Mike, Ms. Zoe, etc.). If a person contributed a concept, a “1” was recorded at the intersection of the rows and columns; all other spaces were filled with zeroes (see Figure 6.2).

Figure 6.2: Example of the coding method for 2-mode graphs

	Concept 1	Concept 2	Concept 3
Mr. James	1	1	1
Mr. Mike	1	0	0
Ms. Zoe	1	0	0

Network graphs were generated using Netdraw, a software program that is included in the Ucinet suite for each concept cycle to display the links between the concepts and the participants who contributed the concepts. The software created graphs that displayed two types of nodes, joined by edges (a directional arrow). Participants were represented by red dots to distinguish them from ideas which were represented as blue squares. The data were analysed to determine the frequency and composition of cliques. An example (see Figure 6.2) shows Mr. James, Mr. Mike and Ms. Zoe have all contributed to concept 1 but only James contributed concept 2 and 3.

Directed graphs analysis. The data were used to create a series of directed graphs to determine the extent to which each participant, represented as red, light gray or dark gray nodes, contributed to the development or transmission of concepts from one participant to another, represented as blue nodes, and to calculate the size and extent of highly linked 3-core and 4-core components that would be indicative of the formation of a large component (Newman, 2002). Directed graphs display the connections between two variables by ties that show the direction of the relationship. Three-core networks are characterised by nodes connected by two pathways between any two nodes (coloured dark grey); 4-core networks have at least three pathways between nodes (coloured light grey), and thereby greater network robustness and redundancy. The data were coded as a square matrix. For directed graphs, the convention is the “y” axis represents the node at the start point of an edge (thread) and the “x” axis represents the node at end of an edge. For the discussion thread *concept 1-Mr. James-Ms. Zoe-Mr. Mike* (see Figure 6.3), a “1” is placed at the intersection of concept 1 and James to

represent the first edge, the intersection between Mr. James and Ms. Zoe represents the second edge, and the intersection between Ms. Zoe and Mr. Mike represents the third edge. For the discussion thread *concept 2-Mr. Mike*, where Mr. Mike was the only person to contribute concept 2, is represented by a “1” placed at the intersection between concept 2 and Mr. Mike.

Figure 6.3: Example of the coding method for directed graphs

	Concept 1	Concept 2	Mr. James	Mr. Mike	Ms. Zoe
Concept 1	0	0	1	0	0
Concept 2	0	0	0	1	0
Mr. James	0	0	0	0	1
Mr. Mike	0	0	0	0	0
Ms. Zoe	0	0	0	1	0

Network graphs including the k-cores (both 3-core and 4-core graphs) were generated using Netdraw, part of the Ucinet suite (Borgatti, Everett & Freeman, 2002).

Analysis of participant roles as innovators and adopters of concepts. The directed graphs were also used to carry out further analyses of the roles played by participants, to establish whether some participants, more than others, were responsible for initiating concepts, and whether others were more likely to adopt concepts. The data represented in each directed graph was transcribed to form a 3 x 3 matrix, with each cell of the matrix representing a value based on whether a participant was the first to initiate a concept (0 = no concept, 1 = 1 concept and 2 = two or more first concepts) and whether the participant node was linked to another node (0 = no linkage, 1 = linked to one other person and 2 = linked to two or more persons). The scores were tallied and the mean calculated for the whole session to generate a score (first ideas, connectivity) = (0-2, 0-2) which was displayed as a graph.

Analysis of participant, innovation index, academic scores and concept order. A Pearson correlation analysis (Carver & Nash, 2005, p. 53) was performed using SPSS software to determine whether there was a relationship between both the innovation index and the academic ability of the students and the frequency of concepts generated first (first concepts), the total number of concepts (total concepts), unique concepts, the first concept in a cluster of three or more (maverick concepts) or the presence of a concept in a cluster of three or more (maven concepts). The academic

scores and innovation indices were graphed to determine if they were normally distributed before applying the Pearson analysis.

Analysis of question type, length and elaboration. A Pearson correlation analysis was performed using SPSS software to determine whether there was a link between the type and richness of the questions asked during the team learning activities and participant productivity. A scale of 1 to 6 was used to classify the questions based on Bloom's taxonomy (Bloom & Krathwohl, 1956; Limbach & Waugh, 2005) and rated by independent evaluators. Questions that interrogated the participant's knowledge by asking them to recall facts or make lists were assigned a rank of 1. *Comprehension* questions that asked participants to demonstrate they understood the information they had learned was given a rank of 2 and questions about the *application* of the information was allocated a rank of 3. Questions that expected students to *analyze* and compare information were given a rank of 4. Questions that asked participants to engage in the *synthesis* of ideas and put forward hypotheses was given a rank of 5 and questions that called for *evaluation* including making judgments and decisions was assigned a rank of 6.

Three measures of participant productivity were considered; the total number of ideas generated, idea length and contribution. The total number of ideas generated by each individual was counted for each of the 140 discussion cycles of the study. The length of the ideas was determined by the number of words in each contribution. The contribution score was calculated by multiplying the number of ideas and the word length.

Group flow analysis. A measure of the group level of engagement was calculated by taking the mean scores for seven of the eight aspects of flow across each group. The flow data, both before and after the student sessions, were subjected to an alpha reliability analysis using SPSS (Carver & Nash, 2005) and subjected to a reliability test. A paired samples t-test was employed (Howitt & Cramer, 2005) to determine whether the means of the before and after flow were significantly different from each other. This is the usual test where scores are obtained at different times for the same population.

Test to determine if concepts acted as catalysts. In order to determine whether concepts contributed by participants, acted as catalysts for the generation of additional concepts, a paired samples t-test (Howitt & Cramer, 2005) was used to compare the means of the numerical order of two classes of concepts generated in response to the

questions. If the questions acted as the catalysts, the isolated concepts would be distributed evenly throughout the whole sample. If the concepts, as well as the questions acted as catalysts, the isolated concepts would be distributed mainly in the second half of the sample.

Summary

This study of the use of a collaborative tool for collective knowledge creation is explored through the lens of activity theory informed by complexity theory. The study focuses on human activity at cognitive, collective and cultural scales, and in particular, how the rules, roles and relationships are transformed via the collective use of a tool in pursuit of individual or collective aspirations. The analysis also explores whether some aspects of change in human activity system occur spontaneously. The data were presented as a series of case studies. In chapter 7, the case studies are based on the observations by the teachers and the students of their own activity. The data were aggregated using a complexity-activity theoretical lens. Chapter 8 is a series of case studies that explores the process by which motor and speech routines become automated in order for people to perform fluently the role of facilitator. The data were aggregated via a lens of four types of speech including the ideal facilitator speech, inner speech, authority speech, and previously learned speech routines. Chapter 9 presents a series of cases in which social network analysis is used to analyse the “written speech” discourse of the participants to understand how groups generate and develop ideas. The analysis also considers whether any aspect of the activity is self-organising (or autocatalytic). A mixed methods approach is also adopted to allow the data to be repurposed to more deeply explore interesting inferences. Theory building proceeds via categorical aggregation and by relating the data to key theoretical understandings drawn from the literature review. The research design is represented in Figure 6.4 Research plan, data collection and analysis and Figure 6.5 Data analysis and organisation of chapters.

Figure 6.4: Research plan, data collection and analysis

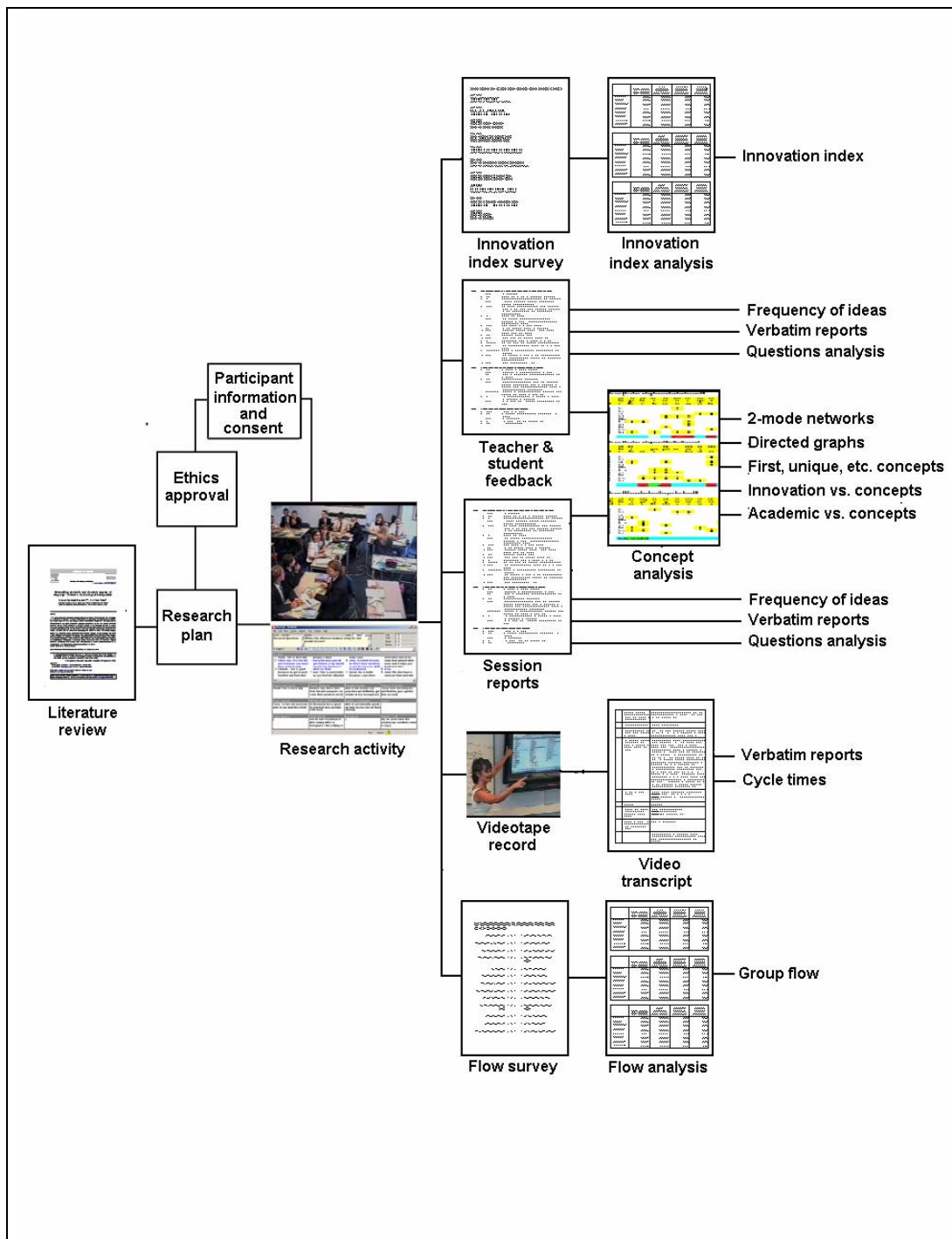
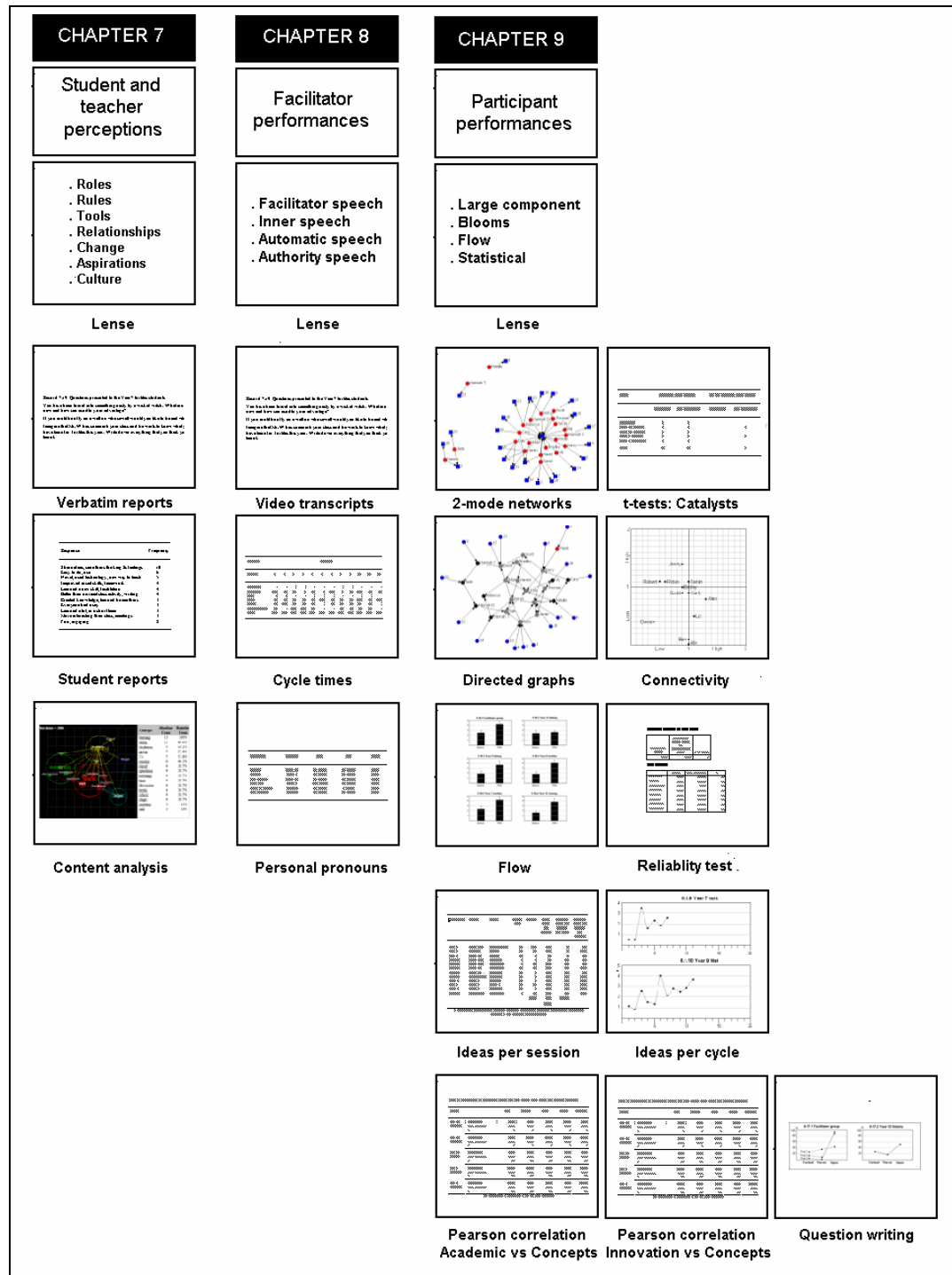


Figure 6.5: Data analysis and organisation of chapters



CHAPTER 7

STUDENT AND TEACHER PERCEPTIONS OF THE TEAM LEARNING ACTIVITY

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Overview of the chapter

In accordance with the research objective set out in chapter 6 this study seeks to examine whether and how cultural differences between teachers and learners when using recently developed tools, in particular a team learning system, influence student engagement, enjoyment and learning. This is the first of three chapters that present the results of the study.

Although ICT has been available in schools for over twenty years, the evidence is that teachers make infrequent use of such tools in the classroom (Becker, 1995). Teachers generally deny students access to the tools that are a normal part of student home life and social fabric (Downes, 1989) and which they often view as entertainment (Downes, 2002). This situation is attributed to many factors including computer phobia (Selwyn, 1997), the technology breaks down or does not work (Iding, Crosby & Speitel, 2002), teachers fear they will lose control (Selwyn, 1997; Sandholtz, Ringstaff & Dwyer, 1997), teacher conservatism (Clements, 1997; Windschitl, 1999), teacher beliefs (Niederhauser & Stoddart, 2001), teachers see no connection with classroom learning (Ballard & Buchler, 1999) and a persistent school-going culture (Engestrom, 1987a).

The analysis employs the complexity-activity theoretical model to explore the collective activity of the teachers and their students and the nature of their interactions when using the team learning system. The complexity-activity model comprises:

- the **tools** used by the participants that extend their power and capability,
- in order to play a **role**, for example, teacher or facilitator, student or participant, that is determined by
- the **rules** of how tools are used in collective activity, which in turn determines
- the **relationships** that develop between the participants as each pursues their individual, and occasionally collective interests, which results in
- a **change** in activity which may either be incremental or transformational depending on whether
- the activity is consciously directed towards the **aspiration horizon** or spontaneous emergence in the activity system, outside of conscious control, and
- which determines whether a **culture** persists or is transformed.

In chapter 7, this chapter, I report on the recollections of the experiences of the teachers and students at an English secondary college with a team learning system. There are 10 case studies (see Table 7.1) of the activity of four teachers at the school - head teacher Mr. David, vice-principal Ms. Debbie, technology teacher Ms. Zoe and history teacher Mr. James - and the students of Years 7 and 8 textiles and Years 9 and 12 history and a facilitator's group.

Table 7.1: Summary of the case studies

No.	Case study	Role
1	Mr. David	Head teacher
2	Ms. Debbie	Vice principal
3	Mr. James	History teacher
4	Ms. Zoe	Textiles teacher
5	Facilitators group	Student and teacher facilitators
6	Seniors	Student feedback meeting
7	Year 12	History class
8	Year 9	History class
9	Year 8	Textiles class
10	Year 7	Textiles class

Two cases were excluded from the analysis. Mr. Mike, a teacher who trained as a facilitator, did not use the tool in a classroom setting and was unavailable for the teacher feedback session. No feedback was obtained from the seniors session.

The teacher case studies are presented as narratives compiled from the verbatim reports of feedback session as well as a Leximancer analysis of the content of the individual teacher responses to a set of 18 questions which is presented in Appendix III, (see page 437). A sample of the transcripts generated by the teachers in response to the questions is shown in Appendix VIII (see page 446).

The student case studies are based upon the verbatim report of feedback sessions conducted with Year 8 textiles and Year 12 history in response to a set of 20 questions and post-session reports of the facilitators group, Year 7 textiles and Year 9 history collected by the facilitator or the teachers who conducted the sessions. The questions are reported in Appendix II (see page 435).

Chapter 8 explores the mental and physical struggle that facilitators went through to think, say and do what was necessary to facilitate a meeting or learning activity using the tool and how this is related to changes in the participant activity. Chapter 9 reports on the analysis of the students' performances including their productivity, levels of engagement and enjoyment and their interactions in response to the questions.

Head teacher Mr. David and his experiences

Mr. David is the 51-year old head teacher of the school and the sponsor of the research. The school is a co-educational secondary college in the South East of England that offers Years 7 through 11 and a Sixth Form. Mr. David came to school headship through teaching physical education. He is considered by his peers as a social entrepreneur in British education. He has been an advisor to education administrators about how to transform schools through the integrated, and more engaging use of teamwork, ICT and pedagogy. He has worked as a business entrepreneur, as do many other British school head teachers. This new breed of head teacher had its genesis under Prime Minister Margaret Thatcher with the devolution of accountability to school managers and boards. It continued apace under Prime Minister Blair and New Labor. The emerging generation of head teachers has bridged the world of business and

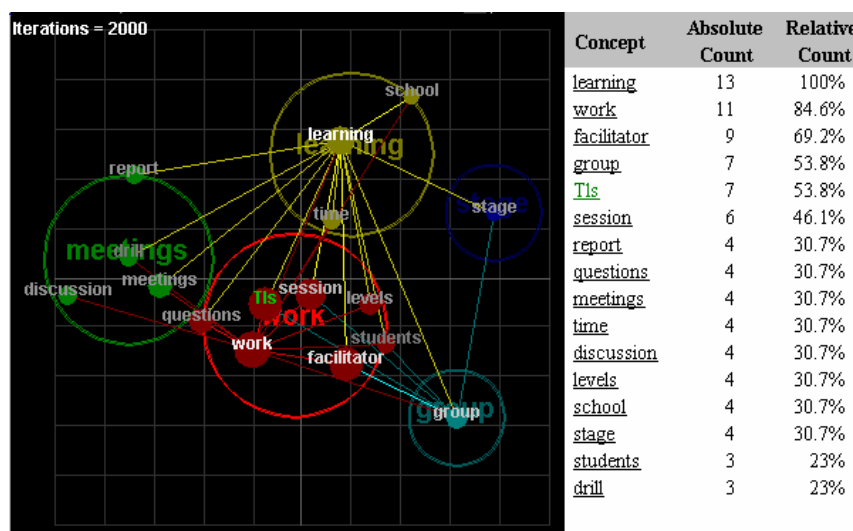
community. Many generate revenue for their schools by working as consultants to other schools or run businesses as publishers and marketers of their own educational, school management and professional development products and services.

Aspiration horizon. Mr. David aspired to playing a major role in transforming the school education system around the world and to receiving accolades from his peers for his novel and sometimes-unconventional solutions to problems facing schools. He also aspired to financial security when he retired. The team learning system that is the subject of this study became a part of the way Mr. David engaged with the world. He used the tool to conduct workshops that helped him expand both his influence as a ‘thought leader’ in school education, gain more consultancies and change the way teachers teach and learners learn. He became the “interactive” Mr. David rather than the “knowledge telling” Mr. David he was before the team learning system entered his life. In each of his workshops, his goal was to help head teachers and teachers discover for themselves what they should do to modernise their schools, rather than be told what to do. Mr. David said, “they work it out for themselves.” A short presentation followed by an interactive workshop was, in Mr. David’s view, a more effective way to ensure his peers developed ownership of his ideas. Mr. David also facilitated electronic events with parents and school governors, meetings of the school leadership team and in-service days. He also provided leadership-training courses as far afield as Amsterdam, Barcelona, Dubai, Hong Kong and Qatar, behavioral change workshops with students, FastTrack teacher development days, Raising Attainment Through Teaching and Learning sessions with under-achieving schools and small business linkage meetings.

Other than for “speaking engagements” his most significant use of the tool was for large-scale interventions in failing schools. Mr. David became one of the leading consultants in the Britain for the DfES, now the Department of Children, Schools and Families (DfCSF). The DfCSF awarded his private company contracts to help failing schools that entered into “special measures” in order to return them to good health. Throughout the course of each 18 to 24 month intervention, Mr. David managed a team that helped to promote distributed leadership throughout the staff, implemented new pedagogical practices, built capacity in the parent community, fostered teacher confidence in their own abilities and developed numerous new linkages and connectivity that resulted in the spontaneous emergence of new capability and results. At each step of the way, the team learning system was used variously to give teachers, parents, governors and students voice, to plan and implement various stages of the

change program, obtain feedback about the progress of the interventions, and change classroom culture. The concept analysis of Mr. David's responses (see Figure 7.1) showed that he saw the team learning system as having three purposes – to support his work (11 instances) as a facilitator (9 instances) and to assist in the conduct of group (7 instances) meetings (4 instances) and school (4 instances) learning (13 instances). He saw the tool in practical terms. It helped him quickly collect information from people and instantaneously produce a report (4 instances), thus saving him time (4 instances), which appeared to be in short supply, given his wide range of interests and demands on his time.

Figure 7.1: Concept analysis of Mr. David's responses



Tools. The school acquired a portable team learning system several years prior to the commencement of the study in 2004 and rarely used it. By the time this study was completed, several systems were in use at the school in science, history and English.

Mr. David said he learned to prepare the question sequences for his team learning system sessions by trial and error. He found that unique thinking processes were to be found in every field and there was a rich source in the Specialist Schools Trust Gateways occasional pamphlet series about educational issues, particularly pamphlets written by Professor David Hargreaves on the subject of personalised learning and Professor Brian Caldwell about re-imagining schools. Mr. David discovered that open questions worked best. He has also helped to create workshop methods for inter-agency working between schools, health, police and social security

authorities to attend to 55 national priorities for children via the Every Child Matters program and a series of workshops to help schools prepare for inspection.

At the feedback workshop, Mr. David said he used the tool mainly for “gathering information.” He regarded groups as instruments to achieve his aspirations as a consultant or head teacher rather than use the tool, as designed, to create new knowledge. He said, “The tool accelerates the gathering of information and produces an immediate report.” In a conventional meeting without the technology, “there is no paperwork to follow up afterwards and this leads to broken promises.” At the end of a session, generally one hour or more, the participants are mentally exhausted. He explained that the tool gave him the ability, as a facilitator, to drill in deeper and deeper “in a Six Sigma fashion” to “truly identify the underlying issues. He said, “Closed questions do not work, nor questions that are very complicated and multi-faceted.”

Mr. David said, “The main barriers to the use of the tool are the facilitator’s limited understanding of the power of the system and time to prepare thoroughly.” He offered the opinion that “most facilitators are only able to use 10 percent of the capability of the system.” “More recently a new generation of the technology with USB keyboards and hubs made it even easier to use,” he said. The teachers were resistant to setting up a special classroom to support discussion because their lessons were designed to be delivered to students seated at individual desks, facing the blackboard and the teacher. Mr. David said the teachers moved the tool from classroom to classroom in the same way teachers themselves moved between classes. Teachers would disconnect the keyboards from their computer and display system. Another teacher would then connect their personal computer to the system in another room. Mr. David regarded the need to connect and disconnect the tool each time as a fault of the technology rather than the consequence of the school’s own lack of planning. “The facilitator must allow time before a session to set up the system, get it working and deal with technology failure,” he said. Mr. David also used the team learning system in contexts for which the tool was not designed, such as classrooms or conference rooms where the tables were arranged in rows, thereby making it difficult for participants to have a discussion.

Roles: When the study began in 2003, Mr. David possessed some skills as a presenter but none as a facilitator. Over the ensuing years Mr. David’s role was significantly transformed. As his fame grew, he became an itinerant promoter of school improvement and progressively handed the day-to-day management of the school to Head of College Ms. Debbie. Mr. David became an infrequent visitor to the school

where he is still nominally the head teacher, but his influence remained. Most days of the year he worked elsewhere in the United Kingdom presenting lectures and seminars or helping to revitalize failing schools.

He became for a time the executive principal of two City Academy partnerships that became the latest and best practice models for school renewal in Britain. Twelve of these failing schools were rejuvenated by the Blair Government with the support of private sector investment. The Blair Government decided to expand the program to a further 400 schools (Caldwell, 2004), which has generated even more work for Mr. David. As a consultant to such organisations as the Specialist Schools Trust, an association of over 3,000 secondary schools, the British Council that promotes British products and services overseas and technology companies such as Cisco and Microsoft, Mr. David played a major role in shaping the thinking of British educators. He became the British education distributor for the team learning system that is the subject of this study. Mr. David explained that when he deliberately decided to become a facilitator instead of a presenter, this dramatically changed his relationship with people when he worked with them for the first time. “People come to events expecting the keynote to do all the work,” he said. “They generally find it hard work when forced to think and participate.”

At the feedback session, Mr. David said he received no formal training as a facilitator. He worked out how to use the system by observing the researcher when they jointly presented seminars for school in-service days in northern England and for an ethics conference sponsored by the education supplement of a British newspaper. Mr. David subsequently, and inadvertently, became a role model for others. People who experienced his sessions would contact him to find out where they could acquire the team learning system, so they could run workshops in the same way. Mr. David said his role as a facilitator was to listen to everyone and help each person shape what they wanted to do. “Good facilitation skills are critical to keep the discussion open or steer it to a conclusion. The facilitator must develop an ear for what is happening in the group,” he said. “There is usually a change in the level and quality of the noise when the group moves off-task and the facilitator must switch from automatic mode and engage the group in a new way.” Mr. David said the facilitator should also keep to the time allocated for each question. The facilitator’s job is “to encourage full participation by all present, to lead the discussion and open up minds, to draw out conclusions that the group generates, and to silence the loud mouth,” he said. “The play activities at the start

of a session are a leveler and break the ice. They seem to clear the mind like a sorbet does between courses. Reading the ideas aloud focuses the group on their common interests.” “Students who cause trouble in a normal classroom become more engaged when using the tool. They may seek attention and type silly ideas. One way to deal with this problem is to give them the job of facilitator. Another way of dealing with group performance and engagement issues is to move on to a new activity, play a game or create a competitive activity,” he said.

Student attention appears to be one of the major problems that schoolteachers encounter. Lose attention and you lose control of the class. Lose control of the class and you can lose your job. Mr. David reported that the questions attracted and controlled the group’s attention for as long as the group had something to contribute or members were curious what others had to say about the topic. Once the group lost focus, the talk-type-read-review etiquette that scaffolds a facilitator’s leadership role, became irrelevant. Mr. David said the facilitator had no choice but to switch from unconscious and automatic organisation of the meeting and call up another but reliable “get-back-on-track” routine, or consciously invent and trial a new routine. “Although the Talk-Type-Read-Review etiquette helps the group leader maintain momentum by organising the turn-taking in a normative way, if the participants lose focus because the question is boring or they know little about the topic, the facilitator loses control of the meeting,” he said.

According to the transcript from the feedback session, Mr. David observed that the team learning system automated the questioning role of a teacher so that participants became and remained actively engaged as long as the question was interesting and within their capability. He said the facilitator was required to do very little except to keep time, control the software in accordance with the time allocated for each step of the etiquette, and announce what to do next, “something a disembodied voice in the tool could easily do”. This is an interesting observation. Mr. David ascribed some human-like qualities to the tool and that, in some ways, the facilitator’s role is relegated to that of a time-keeper.

Culture. Mr. David noted that the team learning system was associated with a change in the culture of teaching and learning. The tool is “the antithesis of the “chalk and talk” or “sage on the stage” model of teaching,” he said. If a teacher is to use the tool effectively he or she must be “facilitator of learning and not be knowledgeable about everything.” It is “not the normal way of downloading content into children” and it “removes the dominance of the teacher,” he said. The teacher takes on a different role

with the students, “more of a guide on the side type learning, more listening by the teacher and higher level of disclosure of the facilitator’s ideas” rather than the curriculum content. Mr. David acknowledged that schools generally, even the school he led, employ a traditional approach to teaching and learning that Scardamalia & Bereiter (1993) describe as “knowledge telling”.

Mr. David also said, “The tool is a good fit with youth culture. Young people like technology, especially interactive learning technologies which encourage discussion rather than asking for opinions or facts.” This observation is consistent with the findings of various researchers (Montgomery, 1996; Bordieu, 1997; Arthur, 2001; Downes, 2002; Elliott, 2003b; Findlay, Fitzgerald & Hobby, 2004) about the how young people engage enthusiastically with tools. He also said, “The tool is a good fit with student voice,” the model of personalized learning (Hargreaves, 2004) adopted by the British government.

Relationships. The use of the team learning system helped change the relationship between the teacher and the students. According to the transcript, Mr. David said, “participants can see other ideas and this “makes them think about their own thoughts and about themselves compared with others.” Mr. David said, “people also like to see their own work displayed for others to see and consider. Students engage with the tool because it promotes equality and gives them the ability to get their views across.”

Rules. Although Mr. David did not attend a formal training session he appears to have adopted most, but not all of the rules for conducting a meeting. Mr. David said his sessions normally began with “warm-up” or play activities, after which he clearly stated the task. As soon as the participants typed their ideas, they were read aloud and the common themes identified. However, he often bypassed the discussion step. Although Mr. David gave the participant’s voice through their keyboards he did not encourage discussion or dialogue, which is what teachers and schools have become accustomed to (Delpit, 1988), perhaps unconsciously and automatically.

Change: Mr. David described two kinds of change, his own and the group he interacted with. He said his first session was a steep learning curve. It was a public session and “there was no hiding place.” He said the tool became easier to use after he learned how to ‘drill-down’ so that he could get to the root cause of issues. Mr. David said, “The participants help the facilitator to improve their performance. Each challenge or type of problem that confronts the facilitator generally improves the facilitator’s understanding about how to work with groups.” This kind of interaction between the

facilitator and the group appears to be a dialectical process whereby feedback from each other's performance allows them to each make separate adjustments, but which are collectively rewarding.

Mr. David used the example of the Tuckman (1965) team formation model to explain the effects he observed. He said that "during the course of an activity "groups go through the storming, forming, norming and performing stages of team formation" provided "the session is long enough and the facilitator clearly states the focus and intended outcomes. The observation that a shared focus leads to the alignment of interests is consistent with Schein's (1988) concept of shared goals. Ideas are shared, copied and evolved. Mr. David said that people "come on board and become part of the team." He said the use of the tool also "stops the dominant characters taking over the meeting. No one is left behind or embarrassed by the process as all contributions are recognized or valued." In the school classroom, "students with lesser abilities become more engaged because they are able to contribute without being laughed at." Mr. David said, "The tool achieves 100 percent participation whereas in most meetings only a few become or remain engaged." These observations also have parallels with Schein's (1988) finding that empathic listening to other points of view, leads to the formation of effective teams.

Mr. David said the facilitator helps the group acquire or create new knowledge about the issues that are being discussed, beyond what they already know, without contributing directly to the discovery. He said that the crossover from individual to group work is the process of identifying the common themes, which is a knowledge-building step. "At this point in the activity, a group response is sought and the members of the group have a shared responsibility for finding a solution," he said.

Mr. David's observations are consistent with a shift from a traditional turn-taking face-to-face meeting, where the spoken word is influenced by perceptions of the origins, status, power and authority of the speaker (DeSanctis & Gallupe, 1987) to a new more democratic form of engagement. In the team learning system setting, the ideas appear to be decontextualised (Vygotsky, 1978) so they are more readily accessible by all participants and independent interpretation because they are displayed on the shared screen relatively anonymously. In this way the meaning making process became a routine activity rather than a political activity and this may have helped the participants to find common ground within their ideas and unify them. The reading aloud of the ideas without judgment or attribution seems to make them all available for

further concept development or decision-making that perhaps prevents dominant members of the group from exerting undue influence.

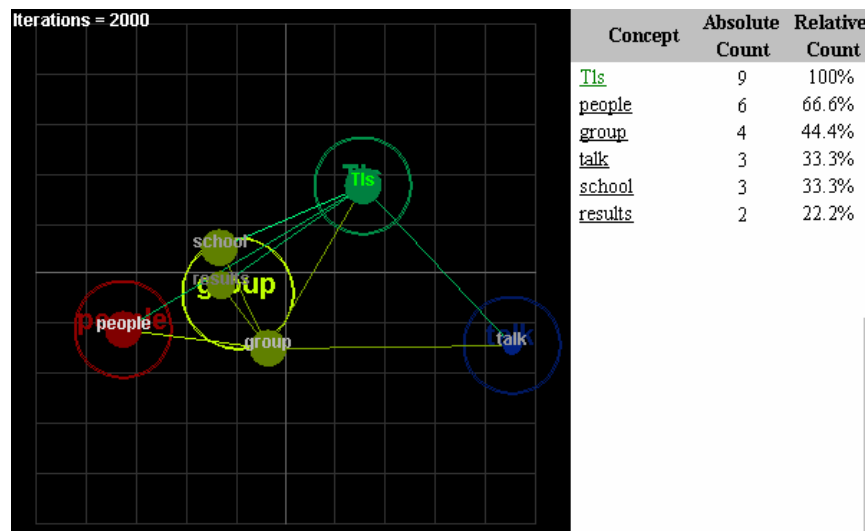
Head of college Ms. Debbie and her experiences

Ms. Debbie is the 54-years old head of college. Originally a science teacher, she became a mentor for other teachers, and eventually became responsible for the day-to-day management of the school, in the absence of head teacher, Mr. David.

Aspiration horizon. Ms. Debbie's aspirations were quite modest compared with Mr. David's goals. He was interested in changing the world while she was interested in keeping the world in good order. They made a good team. She also wanted to build modestly on the work that Mr. David had begun. She could do this by mentoring her teachers and engaging more widely with both the students and the parents to help their children learn and develop. The team learning system became part of her toolset for achieving her goals, but always one step removed. According to the transcript from the teacher feedback workshop, Ms. Debbie said she had no plans to learn how the use the tool herself, but instead employed an assistant to "press the buttons" on her behalf.

Her detachment from the tool, both in terms of its use and her description of its use, is reflected in a simple, but conceptually limited, concept analysis (see Figure 7.2).

Figure 7.2: Concept analysis of Ms. Debbie's responses



The analysis was conducted a second and third time to be certain it was an accurate reflection of her reported experiences with the tool, because according to the

concept analysis she had little to say, yet her narrative was much richer. The concept analysis showed she saw the tool (9 instances) as a way to help people talk (3 instances) about a topic (6 instances) in small groups (4 instances) in a school setting (3 instances). Like Mr. David she was focused on results (2 instances).

Tools. Ms. Debbie said she facilitated sessions with the team learning system “to learn the views of students about the source of unacceptable behaviour,” with “local primary schools to record the views of parents”, “for several middle leader courses a year to evaluate and synthesize the issues they face” and “for annual staff questionnaires as inputs to the school development plan”. “Not having enough sets for everyone who wants to use the system, also gets in the way,” she said. “You need time to set it up in a classroom and pack it away again. Sometimes some of the equipment is not working.”

Ms. Debbie also saw the tool as a way to collect information from the groups with whom she interacted, and as a conduit to the school teaching team for parents and students views, that enabled the school to improve its performance. Ms. Debbie found the tool to be unreliable because different users misplaced essential parts that rendered it unworkable for the next user. This is a common problem with shared resources which Senge (1992) calls a “tragedy of the commons” systems failure.

Roles. Ms. Debbie teamed with her personal assistant, Julie, to facilitate electronic meetings. She learned how to use the tool by observing the researcher when he facilitated a session with the senior leadership team. She decided to use the tool for staff planning and school improvement sessions. Ms. Debbie said she divided responsibility for the sessions with her secretary. Ms. Debbie planned the sessions, crafted the questions, created the templates and handled the leadership aspects of facilitation. Julie acted as her technical facilitator.

Ms. Debbie said, “The facilitator’s role is to encourage people to participate and to help people think more deeply.” However, “my lack of expertise in the use of the equipment prevents me using the tool more widely,” she said. “To become a facilitator of learning in the classroom you firstly need good facilitation skills and it requires more planning as you can’t afford for it to go wrong,” she said.

It is interesting that Ms. Debbie acquired sufficient skills to use the tool by watching the researcher facilitate a session. This type of learning is identified by Vygotsky (1978) as imitation and is explained by research conducted by Rizzolatti et al. (1996) and Jeannerod (1994) which showed that the same “mirror neurons” are activated when forming an image of an action as are activated when performing the

action. It is thus possible to observe a new kind of activity, imagine oneself performing the role, and then perform that role.

Ms. Debbie also acknowledged her limitations and the higher risks associated with using the tool in the classroom when she said, “you can’t afford for it to go wrong.” However she was not specific about what the risks might be, although the prime candidates were the fear of losing control of the classroom if the technology broke down or the loss of epistemic authority by appearing to not know what to do, having previously claimed the role of the classroom expert (Selwyn, 1997; Sandholtz, Ringstaff & Dwyer, 1997).

Relationships. Ms. Debbie said that the relationship between the teacher and students changed from a “them and us” feeling to an “us feeling” while using the tool, an effect that was also reported by other teachers. She said the tool “puts everyone on the same level” which was “not the same as the teacher-student relationship when you stand in front of the class and teach,” she said. “The students become more willing to talk to you about their concerns and became engaged because (the tool) gives them the ability to get their views across. However, it comes down to the willingness of the facilitator to work outside the box and be prepared for equality. It even works well with large groups of difficult students, who are normally hard to manage when they come together,” she said.

Ms. Debbie said that normally difficult students developed positive behaviours when they engaged with the tool. She explained that the change occurred as an unintended consequence of using the tool, and not from any purposeful action on the part of the teachers to engage the students in a more equitable way, nor an intention on the part of the students to engage with more interest and excitement.

Culture. Ms. Debbie said that when the students engaged with the team learning system, they did so willingly because it gave them an opportunity to participate in discussions and express their opinions openly, which they were unable to do in teacher-directed classrooms. “The tool fits with the culture of young people,” Ms. Debbie said. “It allows them to say what they want to and have greater control over their lessons rather than do exactly what the teacher says to do.” “Students become quite adventurous with their ideas and tend to get excited.” “The tool also gives people the feeling that you are interested in what they think” and “people like to show others what they think.” There is “a novelty factor.” “It is also much more fun than normal meetings. You get a lot more back no matter who the audience,” she said.

This suggests that the students readily accepted a rigid level of social control imposed by the talk-type-read-review etiquette of the tool, which determined when and how they conversed, in exchange for the freedom to express their opinions, which they were unable to do in the traditional classroom. The common focus of all the conversations and the play-like features of the team learning system experience may also have contributed to a higher sense of enjoyment and feeling of achievement consistent with flow (Boyer, 1996; Csikszentmihalyi, 1997).

Rules. Although Ms. Debbie was not formally trained, she recognized the importance of the rules embedded in the warm-up questions. However, unlike the teachers who had been trained in the use of the tool, she was unable to explain the meaning or purpose of the talk-type-read-review etiquette. She said, “The play activity helps people get over their fears about using the tool and making spelling mistakes in public.” “If you do not do the ice-breaker questions you don’t get as good a result.” “Initially people feared the use of the tool, but that quickly turned to enjoyment.” “Because people discussed their ideas with someone else before they typed their ideas they somehow gained approval from each other,” she said, “This relieved the stress associated with contributing.” “Everyone’s opinion is valid.” “If and when the group starts to act up, the facilitator needs to stop and do something different for a minute and then start again on a different tack,” she said.

Ms. Debbie learned how to use the tool, simply by using it. This suggests that the rules are encapsulated in the design of tool and function in the same way as the “initial conditions” of complexity theory (Guastello, 1995, p. 18) or what Engestrom (2000) identifies as use values.

Change. Ms. Debbie described two kinds of change that occurred during her sessions. She found that the tool stimulated and helped people bring new ideas to the fore and in doing so changed the way people thought about the topic. She also noticed that when people made use of ideas presented by other people, this helped transform the relationships between members of the group in a synergistic manner. She explained, “At the start of a session the focus was on the keyboards when people input their ideas, but then the focus shifted to the screen.” Ms. Debbie explained that the questions stimulated the initial ideas and the ideas then stimulated or catalysed further ideas. She said, “I initially concentrated on my own responses but afterwards I listened to others and used their ideas to either support or agree with or just help to springboard to other views and widened up my mind.” “The tool makes you reach into the back of your mind to find

something that is lingering there.” “Hearing other views made me question my own ideas and helped scaffold my way to a more in-depth view.” “As participants add more and more of the same response it influenced the group to identify or create a theme.”

Ms. Debbie noted that the shared display played a role in the transfer of the ownership of ideas from individuals to the group. She said the ideas generated by the group become available instantly and simultaneously for others to view or evaluate, which then stimulated further ideas. This seems to confirm that concepts generated by the participants perform the role of catalysts via a process of “rememberings” (Gabora, 1998) and that that conceptual sets, in the sense of Wittgenstein’s language games (1999) of inter-related and interdependent concepts, behave as autocatalytic sets, such that concept A stimulates the memory of concept B, concept B reminds us of concept C and so on. The questions also seem to perform the role of a catalyst at the start of the process. Because the ideas were generated on the screen keystroke-by-keystroke, people were curious about how the ideas might evolve. They tended to anticipate what letters or words might appear next, and so paid more attention to the meaning of the ideas, particularly new possibilities. In doing so, the participants became more open to the ideas that eventually formed, having thought of the ideas themselves before they actually appeared. This seems to be a form of anticipatory sensemaking, which is a right brain approach to novelty (Goldberg, 2001). The display also appears to have acted as a mnemonic device that shifted the cognitive load from the brain to the surround, which reduced the mental effort (Pea, 1993). The display also allowed the ideas to be seen twice, firstly, as they are being generated, and secondly, as they accumulated in the team space. The ideas were also reviewed as a complete block during the sensemaking stage, which allowed all of the ideas to be attended to.

History teacher Mr. James and his experiences

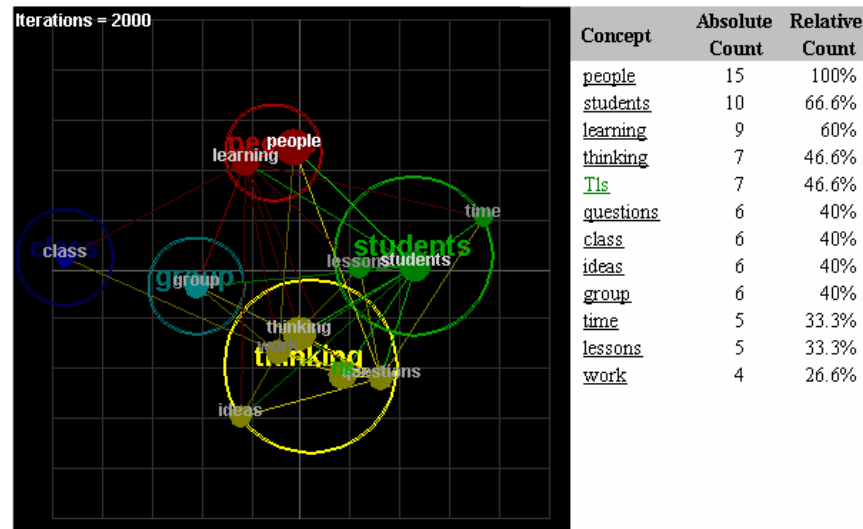
Mr. James is a 28-year old history teacher. He had just completed university and his teacher internship when the study began. Four years later as the vice-principal for learning Mr. James became responsible for the professional development of other teachers at the school.

Mr. James first use of the team learning system was a workshop for senior students to obtain feedback about their school experiences. Several weeks later he used the tool for a series of Year 12 history lessons about the reformation. Six months later

he conducted a session with Year 9 dealing with World War II. He also used the tool for staff meetings, staff training sessions with external learning providers, community groups such as an action-planning meeting with a local multi-agency delivery group, and workshops with local feeder primary schools around contentious transition issues.

Aspiration horizon. Mr. James enjoyed his role as a teacher of mainly senior students. He prided himself on his friendly, accessible approach to teaching and regarded his relationship with the students as more democratic than other teachers. He also liked to make use of innovative teaching methods and endeavoured to make his lessons interesting by introducing novel memorisation methods such as acrostics and rhyme.

Figure 7.3: Concept analysis of Mr. James' responses



After viewing the videotape record of his first two sessions, a meeting with the seniors and an extended lesson with Year 12, Mr. James was surprised at the mediocre results he achieved in the classroom. He could not understand why the meetings he facilitated with external groups were very successful, yet his classroom sessions were not. The concept analysis (see Figure 7.3) of Mr. James' experiences suggested that he saw the team learning system (7 instances) as a tool to support thinking (7 instances) and idea (6 instances) generation by asking questions (6 instances) of a class (6 instances) of students (10 instances) or a group (6 instances) of people (15 instances) to achieve some kind of learning (9 instances) outcome. Some of the time (5 instances) the sessions did not work (4 instances).

Tools. Mr. James first session was a workshop for the seniors students to gain feedback about their experiences of Year 12 and to evaluate the school's dress code. Mr. James was not the content expert, the students were. He merely asked the questions. The session was judged by the participants as a great success. Two hundred ideas were generated in response to 14 questions in just over one hour. The questions are shown in Record 7.1. The questions called for personal opinions about each of the issues thereby making the issue discussible.

Record 7.1: Questions presented to the senior students

Play: Type the words of your favourite song OR what you had for breakfast OR
The quick brown fox jumped over the lazy dog.

If you were designing your ideal sixth form what five key features would you advertise as your main strengths?

You have been invited for that rare treat, a private meeting with the Head Teacher, what five things would you say Greensward do well in the Sixth Form?

Having had tea with Mr. T. you get to spend half an hour with Mr. S. what five things would you say are a weakness of the Sixth Form?

What would you say to somebody who was planning on applying to (the school's) Sixth Form?

What are the strengths of the Sixth Form Leadership Team?

What are the weaknesses of the Sixth Form Leadership Team?

Summarise what you think the dress code is at present in 50 words or less

You are Mr. S. for the day; rewrite your own dress code in no more than 50 words.

The Governors have asked you to explain the thinking behind your dress code, do this as concisely as possible.

Is the dress code more restrictive to males or females?

How important is the issue of the dress code to you?

Mr. James was disappointed with his second session, a classroom learning activity he conducted with Year 12 history to review what they had previously learned about the reformation. His own assessment of the session was that his delivery could have been more fluent and the session more interesting, even though the students said they enjoyed the group discussion. He attributed the student criticism of his performance to the quality and style of his questions. The questions are shown in Record 7.2. At first glance, the questions have the "look and feel" of open-ended questions, because they are crafted in a novel manner, but some of the questions seek factual responses and offer few opportunities for genuine discussion while others,

although they are open-ended, offer few cues about the type of response the teacher was seeking. In addition, the students may have become acculturated into responding to almost any kind of question with “correct” answers, or interpreting open questions as “trick questions” rather than discussible questions.

Record 7.2: Questions presented to the Year 12 students

You are a German peasant named Hans. I want you to answer the following questions: What keeps you awake at night?

What do you feel about the local parish priest Porrick?

Write a rhyming poem criticising the conduct of the Papacy.

You are writing for the Catholic Chronicle. Describe your ideal religious service.

You are Pope Alexander VI. Who or what is the most important thing in your life?

Which living, or dead, people do you most despise?

What have been the toughest challenges for the Papacy over the last two hundred years?

You are presenting a report to the Lateran Council - write a 50-word summary of the recent achievements of the Papacy and the way ahead.

What makes a good essay?

How would you start?

Mr. James was well aware of the theory about how to teach with the tool. In his feedback to the researcher he said, “open-ended questions are the key to the successful use of the tool because they stimulate dialogue.” “The questions are created in one of three ways; by the facilitator before the session, by the participants during the session or sourced from sets of questions devised for standard meeting and learning activities included in the software,” he said. Mr. James chose to create, save and use his own questions. Mr. James said there is a “feel good” factor associated with the use of the team learning system. “It allows fertile questioning of people about themselves which they like to do,” he said, “Open ended questions are better for stimulating debate and creating a creative classroom atmosphere.” “The students are far more engaged with open rather than closed questions which tend to be factually based and boring.” “Open ended questions are crucial for engaging the lower ability students because closed answer questions require factual knowledge that they may not have.” “I learned to improve my question writing when I watched a video of my first lesson using the tool. The lesson was rubbish because I used too many closed questions,” he said.

Mr. James found it difficult to hand over complete control to the students, which is difficult for some teachers (Vaughan, Klinger & Bryant, 2001). Teachers are often unable to strike a balance between a constructivist pedagogical strategy and the curriculum content because constructivism has yet to be developed into an easy-to-implement, practical approach (Windschitl, 1999). His decision to review a topic rather than explore a new topic compounded the problem. It is possible that Mr. James could have achieved a better result if he had asked the students to apply what they had learned to new situations using high-level questions on the Bloom's scale, such as application or synthesis level questions (Bloom & Krathwohl, 1956; Limbach & Waugh, 2000). However, Mr. James was unable to craft these kinds of questions.

I will show in chapter 8 that the locus of control shifted backwards and forwards between Mr. James and his students, which also contributed to the unenthusiastic reception. After the students had responded to a question, Mr. James lectured them about the same topic, covering identical material, twice, unable to resist performing as the content expert, in contrast to the seniors students meeting, where Mr. James simply used the tool to present the questions, and where he acted in the role of the facilitator. At the seniors meeting Mr. James did not lecture the participants nor ask them questions to test their knowledge, because on that occasion, the participants were the context experts.

Mr. James dealt with the same kinds of technical hitches as Ms. Debbie encountered. Some of the keyboards did not work because, in the rush to set up the equipment he did not connect some of the keyboards. Mr. James said the task of connecting twelve keyboards to a computer every time it was used, was almost as complex as setting up a small network of computers. He said, "the tool also works best when you are completely familiar with how the equipment works." "A problem for me is the time to set up the system especially if I am teaching in different rooms" so "I have trained the class to set up the equipment," he said. "When you have a large group of thirty, and not all of the keyboards work, there are too many people per keyboard, and you have a problem."

Roles. Mr. James found it easy to use the tool to facilitate activities after just one day of training. However, four years later Mr. James said he "still has not fully explored" the software. "The facilitator's job is to ensure every student feels personally connected to both the activity and to learning itself, to organize the learning activity and provide structure as (the session) moves through the different stages," he said.

Mr. James beliefs about his role as a teacher appear to be in conflict with his role as a facilitator. He constantly felt the need to do more in order to teach the students, whereas if he had done “less”, the students may have taken greater responsibility for their own learning. It is possible, that the many different and conflicting models of facilitation contribute to the confusion about the most appropriate role for teacher-facilitators. The models range from the “hands-off, “guide or encourager style (Capece & Schantz, 2000) to the facilitator as an agent of change, expert, initiator and contributor (Wright & Rohrbaugh, 1999). Even the Vygotskian (1978) notion of a teacher as a guide through the Zone of Proximal Development is based on an interventionist assumption. Implicit in the design of the team learning system is a “hands off” mode of facilitation advocated by Heider (1997) based on the Lao Tzu concept of leadership, which ensures that when the job is done the people believe they did it themselves.

Rules. Mr. James noted that social influences played a big part in maintaining order. He said, “at the start of sessions you may get an inappropriate contribution. Then, as the students see others using the keyboards, to make valuable contributions, they become more engaged.” Mr. James found that the etiquette provided the rules by which the participants interacted with each other and the facilitator. “The etiquette encourages respect for others. People learn to listen to all the ideas respectfully.” “The tool also allows the exploration of ideas,” he said. “The play activity at the start of the session and the creative questioning means students think it is more fun than work.” “If you do not use the fun starter questions it can be a disaster with small groups of people, as they can be very self-conscious.” “The etiquette is good for encouraging thinking at the beginning. The reading out stage is important because it focuses the attention of the group back to the topic and helps identify the themes,” he said

Mr. James’ observations seem to suggest that each kind of discourse has its own unique set of rules for communication (Wegerif, 2002) and are generally invisible to the participants or even the facilitator, but can be made explicit by observing or reflecting upon the activity.

The “play questions” at the start of the session appeared to send a message to participants that personal opinions, creativity and borrowing parts of ideas from other people was allowed. The reading aloud process signalled that participants should respect each other’s contributions which appears to parallel the respectful listening aspects of dialogue (Isaacs & Senge, 1999). The themes stage exhibited some aspects of dialectical

discourse because it helped the participants integrate the group's ideas into a new, all-encompassing model.

Relationships. Mr. James noted that the team learning sessions resulted in a “more democratic process than normal lessons or meetings. “Everyone contributes” and “people feel more valued,” he said. “It is a fast, fantastic way of collecting data and opinions in a very short time.” He said the classes were louder than normal, as the students discussed what to type. “Because everyone contributes at the same time, this leads to engagement,” he said. “The students also feel a “greater sense of equality. They feel enfranchised and can have fun.” “The transcript of the sessions provides evidence of student learning or a record of what was said and this leads to more transparency.” The teacher “becomes the agent of fun.” “The students also appreciate you taking the time to work with them using the tool, especially as most other teachers do not bother,” he said.

Mr. James' assessment of the student experience is consistent with Grolnick, Ryan and Deci's (1991) finding that students are motivated by a sense of competence, autonomy and relatedness when teachers give them the opportunity to discuss and express their own opinions. Even the Year 12 history students who were critical of Mr. James session said they appreciated the opportunity to interact with each other and express their own opinions.

Culture. Mr. James described the team learning system as a good fit “with youth culture.” He saw it as part of a trend towards a “society that values individualism, and individual expression,” where “the emphasis on speed of thought and typing mirrors youths' obsession with doing everything yesterday.” Mr. James said, “The fun questions which focus on the students' interests send the message you are interested in them as people and value their views more than you value subject content. The tool changes the locus of control from teacher-centred to student-centred. The students say they do not normally have the freedom to express themselves,” he said. Mr. James attributed the teacher-centered nature of classrooms as being “due to the culture of the examination system rather than the school.”

Change. Mr. James described three changes that occurred during his team learning system workshops. He noticed that his own performance as a facilitator became automatic when the group developed more skills in higher-level thinking and their joint performance improved. Mr. James said, “it became easier for me to use when I was able to teach other people how to run meetings, especially students.” He pointed out the

facilitator needs to become more interventionist when a group “gets into trouble.” “For most of a session, the facilitation process is automatic and easy to do,” he said.

“However, if the quality of responses worsens, the facilitator must intervene” to ensure the students remain on task.” “You can tell if the class is in trouble with a topic because there are fewer responses and they are less descriptive or fertile. I ensure the themes or key ideas are discussed as far as possible. I let the students lead this. It is important to begin with the fun activities, which trains students in how to use the tool. You also need to restrict the amount of discussion,” he said. Mr. James also observed, “the ways students respond to the questions changes the way the facilitator asks the questions and facilitates the session. The facilitator might for example, get feedback from the students about why the session failed to work.” Conversely, “higher level and good quality responses might lead the facilitator to give more time to a question to explore it in more depth. If a question is not working, it is time to move on to a different question or activity,” he said. “The group discussion promotes higher order thinking such as the evaluation of ideas whereas (in a classroom) most individual thinking is simply collecting data or ideas,” he said. “There is also an emotional aspect to group interactions which the students feel excited about.” “Students focus on ideas they can either challenge or incorporate into their own thinking. Individual ideas also stimulate wider discussion beyond the student’s own experience or thinking,” he said. These observations by Mr. James are consistent with Smith’s (1977) findings that collaborative work is related to higher levels of critical thinking and less rote memorisation, Hansen and Stephens (2000) view that collaborative learning requires participants to be active knowledge creators rather than be passive recipients, and Kulik and Kulik’s (1979) findings that student discussions are more enjoyable than traditional lectures. As I will show later in this chapter, the Year 12 students were critical of their teacher’s performance, but not for these reasons, because in some ways they were oblivious to the problem, having been acculturated into the world of “school-going.”

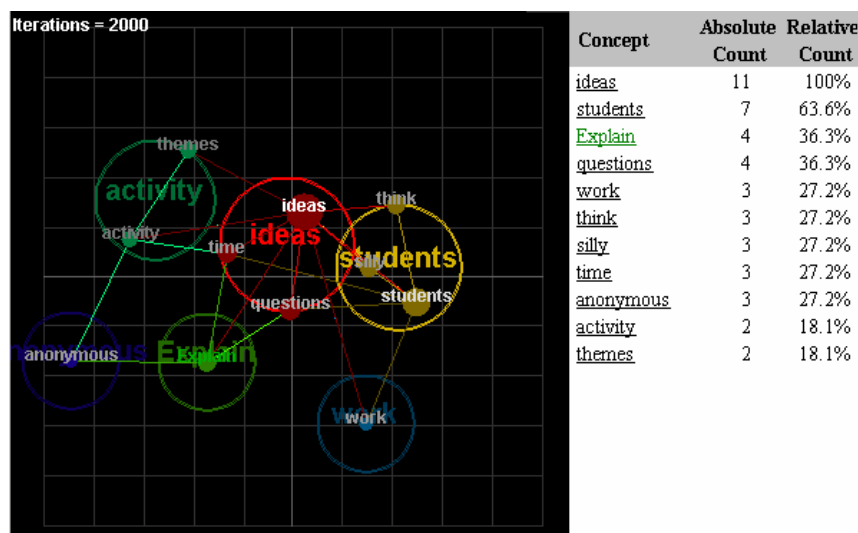
Textiles teacher Ms. Zoe and her experiences

Ms. Zoe, the textiles teacher, was a member of the school’s executive. She had over 15 years experience as a teacher and was responsible for teacher training for local feeder primary schools. Ms. Zoe conducted two sessions for this study, one with Year 8 textiles and another nine months later with Year 7 textiles. Ms. Zoe facilitated her first

team learning system one month after attending the training day. During the course of the next two years she conducted over 40 sessions with the tool including staff training sessions, teacher training outside the school, community meetings but very few classroom activities.

Aspiration horizon: Ms. Zoe’s original intention was to use the tool to generate ideas. She was concerned about how its’ use might affect her ability to keep control of the class and the reduction in teaching time to cover an over-crowded curriculum. Said Ms. Zoe, “I was really keen to use the tool in the classroom, but was more interested in generating many hits than quality ideas.” She had a target in mind, “over 100 ideas so I took some time framing the questions to achieve this goal.” Her focus was quite clearly on idea production rather than student learning.

Figure 7.4: Concept analysis of Ms. Zoe’s responses



The concept analysis (see Figure 7.4) confirmed her intention to ask the students (7 instances) to generate ideas (11 instances) in response to the questions (4 instances) she had created. She was anxious about completing the activity within the time (3 instances) allocated for a normal classroom activity and about the possibility the students would post silly (3 instances) ideas. Her role was to explain (4 instances) what to do, to ask the students to think (3 instances) and to invite participants to suggest common themes (2 instances). She felt that anonymity (3 instances) contributed to the success of the session, which the children did not see as real work (3 instances).

Tools: For her first classroom activity, Ms. Zoe chose the topic of garment design and prepared a series of four questions for her class to consider, as shown in

Record 7.3. The students were asked to imagine themselves as consultants to a clothing company and to determine what they would need to learn about their customer's requirements, the target market, the types of activities the garments would be used for and the styles that could be produced. The questions mostly drew on the tacit knowledge of the students rather than anything the students had previously learned. The process employed by Ms. Zoe had some of the elements of a creative process that a business might use to reinvent their products. The questions also contained scaffolds (Bruner, 1956) to indicate to the students how they should respond:

Record 7.3: Questions presented to Year 8 textiles

Warm-up: Type anything you like, the words of your favourite song, what you had for breakfast or the quick brown fox jumps over the lazy dog.

Warm-up: You have been turned into something nasty by a wicked witch. What are you now and how can you use it to your advantage?

The head of a large clothing company has asked you to design and make a pair of shorts for a chosen leisure activity - what questions would you need to ask her? e.g. are they for boys or girls?

You are having lunch with the financial director of the Company who will decide which target group you will be designing for - write down all of the different types of people you could design for e.g. teenage girls

Your supervisor thinks that football is the only leisure activity where people wear shorts and you don't want to make another pair of football shorts. Write a list of all the other leisure activities where you could wear shorts

There will be a bonus for the best ideas and you want to impress the head of the company with your knowledge and expertise - write down all the different styles of shorts that you can think of e.g. Bermuda shorts

The session was a success. The students participated with unbridled enthusiasm and generated over 400 ideas in 40 minutes, which was all the time that remained after Ms. Zoe struggled for 30 minutes to explain what to do, interspersed with administration and behaviour management activities. Ms. Zoe found the session "frustrating." Some of the keyboards did not work, the activity was held in a classroom in which she normally did not teach and she had to re-arrange the room so the students could share keyboards and converse with each other. She said, "Like other tools I use, it allowed me to get far more done. I work with students in exactly the same way as in my non-technology classroom - in pairs." "The tool is a good fit with what I want to do as a teacher," she said.

Roles. Although Ms. Zoe claimed that she was a facilitative-style teacher, there are clues throughout the video record and the feedback about her experience with the

team learning system, which showed she was, and remains, a traditional teacher at heart. The analysis of her performance reported in chapter 8 shows that for the first 30 minutes she dominated the classroom with “teacher talk”. She did not stop talking, even for a moment. She expressed a fear she would lose control of the class by using the team learning system, and that asking the students to undertake the warm-up sessions was in her mind, a waste of time. “The time I lost at the beginning of the session showing the students how to use the tool was made up later in the session” by which time the students were socialized into a pattern of responding, she said. “There was some silliness choosing the names but when that was over they were fine. If you make an issue out of the silliness, it becomes worse. I liked that fact that they are all at an age when they were keen to participate.” “Sometimes you feel that your job as a teacher is just “to entertain” the students,” she said.

Ms. Zoe’s experience is typical of the first stage of tool adoption identified by Sandholtz, Ringstaff and Dwyer (1997) which is characterized by frustration and anxiety as teachers try to force the tool to fit traditional instruction activities. What Ms. Zoe did not mention in any of her feedback was that her session teetered on the borderline of failure, as recorded in the videotape of her session.

Rules. Ms. Zoe attributed the successful use of the tool to the etiquette, which set the pattern for how people should engage with each other. “The “warm-up activity” at the start of the session is necessary” she said “to get the “audience used to the keyboards and the F9 (submit) function.” “It also allows the teacher to explain the talk in pairs and share the keyboard rule as well as respond appropriately to the facilitator requests for “last responses,” “read the ideas aloud” or “summarize the key themes.” Ms. Zoe said the talk-type-read-review etiquette “encourages thinking before writing which normally prevents silly answers.” “The open-ended questions helped students to think creatively while the parallel thinking allows student to piggyback their ideas off other ideas.” “The reading aloud encourages students to become involved,” she said.

Ms. Zoe’s observations are consistent with the findings of Poole and DeSanctis (1990) that differences in participant’s experiences of the use of collaborative technologies such as team learning systems and group decision support systems is determined by how the tool is first introduced to users and how faithfully the facilitator follows the rules embedded within its features.

Relationships. Ms. Zoe reported that a more equal relationship developed between the teacher and her students when using the team learning system. The students

agreed with this opinion (see student feedback in this chapter, pages 252-260). “The student-teacher relationship is “far more friendly and on a more equal footing when using the team learning system,” she said. The teacher is “working alongside” the students “looking for the same information. When responding to open questions, the students feel less threatened and fearful they might get something wrong and are more prepared to contribute,” she said. This is an important observation. Ms. Zoe appears to recognize that the act of asking closed questions to test for memorisation establishes an adversarial relationship between the questioner and the respondents. If you know the answer to a closed question you appear knowledgeable; if you do not, then you appear ill informed. Closed questions involving yes-no or right-wrong responses create the circumstances for self-esteem to be shattered. Some teachers go even further and use the threat of asking a closed question as a behaviour control tool. Asking closed questions results in group division rather than the social cohesion that normally accompanies collective learning and development. As Griffin and Cole (1984) suggest development in the school classroom becomes “circumscribed by the adult’s achieved wisdom”. Asking open questions sets up a different dynamic. Open-ended questions give respondents the opportunity to offer their own interpretation of a situation or issue and create a space in which a diversity of opinions may be listened to, analyzed and further developed. The dynamics are about inclusion and the development of a joint or complementary focus, which leads to social entrainment (McGrath, 1990) and team formation (Schein, 1988; Losada, 1999).

Culture. Ms. Zoe observed some differences between the student and home experience of technology. She said the team learning system allowed the students to “all talk at once which is what young people do all the time via the keyboard or a telephone keypad.” She also noted, “the technology at school is not as good as what they use at home.” Ms. Zoe thought that the high levels of enjoyment and engagement that she observed in her classroom were achieved by introducing a “competitive element.” “They do not see learning this way as work,” she said. “The tool offers “something different” to the normal school experience and “singles out the class for preferential treatment” so it “makes them feel special,” she said.

Change. Ms. Zoe reported two kinds of change, a personal shift to unconscious competence and a change in the mood of her student group, from a moderate level of engagement, to a highly engaged and excited state. Ms. Zoe found the tool became “easier to use” by her third session and then “far easier to use over time.” “Sometimes I would facilitate the sessions from memory,” she said. “At other times I would refer to a tick sheet.” “You become unconsciously competent after you have done many sessions. Learning to drive a motor car is a good analogy,” she said. Sometimes “the responses get silly or fewer” when the “students are losing interest” and the role of the facilitator “goes from automatic” to interventionist in order to maintain control or move the activity to a new level,” she said. This appears to be a switch to automatic operations (Leont’ev, 1978), at which point Ms. Zoe did not have to think consciously about what to say and do. The change did not occur immediately, nor under her conscious control, but after an extended period of tool use and without external scaffolded support. When Ms. Zoe first began using the team learning she was apprehensive and fearful about the possibility that she would lose control of the class and how this could impact on how she was regarded as a teacher. She used a tick sheet to shift some of the cognitive load to the surround to help remember the steps of the procedure to assist her performance. Over time she was able to dispense with the mnemonic and rely on her unconscious memory to perform the activity automatically. As I will show in chapter 8, she was able to switch from purposeful, conscious thought – in which the frontal lobes played a major role in the creation of new routines or “kinetic melodies” (Luria, 1987, pp. 30-31), to a more automatic performance about 30 minutes into her first performance, when the student activity became routine. At a group level, the changes observed by Ms. Zoe were also significant. Ms. Zoe said the students discovered that “learning this way is fun which is unlike any other classroom activities.” “The more provocative, engaging and open the questions, the better the result.” She said, “the students also used the ideas that others had created to develop new and different or better ideas themselves and had considerable fun doing so.”

The Year 12 history students’ experiences

Twelve students in Year 12 studied history with their teacher Mr. James. In giving their feedback to the researcher about their first experiences with the team learning system, the students said they admired Mr. James for his enthusiasm and

interesting mnemonics such as acrostics and short poems to help recall historical events. The students saw school as an important tool for developing and maintaining a social life and that alternatives to school such as "no school" would deprive them of opportunities to meet other young people. It was also important that home and school life should remain separate and that if home became the same as school, then life would be boring.

Aspiration horizon. Year 12 aspired to complete their high school studies as soon as possible. In response to series of questions about their use of tools at home and school, the students said they were generally content with the services provided by the school but felt their education could benefit from improved access to teaching techniques that catered for their different learning styles, discussion and more respect from teachers for student opinions. They also wanted to discard the school uniform and adopt a university-like lifestyle with more flexible school hours, more control over their own learning and the option of learning from home. They routinely used mobile phones, MSN instant messaging and the internet for communications and cars and bike for mobility to maintain a social life. Most of these "normal" technologies were banned in school. Even Year 12 students were prevented from using mobiles and sending text messages at school. However, all students had access to a school-provided learning environment called the Digital Brain the students said few ever used. Most of what passed for ICT use in the school was for first order knowledge processing function such as entering, displaying and sending information, an issue that Scardamalia and Bereiter (1993) highlighted and is still the case. The students said they would prefer access to better and more useful tools in the classroom and be able to interact with teachers and other students over the internet. However, computers were not a large part of the student's home and school life. They mainly used computers to access the internet, undertake research and prepare essays. Computer use at home exceeded school use. Only one third of the Year 12 students used computers at the school, the same students who used computers regularly at home, generally for 3-4 hours a day. One third of the 12 students said they never used computers at school and another third used computers for less than half an hour each day. The students regarded the school computers as inaccessible, due to restrictions placed on their use, or in poor working order. One of the students, the only student in the study who did not enjoy using the team learning system, said she did not like using computers, as she found them boring and frustrating.

Tools. The feedback from the Year 12 history students (see Table 7.2) showed that they enjoyed their session with Mr. James. They said they felt more involved, appreciated the opportunity to discuss ideas with other students, reflect on other students' opinions and liked the novelty of typing. However, the students were critical of their teacher's performance.

Table 7.2: Year 12 history comments about their experiences

Response (n = 20)	%
Felt more involved	20
Good, more interesting, fun, enjoyable	20
Facilitator was not well prepared or fluent	15
Discuss, see or hear other people's ideas	15
Felt more creative, cared about my ideas	10
Novel, typing	10
Hard to type	5
Not my learning style	5

They said their teacher was slow to get started and did not know what he was doing. One student said group discussion did not suit her preferred learning style of working alone. She also said it was a slow way of passing on information (see Record 7.4). None of the students commented on Mr. James' excessive use of the lecture and closed questions, possibly because, for them, these two pedagogical approaches were what they expected. As the survivors of a student population that began school 12 years earlier they had become socialized into the culture of school-going (Engestrom, 1987a) which is accepting of the lecture, closed questioning and working alone.

Record 7.4: Year 12 experience with the team learning system

Huckerby: It was good fun, took a while to learn but was awesome. Mr. James didn't have a clue.

Sarah: I find it a slow way of passing on info. Mr. James was fine. It just doesn't suit me learning this way.

Carly: More creative, more of a group activity. Feel connected as a class, more fun.

Alex: It was rather good. Mr. James seemed a bit clueless though. Poor lad.

Roles. The students said that when they used the team learning system they felt they were on the “same wavelength” as the teacher and “the role of the teacher and the students becomes the same” (see Record 7.5). The application of the rules associated with the tool appear to have provided a level of leadership for the group that helped them feel more engaged with each other and more empathetic with their teacher, despite his poor performance. This is consistent with the onset of the team state (Schein, 1988) characterized by the participants all working on the same tasks at the same time, or coordinated different tasks caring about what they were doing, allowing everyone equal air time, both to discuss and share opinions, but also allowing everyone to express an opinion without criticism – factors which appeared to be all present in the session.

Record 7.5: Year 12 view of their roles

Huckerby: I feel involved, more interested in the lesson and actually care about what I write.

Liz: I feel as if we are all part of the class, rather than the teacher being a separate thing

Alex: You are more on the same level, interacting with each other and you feel more involved as a whole group.

Carly: We mould into one role.

Rules. Generally the Year 12 students saw little difference between the rules of the normal classroom and the rules when using the team learning system (see Record 7.6). The students said the team learning system gave them the opportunity to offer honest opinions, but also to respect, and be open to other opinions and new ideas. They were expected to make sensible contributions and use no silly words or swearing and take care of the equipment. Although talking at the same time in class was considered rude, typing at the same time as everyone else, during a team learning system setting, was not. The students said they were expected to listen to the teacher and each other in the normal classroom setting. They were also expected to be courteous or polite and tolerate whatever the teacher did. Chewing gum was not allowed, nor was fighting, causing disturbances or talking back to the teacher.

Record 7.6: Year 12 view of the rules for using the tool and normal classroom

Robin: Same as class rules.

Jenni: To always be listening, don't talk when the teacher is, just being polite.

Liz: Everyone's opinions are heard rather than just one or two everyone's opinions are heard rather than just one or two.

Ben: Be sensible with answers, honest with them, respect what everyone else says.

Alex: I guess about the same, since you are typing you aren't really butting in. But I suppose no swearing on it or random typing when we are doing other stuff.

Relationships. The students observed they felt a greater affinity for each other and their teacher when working in the team learning system environment (see Record 7.7). They said that everyone was able to have a say, not just those who put up their hands. The students felt more involved and closer to each other when they worked and learned this way, but they also felt the teacher become more engaged with them.

Record 7.7: Year 12 views of their relationships

Jenni: I felt more involved with everyone else. Lots of group discussion.

Carly: More creative, more of a group activity. Feel connected as a class, more fun.

Scott: A lot of group discussion, which is damn good. I think that it brings people together.

The student experience of increased group cohesion is consistent with a change in the interconnectedness of the group that occurs when groups become a team (Losada, 1999) which emerged despite their teacher's poor performance. Groups can become teams when they are led positively and democratically and are subsumed into the group. The team learning system appears to provide some of the qualities of a leader via the etiquette, as well as the user interface, because it provides support for coordination and greater opportunities for creativity and sharing of information, which Schein (1988) shows contribute to the formation of effective teams. Perhaps the team learning system "participates" as a quasi-leader in the group development process and takes on some of the traits of joint activity (Tikhomirov, 1999, p. 355).

Culture. Overall, the students saw no or little difference between the culture of the normal classroom and the team learning system session (see Record 7.8). Only one student saw similarities between the team learning system and chat rooms or instant messaging.

Record 7.8: Year 12 opinions on the school and TLS cultures

Robin: Both. Treating others with respect and general politeness to others.

Jane: It's the same.

Robert: I think that this (the team learning system) is very similar to the types of youth culture today. Using chat rooms all the time

A possible explanation for the perceived lack of difference between Mr. James' normal teaching performance and the team learning session was there was no difference, because he performed as a traditional teacher on both occasions. But there were some changes, if only for a fleeting moment. Both the teacher and the students felt the relationship became closer. Both saw a blurring of the roles between the teacher and the students. Only the teacher perceived a change in the rules.

When considered through the lens of Fichtner's (1984) model of inter-subjective relations, the use of the tool with Year 12 appears to have resulted in the achievement of the first level of communication – coordination – in which the participants worked on a common object but remained individuals. This is consistent with an early stage of group formation as considered by Tuckman (1965) where the group may have established new set of norms, but has not reached the performing stage. The talk-type-read-review etiquette or its modified version of (talk+type)-read-review clearly provided the norms - the rules in activity theory - for the group. After the first question, the students adapted the typing and talking steps, and without contrary feedback from their teacher, followed this sequence for all the remaining cycles. A second and more complex kind of inter-subjective relations which Fichtner (1984) identifies as cooperation, and which involves the joint completion of tasks or joint solutions of problems, was also achieved from time-to-time, when the students and teacher engaged in joint sensemaking activity. But what was not achieved with Year 12 was what Fichtner (1984) calls reflective communication, which involves coming together as a collective subject and pursuing a common subject or aspiration in such a way that the activity becomes self-regulating and self-sustaining. This form of intersubjectivity seems to be equivalent to the performing stage of group development that Senge (1992) refers to as team learning and which involves the orchestration of activity. In this session, it would have been difficult for the group to have achieved such a state, because Mr. James, in his role as a traditional teacher, constantly wrested back control of the group every time the group showed signs of taking responsibility for its' own activity.

Change. The students felt there was little difference between their normal lessons and the team learning experience with their teacher, although some did see some possibilities for greater independence and control over their own learning (see Record 7.9).

Record 7.9: Student views regarding change

Liz: More interaction, more use of these things (the TLS). Maybe sometimes work from home on the Internet and get taught from there!

Sarah: More control over my own learning, some teachers need to recognize that you're entitled to your own opinion even if it doesn't agree with theirs.

Robert: It's more interactive, teacher is more involved.

For a fleeting moment, the Year 12 students experienced what Davydov (1979) describes as the first stage of any change process, "a felt need", but which on its own is "not capable of giving rise to any specifically directed activity" (p. 50). They had none of the passion and enthusiasm of Years 7, 8 and 9 who had yet to succumb fully to the dominant culture of "school going". The Year 12 history students appeared to be ready to accept obedient roles in the world of work (Miettinen, 1999, p. 328) where they will live out their lives without challenging the existing order of society. Mr. James had his own "felt need" in the context of his interactions with Year 12, which was to discover why his workshops with students and community groups worked better than his classroom interactions.

The Year 8 textiles students' experiences

In marked contrast to the subdued Year 12 experience, the Year 8 textiles students had fun! For them it was an opportunity to play and to enjoy interacting with each other and their teacher. It was also a more engaging experience than the dreary ICT classes where they were required to learn what they already knew or the normal textiles class, which rarely stretched their brains.

Aspiration horizon. The opportunity to use the team learning system was a welcome diversion from the daily routine of starter activities, the boring "safety quiz," which the teacher admitted was designed to keep the students busy and under control while she signed their homework books and called the attendance register. In their feedback to the researcher, the Year 8 students said they would like to see fewer and less rigid rules at the school, greater equality between students and teachers, and improved teacher-student relationships. They also said they would like to use phone, text, or computer chat to talk to other students about homework, search the internet for information for assignments, get in touch with students overseas and learn through play. The students said they would like to make more use of computers because "learning this

way is more fun.” They expressed the view that technology could improve their relationships with their teachers, as there would be more emphasis on personalised learning.

The Year 8 student experience of information and computer technology (ICT) was similar to schools generally (Downes, 2002). At school, the students said they had limited access to ICT, while at home they used the computer extensively. At home, almost half the students used computers 3-4 hours daily and the remainder for 1-2 hours per day. They regularly chatted to friends over the internet, communicated via email and text messages and played games. Most students said they had no access to computers at school or limited access, (see Record 7.10). The students said teachers rarely use ICT in their teaching and exercised tight control over access to technology. The students said that although it is possible to access ICT at the library during lunch breaks, the library staff members restricted its’ use. The students who did have access to computers at school said they did so for less than two hours each week and only to “learn” how to use computers, an activity they regarded as unnecessary. Most of the students said they would like to use the same tools at school as they did at home.

Record 7.10: Student experience with technology at the school

John: The teachers think computers distract us from our work

Cara: The computers are only available in the library

Adam: They are dodgy

Sam: The librarians block our use of their precious computers.”

Clearly the aspirations of the students and their teacher were quite different, especially when using the team learning system. Power differences between the teacher and the students ensured there would be no joint object, and even less prospect for internal and external transformation of the object. The teacher used the students as an instrument of her desire to look good as a teacher, as her objective was to generate a large number of ideas. The student’s objective was to have as much fun as they could while participating in an activity that was novel. Some students may have chosen to attend school to learn, while others did so to socialise with other students. The activity system is much more like overlapping activity systems.

Tools. The students reported that their first experience with the team learning system was “fun” “exciting”, “interesting” “good” or “a great idea” (see Table 7.3).

They said they had “learned a lot” and did not see it as learning. One student said it “beats learning.”

Table 7.3: Year 8 textiles comments about their experiences

Response (n = 57)	%
Fun, exciting, enjoyable, really great idea	44
Novelty, of typing, discussion etc.	34
Better than normal class activity, writing	4
Discuss, see or hear other people’s ideas	4
Learned something, better than learning	2
Facilitator was less strict	2
Hard to type	2
Let’s do this again	2

When asked to suggest improvements, most students said they wanted their own keyboard, more time to discuss the topics and for the ideas to be displayed on a larger screen so they were more readable. The students said the teacher’s performance was very good, although one student commented that the teacher needed more practice. The students regarded the team learning system activity as a novelty because they had never experienced anything like it before, especially the ability to type ideas and communicate with every other person in the classroom at the same time (see Record 7.11). The novelty factor may account for some of the high levels of enthusiasm, enjoyment and engagement that were evident. The students said that if they were required to use the tool every day in most classrooms this kind of activity could become equally boring.

Record 7.11: Students experience of the first session

Kerry: It was fun and I learned a lot.

Hazel: It is more fun and everyone can share there (sic.) point of view.

Brad: This is a lot more fun and everyone can share there (sic.) points at once!

Jane: I have more fun doing this and the time goes quicker than normal

The students reported that they became so involved in the activity they did not notice the passing of time, which seemed to travel “quicker than normal”. This experience, taken together with the many reports of “fun” and being in control of their own destiny are typical of the flow experience (Csikszentmihalyi, 1975), which is experienced when people engage in interesting activities that are just beyond their

capability. Usually flow is regarded as a personal experience, but in this classroom there was such an outbreak or epidemic of the experience, it suggests the possibility of a “group flow” state that emerges when the fun becomes infectious.

Roles. When asked to consider whether the use of the tool made any difference to how the teacher engaged with the class, the students said it “meant less work for the teacher,” less work to maintain control and easier to review student progress (see Record 7.12). The students said they felt more involved and more in control of their learning. The apparent anonymity allowed the students to express their opinions more openly and therefore they felt more comfortable contributing. They said the speaking turns are controlled, not by the teacher, but by the team learning system.

Record 7.12: Student comments about student roles

Mark: We don’t have to raise our hand and wait for the teacher to tell us to speak, and we don’t have to shout out. This is an easier and enjoyable way.

Jamie: You all get to have a say and all people are listening to what you think.

Chloe: It is more fun and everyone can share their point of view.

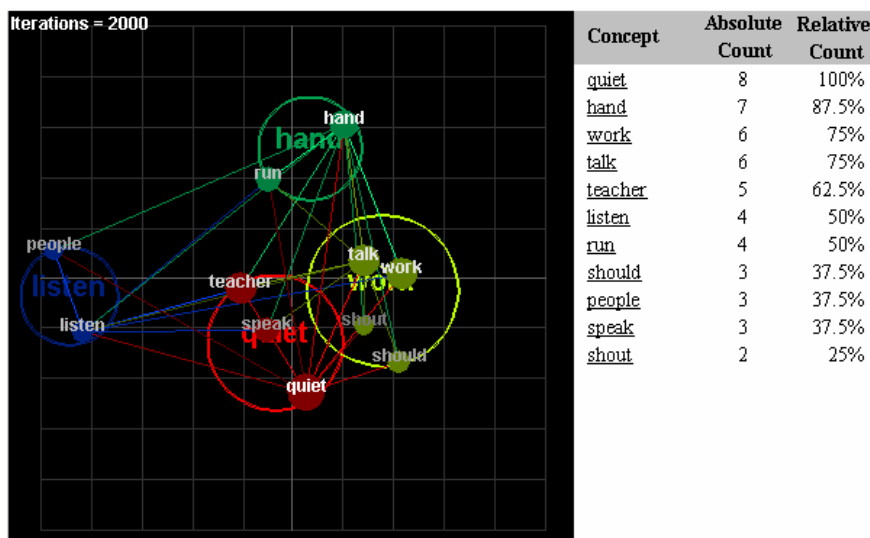
Harriet: This is fun and people who do not normally speak up in a lesson can get their ideas in.

The student response to the activity appeared to have the features of play. While using the tool, the students took on greater responsibility for their own learning, and in effect behaved as if they were “a head taller” (Vygotsky, 1978, p. 102). They appeared to raise “the demand on themselves” (Brostrom, 1999) and generated ideas at will, and in doing so brought “themselves into the zone of proximal development” (p. 102). The hypothetical nature of the activity may have contributed to the positive response. The students were asked to imagine themselves in a new role as designers and marketers of a range of fashion items. How much of the playful response was due to the nature of the task, the affordances of the tool or the play interaction itself, is not clear. The task was clearly playful. They played at being designers and marketers rather than “mothers and fathers” or “doctors and nurses.” The tool appeared to create an environment in which the participants were able to play with ideas that became representatives for other ideas, in much the same way children are able to use objects as props, and for example sticks become a doll or a sword (Elliott, 1990, p. 15). As each new set of ideas was revealed, this sparked the emergence of further ideas. The sequence of questions operated somewhat like a game (Sweeter & Wyeth, 2005), in which new, more challenging tasks, were presented upon the completion of a task, which ensured that the participants

received intrinsic rewards, for progressively raising their level of performance (Malone & Lepper, 1987). The students also observed that the teacher played a less active role as a classroom controller. They said the tool and the etiquette performed some of the teacher control function and they felt more in control. This is consistent with the Boyer (1996) finding that when students have control over their destiny their sense of enjoyment and achievement consistent with the occurrence of flow.

Rules. The Year 8 students reported a significant difference between the rules that applied to their normal classroom and the rules that applied when using the team learning system, a movement from the rules of “work” to the rules of “play”.

Figure 7.5: Concept analysis of Year 8 textiles experience of the classroom rules



The concept analysis (see Figure 7.5) showed the student’s perception of the normal classroom was they were required to work (6 instances) in an atmosphere of compulsion and control (3 instances of should), to be quiet (8 instances) and listen (4 instances) attentively to the teacher (5 instances) and raise a hand (7 instances) to gain her attention or to seek permission to contribute or to be selected to make a contribution.

The students said their teachers insist on good behaviour such as remaining in your seat and only speaking when spoken to by the teacher (see Record 7.13). Students were also expected to pay attention to the teacher and do what the teacher requests. They said they would receive punishments if they did not do what they were told, such as being separated from their friends or isolated from other students.

Record 7.13: Student comments about the rules of the normal classroom

Tom: You are expected to raise your hand when you want to talk but you don’t

always get picked to say what you want.

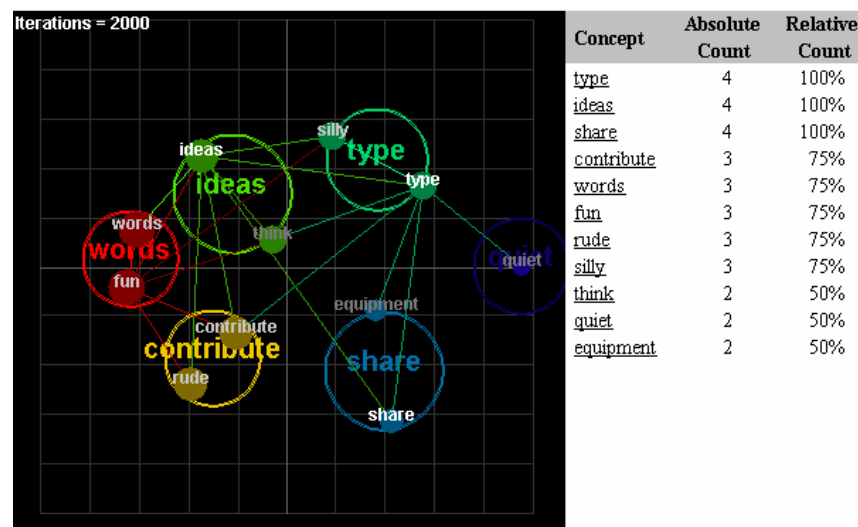
Chloe: To be silent and get on with the work set.

Louise: Be quiet and listen to the teacher who sometimes doesn't let you say something important.

John: We should concentrate on what the teacher has said and get on with the work quietly.

The students perceived that the rules of the team learning system classroom were more open and democratic as shown in the concept analysis (see Figure 7.6. The students said they were expected to think about the topic (2 instances) and contribute (3 instances) their ideas (4 instances). They were able to type (4 instances) their words (3 instances) via the keyboard and share (4 instances) them with other students. Everyone was able to have fun (3 instances).

Figure 7.6: Concept analysis of Year 8 textiles view of team learning system rules



However, all students were expected to behave sensibly, not make silly (3 instances) or rude (3 instances) comments, and to be careful with the equipment (3 instances). The students said they enjoyed being allowed to talk, share and interact more and it was easier to concentrate on what they were doing (see Record 7.14). Because everyone had a say or turn, it gave shy people the confidence to contribute. There was more freedom and fewer rules to obey. They did not have to raise their hand to speak so there was no waiting to contribute their ideas. The students said they wanted to use technology in the classroom but their teachers would not allow it and in some cases deliberately blocked access.

Record 7.14: Rules of the team learning system classroom

John: The teacher doesn't have to teach; you teach each other.

Mark: MARK SAYS VERY LOUDLY: IT MAKES U FEEL LIKE U R LESS INFERIOR ALL THE TIME U CAN SAY WHAT U WANT 2 SAY WHENEVER U LIKE THAT WOULD BE MAGICAL

Mary: My role is different because I get my say instead of teachers only picking some people with their hands up.

The students said that the rules associated with the tool changed both their relations their teacher how they interacted with each other. This suggests that the rules associated with tools, which are essentially the “initial conditions” of complexity theory (Guastello, 1995, p. 18), may be the critical mediating factor rather than the tools themselves. The new roles were not a mediating factor either, and appeared to be simply a consequence of the adoption of the tool and its “designed in” rules. When the teacher adopted the new rules that allowed discussion and the sharing of ideas, the teacher inadvertently, signaled that she was, at least temporarily going to adopt a new role as a facilitator and give the students more autonomy. She struggled with the new role because it was new to her and in conflict with her traditional and familiar role. Although the student-teacher relationship became more interdependent during the session, this development was unrelated to the object/aspirations of either the students or the teacher. The student and teacher activity trajectories came into alignment as a consequence of following the etiquette, which synchronised the group temporarily, a form of entrainment (McGrath, 1990). In the absence of a shared object, the implicit rules in the tool appeared to mediate the activity even though the participants in the activity had separate intentions.

Relationships. During the workshop the students felt more included or had a sense of belonging, there was more group discussion, individual views were heard and everyone had a say (see Record 7.15). The conversational turns were controlled by the activity rather than by the teacher and there was no need for students to raise their hand for permission to speak. Copying of information from the blackboard was no longer required. The students said they felt more engaged. They also felt more appreciated by other students as well as the teacher

Record 7.15: Year 8 view of their relationships

Kerry: Because you all get to have a say and all people are listening to what you think.

Harriet: It makes you more comfortable because you don't have to worry at people laughing at you.

Bradley: It makes you feel like you are in control for once

Tom: This is much better as you feel more attached to the class.

This result is consistent with a change of state, from the large power distance that exists in a traditional classroom, where the teacher exercises total control and which the students describe as work known as “school-going” (Engestrom, 1987a), to a more democratic relationship, where the teacher is more of a participant in the group process of creating new knowledge and the power that is exercised by the teacher and the students is more equal.

Culture. The Year 8 textiles students were asked to compare the culture of the normal school classroom with their experience of the team learning system. Nineteen of the 22 students said it was more aligned with their own culture than the normal classroom. They said it was more fun and more democratic (see Record 7.16) because the team learning system encouraged more people to have their say. They also felt they became more closely connected to the teacher and that the teacher could understand them better, because she could see what everyone was thinking via the shared screen, rather than hear from the very few, who normally raised their hands and were sometimes given the opportunity to speak.

Record 7.16: Year 8 perceptions of the classroom culture

Adam: Doing this and being able to express myself, coz I'm shy but with this I can say what I want in confidence. This is a great idea.

Jane: It is more fun this way, and I think people concentrate more, also people may not like to put their hands up and speak aloud.”

Mary: This sort coz you can discuss things and everyone gets a turn.

Jade: I PREFER WORKING IN GROUPS, AS I FEEL MORE COMFORTABLE, AND I PREFER TO SHARE IDEAS, JUST IN CASE MINE ARE WRONG OR SOMETHING

The students said they would like to learn to facilitate the classroom activity, to develop their leadership skills and experience being a teacher, although some had reservations (see Record 7.17). Several students said they were more likely to listen to people their own age and would become exposed to more ideas using such a tool. Some said they were shy and would not have the confidence to lead the group. Other said the

students might say silly things, their behaviour might be difficult to control and if undertaken too often, the activity could become boring.

Record 7.17: Year 8 interest in becoming a facilitator

Jade: I wouldn't like this in every class, coz the only reason classes are alright is coz that every lesson is different and if in every lesson we had these they would all be the same. It would be boring too.

Scott: But it would be hard. Some immature people write silly things.

Natalie: Yes, it might be better because people might listen more to some1 (sic) nearer to their age.

This expressed interest by the students in having greater control over their own learning is consistent with the recognition by some educational leaders such as head teacher Mr. David and Hargreaves (2005) that are likely to be motivated and perform better, when they are placed at the centre of the learning process or encouraged to become the designers of their own learning activities (Findlay & Fitzgerald, 2006). However, the students also recognized that if they were to become facilitators of classroom activities they would face the same control and coordination issues that their teachers face every day.

Change. The students regarded the team learning activity as better than, and significantly different, from normal lessons. The recurring themes in the feedback transcripts were *more fun, sharing ideas and learned from each other, more engaged, time went quickly* and feelings of *being closer* to each other and to their teacher, which taken together is indicative of a change of state from a traditional classroom to a more democratic one, from a sense of separateness to a sense of belonging.

The facilitators group experiences

At the commencement of the study, the researcher conducted a one-day facilitator training program for three teachers and nine Year 12 students. The session began with a model meeting of three fun questions to introduce participants to the technology and the etiquette for using the tool, a demonstration meeting on the topic of *Changing the world* so the participants could observe and note the differences between a conventional meeting and the team learning activity, and a learning activity, to report on what the facilitator said or did to conduct the meeting.

Table 7.4: Facilitators group comments about their experiences

Response (n = 47)	%
Share ideas, see others thinking & feelings	21
Easy to do, use	13
Novel, used technology, new way to teach	11
Improved social skills, teamwork	9
Learned a new skill, facilitation	9
Better than normal class activity, writing	9
Created knowledge, learned from others	6
Everyone had a say	6
Learned a lot, in a short time	6
More interesting than class, meetings	6
Fun, engaging	4

This analysis is based on the responses to a questionnaire administered to all participants at the conclusion of the training day. During the course of the day, participants also learned how to craft question sequences to use with the tool. Most of the new facilitators led a group activity to practice their newly acquired facilitation skills. The participants said they found the tool easy to use (see Table 7.4), gave everyone a say, allowed people to rapidly share ideas, and improved their social and teamwork skills. The session was generally more fun, engaging or interesting than normal classroom activities. Most of the student facilitators were asked to attend the training day by the head of Year 12 and did not know what to expect. They thought the opportunity to learn to facilitate meetings could have been a useful addition to their curriculum vitae. After the session the participants said they “learned a lot”, not from information presented by the trainer, but by observing and reflecting on the performance of the facilitator and each other’s performance (see Record 7.18). One participant observed that the learning process works in a significantly different way to the traditional way of teaching and learning:

Record 7.18: Participant feedback about the training session.

John: No knowledge is given by (the) facilitator but lots of knowledge is gained by the participants.

Mr. Mike: The fact that people aren't shouting over each other - have you been to a staff meeting?

Ms. Zoe: We can see other's ideas and this helps to springboard new ideas for ourselves

Jane: Everybody's views and opinions are heard and there's a high level of participation

These observations by members of the facilitators group that their ideas acted as a "springboard" or catalysts for the formation of other related ideas and that the group created its' own new knowledge provides, some evidence for the possibility that higher-order knowledge can be created from lower-order information (Cohen & Stewart, 1994; Kauffman, 1995; Bereiter, 2000). Although there are some parallels with Leont'ev's hunt (Tolman, 1999, p. 72), where individual activity contributes to the overall success of a collective activity, the point of departure in this case, is there was no common purpose, just joint activity. Tolman (1999) argues that the collective hunt makes no sense unless the game plan is worked out beforehand. This may not necessarily be so. The individual objects of the training day activity for the teachers, the students and the researcher were all different, yet each learned by observing and making sense of the other's activity. The participants had little say in what was to be done to them or for them by the researcher, other than agree to participate.

The Year 7 textiles students' experiences

Ms. Zoe facilitated her second learning activity with a Year 7 textiles class six months after her first session with Year 8 textiles having gained further facilitation experience of the tool for community meetings and teacher training. Twenty students participated in the session. She asked the students to evaluate the Year 7 textile's course they had just completed and to make suggestions about improvements for the next year's intake of students (see Record 7.19). The feedback is derived from a questionnaire completed by the students at the conclusion of the session.

Record 7.19: Questions presented to the Year 7 textiles students

You have been turned into something nasty by a wicked witch. What are you now and how can use it to your advantage?

If you could be a fly on a wall on whose wall would you like to be and why?

Imagine that Mr. W has come into your class and he wants to know what you have learnt in Textiles this year. Write down everything that you think you have learnt.

Having written your list you realize that there were certain bits of the Textiles course that you really liked. List every task and activity that you liked and explain why.

Now that you have written your list it is also obvious that there were bits of the course that were not so good, explain what these things were.

Ms G. has heard that you have lots to say about textiles this year and wants to know how you would change the Year seven course for next year's students - what would you tell her?

Finally you have been asked to suggest things that you would like to do in the Year 8 textiles course - what kind of things would you suggest?

The students found the activity enjoyable, interesting, useful, novel and fast (see Table 7.5 and Record 7.20). They particularly appreciated being able to see and hear other students' views, express their own opinions and hold different views, that everyone was involved and they felt a sense of togetherness. The student experience was similar to Year 8 textiles.

Table 7.5: Frequency of Year 7 textiles student comments about their experiences

Response (n = 34)	%
Fun or enjoyable	21
Novel or interesting	18
See, or discuss other people's ideas	18
Free to express opinions, different views	15
We used computers, keyboards	11
Everyone was involved, worked together	11
Useful activity, learned something	6

The students said the session could have been improved if the computer display was larger, if they had spent more time using the system or if the teacher had asked questions that were more interesting. Many of the students did not see themselves as being in control, saying they had been "made to do it" or "were asked to do it" by their teacher.

Record 7.20: Year 7 student feedback

Elizabeth: It was enjoyable because you could see what everyone else thought. It was useful and interesting because it was new and fast, faster than writing on paper

Sarah: It was all fun

Rachel: Working on the computer. Seeing what other people wanted. Everyone getting to express their views. Having fun.

Arthur: Nothing could be improved because it was a great lesson.

Jodie: It was interesting knowing what other people liked and didn't like.

The Year 9 history students' experiences

Mr. James facilitated a session with Year 9 some six months after his first sessions with Year 12. He had gained some experience using the team learning system with community groups and several sessions in the school classroom. The focus of the session was 20th Century events, which explored the similarities and differences between the First and Second World Wars and the Second Iraq War, the so called "war on terror". The questions are shown in Record 7.21.

Record 7.21: Questions presented to the Year 9 history students

The year is 3001 and you are a student researching the 20th century. You have found a book of newspaper headlines, what five headlines might you see?

You are an American adviser watching Europe in 1914; write a memo to President Wilson explaining why war broke out in Europe?

Are there any similarities between Britain's entry to World War I and her entry to the Iraq War?

V E R S A I L L E S - Write an acrostic that is all about the treaty.

"Religion is a major reason why some western world leaders enter a war". Give examples either for or against this idea.

Write down five adjectives to describe Germany in 1930.

You work for the travel guide company Lonely Planet. Describe what you think life is like in poor countries in the Middle East.

What similarities are there between the rise of Hitler and Osama Bin Laden?

You work for MI6 and have been asked by Tony Blair to research the rise of radicalism. You need to explain how to stop such people achieving power and influence?

In the style of Eminem without the bad language write a rap about the Cold War. JFK - Hero or Villain?

This analysis is based on responses to a questionnaire administered at the conclusion of the session. The students found the activity was novel and many liked the idea of typing rather than copying notes from the blackboard by hand (see Table 7.6). They enjoyed the session, especially the ability to discuss ideas and have their say, see other people's views, compare them, and have their own ideas seen and discussed by

others. One student said the session was a welcome escape from a disliked subject; another felt elated she had discovered a new learning method, another enjoyed the anonymity and yet another appreciated “everything” about the session.

Table 7.6: Year 9 history student comments about their experiences

Response (n = 27)	Frequency
Free to express opinions, different views	30
Discuss, see or hear other people’s ideas	21
Novelty of typing, using keyboards	15
Better than normal class activity, writing	15
Fun or enjoyable	7
Learned something	4
Able to be anonymous	4
Everything	4

When asked to suggest improvements to the session, some students said the questions could have been more interesting. Others were critical of the small screen and small font used to display the text. Some students would have liked to spend more time on the activity while a small subset of the group felt that no improvements were needed. Other students said they would have preferred a more practical activity.

Record 7.22 shows a representative sample of the verbatim comments from students. The students’ experience is similar to that of Years 7 and 8 who both found the session was more fun than normal classroom experiences. The students said they felt connected to other students and appreciated that their ideas were recognized or valued by others.

Record 7.22: Year 9 student feedback

Emily: I liked that everyone could see my ideas without knowing they were mine.

Lauren: It was more fun than writing.

Sam: It was good to compare people's ideas easier than class discussions

Louise: Connecting with other people, other people's views/opinions.

Martin: Longer and a bit more variety in the questions would be nice.

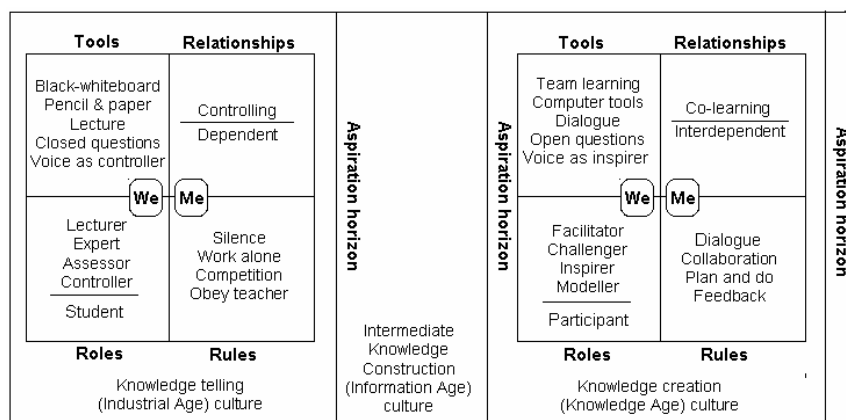
Charlotte: It was very enjoyable. Longer time. Different questions

Summary and conclusions

The analysis suggests that the introduction of the team learning system **tool** and its associated **rules** contributed to a change in the **roles** of the students and the teachers in some but not all sessions. Generally, the use of the tool resulted in a more interdependent and closer **relationship** between the students and the teachers, transformed the **culture** of the classroom from a traditional to a more democratic space, but only for a brief moment, and achieved increased student enjoyment, engagement and productivity, which better met the **aspirations** of the students than the traditional classroom.

The **changes** in the student and teacher activity before and during the team learning sessions are summarised in Figure 7.7. through the lens of the complexity-activity model. The changes draw on the main themes that have been identified in each of the teacher and student case studies and the interpretation of what the teachers and the students had to say. The three frames represent a stage of cultural development of the students, prior to the use of the team learning system (the frame on the left) consistent with the Industrial Age, and during most, but not all of the team learning sessions (frame on the right) which is consistent with a Knowledge Age culture.

Figure 7.7: Cultural gap between traditional and team learning system classrooms.



In the first frame, the primary tools were the lecture, the black or whiteboard and closed questions. In this cultural context, the students were in a dependent relationship with their teachers who remained firmly in control. The students were subject to rules that required them to remain silent, to work alone and obey the teacher without question. In the knowledge creating culture of the right hand frame in which the team

learning system classroom is located, the students were able to operate autonomously, and employ tools such as the team learning system and dialogical or dialectical discourse. The second frame represents the Information Age culture, for which there was little evidence in this study, where self-study is the main tool, the students work semi-autonomously and the goal is to reconstruct and repurpose existing knowledge.

In this study, the students enjoyed the Knowledge Age culture (see page 149) for a fleeting moment and were encouraged to synthesise new knowledge from their tacit knowledge. The teacher's role was to facilitate, inspire, and model what they hoped their learners could become. As a result the relationship between the teachers and the students became more interdependent and cooperative. The aspiration horizon for the teachers, which occurred at the boundary between the Industrial Age and the Information Age, obscured the more distant aspiration horizon of the Knowledge Age. The teachers' situation is analogous to taking a walk through the foothills of a mountain range. Even if you climb to the top of the foothills, the main and higher mountain range is obscured by other, higher hills.

During their brief visit to a Knowledge Age culture, the students discovered that there were similarities with their own Web 2.0 world. They said they preferred the opportunity to have a say, to share their ideas with others and for their contributions to be recognized and valued. They were pleased they did not have to raise their hands for permission to speak, copy notes from the whiteboard or remain silent until spoken to by the teacher. The Year 12 students were less enthusiastic about the use of the team learning system. Some said they preferred to learn alone, while others saw little difference when compared with the normal classroom. Most seemed to accept the school system as it was. The team learning system guided the way the students worked together by affording group discussion, personal contributions, the sharing, recognition and valuing of all ideas and joint knowledge construction. The tool also helped to shape the teacher activity so they become more facilitative and less traditional.

Each of the teachers in the study continued to use the tool extensively in their work as school leaders, with teachers, community groups and for professional development activities outside the school, but rarely for classroom learning activities. Each reported a significant and positive personal change in their professional lives after using the tool. They were also able to enunciate why teachers should use the tool and how it helped to change the culture of the school classroom so that it became less

teacher-directed and more learner-centered and a better fit with both educational best practice and youth culture.

The teachers offered a variety of reasons for not continuing to use the tool in the school classroom. They said the tool took too long to set-up, there was no room in the crowded curriculum and it was less successful in the classroom than for community events. One teacher acknowledged that several of his lessons were “rubbish”. He realized that his students could not answer many of his closed questions, which challenged his perception of the effectiveness of his teaching. One teacher did not attempt to use the tool in the classroom and two others only used the tool for staff and community meetings. Recommendations that the school set up a permanent classroom, so there were no excuses for not using the tool, were never acted upon. Another, and perhaps more worrying possible reason for discontinuing the use of the tool, is that it revealed the weaknesses in the teacher’s current pedagogical approach, by revealing how little the students could recall from memory, or how poorly they were able to interpret what they had learned.

Most of the teachers erroneously perceived themselves to be facilitators of classroom learning, even though they mainly employed a traditional pedagogical approach. They saw themselves as content experts, and felt compelled to transmit their own knowledge to the students via the lecture and closed questions rather than stand back, be silent and create a space in which the students could create their own knowledge. The teachers said they did not encounter the same difficulties when they facilitated community meetings because they had no unique knowledge to contribute and thus were able to perform “hands off”. The teachers acknowledged that they became unconsciously competent and were able to facilitate sessions without thinking about what to do or say.

Several of the teachers found it very difficult to craft open-ended questions although they knew and understood, theoretically, what was required. This has interesting parallels with Luria’s (1976) peasants who refused to or were unable to formulate any questions. In this study, the teachers’ initial inability to formulate open-ended questions appears to be associated with a deeply embedded pattern of closed question asking designed to assert classroom control. The teachers also feared the students would not learn anything if they gave them more control over their learning. However, the inability of the students to recall previously memorized information may account for teacher’s not wanting to use the tool because it revealed weaknesses in their

teaching performance. The school's major commitment to a program to support student facilitators in the classroom was not carried out in practice. Only two of nine students who trained as facilitators were able to use their skills in the classroom and only then for less than five minutes.

Most of the student groups reported that they had a "fun" experience in which they felt more connected to each other and their teacher, which may be symptomatic of either team development (Tuckman, 1965; Schein, 1988) play (Vygotsky, 1978) or flow (Csikszentmihalyi, 1997), but also perhaps with the Fichtner's (1984) model of tertiary inter-subjective relations. I suspect these models have several features in common as shown in Table 7.8. The experiences reported by many of the students were generally indicative of a "group flow state" in which all of the participants shared a similar peak experience partially through their own engagement with the task but also amplified by their greater affinity with each other (Schein, 1988).

Table 7.7: Play, flow, team formation and reflective communication similarities

Factor	Play	Group flow	Team formation	Reflective communication
Fun	Yes	Yes	Yes	-
Engagement	Yes	Yes	Yes	Yes
Time passing	-	Yes	-	-
New knowledge	Yes	-	Yes	Yes
Affinity	Yes	Yes	Yes	Yes

The flow state appears to be equivalent to the reflective communication level of inter-subjective relations as described by Fichtner (1984) where the focus of the group shifts from individual activity to collective activity that is both self-governing and self-reflecting. The result is what Bakhtin (1982) describes as a "rich polyphony of ideas," generated not by characters in a novel speaking to the reader as described in the original context, but between real people in a classroom via a kind of "social heteroglossia" (Bakhtin, 1982, pp. 262-263). Whereas conventional meetings involve turn taking which ensures that communications are sequential, meetings using the team learning system enabled parallel communications. This appears to have achieved greater connectivity between the participants and may have led to the formation of a large component, in the manner of Kauffman's "buttons and threads" analogy (Kauffman,

1995, p. 57) and at a higher level of organisation. I will explore this aspect more fully in Chapter 9.

In the team learning system classroom the teacher-facilitator did not need to contribute any knowledge directly to the group by way of knowledge content, yet the group gained considerable knowledge in the process. The process appears to work in the following way. The questions stimulate a discussion amongst the participants who then respond with their own tacit or previously acquired knowledge. The ideas appear to stimulate more discussion and further ideas. The ideas are then evaluated in a sensemaking step and possible patterns are detected by group members. The collection of concepts starts to coalesce into the kernel of a new theoretical model, process or theory. The participants do not set out to create something new, but do. The facilitator merely keeps time and asks the questions. No one person devises the new model. It emerges.

This “hands-off” approach to teaching and learning appears to explain Bereiter’s paradox (2000) and how supposedly “mindless” simple systems give rise to more complex knowledge formations. The team learning system helps to bring ideas together in close proximity as in abductive (Prawat, 1999) or metaphorical thinking (Fichtner, 1999) so the participants can easily create new combinations, which stimulates the production of further new concepts from which more robust concepts coalesce. The traditional classroom appears to offer little opportunity for the creation and spread of even the most contagious and radical ideas because control is the order of the day. But in the team learning system classroom, where control is subservient to process, the ideal conditions could be created for epidemics of ideas to be conceived, combined in novel ways, and spread.

CHAPTER 8

THE FACILITATOR PERFORMANCES

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Overview of the chapter

The purpose of this chapter is to analyse the video record of the performances of five facilitators – the researcher, two teachers and two students - to observe what they said and did when using the team learning system and how this affected the use of the tool.

The first section describes the ideal facilitator activity, the role of the facilitator, and what a facilitator must do and say to coordinate a collective activity. The section also describes what the new facilitators learned during their one-day training program. The second session reports on two benchmark sessions conducted by the researcher, to provide a comparison with the sessions conducted by the new facilitators. The third section examines in detail, the use of discourse and motor activities and the variations from the ideal facilitator speech due to three other speech types - inner speech, previously acquired automatic speech routines and authority speech - and how these variations affected the facilitator, the participants and their collective performance. It also considers whether an appropriate amount of time was spent on each of the discussion steps determined by the talk-type-read-review etiquette. The fourth section reports on the use by the facilitators of personal and collective pronouns in their

communications with the participants, and the changes that occurred in their relationship with the participants, as their sessions progressed.

The video record of the sessions

Five sessions were recorded on videotape, transcribed and analysed (see Table 8.1). A sample of a transcript is shown in Appendix VIII (see page 448). Two sessions were facilitated by Mr. James, the history teacher, one with assistance from two student facilitators Jane and Helen. One session was facilitated by Ms. Zoe, the textiles teacher and two sessions were facilitated by the researcher. The sessions were all completed within a normal classroom period. The duration of the sessions ranged from 26 min to 1 hr 11 min (M = 53 min 35 sec, SD = 18 min 57 sec). The facilitators asked between 6 and 14 questions (M = 9.00, SD = 3.08). The initial warm-up question cycles ranged in duration from 3 to 18 minutes (M = 10 min 7 sec, SD = 6 min 24 sec). Subsequent question cycles ranged in duration from 1 to 15 minutes (M = 6 min 59 sec, SD = 2 min 59 sec).

Table 8.1: Duration of the question cycles for the videotaped sessions

Session	Facilitator	Cycles	Students	Duration	Mean cycle time
Seniors	Students Mr. James	14	14	1 hr 11 min 7 sec	5 min 24 sec
Year 12	Mr. James	9	12	1 hr 0 min 11 sec	6 min 41 sec
Year 8	Ms. Zoe	6	22	1 hr 8 min 15 sec	11 min 22 sec
Year 12	Researcher	9	9	26 min 26 sec	2 min 56 sec
Year 8	Researcher	7	22	41 min 57 sec	6 min 59 sec

The ideal facilitator activity

When groups engage in discourse, anarchy or chaos is generally avoided by assigning control to a member of the group who assumes the role of group leader, chair, facilitator or teacher (Quinn, 1998; Gustafon & Gibbs, 2000). The main role of the leader is to act as a coordinator so that the group can achieve some purpose. The teacher uses his or her voice to guide the meeting process, establish the rules of engagement, maintain order, influence the discussion and give feedback (Findlay, 2004).

In the school classroom, much of what teachers do involves the use of speech to communicate ideas via the lecture (Hansen & Stephens, 2000), ask questions to check for understanding (Scardamalia, 1993) or to guide thinking (King, 1992; Elliott, 1993), give instructions (Cohen, 1994; King, 1997) and maintain control over student behaviour (Ainley, Luntley & Jones, 2004). The lecture is the most popular pedagogical technique and is an expression of what the teacher knows.

In marked contrast to the type of speech used in a traditional classroom, facilitators have little to say and provide their participants with many opportunities to voice their opinions and progressively take responsibility for their own learning. The facilitator-teacher contributes to the learning process by reframing what she knows as sequences of open-ended discussible questions (King, 1990; 1991) that promote discourse among the students.

When the facilitator-teacher uses a collaborative tool in the classroom, she must introduce the participants to the rules inherent in the tool so the participants know how to engage usefully in the activity (Poole & DeSanctis, 1990). She welcomes people to the session, ensures the participants become well acquainted and announces the topic. She clearly and concisely explains how the meeting process will work, asks the questions, ensures everyone keeps to the time allocated but expects the group to be responsible for all the thinking and the decision-making. The facilitator also operates the computer and selects the appropriate tools for each stage of the session. The best facilitators become transparent to the group so the members believe “We did it ourselves!” (Heider, 1997). Experienced facilitators of electronic meeting report that they become “unconsciously competent” through practice and eventually perform the role without having to think consciously about each step of the process. However, until a facilitator learns how to use a tool in context and is able to explain fluently to the users what to do, her performance may confuse the participants, and the group activity can become chaotic.

In this study, the trainee facilitators acquired their skills during a one-day training program conducted by the researcher. The purpose of the training session was to teach facilitators what to say and do when using the team learning system. At the start of the training session, the researcher, in his role as the trainer, facilitated a model meeting, which set the standard expected of the facilitators. During the day, the facilitators were asked to rehearse their new skills on four occasions, so they became

practiced in the method. They learned what keys to press, the mouse movements, how to navigate around the software, what to say to facilitate a session, and how to prepare a question sequence to guide the discussion. Each facilitator was required to facilitate a short session for the entire group to complete their training activity. The “facilitator’s speech” (see Table 8.2) is published in the Zing On-line facilitator Course (Findlay, 2005) in step-by-step pictures.

Table 8.2: Team learning etiquette and facilitator speech

Question	Activity	Ideal time	Ideal facilitator speech
1	Describe activity	30 sec.	The topic today is human cloning, but before we begin, we have three fun questions to learn how to use the tool.
	Type	1-2 min	What I’d like you to do now is pull your keyboards towards you and type anything you like, the words of your favourite song, or if you can’t think of anything, the quick brown fox jumps over the lazy dog. Off we go. When you have finished typing press F9 please.
	Log-on	1-2 min.	Now we are going to log-on. To log-on type your own name, or an alias, or if you are working in a group, a team name, like the Wombarra wombats....off we go. Press F9 to send it up and wait until everyone else is finished.
2 & 3	Describe activity	30 sec.	Now we are going to learn the etiquette, which is to talk first for a minute or two in small groups, then type our ideas, then we will read them aloud, and finally we will make sense of the ideas. So what is your favourite story, author, title and why?
	Talk	2-3 min.	Talk to your partner for a minute or two. Off we go.
	Type	2-3 min.	Let’s start capturing those ideas please....off we go...remember to press F9 to send it up.
	Read	3-5 min.	Now we are going to read the ideas aloud. I will read the first few ideas, next time I will be looking for volunteers to read. So in response to the question [name of question] we have...
	Review	1-2 min.	So what are the key ideas please?

During the training session, the facilitators took turns to learn the facilitator speech. One read the instructions aloud while the other practiced the facilitator role, including what to say and do. They then reversed roles.

Three cycles of “warm-up questions” introduce participants to the tool. The first question is designed to familiarise the participants with the software, their keyboard, the input method (F9) and where the participant’s keystrokes appear in the display. During this practice activity, the participants type their name to log-on, either an individual name if they were working alone or a group name if they were sharing a keyboard. The participants learn the talk-type-read-review etiquette during the second question cycle that is reinforced during a third cycle. The etiquette establishes the norms for working together as a co-coordinated group. The facilitators use a form of speech called the “facilitator’s speech” that helps first-time participants learn how to use the tool in just a few minutes. The purpose of the speech is to give clear but concise instructions to participants about how to engage with the tool and each other. The instructions include the names of the personal spaces, which are called *playspaces*, and the shared space, which is called the *teamspace*. The facilitators learn how to operate the computer, to create and select questions in the correct order, maximise the teamspace so the collected ideas can be viewed together, how to log-on, which involves each person typing their name in a playspace and pressing the F9 key to display their name (or group name), and how to identify patterns in the ideas and record them using the Theme tool. They also are given guidance about the ideal length of time to spend on each stage of the etiquette.

Initial analysis of the facilitators’ performances

The initial analysis showed that at the start of the session both the teacher and student facilitators struggled to sequence what they had to say and do. They were unable to deliver a coherent and well-organised performance compared with the researcher’s simpler, clearer and more complete use of the “facilitator’s speech”. However, their performance improved as their speech and motor actions became routine.

The errors or variations in the speech and motor actions were identified and sorted into types. When considered against the backdrop of the literature review, the errors were a good fit with a pattern of three speech types. The speech that were considered to be errors were speech used to learn how to sequence the activity, speech designed to exert control over the participants and previously learned phrases instead of the “ideal facilitator” speech.

The analysis is reported through the lens of the following four types of speech identified during the initial analysis:

- *Facilitator's speech*: is an ideal form of speech necessary to give precise instructions to participants in a meeting or learning activity, so they know what to do when working together in a group and participate in a coordinated manner as shown in Table 8.2.
- *Inner speech*: involves “talking aloud to yourself” (Verenikina & Gould, 2003).and is a form of speech normally associated with the development of new motor skills (Vygotsky, 1978). Inner speech may also be associated with explanatory gestures (McNeil, 2005) used to figure out what to do or say. This may involve pointing at features of a computer display instead of using the appropriate terminology or giving emphasis to what is said.
- *Automatic speech*: is defined as a previously learned speech routine or “kinetic melody” (Luria, 1973, p. 31) which allows the person to speak fluently and without consciously having to think about what to say in familiar situations.
- *Authority speech*: is defined as the use of speech to exert or maintain authority and control in the classroom or meeting (Walker & Warhurst, 2000; Delpit, 1988) and may have a threatening aspect, implying or explicitly stating the sanctions that may be imposed if the group does not obey. These forms of speech include sarcasm, ridicule and asking closed questions with the intention of embarrassing the student.

The criteria for judging the performances. The facilitator errors were judged against two sets of criteria. One set of criteria derived from the Zing On-line facilitators course (Findlay, 2005) which sets out the standards expected of facilitators, and the other from the initial analysis of the data. The standard set by the Zing facilitation manual is that the facilitator speech should be clear, precise and free flowing with few or no instructional errors, well integrated with the motor performance using no or few unnecessary keystrokes and mouse movements. Typed instructions should be completed just ahead of giving verbal instructions to ensure the participants do not submit ideas to unintended locations. The facilitator should also occasionally inform participants of what they will be expected to do next, and the question asking process should be seamlessly incorporated into the facilitator speech. The initial analysis showed that the

facilitator instructions and activity should be free of inner speech (Verenikina & Gould, 2003), previous speech routines and authority speech.

The analysis of what the facilitator said and did by comparison to the ideal facilitator speech is reported under seven headings:

- **Introduction:** This section comprises the information provided by the facilitator to explain the purpose of the question or the activity.
- **Log-on:** This section comprises the instructions given by the facilitator to name their playspace.
- **Explanation:** This section deals with the instructions given by the facilitator to the students about the talk-type-read-review etiquette, when to commence discussions and when and how to use the keyboards.
- **Contribution:** This section relates to what the facilitator said to encourage the students to commence typing ideas.
- **Reading aloud:** This section considers how clearly the facilitator modeled and explained the process for reading the accumulated ideas aloud without comment.
- **Sensemaking:** This section concerns the instructions given to the students to inspect the collected ideas for underlying patterns in the concepts and to report the concepts to the facilitator who captured them using the Theme tool.
- **Subsequent activities:** This section summarises the facilitator performance for the remaining cycles.

The analysis also considered whether a facilitator spent an appropriate amount of time on each stage of the process, according to the guidance given in Figure 8.2, for example if the facilitator omitted a step or presented the step in an incorrect sequence. The actual task times for each stage of the process were calculated from the time stamp on each frame of the video record.

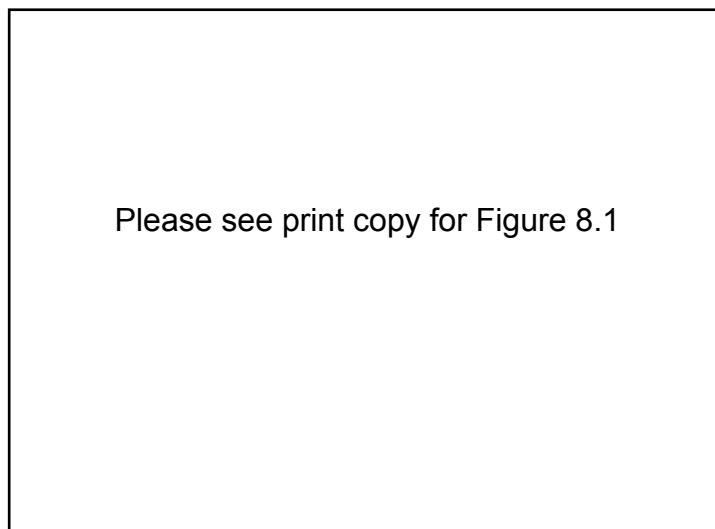
Benchmark performances by the researcher

The researcher facilitated two sessions that were recorded on videotape to benchmark the performances of the teacher and student facilitators. Initially it was proposed to use the record of the facilitator training day as the benchmark, but at the last minute, the session was relocated to a classroom that lacked recording facilities.

Year 8 cloning session with the researcher

The researcher conducted a meeting with Ms. Zoe's Year 8 textiles class on the subject of the ethics of human cloning. The researcher is shown in Figure 8.1 seated in the centre of the classroom. Students were seated at tables in groups of four and five facing the display, which is not visible in the figure. The researcher delivered a performance that closely followed the ideal facilitator's speech with one sequencing error, two instances of out-of-place automatic speech routines, and one instance of inner speech. The researcher did not use any authority speech routines and relied on the close attention paid to the activity by the students to maintain control. The researcher asked seven questions (see Record 8.1) about the topic of human cloning that ranged in length from 54 seconds to 882 seconds (14 min. 42 sec.) at an average rate of one cycle every 2 min. 56 sec. The researcher attempted to establish the talk-type-read-review etiquette at the start of the session, but this was fully subsumed into the typing activity by cycle 4.

Figure 8.1: Year 8 session facilitated by the researcher



The participants initially followed the talk-type-read-review pattern but this quickly became simultaneous talking and typing, (talk+type)-read-review which the group first learned from Ms. Zoe, their teacher, who placed little emphasis on discussion and did not establish a separate period for discussion as part of the pattern of use.

Record 8.1: Year 8 cloning question sequence

Facts: What do we know about human cloning? What do we need to know?

Features: What are the benefits of human cloning?

Faults: What are the problems, dangers, difficulties with human cloning?

Feelings: How do you feel about human cloning? Your gut reaction?

Vote: If we could live 100 years longer with cloned body parts would you agree to human cloning?

Fantasy: Creative new proposals? What could we do differently about human cloning?

Future: What should we do next about human cloning?

The task times obtained from the video record (see Table 8.3) show that the training session began with a long, 300 second (5 min. 0 sec.) introduction, which included instructions about how the students were to log-on in order for individual data to be collected, but was unnecessarily long, and may have resulted in participant unrest if it had continued much longer. The students were keen to start typing as soon as the question was announced and discussed the topic for only 24 seconds before they began to type. The facilitator endeavoured to maintain the talk aspects of the pattern by reminding participants to discuss the topic but the students ignored the request. Twelve keyboards were shared among 22 students, so as soon as one student completed an idea the keyboard were handed to another student. A vote activity was completed at question 4 in the shortest time of any of the questions, just 54 seconds. Activity 3 combined two activities, the initial question followed by a supplementary question, which required the students to summarise the ideas they generated during the first part and extended the question cycle time to 882 seconds (14 min. 42 sec.).

Table 8.3: Question cycle times for Year 8 cloning session

Activity	Seconds						
Cycle	1	2	3	4	5	6	7
Introduction	300						
Question	25	17	31	7	54	24	18
Talk	24	15	7			7	
Type	151	59	128	47	66	104	129
Read	75	120	328			114	151
Review	52	70	388				
Total	633	281	882	54	120	249	298

Introduction. The researcher began the model session for the Year 8 students with a brief explanation of the purpose of the meeting (see Record 8.2). The facilitator employed an instance of an automatic speech routine “so what we are going to do” that did not fit with what he wanted to say and made a comment about the research activity that would have been better delivered earlier in the presentation when he was explaining the purpose of the data collection process. He also used inner speech when he said, “let’s find the human cloning template” to help guide his motor activity and an inappropriate comment when he said, “which may not be much”. Otherwise the introduction provided clear instructions for the participants.

Record 8.2: Researcher’s introduction to the Year 12 cloning activity

So let’s do the human cloning... topic... Lets find the human cloning template...so what we are going to do... This is probably a good one because you have not done it before so we will see if it’s enjoyable or not. So we are going to find out what we already know about human cloning, which may not be much, then we are going to think what are the benefits of doing this, what are the disadvantages of human cloning, how do we feel about it, is it a good idea or not, should we go ahead with it and what could we come up with that is different. ...the creative...and then we’re going to get you to make some decisions about it...should we do it...we are going to take a vote. Alright, so let’s begin.

Explanation. The researcher began by informing the participants about the etiquette (see Record 8.3) and gave clear instructions about how to engage with each other with “*you talk about it in small groups....*” The researcher also seamlessly integrated the question into the instructions and directed their attention to their own tacit knowledge, by asking the students to think about what they may have “*heard or read in the papers or seen on TV*” when they considered the human cloning issue.

Record 8.3: Researcher reminds the students of the etiquette

Uhhh...you know the etiquette. You talk first about it in small groups, then you type your idea, then we read them out and then we make some sort of summary. So if you would like to turn to the people in your group and have a chat, what do you know about human cloning? Ask them what they know or have heard or read in the papers or seen on TV. OK?

Contribution. After the students had discussed the topic, for what the researcher judged to be a suitable length of time, he gave instructions about how to type and submit the ideas (see Record 8.4). He used simple everyday language rather than the

technical terms for the parts of the computer or software. Such instructions need to be simple and clear, and where appropriate include the correct names of parts of the tool so the participants develop the “language game” of the tool.

Record 8.4: Researcher reminds the students to type and submit their ideas

As soon as you’ve got some ideas you can type them up and send them up with the F9 key please.

Log-on. The researcher then remembered to log-on, a sequencing error, which although not vital to the process, (see Record 8.5) was required to be completed immediately following the first question for best results. He asked the students to log-on using their first names so that it would be possible to identify the source of the contributions for the data analysis. He belatedly performed this task between activity cycles 1 and 2 at a time when it would not interfere with the talk-type-read-review cycle. Such sequencing errors can be confusing for the participants, and lead to anarchy rather than co-ordination. The errors could also potentially affect the facilitator’s performance, particular if the facilitator becomes anxious about their inability to live up to an internalised model of the ideal activity.

Record 8.5. Researcher belatedly logged students on

Researcher: (Researcher selected log-on mode) That’s good. Let’s have a look what we’ve got. Now I should have asked you to log on at the beginning. What I’d like you to do is type for me your first name and initial. If you are sharing a keyboard, have your first name and initial and the other person’s first name and initial so I can see where the ideas are coming from, so if its Adam F and Adam G, whoever is the second person on that keyboard if you could please.

Student: F9?

Researcher: Yes F9. So it goes up on the bar and if you could just wait for everyone to finish.

Reading aloud. The researcher then modeled the reading aloud activity (see Record 8.6) so that the students would know they were expected to read the responses exactly as they appeared on the display without comment or paraphrasing.

Record 8.6: Researcher demonstrated the reading process and repeated the topic (Researcher maximised the teamspace) I’m going to read out the first lot of ideas. Then I’m asking for volunteers after that. So what do we know about human cloning? So far we’ve got, Not much. Its like have copies of one person....

Review. The facilitator then asked the participants to identify the key ideas, not by asking specifically for the common themes (see Record 8.7), but using a speech routine that did not use the words “main themes” or “common theme” that lacked the clarity of the ideal facilitator speech.

Record 8.7 Researcher asked for the common themes.

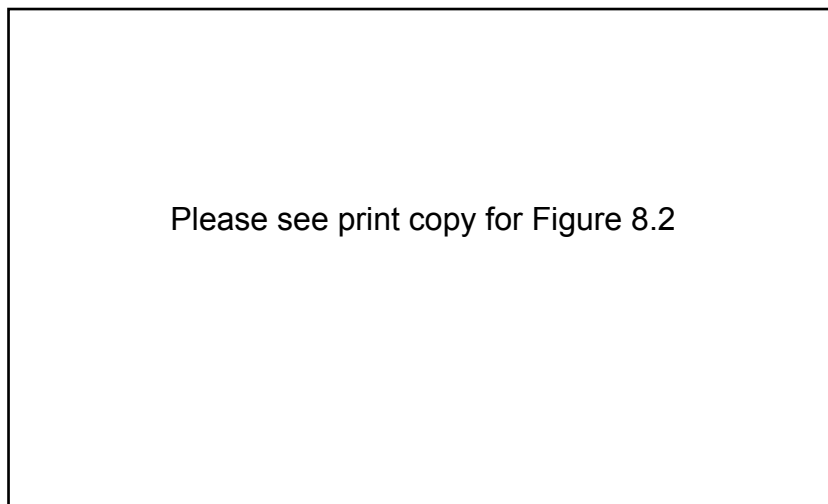
(Researcher selected the Themes button) So what have we got here, what do we know so far about DNA, er, about human cloning? Yes?

Subsequent activities. The researcher followed the pattern established during the first questions cycle for the remaining activities, which the participants followed reliably.

Year 12 cloning session with the researcher

The researcher also facilitated a model session with the Year 12 history class. Figure 8.2 shows the researcher seated in the centre of the classroom with two groups of four students on either side of the display, which was projected on the classroom wall. The session comprised nine activities as shown in Record 8.8). The sessions ranged in duration from 33 seconds to 422 seconds (7 min. 2 sec.), at an average of 2 min. 56 sec. per cycle (see Table 8.4). Three of the cycles did not follow the etiquette, for example, cycle 4 where the students summarised the key ideas from the previous question and no further summary was required.

Figure 8.2: The researcher facilitates a session with Year 12 history



Questions 7 and 8 were yes-no votes, about whether governments should allow human cloning at all, or for therapeutic purposes, and therefore required no discussion or summary.

Record 8.8: Year 12 cloning question sequence

Facts: What do we know about human cloning? What do we need to know?

Features: What are the benefits of human cloning?

Faults: What are the problems, dangers, difficulties with human cloning?

Summarise: Summarise the main problems, dangers or difficulties.

Feelings: How do you feel about human cloning? Your gut reaction?

Fantasy: Creative new proposals? What could we do differently about human cloning?

Vote: Should governments allow human cloning? Yes or No?

Vote: Should we allow human cloning for therapeutic purposes? Yes or No.

Future: What should we do next about human cloning?

The students were as keen as their junior school colleagues to respond to the questions, but rather than discuss the topic as requested, they began typing almost immediately the questions were announced. In one instance, the students began typing while the question was still being asked. Every student had their own keyboard. During the session the researcher made a series of tactical errors and asked closed questions at cycles 7 and 8, which meant the session ended on an inconclusive note, and the sensemaking step became unnecessary, because the responses were identical.

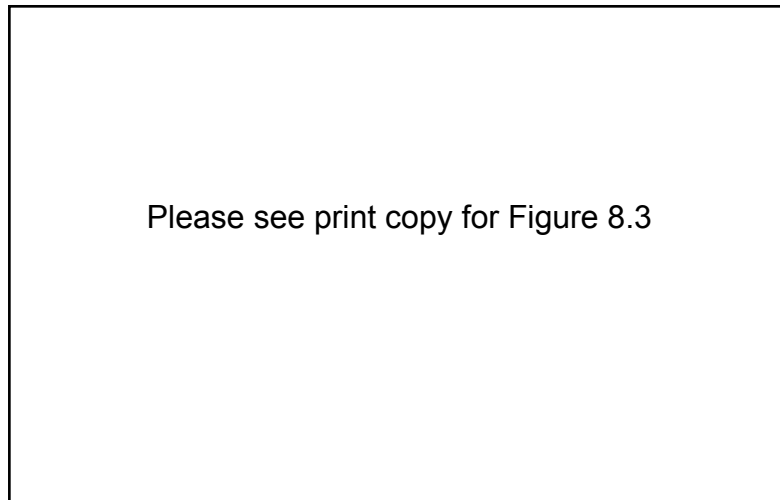
Table 8.4: Question cycle times for Year 12 cloning session

Activity		Seconds							
Cycles	1	2	3	4	5	6	7	8	9
Time-out	-	-	-	-	-	-	-	-	-
Question	116	10	58	11	21	20	39	21	29
Talk	70	5	22	-	-	1	-	-	-
Type	99	63	32	45	30	45	14	12	59
Read	105	70	97	-	123	59	-	-	108
Review	32	100	70	-	-	-	-	-	-
Total	422	248	279	56	174	125	53	33	196

The history teacher's first performance

Mr. James's first performance as a facilitator was a meeting for twelve Year 12 students and two schoolteachers. They discussed a sequence of 14 questions in 1 hr. 0 min. 11 sec. dealing with the student experience of the school, their expectations of teachers and the dress code. The questions are shown in Record 7.1 on page 236.

Figure 8.3: Seniors session facilitated by Mr. James



Mr. James performance began with uncertainty but quickly became automatic and fluent. Figure 8.3 shows the participants seated around a table in a large group, some typing, while others observed the ideas as they appeared on the display in the foreground (behind the camera). Mr. James was standing out of frame to the left of the image, facing the group. Mr. James established a reliable discourse pattern, as shown in Table 8.5, which persisted for most of the session, but began to deteriorate towards the end when some of the participants left the meeting.

The discussion cycles ranged in duration from 142 seconds (2 min. 22 sec.) to 521 seconds (8 min. 41 sec.), an average of 305 seconds (5 min. 5 sec.). The session was interrupted by two time-out periods by visitors to the meeting, one who attempted to hijack the discussion, rather than participate as a member of the group.

Table 8.5: Question cycle times for the seniors' session

Activity	Seconds													
Cycle	1 (Logon)	2	3	4	5	6	7	8	9	10	11	12	13	14
Timeout	-	129	-	-	-	-	-	31	96	-	-	-	284	-
Question	-	39	26	28	9	5	6	25	7	20	4	9	5	11
Talk	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type	-	145	127	133	82	19	71	94	109	79	58	51	53	52
Read	-	122	92	113	22	-	71	72	76	85	52	38	-	45
Review	-	91	93	87	107	91	33	62	233	274	124	44	-	-
Total	351	526	338	361	220	197	181	284	521	458	238	142	342	108

Introduction. At the start of the session, and before the student facilitators introduced the participants to the tool, Mr. James welcomed the students and teachers to the meeting. Record 8.9 illustrates a fluent and confident delivery where every aspect of the speech was presented without grammatical errors or pauses, in contrast to his second performance as a facilitator, also reported in this chapter (see pages 289-295).

Record 8.9: Mr. James introduced the topic to begin the session

Before I go to Jane and Helen who'll explain how the technology works, we'll try to discuss seven or eight key issues that (names of fellow teachers) and myself are addressing as the year progresses. So we'll start with the immediate challenges (inaudible) and the wider issues you have. So feel free to air your feelings as representatives of the sixth form and the idea is that by the end of the session you will have all contributed what you think and myself and (names of other teachers) will have an idea of what we need to be doing and how to support you.

Explanation. When Mr. James assumed control of the session from the student facilitator's, Jane and Helen, he was uncertain what to do. He consulted the training manual twice, made several changes to the computer, and still did not recall how to begin, so he decided to repeat some of his earlier introduction (see Record 8.10), hoping it would help him recall what to do and say next.

Record 8.10: Mr. James was not sure what to do.

(Consulted the manual twice and made a change to the computer twice). OK. Right. (Inaudible) of the session aimed at trying to establish your gut reaction about what you think about sixth form.

Log on. After a very long pause, and instead of asking either a play question to socialise the group into the etiquette, or ask the first question to initiate the discussion, Mr. James asked the students to log-on again, a task the student facilitators had already completed (see Record 8.11). Mr. James compounded his sequencing error by giving a muddled instruction about how to log-on. He concatenated a series of automatic speech routines “*now you might want to*” which he used twice and “*so here’s a chance to*” with words he learned at the training day such as “*anonymous*” and “*contributions*”.

Record 8.11: Mr. James began a second unnecessary log-on process

(Long pause as he adjusted the computer) Now you might want to actually make some contributions and you might want to be anonymous so here’s a chance now to change your names ...for some of the questions are for example..... what you think you do badly (inaudible).

Having committed to an unnecessary second log-on process, Mr. James was then uncertain how to perform the task. Record 8.12 shows that he paused several times to adjust the computer in an attempt to remember the correct sequence. Mr. James then began to speak using literal phrases *it doesn’t give you* and *so it makes it*, which is a type of inner speech that he used to explain to himself what to do. He also replaced the correct nomenclature with the word “it” because he could not automatically recall the names of parts of the software, and imparted some irrelevant information about how the software worked, as a way of filling in time to cover up his uncertainty about what to do. He then tried an existing speech routine *I’ll give you a chance to....*which did not work, so he then tried another existing speech routine *you can do* and abandoned it, then finally attempted a new speech routine he had trialled a few minutes earlier *you can now change your names* which he concatenated with *so it makes it anonymous*, which is a form of inner speech used to explain to oneself what to do.

Record 8.12: Mr. James concluded the log-on process

(Long pause while he adjusted the computer) It doesn’t give you in order of participants...it puts the contributions up in the order they were actually made. I’ll give you a chance to.... you can do.... you can now change your name so it makes it anonymous. (Long pause while he adjusted the computer) If you want to change your names, you can do so now.

Second introduction. When Mr. James finally began the formal meeting at cycle 2, he delivered a fluent introduction to the question (see Record 8.13) although he was initially uncertain whether to describe the first question as a “topic” or an “agenda”,

possibly because he was relying on visual cues on the computer display which identified the question/activity box as “Agenda”, the likely source of his confusion.

Record 8.13: Mr. James introduced the first question

Right. OK. The first topic....agenda. If you could design your ideal sixth form, what five key features would you have to advertise as your main strengths, design your own college OK (inaudible), five things you want to advertise to people coming to the school, five most important strengths of the sixth form.

Contribution. Mr. James then made a second and more serious sequencing error. He should have asked the participants to discuss the topic for several minutes, but instead he asked them to start typing immediately (see Record 8.14). The omission of the discussion step set up a (type+talk)-read-review pattern for the remainder of the session instead of the required talk-type-read-review procedure. Mr. James also forgot the correct names for the playspaces, calling them “workspaces”. He also pointed to the video screen saying, “your ideas appear in that space there” instead of the correct name, a further example of using inner speech to help sequence the activity.

Record 8.14: Mr. James provided some clearer instructions

Teacher: Soon as you type out your idea you press F9 and you see your ideas appear in that space there (points at the display).... nuh...workspaces....If you (inaudible) as many times as you want to...if you are in twos, type something out and press F9, then give it to the other person, OK?

Student: Do you want all five then press F9?

Teacher: All five then press F9. Then swap round.

Students: (General chatter of discussion and sound of typing on keyboards).

Reading aloud. Mr. James correctly modeled the process for reading the ideas aloud without comment or elaboration and used the correct facilitator speech. Record 8.15 shows that after Mr. James established the required reading aloud pattern, Joe, the next reader, followed the same pattern.

Record 8.15: Mr. James established the reading aloud pattern

Teacher: Alright. These are what you’ve come up with. I am going to ask....I ‘m going to read the first two or three then I’m going to pick on you to read out. The first person said school dinners, highly important for your ideal sixth form. Supervised study. Variety in lessons. Friendly community. High standard of teaching. Social Inclusion. Good facilities. Motivated students who are happy. High grades. Clean college. Good use of technology. Staff. Joe, if you could read out the next three for me please. If you can see from there.

Joe: Good psychology in teaching. Friendly people. A clean college. A clean common room would be nice. Subjects which are available, subjects which are available and the results for A-levels are at very good high levels. Friendly people. Great atmosphere. Strong academic reputation. Relaxes good facilities. Wide range....wide range of subject combinations. Nice dinners.

Teacher: Mr. O'Connell you can read out the next...two or three....

During the reading aloud process, Mr. James received his first round of positive feedback from the group, when they laughed at the responses and appeared to acknowledge the novelty of the ideas (see Record 8.16). This appears to be a turning point, after which Mr. James performance became more fluent.

Record 8.16: Students laugh at their own responses

Mr. O'Connell: Good sports facilities. Range of courses. Good student/staff ratio. Good computing facilities. Study area. Loads of opportunities to get involved in other stuff. (inaudible).

Students: (Laughter)

Mr. O'Connell: A wide variety of subjects. Popular courses that don't clash with each other on the timetable. The student/staff ratio. (inaudible) services.

Students: (Laughter)

Sensemaking. Mr. James introduced the sensemaking step without any errors (see Record 8.17) but had to repeat the instruction before the group responded. He acknowledged each participant's suggestions for a theme before typing them into the theme tool. Mr. James should have recorded the contributions without comment, but in his role as a teacher, could not help making observations, for example when he said *facilities are obviously important to you*. Such comments appear to be subtle forms of authority speech which remind participants who is in control.

Record 8.17: Mr. James established the automatic sensemaking pattern

Teacher: Let's see if we can pull together some common themes. Ok, so are there anything that's common most of you are coming up with...the messages we are coming up with...any contributions....what are the messages coming across of the ideal sixth form.

Student: Facilities

Teacher: (types word) Right, facilities, OK. Facilities are obviously important to you.

Student: Range of courses.

Teacher: (types word) Range of courses. Yep

Sound: (of typing)

Student: Friendly

Teacher: (types word) Right, friendly.

Student: Good teaching

Subsequent activities. By the time Mr. James completed the second question cycle his performance was fluent and remained so until the conclusion of the session. He had become, at least for the time being, unconsciously competent and was able to perform automatically without having to think about what to do and say. The group responded positively, automatically and productively to his instructions and became synchronised in time with Mr. James' performance, which is consistent with social entrainment (McGrath, 1990). Mr. James began to use speech routines which more closely approximated the ideal "facilitator speech" that became better integrated with the motor activity, in the form of a Lurian (1973) 'kinetic melody'.

The history teacher's second performance

Mr. James second performance as a facilitator was a classroom activity with his Year 12 history class. The activity was disorganised at the start, as was his first session. The topic was the reformation and the spiritual crisis of the 15th Century. Table 8.6 shows that Mr. James completed 12 questions.

Table 8.6: Question cycle times of the Year 12 history session with Mr. James

Activity		Seconds											
Cycles	1	2	3	4	5	6	7	8	9	10	11	12	
Time-out	-	-	-	-	-	-	-	-	-	-	-	-	-
Question	427	23	75	6	38	6	240	6	12	149	57	72	
Talk	7	3	-	-	-	-	-	-	-	-	-	-	
Type	86	59	64	64	78	176	45	42	62	119	58	231	
Read	91	120	27	70	60	-	68	58	55	37	63	-	
Sensemaking	72	-	435	120	70	-	-	81	77	96	65	-	
Total	683	205	601	260	246	182	353	187	206	401	243	303	

The activities comprised two warm-up questions, a four-question sequence about the reformation, a four question sequence about the papacy, and two questions about

writing an essay on the topic of the reformation. The session was completed in 1 hr. 0 min. 11 seconds at the rate of one question every 6 min. 40 sec. The cycles ranged in length from 182 seconds (3 min. 2 sec.) to 683 seconds (11 min. 23 sec.).

Mr. James recovered his composure towards the end of the first question cycle, and was able to establish a reliable pattern of interaction for the remainder of the session, just as he had done for the seniors session. However, his performance was diminished by his inability to relinquish his role as a traditional teacher. Much of the session was taken up with mini-lectures and closed question asking. Before the session began Mr. James was heard complaining about the length of time taken to set up the team learning system (see Record 8.18).

Record 8.18: Mr. James comments on the set-up time
(Off camera). It took me 20 minutes to set it up. It took ages.

Introduction. Mr. James spent 427 seconds (6 min. 47 sec.), or most of the cycle, explaining and re-explaining the purpose of the session and the mechanics of the technology. A short sample of his performance is shown in Record 8.19. He twice referred to “keyboards” as “small computers”, an unconscious automatic speech routine that may have been appropriate in another context, such as a computer laboratory, but not in this setting.

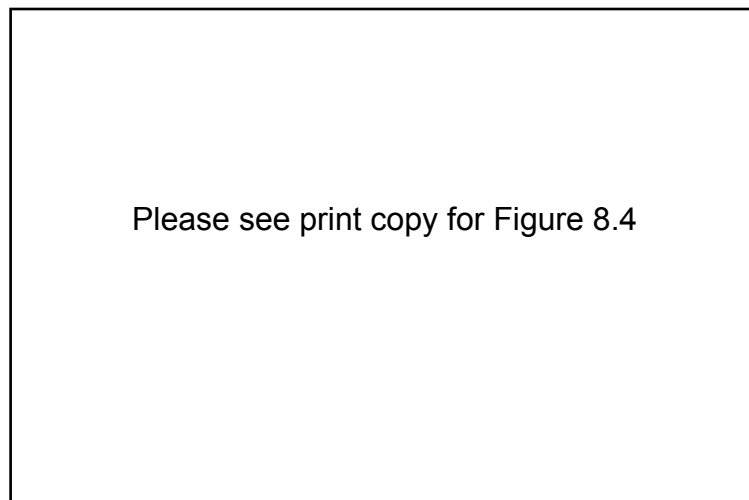
Record 8.19: Mr. James introduced the software to Year 12

I’ll tell you a bit more about the actual software. The session is based on the *small computers* you have. These *small computers* feed into my laptop. The information is then shown on the screen. So it’s a team.....situation....where the ideas are actually shown on the screen. The idea is you can all think at the same time. The aim of the lesson is twofold. The first is to recap actually what we know about the (inaudible) and try to make a value judgment about whether it led to the reformation or not....was it in a state of flux or not.... and secondly (inaudible) as well.

When Mr. James completed the introduction, he could not recall what to do or say next. He should have said, “what I’d like you to do now is pull your keyboards towards you and type anything you like, the words of your....” so the students could learn how to use the keyboards, but he had not delivered this part of the performance since the training day a month earlier, where he gave the two student facilitators responsibility for conducting the warm-up questions cycles. He was unfamiliar with the sequence and did not know where the activity fitted in the overall scheme.

Mr. James consulted the manual several times, and on one occasion, for almost a minute, without being able to discover how to begin (see Record 8.20). The body language exhibited by some of the students changed from relief to embarrassment each time he seemed ready to start the session, but failed to make headway. Figure 8.4 shows the students seated at a large common table in silence as Mr. James consulted the manual.

Figure 8.4: Mr. James consulted the manual when he forgot what to do and say



Frustrated by his inability to begin the session, Mr. James reverted to a traditional teaching role, to give the impression he was in control and knew what he was doing. He asked a closed question of the group (see Record 8.19), possibly to head off any student unrest that might normally eventuate when a teacher lacks confidence, then waited while a student answered the question and consulted the manual again.

Record 8.20: Mr. James switched between the facilitator and the teacher role

Teacher: (Flicked through manual a second time) What are the two interpretations, Ben? The two interpretations about the reformation church?

Ben: It was (inaudible).

Teacher: (Made a second adjustment to the computer) At least you are not (inaudible).

Log on. Eventually, Mr. James worked out what he could do, even though it was not the required next step. He began with the log-on, a procedure he recalled from the previous session, rather than the required “warm-up” activity, which he had practiced on the training day (see Record 8.21).

Record 8.21: Mr. James began the log-on activity but forgot a preceding step.

Right, the first thing we are going to do is (very long pause as the teacher finally decides to start by logging-on).....log on. You are going to give yourselves a name. You can use a fictional name. It's entirely your choice. In this box there....and as soon as you're done you press F9. Do that first.

Explanation. Performing the action of asking the first question presented by the team learning system seemed to remind Mr. James of what to do next. The “remembered action” provided a link to the sequence he was supposed to employ, and helped to guide his subsequent performance. He developed a kind of orchestrated momentum (see Record 8.22) and the words and actions became correctly sequenced. He achieved this by using cues from the software user interface to remind himself of what to say, an example of distributed memory (Pea, 1993), even though some of the cues were inappropriately used. He started by talking about the “*focus session*” (the name of the box on the display where the topic appears) but quickly realised this was irrelevant information. Without pausing he conflated “*focus session*” with “*introduction to get used to how to use the keyboards*” as if they were a natural fit. He then spoke briefly about the “*agenda item*” which was another cue on the user interface, but also irrelevant. What he should have said was “What I’d like you to do now is pull your keyboards towards you and type anything you like”. He then correctly asked the participants to respond to the second “warm-up” question “*If you could be a fairy tale... and what would you be like to live with?*” which he appeared to read off the computer display, so that his delivery was flawless. Then he correctly told the participants about the “talk-type-read-review” etiquette which was also displayed on the screen as part of a timer, pointing to the words as he spoke. He incorrectly called the teamspace the “*work area*” which appears to be a scrap of a speech routine from another context and even though it was the incorrect terminology, filled a gap in his explanation. At the end of the explanation he even congratulated himself for completing the introduction with the word ‘beaut’, an instance of inner speech.

Record 8.22: Mr. James eventually “got his act together”

OK, Right the focus session and introduction to get used to how to use the keyboard. Agenda item. If you could be a fairytale, cartoon or movie character who would you be and what would you be like to live with? First of all there is an etiquette which is (with emphasis) talk-type-read-review. You (inaudible) talk to the person next to you, you type your contribution. OK? You press F9 to send it to the work area as you will see and then as a group we will review what your

contributions are. And try to draw out common themes. OK. (with great emphasis) Talk. Type. Read. Review. Alright? Beaut.

Contribution. Although Mr. James announced that he would be following a talk-type-read-review etiquette, he changed his mind and instructed the students to “*talk for a second or so*” instead of the required “discuss the topic for a minute or two” (see Record 8.23) Thereafter, the students routinely followed a pattern of typing without discussion.

Record 8.23: Mr. James eliminated the discussion step

Teacher: So, talk for a second or so about what character you will be, and then we’ll type...and (inaudible). OK. Lets go.

Students: (Chatter)

Noise: (keyboard noise)

Reading aloud. Mr. James brought the typing to a close after three rounds of polite reminders to finish typing (see Record 8.24). He correctly modeled the reading aloud activity, and once he had established the pattern, which involved asking who had contributed the ideas, he then handed over the reading aloud to the participants who reliably followed the pattern he established.

Record 8.24: Mr. James modeled the reading aloud process

Teacher: OK last ideas please. (pause)

Teacher: Very last ideas now. Very last ideas. F9 to eh.... (pause)

Teacher: Come on chaps, F9. (pause)

Teacher: Lets review what we have. I’ll read first. You can tell me who is who. Buffy, good for killing demons, who was that? Where’s Buffy? Who’s Buffy?

During the course of the reading aloud, the participants laughed at their own contributions and those of other participants (see Record 8.25). They were all curious to see what others had to say and remained attentive. The students reacted with laughter to novel associations between the characters, their characteristics and the author.

Record 8.25: Students and teachers laughed at novel contributions

Teacher: I would be angelica out of Rugrats because I’m a spoiled brat. I’d be a nightmare to live with.

Students: (Laughter)

Teacher: I’d never have guessed. Bugs Bunny, The amount of carrots that we would have to buy would be extortionate.

Students: (Inaudible, followed by laughter)

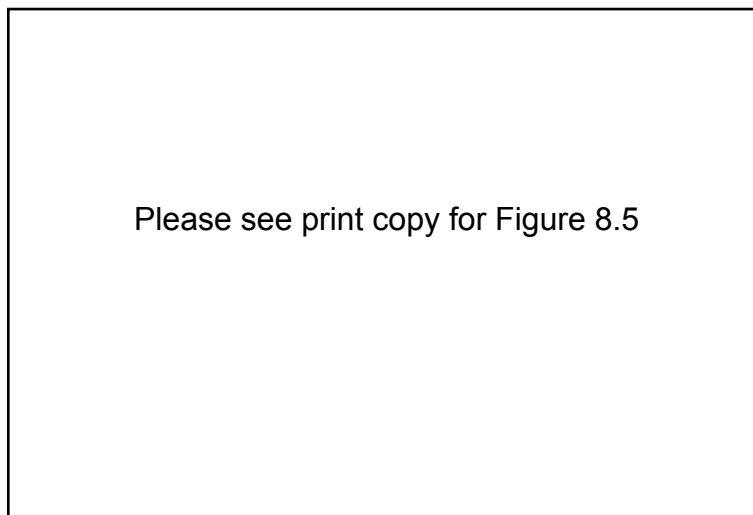
Review. Mr. James selected the theme tool and asked the participants to identify the key ideas, as shown in Record 8.26.

Record 8.26: Mr. James introduced the sensemaking step

So the idea is we look at these ideas and (unintelligible) they are interesting they are your ideas, we will now try and get.....identify, some common themes...so we'll look at those (as he makes a change to his computer including a pause)

Subsequent activities. Mr. James's performance improved as the session progressed. His instructions became more fluent and concise, but he frequently reverted to the traditional teacher role of lecturing and asking closed questions. On these occasions, the students became silent and exhibited body language of boredom or embarrassment.

Figure 8.5: Year 12 student body language during a mini lecture



In Figure 8.5, three students have their arms folded tightly to their bodies, six students directed their gaze downwards, especially the students closest to the teacher and one student slumped in his chair. Record 8.27 shows that Mr. James asked the students to identify a weakness of the church only moments after he had asked them to respond to a question about the weaknesses of the church via the team learning system. His question was met by silence.

Record 8.27: Questions that the students had already answered

Teacher: One of those themes is a weakness.....which of these themes talks about a weakness of the church?

Students: (silence)

Teacher: Which of these words reminds us of a weakness of the church?

Students: (silence)

Teacher: One of those themes is a real weakness.

Mr. James delivered at least six mini-lectures during the course of the team meeting activity. Each lecture dealt with identical material to the responses contributed by the students. Because Mr. James used the theme tool to summarise the student responses, this meant that the same material was covered three times. Record 8.28 shows Mr. James delivering one of his lectures:

Record 8.28: Mr. James lectures the Year 12 students

People needed the church, you could not go to heaven without the church, because the church will get you out of purgatory, or get your friends out of purgatory, so if Robin (a student in the class) dies, we can sing regular masses for Robin and his soul, to get him out of purgatory, the more songs we sing for him, the higher from purgatory he will go. We can do things to get rid of sin, like going to confession...they'll take our sin marks off us...So the church helps us get out of purgatory...

Mr. James also used the questioning process as a way of regaining control over a student who became disengaged. Record 8.29 shows Mr. James targeting the student with a question, not about the topic but about a factual response given by another student a few minutes earlier. This tactic was not about learning, but was designed to send a warning that if students did not pay attention, the teacher would cause them embarrassment.

Record 8.29: Mr. James used a question to embarrass a student

Teacher: It's clearly the peasant that's at the edge of a spiritual crisis. Maybe he can't articulate that in those words, but clearly (inaudible) with the Pope, and that leads on to Robin's point. What was Robin's point (pointing at student), Dave?

Dave: (silence)

Teacher: In a spiritual crisis, what are you doing?

Dave: (inaudible)

Teacher: Correct.

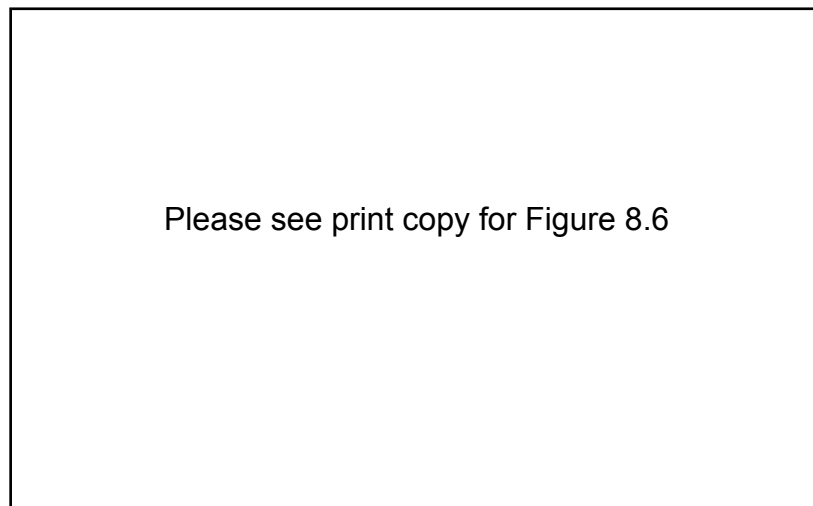
Overall, Mr. James's performance had some significant gaps. Although he could consistently facilitate a session using a modified (talk+type)-read-review etiquette, Mr. James was unable to correctly sequence or introduce the warm-up activities that preceded the formal learning or meeting activity. His introduction was a muddle of inner speech, emerging speech routines, old speech routines that were appropriate to

other situations, authority speech and the lecture. Despite the errors, the joint teacher and student activity became synchronised as the session progressed. The rapid cycling through the etiquette appeared to help organise the activity.

The textiles teacher's first performance

Ms. Zoe facilitated her first team learning session with the 22 students of Year 8 textiles. The purpose of the session was to develop a concept for a new fashion range, identify the types of customers, the possible types and styles of garments and the criteria for choosing the best option. Figure 8.6 shows the students seated in pairs and groups of three and four students around desks each designed to seat two students.

Figure 8.6: Ms. Zoe facilitates her first team learning session with Year 8 textiles



The teacher directed the activity from the front of the classroom and the contributions were displayed on a large wall-mounted flat-screen monitor. Her first performance exhibited most of the characteristics of a traditional teacher including an authoritarian approach to classroom behaviour control. She struggled, more than any of the other facilitators in this study, with what to say and do. Her initial performance was long-winded, repetitive and lacked clarity. But 30 minutes into the session her pedagogical style changed. Ms. Zoe entered into the spirit of the moment and encouraged the high level of fun and engagement with a commentary that praised the students for their contributions and provoked an avalanche of enthusiastic responses. The session comprised six activities in 1 hr. 8 min. 14 sec. at the rate of one question every 11 min. 22 sec. Table 8.7 shows that the initial “warm-up” activity” consumed almost 1719 seconds (28 min. 39 sec.) of which 10 minutes was devoted to

administrative activities, including a ‘starter task’, to keep the students occupied while the teacher marked the roll and signed the homework books. After the initial hiatus, Ms. Zoe was able to reliably adopt the facilitator speech and a regular pattern of interaction, which persisted for the remainder of the session. The shortest cycle was 431 seconds (7 min. 11 sec.).

Table 8.7: Question cycle times for Year 8 textiles facilitated by Ms. Zoe

Activity		Seconds					
Cycles	1	2	3	4	5	6	
Time-out	596	-	-	-	-	-	
Question	859	94	130	47	100	46	
Talk	-	-	6	-	-	-	
Type	264	194	99	125	133	144	
Read	-	170	122	173	215	217	
Sensemaking	-	-	85	86	78	-	
Total	1719	458	442	431	526	519	

Introduction. Ms. Zoe began the session with a series of administrative activities. During this time she performed as a traditional classroom teacher. Record 8.30 shows that as the students filed into the classroom she directed many of the students to sit at certain desks and with students she specified.

Record 8.30: Ms. Zoe gave the class very specific instructions

Students: (Chatter)

Teacher: (Raised voice, chatter stopped) Phil. Will you come down here with me and work with David for me please.... Homework diaries straight out, diaries, pencil cases straight out.

Students: (Chatter)

Teacher: (Raised voice, chatter stopped) Harriet, wait a second. Harriet, Hannah.

Teacher: I’m going to get you wrong as well, aren’t I?

Teacher: Let’s shift you across slightly.

As Ms. Zoe moved around the room, signed the homework books and marked the register, she talked, non-stop while the students completed a “starter task”, a safety questionnaire. Each time the students started to chatter, she raised her voice, and gave

the students further instructions, so there was no space for student conversation. Ms. Zoe revealed that the real purpose of the starter task was to maintain control over the class while she marked the roll (see Record 8.31).

Record 8.31: Ms. Zoe explained the real purpose of the starter task

5, 4, 3, 2, 1... Pens down, every pen. Ok, safety quiz. You know why we do stuff...tasks...get your brain working a little bit....keep you occupied while I'm signing the homework diaries....normally....we are not in the textiles room today because you are lucky enough to be experimenting....testing out this new equipment

Ms. Zoe's role as a traditional teacher was further illustrated by the style of her interaction with the students as they gave their responses to the "starter task" question (see Record 8.32). The students were required to raise their hands to signify they had an answer to give. Five students were selected in turn. Each of the questions was a closed question with just one answer, for example, "*What should go in the corner?*" for which the correct response was "*bags*". When she received the response from a student, she was patronising towards them, saying, for example "*Nice big tick if you got that one right*" and "*some people put work which I quite like*", which were, of course, the incorrect responses.

Record 8.32: Ms Zoe interacted with students as a traditional classroom teacher.

Teacher: The safety quiz...we are going to be back in the textiles room next time and I just need to check that you are up to date. So what should go in the corner, hands up please (pause). Bradley.

Bradley: Bags.

Teacher: Bags. Excellent. Nice big tick if you've got that one right. (Pause). Always do what in the textiles room (Pause) Vicky?

Vicky: Walk

Teacher: Walk. Some people put work, which I quite like. Always, walk, cause remember, we don't have negatives, do we? (Pause) Only how many people on the sewing machine? Kirsty? (Kirsty does not respond) One person on a (pause)....Oh, I've just given it away, but never mind. Jamie?

Jamie: One

Teacher: ...on a sewing machine at a time, alright, sewing machine, it could be machine, if you apply it somewhere else. That's fine. (Pause) What do we need to do with equipment? Vicky you've already answered, so have you Bradley, Hannah? Natalie, sorry.

Natalie: Be careful

Teacher: Be careful with all equipment. (Pause) Always be....Rebecca?

Ms. Zoe acknowledged that she usually employed a traditional pedagogical approach (see Record 8.33) when she revealed that in her normal classroom she wrote information on the blackboard for the students to copy into their exercise books.

Record 8.33: Ms. Zoe commented on her traditional style of teaching

(A writing gesture with the hands) So instead of me standing at the board trying to write everything down, we are going to use technology, so it's quite exciting.

Explanation. Ms. Zoe delivered a long and unnecessarily complex explanation of how to use the team learning system as shown in Record 8.34. Although she delivered an accurate description of the system, and how it worked, she occasionally used incorrect terminology, for example, when she said “*boxes*” instead of playspaces and “*keypads*” instead of “*keyboards*”. She also used familiar automatic speech routines when she did not know what to say next. For example, she said “we are going to have some fun questions *and a few different things*” and “*what we are going to do next*”. She assumed, incorrectly, that some of her students lacked the keyboard skills necessary to participate in the activity when she said, “one of you with keyboard skills can take over”. In fact, all students in the study were computer literate. Every student contributed their own ideas via the keyboard and did not require assistance from other students.

Record 8.34: Ms. Zoe. struggled to explain what to do

Teacher: So what is it all about? We use this...we use this hardware for meetings and similar sorts of things because what happens is it allows all of you to put in all of your ideas all at the same time. If you look in front of you, you've got a keyboard in front of you, and each of those keyboards relates to one of these boxes. I don't want you to do anything with it now. I want you to take turns and play nicely and share rather than one of you...one of you with keyboard skills can take over. I want you to share between you. And what we are going to do is I'm going to take you through the process of how you use them, and we are going to have a few fun questions and a few different things and then we are actually going to brainstorm our design brief, that is your shorts, so it should help you in producing your first piece of work.

During the first few cycles of the session Ms. Zoe made subtle demands such as “I want...” which reflected an authority power stance rather than a more facilitative approach which would have made use of indirect and empathetic language such as “if you would”.

Contribution. At first, Ms. Zoe was reluctant to give up control and shift responsibility to the students. On three occasions, at the start of the session, she changed

her mind about relinquishing control to the students. Record 8.35 shows that Ms. Zoe instructed the students to begin typing, but withdrew the offer with the words "*not yet, not yet*". She then took control of a student's keyboard and demonstrated how to type an idea. She was also anxious that the technology may not have been working and frequently asked the students to inform her whether the keyboards were functioning correctly saying, "*OK check up there, is it working?*" and "*if I pressed F9...can you watch it for me*"

Record 8.35: Ms. Zoe withdrew her offer to give up control

Teacher: Alright! So what I want you to do to begin with, is I would like you to just type....the first one first...type in what you had for breakfast this morning. Yes. Not yet. Not yet. I want you to type in what you had for breakfast this morning. And what you will see is it will come up in a little box. Once you have typed it in and you are happy with that...can you all locate the F9 key on your keypad and Yeh...because what would happen is...

Teacher: (goes to a student keyboard and performs the activity) Say for example I just come over here and take over Kirsty's and I typed in, OK, check up there, is it working?,

Students: (chorus of Yehs, and Yes, No. 1)

Teacher: ...cornflakes. And if I pressed F9...can you watch it...for me.

The demonstration was poorly organised. During the next few minutes Ms. Zoe struggled to work out what to do, and as she made adjustments to the computer, she used inner speech (see Record 8.36) to talk her way through what to do, saying "*so we need to*", "*no we don't want to*", "*that one...it won't let me...I'll type it from here...if I type F9 it goes up there*" and "*yes if I write I had porridge...and I realise I spelt it wrong you can use the backspace...the backspace deletes*".

Record 8.36: Ms. Zoe worked out what to do using inner speech

Teacher: And what happens is it's gone in cornflakes, which is wrong...and...

Teacher: So we will just change that (inaudible) quickly. So we need to...um...bear with me...

Student: inaudible comment

Teacher: (Returns to her computer to make a change)no we don't want to...

Teacher: that one...it won't let me...I'll type it from here...if I type F9 it goes up there....

Teacher: Yes...If I write I had porridge...and I realised I spelt it wrong...you can use the backspace...the backspace deletes...and if you move your cursor with the little directional arrows down the bottom, it will take you back and forwards...

Teacher: And then I press F9 and that's what I had for breakfast this morning. What I want you to do is to type one in and press F9 and pass it to your partner and they type what they have.... just so you get used to what...how we use the keyboards.

Students: (some talk occurs).

Teacher: (Raising voice above noise) Alright, now check as you are writing that it is working, alright, so we might have to relocate a couple of you. It should be OK. So type, pull the keyboard towards you, OK, alright, off you go.

Log-on. After 24 minutes, Ms. Zoe finally relinquished control and she allowed the students to start typing. When the first warm up activity was completed, Ms. Zoe selected the second warm-up question and asked the students to contribute some ideas, as if to finally begin the session. She had forgotten the log-on procedure (see Record 8.37), which meant she had to reverse what she had just begun. She continued to use inner speech to guide herself through the process of selecting a new agenda item saying *"We are going to get back to where I know"* and followed with *I'll bring up the next agenda actually...* and the forgotten log-on step and said *"I know what we'll do, before we do that..."* and began to explain to the students how to log on.

Record 8.37: Ms. Zoe remembered to log-on

Teacher: So! We are going to get back to where I know...each of you...I know that three should work fine...but each of you have a go...we'll start from scratch again....I'll bring up the next agenda actually...

Teacher: (adjusts computer again) Now! What I want you to do for this one...Just to get you back into the swing of it...I know what we'll do, before we do that, (inaudible) turned green, What's I'd like you to do, whatever you type in now (emphasis) is going to be your team name...so its going to be who.....

Second explanation. Ms. Zoe talked incessantly. She announced the second warm-up question and described the talk-type-read-review etiquette, partly to buy some time, while she remembered what to say, and partly to deal with classroom control issues. She spent two minutes delivering a muddled version of the facilitator speech that is normally completed in less than 30 seconds. Record 8.38 shows Ms. Zoe using authority speech to control the students' behaviour saying *"Shhh Shhh Shhh"* and *"David put the pen down"* and *"hang on, one second"*. Ms. Zoe raised her voice as soon as the students started talking, in order to be louder than the students, in a kind of "loudness competition" which only the teacher could win, because she had sanctions that she could apply, if they did not comply with her wishes.

Record 8.38: Ms. Zoe introduced the etiquette

Teacher: Now what's going to happen. Shhh Shhh Shhh,

Students: (the talking stops)

Teacher: David, could you put the pen down.

Student: (inaudible).

Teacher: (inaudible) That's alright. Now what we are going to do now. OK that's fine. What we are going to do, is now we are going to go through a series of exercises and we are going to do a couple of fun ones first and I need you to learn the etiquette of using this. Now what happens, to says for example, that we area staff meeting....I don't know if you have ever seen a staff meeting...you can never imagine what a staff meeting would be like...but you are always going to have people that dominate...its like in a classroom...there's always someone shouting out...there's always somebody....uuh uuh...just basically putting their hand up....or...or...or...overshadowing everybody else....and what this means is you can get as many different ideas down as possible....depending on how fast you can type.. What I want you to do....is not just to go ahead....I want you to discuss it first ...so our topic is...you have been turned into something nasty by a wicked witch. What are you now and how can you use it to your advantage?

Students: (Start to talk)

Teacher: (Raises voice) Hang on. One second. I want you to discuss what you've turned into, then how you could use it to your advantage...You actually type in I could....be something nasty type in a frog and I would scare whoever.

Student: (Laughter)

Contribution. Ms. Zoe then fluently called for participants to contribute their ideas using the keyboards and submit them with F9 as shown in Record 8.39. She continued to be concerned about the noise level and loudly said "*C'mon*", but her indirect request had only a temporary and minimal effect

Record 8.39: Ms. Zoe asked the students to begin typing

Teacher: Alright, so, you're going to have round about two minutes. Once you've got it in, press F9 if you can think of something else and you have extra time, do another (typing motion with hands) one. OK. Off we go.

Student: (Chatter)

Teacher: (says loudly, to try to lower the noise level) *C'mon!*

Students: (Chatter level drops only a little)

Reading aloud. By the time Ms. Zoe completed the first question cycle, she was more relaxed and fluent. She began to realize that the etiquette and the short bursts of typing, reading and sensemaking, helped maintain control. Record 8.40 shows that

Ms. Zoe correctly modeled the reading aloud process. However, she continued to read the ideas aloud herself, and did not relinquish responsibility for the reading process to the student until question cycle 4, instead of question cycle 2. As Ms. Zoe read the ideas aloud, the students quietly but expectantly paid close attention. Then, to Ms. Zoe's surprise, the student began responding with laughter to the novel ideas they had created. The laughter, and later, the creativity, became contagious.

Record 8.40: Ms. Zoe read the ideas aloud to student laughter

Teacher: You've been turned into something nasty by a wicked witch, what are you now and how can you use this to your advantage? What's I'm going to do is ask you to read your own out.

Student: (laughter)

Teacher: Seeing there, I don't particularly want to read out, but I'll do the first couple. Old woman. Old Woman, so I can scare a young man with a wrinkly face.

Students: (Laughter)

Teacher: Whose was that?

Student: (Inaudible)

Students: (More laughter)

During the reading aloud activity (see Record 8.41), Ms. Zoe realised that the students were keen to participate, were highly engaged and very productive. They generated more and richer ideas than she expected. She publicly acknowledged their performance with the words "*this is brilliant*". The students were not only keen to contribute but also keen for their contributions to be acknowledged by both their teacher and their peers.

Record 8.41: Ms. Zoe became excited by the student work

Teacher: I would be turned into a five armed lady.

Students: (Laughter)

Teacher: This is brilliant. What are you now? How could you get an advantage? You'd see, you'd be great at netball because your five arms...the five armed lady...you'd be able to do all this (moves arms as a netballer would). A strange word...is that you again...the man with the shotgun...was that yours one again...I can find out what they are. (Pause). Shark. I would eat people. Mullet Man to scare hairdressers.

Students: (Laughter)

Teacher: Hooray (Restrained laughter) That's your one. OK. An ugly duck and I could nip people's arms off. That was yours over there. Muffin men to scare the baker. Whose was that one?

Students: (Restrained giggles)

Teacher: Bizarre. Be a tree and surprise the squirrels. It should be quite fun doing that. Who's was that one?

Students: (Noisy excitement)

Review. During the sensemaking stage, Ms. Zoe correctly followed the correct procedure and asked students to look for the underlying concepts. However, she was unable to resist switching back to her traditional teaching role, and sometimes typed her own interpretation of a concept rather than what the student said as shown in Record 8.42.

Record 8.42: Ms. Zoe captured the themes

Bradley: Toddlers

Teachers: Toddlers, excellent, I like it. Dale?

Student: Different sort, not religion, its like grunges and goths

Teacher: Sub-cultures, they call that sub-cultures, or should we call them fashion trends?

Student: Yes.

Teacher: Is that alright...lets just put fashion trends. OK Lilly

Subsequent activities. The students remained highly engaged for the entire session. Ms. Zoe eventually abandoned her role as a traditional teacher and her speech more closely approximated the ideal facilitator speech. Although the classroom was very noisy during the discussion and typing phase, the students remained quiet and attentive when a new question was announced and when the ideas were read aloud. During the sensemaking stage the students listened carefully to hear what other students thought about their ideas. The students' relationship with the teacher became more equal and more entwined. Record 8.43 shows Ms. Zoe joining in the activity with complementary comments saying, "*you could ...make it for a baby....a baby sprot (sic) player*", and "*I like baby sprot players*", a kind of co-performance with the students. The student and teacher enthusiasm served to reinforce each other's levels of engagement.

Record 8.43: Ms. Zoe joined in the student activity

Teacher: Because if I'd asked you right at the beginning and just said...well...we're going to design and make a pair of shorts, you'd be saying (body sized shrug from teacher). I have no idea. I haven't got any ideas.....and

this has created all your ideas... You could.....make it for a baby....a baby sprot (sic) player

Students: (Laughter)

Teacher: (teacher plays on a spelling mistake). Alright? I like baby sprot (sic) players

Students: (Laughter)

Teacher: or a sprot (sic) player with one size fits all

Students: (Laughter)

Ms. Zoe became very excited during question cycle 5 when the students generated over 100 ideas in just two minutes (see Record 8.44). She joined in the spirit of the occasion, her enthusiasm resonating with the enthusiasm of the students.

Record 8.44: Ms. Zoe becomes even more excited by the results

See how many ideas you've got now? (Emphatically) Absolutely loads.

Ms. Zoe even attributed some of the success to the team learning system, which she had feared using, and would rarely ever use again in the classroom. Record 8.45 shows her saying "*its amazing.....this is so good for brainstorming, isn't it*" which missed that point that, although the tool was useful for brainstorming, its' primary purpose was to support knowledge creation. The way Ms. Zoe adopted the tool appears to be constrained by her repertoire of traditional pedagogical approaches. She placed the tool in the information-collecting category, with which she was familiar, and in so doing settled for an object of activity (or aspiration) that limited both her learning and development and that of her students.

Record 8.45: Ms. Zoe compared two different approaches to question asking

Teacher: Let's have a look at what we've....you did not get as many.....you still got loads...uh uh ...its amazing...to think that this is so good for brainstorming, isn't it?

Students: (chorus of yes)

Teacher: You can all have a have a go, and think about sometimes, you might think that you're ideas are very good or you might be embarrassed because you put your hand up and everyone turns round...you can get all of your ideas down...its really quite nice like that.

From the commencement of cycle 3 onwards, Ms. Zoe began to frame her facilitator speech increasingly in "we" terms such as "*Let's have a look at what we've...*" rather than "you" terms and to invite participation rather than demand it. At

the start of the session Ms. Zoe was the controller. Yet, as this analysis shows, there was considerable pent-up energy in the classroom just waiting to be unleashed. The teacher spent a considerable amount of energy and time quelling rebellions before they could become established. At the start of the session, she expected the children to be quiet (and they were) and respond to her closed questions using paper and pencils. At the beginning of the session, her relationship with the students was one-sided, and she spent much of the time trying to shape student behaviour. By the end of the session she had established a much more equal culture for learning in which the students were contributors and Ms. Zoe the facilitator, and where the potential energy was directed at learning rather than teaching.

The student facilitators' performances

Seven students attended the facilitator training day. Two were given the opportunity to use their new skills. Jane and Helen shared the responsibility for the 'warm-up' introduction to the seniors meeting facilitated by Mr. James.

Figure 8.7: Two students facilitated the first cycle of the seniors' session

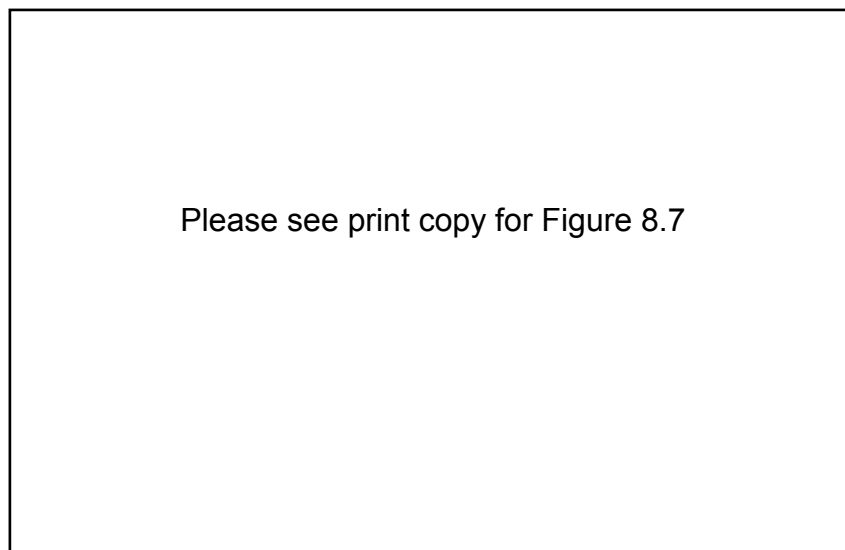


Figure 8.7 shows Jane and Helen seated at the teacher's desk at the front of the classroom facing the participants who were seated around a large table. After a brief introduction by Mr. James about the purpose of the meeting, the facilitation careers of the two Year 12 students Jane and Helen lasted just 2 minutes and 24 seconds, only long

enough to introduce the seniors students to the etiquette of the tool. Mr. James resumed control of the activity as soon as they completed the “warm up”.

Explanation. Jane spoke and Helen operated the computer. Jane began by employing the phrases she learned on the training day (see Record 8.46) which were designed to give clear instructions to participants. However, instead of recalling the ideal facilitator speech routine “*type anything you like, the words of your favourite song, what you had for breakfast...*” she began to use a speech routine required later in the sequence for the log-on-procedure “*to log-on, we need to type our names*”” She realized her mistake, and corrected herself by speaking the remaining part of the correct routine, so that it was conflated as “*we need to type your....the words of your favourite.*”

Record 8.46: Jane explained how to use the team learning system

Alright, let us start using this program. To start off we need to type your... the words of your favourite song, what you had for breakfast, or the quick brown fox jumps over the lazy dog.

Log-on. Jane struggled to explain the log-on process. She was supposed to say “*to log-on we are going to type our names...*” but she could not recall the correct name for the playspaces. Jane used a form of inner speech (see Record 8.47) instead of the ideal facilitator script to help her remember what to say, which became muddled with the instructions; she hoped to give the participants. When she talked about the bar of the playspace, where the participant name appears after the log-on step, she used a form of inner speech “*we are going to change it*” and “*where it says the number*” as an *aide memoire* for navigating around the user interface. Jane also described the playspace as “*your box that you type in*”, that concatenated box and playspace to create a hybrid name “*playbox*”. Jane continued to use playbox throughout her performance.

Record 8.47: Jane explained how to log-on

Now we are going to change it so that you can have, where it says the number, your box that you type in, called the... playboxes...you can change it so it says your name which we'll just do...

Contribution. Jane was initially unable to recall the correct procedure to submit an idea from a personal playspace to the teamspace, nor the proper names of the user interface. Instead of saying “press F9 to send your idea to the teamspace she said “if you press F9, it will *send it to the bit up the top*”, a form of inner speech, that helped her navigate around the software user interface. “*Wholes*” became a replacement for

“whole idea” and a concept “*written*” which is normally associated with writing with a pen was employed instead of “typed” to describe the idea input method (see Record 8.48).

Record 8.48: Jane explained how to submit an idea to the teamspace

Once you have done that you can move the cursor around. If you want to delete the wholes, Alt C, and then once you have written it and you are finished whatever you’ve wanted to say, if you press F9, it will send it up to the bit up the top.

Towards the end of her presentation, Jane grew in confidence and was able make better use of the required terminology and give clear instructions. Record 8.49 shows how Jane continued to use a form of inner speech, to help her think about what to do. She misnamed the playspaces as *boxes* again, but correctly used the word *type* instead of write and *things* instead of ideas or contributions.

Record 8.49: Jane explained how to submit additional ideas

Yes. F9 (pause) OK. (Pause) OK, so now you know how it will work. Type in something, then press F9. The boxes only fit, like a certain amount of words in, so if you run out of space, just press F9 and start typing again and you can send as many things up as you want to.

Facilitator speech patterns

The relationship between the facilitator and the participants appears to have been influenced by the way in which personal pronouns were employed. A word count of the personal pronouns “I/you” and “we” employed by the facilitators during the warm-up cycles was undertaken. Table 8.8 reports on the frequency of use of “you” and “we” and the ratio of “you” to “we”.

Table 8.8: Use of personal and collective pronouns by the facilitators

Facilitator	Session	You	We	Ratio
Researcher	Year 12	19 (54%)	16 (46%)	1.2:1
Researcher	Year 8	37 (59%)	25 (41%)	1.5:1
Mr. James	Year 12	42 (63%)	25 (27%)	1.7:1
Ms. Zoe	Year 8	144 (66%)	75 (34%)	1.9:1
Jane & Helen	Seniors	14 (82%)	3 (18%)	4.7:1
Mr. James.	Seniors	59 (84%)	11 (16%)	5.3:1

The warm-up session was selected for the analysis being the only cycle that all the facilitators completed. This allowed a direct comparison to be made. The analysis showed that the use of “you” dominated all the sessions, and that even the researcher, who had 15 years experience as a facilitator, also used “you” more frequently than “we”. The ratio of the use by the researcher of “you” and “we” was 1.5:1 for the Year 8 activity and 1.2: 1 for the Year 12 activity. The use of “we” by Mr. James increased between the first and second sessions from a ratio of 5.3:1 to 1.7 to 1. Ms. Zoe’s use of “you” and “we” was 1.9:1. The student facilitators used “you” much more than “we” with a ratio of 4.7:1.

At the start of her session with the Year 8 Textiles, Ms. Zoe made considerable use of the “you”, but this declined dramatically when she switched from her normal stance as a traditional teacher to her new role as a facilitator. During a two minute “warm-up” monologue “ Ms. Zoe used “you” 23 times and “we” three times to instruct the group how to use the team learning system (see Record 8.50).

Record 8.50: Ms. Zoe’s excessive use of “you”

I don’t want you to do anything with it now.

I want you to take turns and play nicely.

I want you to share between you.

So what I want you to do to begin with is I would like you to just type.

The transition point for Ms. Zoe occurred when the students contributed a large number of ideas in response to the first “warm-up” question. Her use of the word “we” increased when she associated herself with the surge in student creativity and productivity (see Record 8.51).

Record 8.51: Ms. Zoe’s turning point in the use of “you” and “we”

What we can do now, is that we can bring all these up...we would actually go through these...now we are just going to read these out to begin with and I’ll explain why we read them out...we are going to read through these and see if there are any key themes...I’m not sure whether we have enough time to do that because we’ve got the other stuff to get on with. We’ll just go through and pick these ones out.....

Mr. James use of “you” dominated the facilitator talk when he led his first public session with the seniors and continued until the start of Year 12 history session, as shown in Record 8.52.

Record 8.52: Mr. James began to use “we” instead of “you”

You (inaudible) talk to the person next to you. You type your contribution. OK?

You press F9 to send it to the work area as you will see and then as a group we will review what your contributions are.

Mr. James switched from “you” to “we” during the Year 12 history session when the facilitator and the student activity became closely coordinated. Record 8.53 shows Mr. James began to use “we” more frequently when he asked students to read aloud their contributions in response to the first of two “warm-up” questions.

Record 8.54: Mr. James began to use “we” more frequently

Let’s review what we have. I’ll read first.....

Have a go. We haven’t much time.

We’ll do one more.....very, very quickly just to finish up the introduction.

Summary and conclusions

The analysis shows that all the facilitators – both teachers and students - experienced difficulty organising their activity, both what to do and say because there was a conflict between the use of inner speech and previously learned automatic speech routines. The teacher-facilitators, had to deal with the additional burden of a conflict with authority speech, used to maintain control of the classroom, and previously acquired speech routines associated with the pedagogy of knowledge telling. By the time each facilitator completed the first or second “warm up” activity, the performances became more fluent and correctly sequenced, and the motor and speech activity more seamless, in what Luria (1973) describes as a “kinetic melody” that is performed automatically and unconsciously. The facilitators also learned to use distributed cues such as the etiquette (Pea, 1993) that were visible on the software user interface to help guide their use of the “facilitator’s speech”.

Ms. Zoe began the session as a traditional teacher but switched to and maintained a more facilitative role for the remainder her session. Mr. James appeared to master the facilitative role early, and conducted a very successful workshop with the seniors students, but returned to his traditional teaching role when facilitating a classroom activity. The two student facilitators experienced fewer difficulties than the teachers and were able to introduce the session in a much shorter time, similar to the time taken by the researcher.

During the transition from a traditional teaching role to a more facilitative role the teachers changed their use of personal pronouns from “I/you” to more “we”. The power difference between the teachers and their students narrowed and became more equal and empathetic. The teachers ceased making demands and began encouraging or inviting contributions.

The session timing record showed a regular, repeating pattern of participant interaction, which became entrained with the facilitator activity, and reinforced the other. Discussion was relegated to a minor role by the teachers and subsumed into the typing process that is consistent with Baumfield and Oberski’s (1998) finding that teachers are often unable to incorporate discussion into classroom activities. The reluctance to allow formal discussion may have its origins in teachers’ fears they may be perceived as unprofessional if their classrooms are noisy, even though the higher noise levels may simply reflect greater participant energy and involvement.

A reliable and consistent interaction cycle was established in all of the sessions despite imperfect introductions by each of the teacher and student facilitators. The temporary elimination or addition of steps to the etiquette had little impact on the adoption of the tool by the students. The participants discovered what to do, despite the facilitator’s poor initial performances, although discussion became part of, and subservient to, the typing activity rather than a separate activity. This pattern remained intact even when disruptions impinged on the process such as teacher-led deviations to lecture, ask supplementary questions or discuss an aspect of the responses. The talk-type-read-review pattern of interactions has similar features to the think-pair-share or think-pair-square-share routines of Kagan’s (1992) structures that promotes a regular interaction routine, the reciprocal teaching method (Palincsar & Brown, 1984) which is a repetitive pattern of question asking and summarising by the teacher and the small group-large group knowledge sharing approach of the *Jigsaw* method (Aronson, Blaney, Stephen, Sikes & Snapp, 1978).

Each of the teacher-facilitators found it difficult to abandon their roles as strict authoritarians in the classroom for the new, and less interventionist, role as a facilitator. At different stages during their “teaching” performances both teachers raised their voices to talk above and gain the attention of the students, drew attention to and were critical of student actions and asked closed questions with right/wrong answers to “frighten” the students into more appropriate behaviour. Subsequently, the teachers

found it possible to use the dynamics of the short cycles and rapid sequences of the team learning system etiquette to maintain control.

Emotions appeared to play a significant role in the adoption of the new motor and voice activity. When the teachers were performing weakly, apprehension and fear of loss of control were dominant emotions, but once the sessions became successful, these emotions gave way to a more positive emotional state, somewhat short of the student joy or fun, but certainly in Ms. Zoe's case, approaching this state.

When the facilitator engages in the facilitation role, which involves a complex and highly integrated combination of speech and motor skills, the voice and motor performance appears to be constantly checked for consistency against an ideal, imagined or previously observed model of what the performance could become in the internal plane of action (Hasan & Gould, 2001), and the facilitator tries out new routines, and if they work, adopts them, and if they do not, tries out a new routine. The speech and motor activity of the teachers seemed to become more organized and automatic when the teacher's negative emotional state subsided and the teachers' facilitation activity and the students' participation activity become synchronised.

CHAPTER 9

PARTICIPANT PERFORMANCES

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Overview of the chapter

In chapter 7, a qualitative analysis of the first-time use of a team learning system by teachers and students, showed that most of the students reported high levels of engagement and enjoyment despite the initial inability of their teachers to explain how to use the tool reliably and fluently. In this chapter, I will report on the quantitative analysis of the ideas and concepts generated by the participants to show that the students were able to make a significant and sustained contribution to the classroom discussion somewhat independently of their teachers, not for a short period, but for many discussion cycles. I will show how open-ended, rich, and discussible questions stimulated an “avalanche of ideas” that led to the generation of new knowledge for the participants. The results will also demonstrate that some of the ideas, or their inherent

concepts, acted as catalysts for further ideas, and conversely, that closed questions stimulated few ideas and minimal interaction.

The unit of analysis in this chapter is the *idea* which is defined as a string of words contributed by a participant followed by the submit key (F9) which sends the contribution from a personal work area on the screen, known as a playspace, to a group area known as the teamspace. A second unit of analysis is the *concept*. Each idea contains one or more concepts, as defined in the Research Design (see page 212). Differently worded concepts, which expressed the same meaning, were regarded as a single concept.

The first section of the chapter reports on the productivity and regularity of idea generation by the participants in terms of the frequency, length, rate of production of ideas, and the extent to which the idea generation process became automatic, routine and self-sustaining. The second section considers whether, and under what circumstances, participants adopted concepts generated by participants who were the first to generate concepts. Social network analysis was used to reveal the flow of the discussion and the interactions between participants, to determine whether some students, more than others, were responsible for initiating, transmitting or adopting concepts. The analysis also examined what aspects of the activity exhibited the characteristics of autocatalytic emergence, particularly in terms of the density of communications between participants, and whether such events may have persisted over several cycles. The third section considers the role that closed, open-ended and rich or complex questions played in the generation of ideas or concepts. This section also explored what kinds of questions the teachers and students were able to craft when asked to design open-ended questions, whether there was a prior pattern of cultural conditioning that may have interfered with the activity, and if they were able to learn from experience. The fourth section assessed the extent to which participants experienced the state of peak experience and engagement known as flow while participating in the team learning activity, whether there were any differences between groups, and what factors acted to promote or inhibit flow.

Participant's contributions

In a traditional classroom, students have few opportunities to participate in discussion and exchange ideas with each other. Most open discussion or interaction

averages less than two minutes of each sixty minutes of class time (Applebee, Langer, Nystrand & Gamoran, 2003) and four to five students account for 75 percent of all interactions with the teacher. The analysis showed that the frequency and length of ideas and regularity of the contributions by the participants in the team learning sessions was considerably different to what we know occurs in traditional classrooms.

Summary of participants' contributions. Table 9.1 is a summary of the total number of ideas, the average number of ideas contributed by each person in response to a question, and the average number of ideas each person contributed during a session in response to the 140 questions (discussion cycles) and 12 sessions of the study. The data was obtained by counting the number of ideas recorded in the session reports, of which an example is shown in Appendix VIII (see page 449). Three voting activities conducted during the Year 8 and Year 12 cloning sessions were excluded.

Table 9.1: Summary of participants' contributions

Facilitator	Group	Topic	Group size	Cycles	Total ideas per session	Average ideas per person per cycle	Average ideas per person per session
Mr. J	Year 12+	Reformation	12	12#	121	.8	9.6
Mr. J	Seniors	Issues	14	14	179	.9	12.6
Mr. J	Year 12	Essay	12	6	64	.9	5.4
Researcher	Year 12+	Cloning	9	7	60	1.0	7.0
Researcher	Year 12+	Feedback	9	22	190	1.0	9.0
Researcher	Year 8+	Feedback	22	20	503	1.1	22.0
Researcher	Year 8+	Cloning	22	6	180	1.4	9.4
Researcher	Facilitator+	Training	10	8	114	1.4	11.2
Ms. Z	Year 7	Review	20	7	255	1.8	12.6
Mr. J	Year 9	WW II	15	11	383	2.3	25.3
Ms. Z	Year 8	Textiles	22	6	327	2.5	15.0
Researcher	Teachers+	Feedback	4	21	256	3.0	64.0
				2632	219	1.5(.7)	
(133)							

+ Individual contributions record * excludes two voting activities ** excludes one voting activity # two question cycles missing

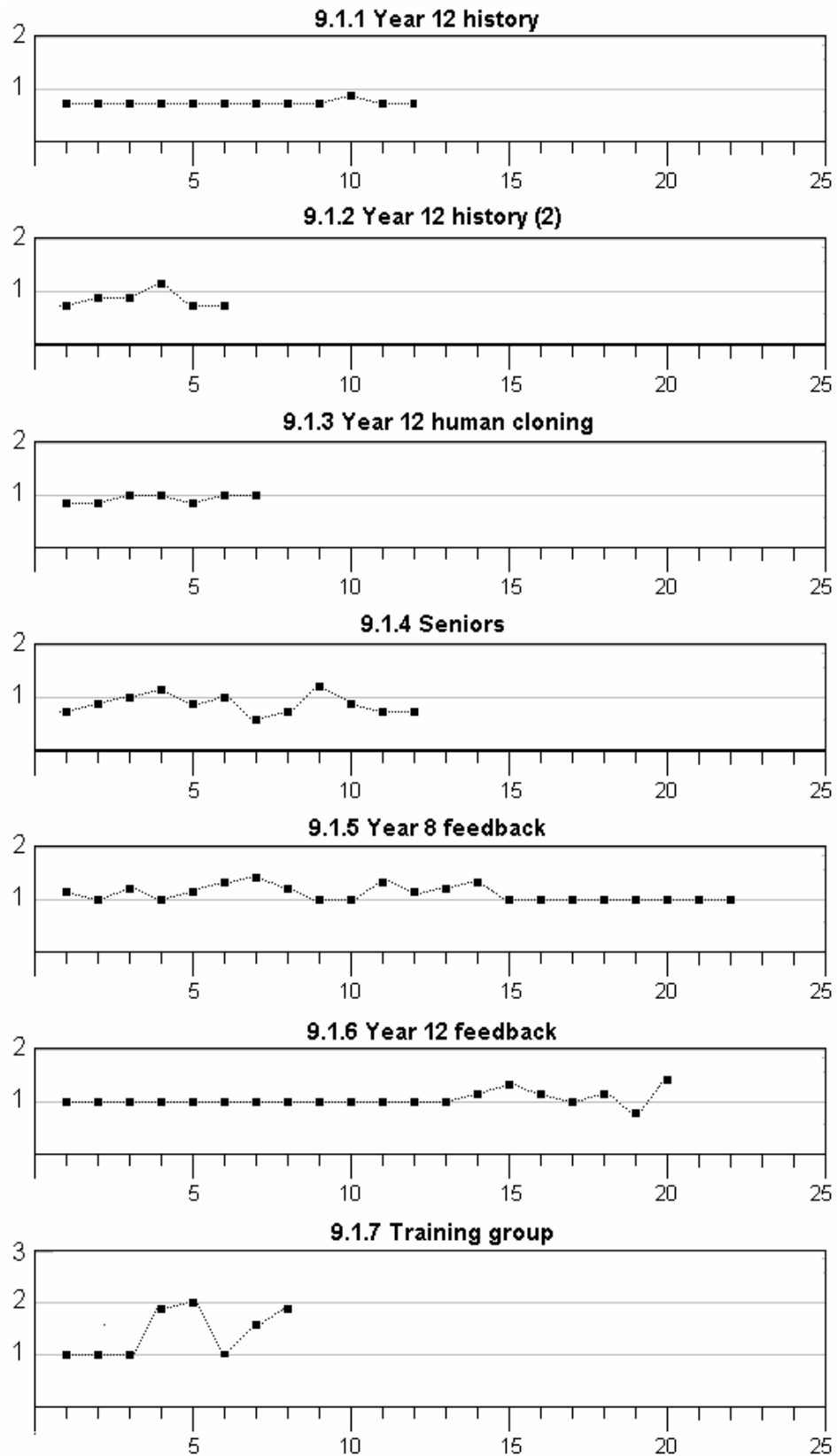
The 99 students and 6 teachers generated 2,632 ideas at the mean rate of 1.5 ideas per participant per question ($M = 1.5$, $SD = .7$). The teachers generated the most ideas (3.0 ideas per cycle), and the Year 12 and seniors students the least number of

ideas (.8 ideas per cycle). Two classes generated a large number of ideas. Year 8 textiles students contributed 2.5 ideas per student per cycle and Year 9 history produced 2.3 ideas per student per cycle. The idea generation rate ranged from 5.4 ideas per session for the Year 12 history essay writing activity to 64 ideas for the teacher feedback activity with a mean of 15.9 ideas per session ($M = 15.9$, $SD = 16.9$). The meeting records from two Year 12 history activities were missing from the computer transcript so the missing data was replaced by an average of the earlier cycles.

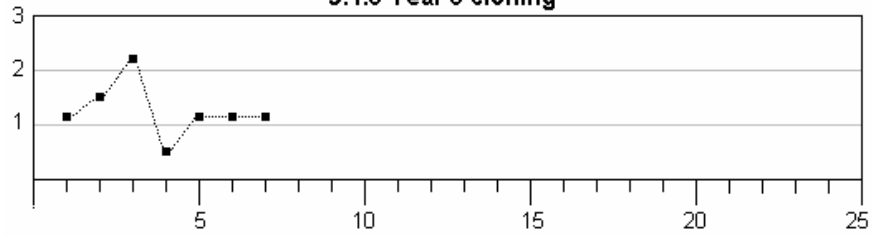
Regularity of participation. In order to determine whether the level of engagement of the participants was consistent or irregular, a threshold was adopted of one idea contributed per cycle sustained over an entire session as the measure of consistent engagement. The analysis of the 12 sessions found that the participants remained engaged for the majority of sessions as shown in Figure 9.1 (see pages 317-318). The cases are arranged in order of increasing productivity from the least productive group, the Year 12 history session (see Figure 9.1.1) to the most productive group, the teacher's feedback session (see Figure 9.1.12).

The participation rate equalled or exceeded the engagement threshold of one contribution per cycle for 109 of the 141 discussion cycles (77.3 percent) at the rate of 1.8 ideas per participant per cycle ($M = 1.8$, $SD = 1.1$). The contribution rate is indicative of a high level of engagement. For the remaining 32 discussion cycles (22.7 percent) that fell below the threshold, the participants consistently contributed .8 ideas per participant ($M = .8$, $SD = .1$). However, the participation rate may have been higher than the analysis suggests. Some groups of students shared keyboards and submitted multiple contributions as a single idea that may have resulted in an underestimate of the frequency of contributions. The contribution rate ranged from an average .8 to 5.8 ideas per participant per cycle with a mean of 1.5 ideas each ($M = 1.5$, $SD = .7$). The length of the contributions varied from 2.8 to 30.1 words ($M = 13.1$, $SD = 5.3$). The shortest session was six discussion cycles and the longest session was 23 cycles ($M = 12.0$, $SD = 5.9$). The contribution rate of three of the groups accelerated during the session; Year 7 textiles (see Figure 9.1.9), Year 9 history (see Figure 9.1.10), and Year 8 textiles (see Figure 9.1.11) consistent with a "runaway" or "contagious" type reaction. The training group (see Figure 9.1.7) and Year 8 cloning (see Figure 9.1.8) also performed well above the benchmark rate for part of the sessions. The teacher feedback session was the most productive (see Figure 9.1.12) but the frequency of ideas varied from 1.4 to 5.8 ideas per cycle.

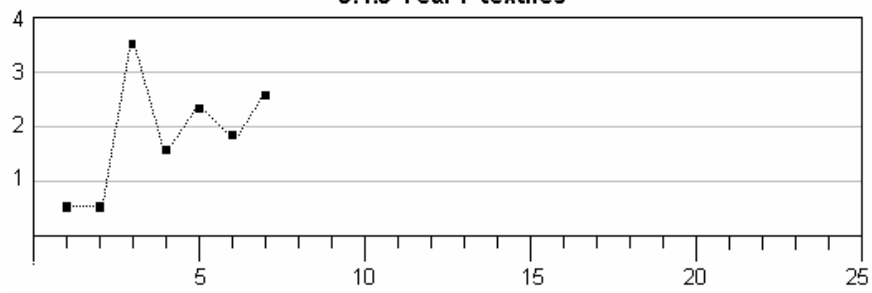
Figure 9.1: Frequency of ideas generated per person per discussion cycle



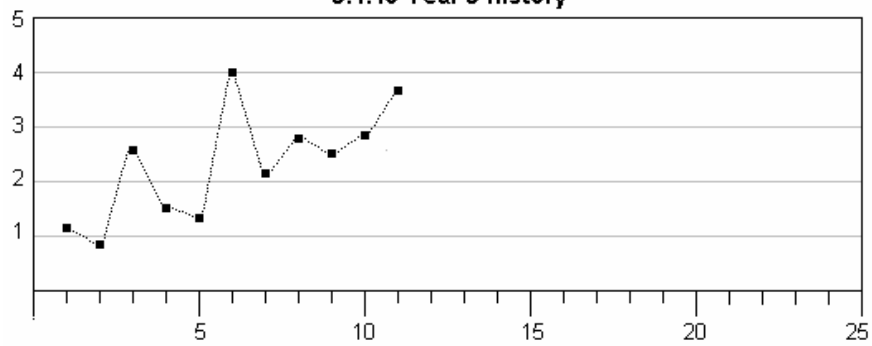
9.1.8 Year 8 cloning



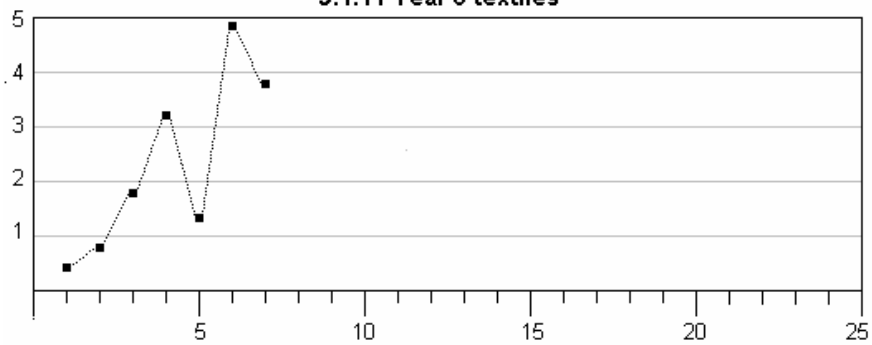
9.1.9 Year 7 textiles



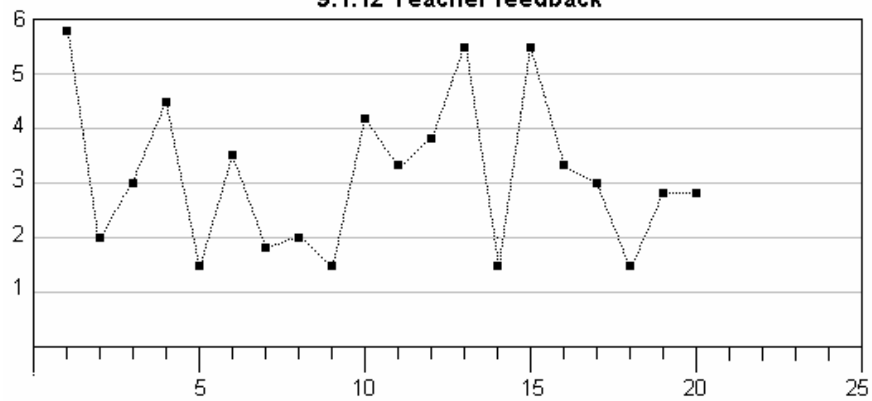
9.1.10 Year 9 history



9.1.11 Year 8 textiles



9.1.12 Teacher feedback



Idea frequency and length by participant. There was a wide variation in the length of ideas between groups. Table 9.2 shows that the seniors and Year 12 students contributed ideas that were significantly longer than the ideas contributed by the younger students in Year 7 textiles, Year 8 textiles and Year 9 history. The table is arranged from longest (most elaboration) to shortest ideas (least elaboration).

Table 9.2: Frequency and length of ideas by participant

Session	Ideas per person		Length of ideas, words	
	Mean	SD	Mean	SD
Year 12 history	.8	0	31.0	5.5
Year 12 cloning	1.0	.1	22.1	9.1
Seniors	.9	.2	19.0	6.9
Year 12 history (2)	.9	.1	13.0	10.5
Year 8 cloning	1.4	.4	12.8	4.2
Facilitators	1.4	.7	12.2	3.5
Teacher feedback	3.0	1.4	11.1	3.2
Year 8 feedback	1.0	.1	11.1	8.6
Year 12 feedback	1.1	0	9.5	3.5
Year 7 textiles	1.8	1.1	8.6	4.0
Year 9 history	2.3	1.0	4.2	1.8
Year 8 textiles	2.5	1.8	2.8	2.2
Mean	1.5	.7	13.1	5.3

Age and idea contribution. The idea length data was subjected to a t-test to determine whether the older students elaborated more than the young students did. The t-test compared the mean contribution of ideas (both frequency and length) of mature participants (Year 12, seniors, the facilitators group and the teachers) with the mean contributions of ideas by the younger students (Years 7, 8 and 9). The analysis showed that the older group of participants generated fewer ideas ($M = 1.30$, $SD = .77$) than the younger participants ($M = 1.80$, $SD = .62$), with a mean difference of .5, which was not a significant result ($t = -1.24$, $DF = 10$, $p < .261$). The analysis also showed that the older group of participants generated more elaborated ideas ($M = 16.80$, $SD = 7.79$) than the younger participants ($M = 7.9$, $SD = 4.31$) a mean difference of 8.94 which was statistically significant ($t = 2.33$, $DF = 10$, $p < .042$).

Table 9.3: Frequency and length of ideas: younger vs. mature participants

Treatment	Mature group M(SD)	Younger group M(SD)	T	DF	p <
Idea frequency	1.30(.77)	1.80(.62)	-1.24	10	.261
Idea length	16.80(7.79)	14.74(4.31)	2.33	10	.042

Rate of idea contribution. The data from five sessions, for which cycle duration times taken from the video record, were analysed to determine the speed of idea contribution. The results are displayed in Table 9.4. The groups generated from six to 20 ideas per minute ($M = 11.6$ ideas, $SD = 6.1$), or one idea every 3 to 12 seconds. Year 12 history, the slowest group, produced only 6.6 ideas per minute.

Table 9.4: Rate of idea generation

Session	Ideas per minute
Year 8 textiles	20.3
Year 8 cloning	15.5
Seniors	8.1
Year 12 cloning	7.2
Year 12 history	6.6
$M = 11.6, SD = 6.1$	

Concept generation, sharing and knowledge building

In order to understand how the participants created and developed new concepts, six sessions were analysed using social network analysis software - the facilitator group, Year 12 history, Year 12 cloning, Year 8 feedback, Year 8 cloning and Year 8 textiles. The analysis focused on what types of questions or activities contributed to the formation, sharing and adoption of concepts and whether some participants played a greater or lesser role in the process. Three analyses were conducted as follows:

- **2-mode network analysis** explored the relationships between the type of question or activity and the structure and flow of the “written speech” discourse.

The structure of the discourse was represented as two nodes comprising the participants (red circles) and concepts (blue squares) numbered in sequential order linked by edges (arrows). The analysis considered the types of question that were asked - closed questions, open-ended discussible questions and Bloom's taxonomic type – to determine whether this led to different patterns of interactions between the participants, including the formation of cliques around single concepts or clusters of concepts.

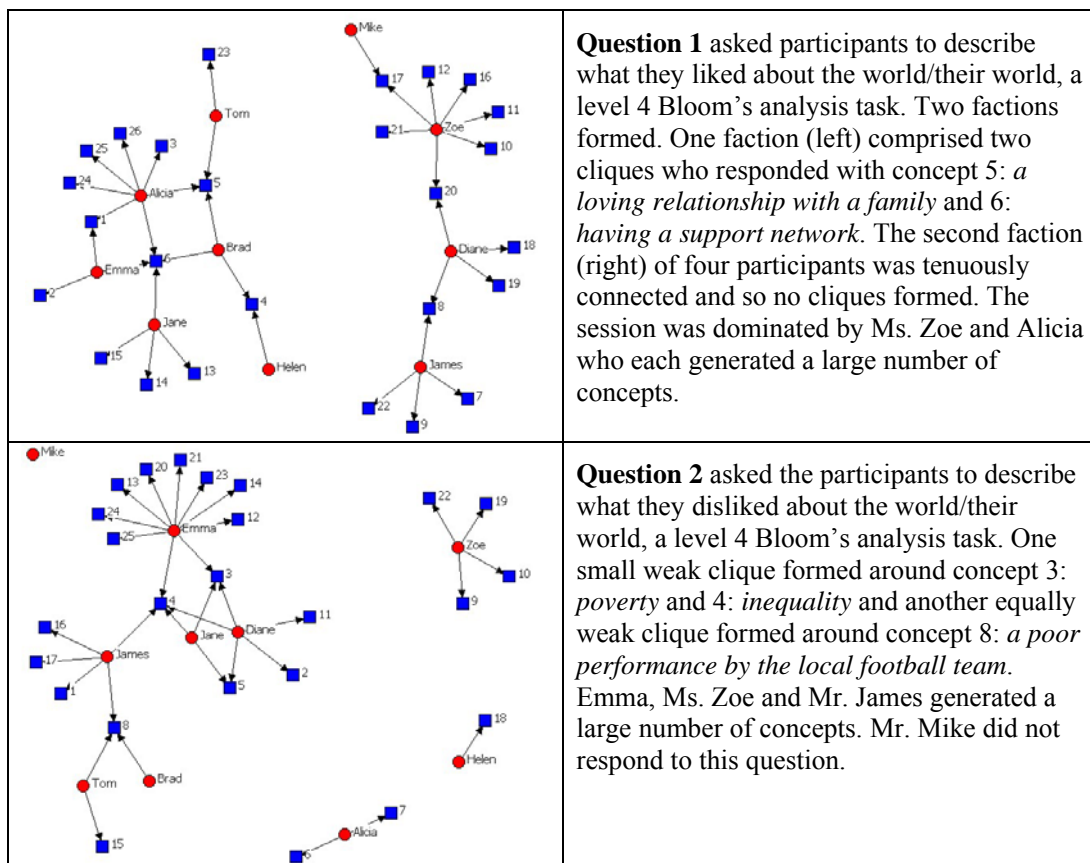
- **Directed graphs analysis** was used to determine whether the participant interactions in the form of “written speech” (Moro, 1999) “speech acts” (Losada, 2002) were sufficiently cross-connected and dense for a “large component” to form (Erdos & Renyi, 1959; Kauffman, 1995; Newman, 2002) consistent with a change in the state of the system, which occurs when the ratio of edges to nodes exceeds 0.5 (Kauffman, 1995, p. 57). The discourse was represented as nodes which comprised numbered concepts in sequential order (blue circles) and participants (red, black and grey circles). Participants linked to one other participant, referred to as a 2-core network, were displayed in red. Participants connected by two links, referred to as a 3-core network, were displayed in black. Participants joined by three links, referred to as 4-core networks, were displayed in grey. Arrows show the direction of adoption of each concept.
- An analysis of the directed graphs for four entire question sequences – the facilitators group, Year 12 history, Year 12 cloning and Year 8 feedback - was undertaken to determine whether some participants were more likely than others to be **concept generators** in the manner of Roger's (1983) innovators or Gladwell's (2002) salesmen or **adopters** in the manner of Roger's (1983) early/late adopters or Gladwell's (2002) mavens.

Facilitators group social network analysis

The social network analysis of the five activities from the facilitators session, which comprised three teachers and seven students, revealed an overall pattern of weakly connected discourse. The session comprised a three-question model decision-making meeting and two feedback questions about how the team learning system functioned. The warm-up questions were excluded from the analysis.

2-mode network analysis: The 2-mode social network analysis of the facilitators group interactions showed some participants generated a large number of ideas but remained weakly connected to others as might occur in an unstructured discussion, while at other times, the participants coalesced into small cliques around one or more concepts, which seems to indicate that some, but not much, group development took place. The disconnected and tentative nature of the group discourse was not surprising as this session was unfamiliar territory for both the teachers and the students. On this occasion, the teachers and the students came together for a common purpose, on a relatively equal footing, to be trained as facilitators. The considerable power difference between them, especially in a traditional school setting, could have contributed to the uncertainty.

Figure 9.2: 2-mode network graphs for the facilitators group session

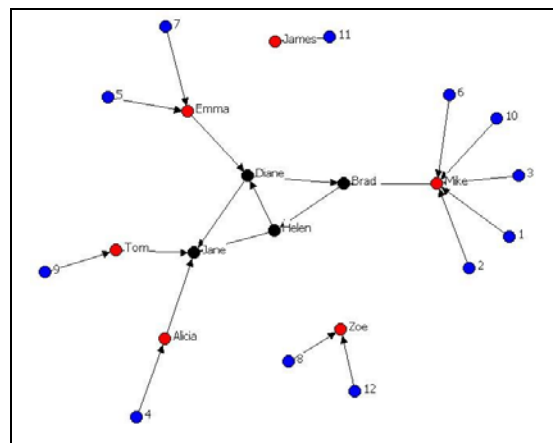


	<p>Question 3 asked the participants to describe what they could do to change the world or their own world, a level 6 Bloom's judgment/decision-making task. The participants formed into two small cliques around concepts 1: <i>provide more funds for medical research or cures for diseases</i> and 2: <i>support a charity</i> involving just five weakly connected people. Although this was a convergent question, the small size of the group, the diversity of interests and power differences may have contributed to the low level of interconnectivity.</p>
	<p>At Question 4, the first of the two knowledge-building activities, the participants were asked to identify and describe the differences between the team learning session and a conventional lesson, a level 5 Bloom's synthesis task. The responses resolved into two cliques. One was a well-connected group of five participants focused on the concept, 2: <i>everyone was listened to or heard</i>, and the second, but weakly connected group focused on concept 8: <i>a higher level of engagement or contribution</i>. There were numerous dissociated concepts typical of a divergent question.</p>
	<p>The size of cliques reached a peak at Question 5, a level 5 Bloom's synthesis task that required the participants to describe what the facilitator did or said to coordinate the session. There were two strongly connected cliques. One group of six participants said 5: <i>the facilitator gave clear instructions what to do</i> and a smaller group of five contributed 4: <i>the facilitator allocated time for each task or stage of the task</i>. The numerous outliers and dissociated concepts reflect a divergence of opinions, a wide concept field or limited knowledge about the topic.</p>

Directed graphs analysis. The directed graphs analysis of the facilitators group discourse sequences for each of the five cycles confirmed that the group remained poorly connected throughout the entire session. The network diagrams for each of the cycles are shown in Appendix V, Figure 1 (see page 440). Participants tended to generate concepts in isolation from other participants and there was little connectivity from one person to another. The group's connectivity peaked when a minority of the

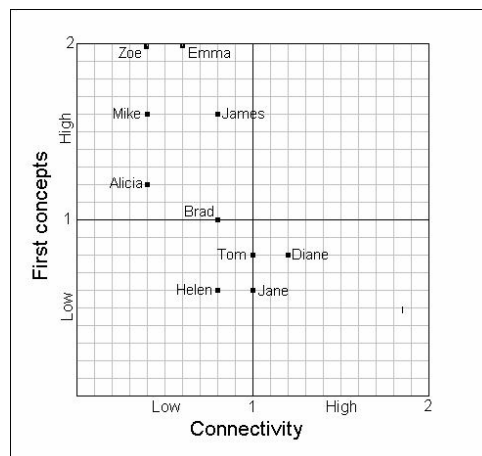
group, David, Jane, Brad and Helen – all students - began to adopt each other's concepts during question 5 as shown in Figure 9.3. This small densely connected 3-core network (black nodes) was consistent with early-stage group development.

Figure 9.3: Directed graphs analysis: Small 3-core network at Question 5



Generators and adopters analysis. The directed graphs for each of the five questions in the session was analysed further to determine which participants were most responsible for the generation or adoption of concepts (see Figure 9.4). The analysis showed that four participants, the three teachers Ms. Zoe, Mr. Mike and Mr. James, and one student, Alicia, dominated the session. Each generated a large number of original concepts. Ms. Zoe was the most prolific generator of concepts, 21 in total, but like Mr. Mike and Alicia, other participants rarely adopted their concepts.

Figure 9.4: First concepts vs. connectivity of the members of the facilitator group



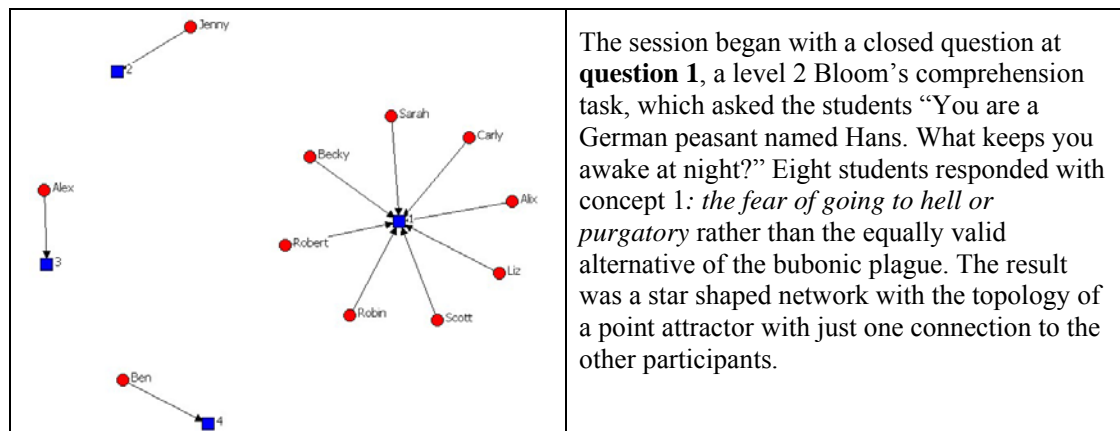
The other members of the group, Diane, Jane, Tom, Helen and Brad – all students - generated few original concepts and tended to be included in one or both of the two cliques that formed, indicating that they were adopters of other participant's concepts. The concept generators in the group performed the role of Roger's (1983) innovators or Gladwell's (2002) salesmen, whereas the participants who were more highly connected tended to fit the profile of Rogers (1983) early/late adopters or Gladwell's (2002) mavens.

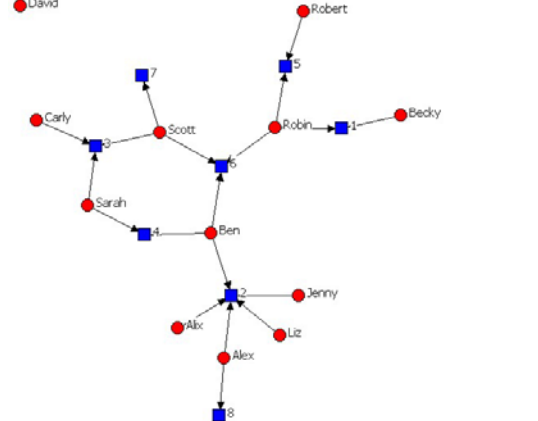
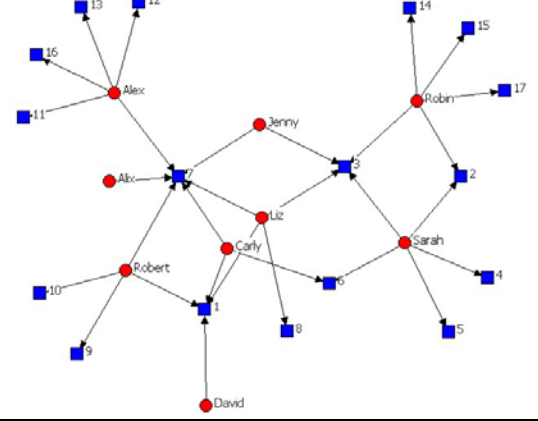
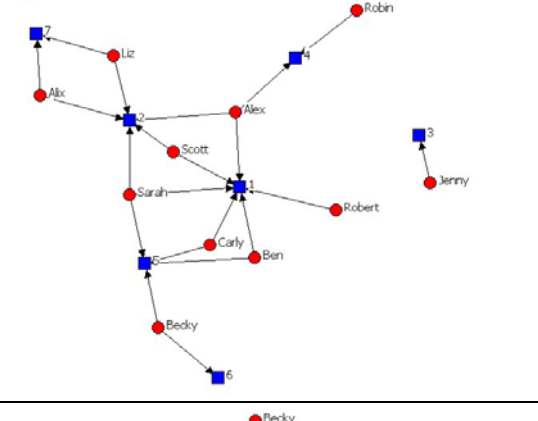
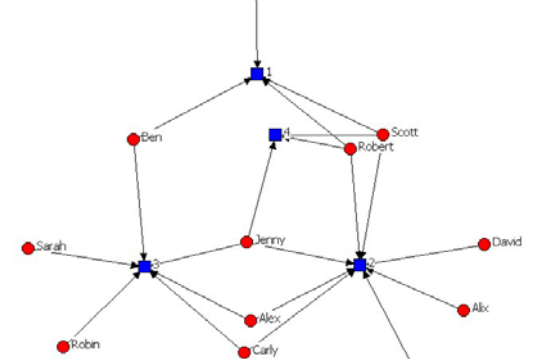
Year 12 history social network analysis

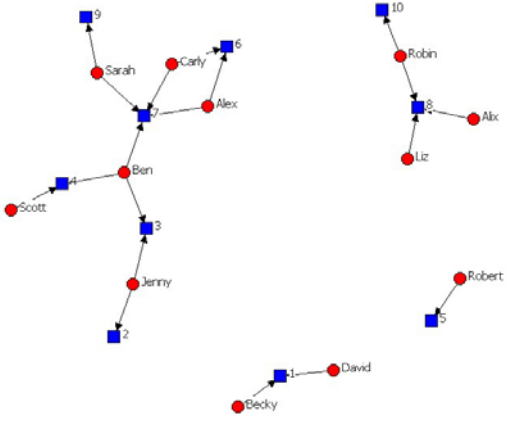
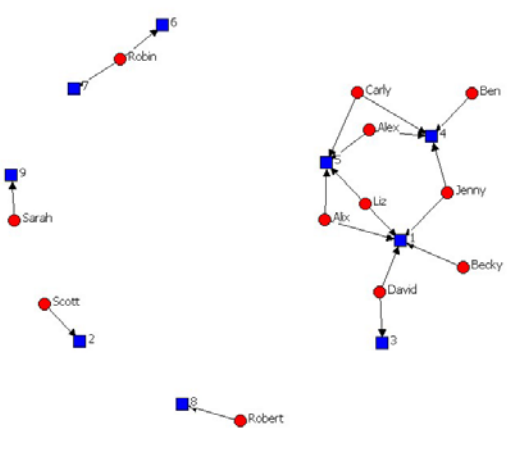
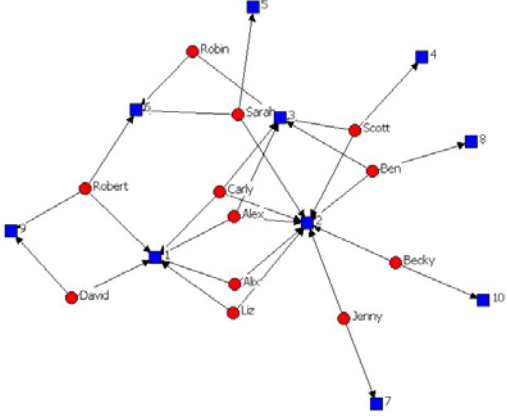
The social network analysis of Year 12 history activity revealed a variety of discourse patterns that appear to be associated with different types of questions. The session comprised 12 questions that explored the Reformation in the Middle Ages. The warm up questions and two questions with missing data were excluded.

2-mode network analysis. The 2-mode network analysis revealed three interaction patterns, a star-shaped formation consistent with closed questioning at question 1, scattered networks indicative of divergent opinions or lack of knowledge of a topic at questions 6 and 7, and several well-connected networks at questions 3, 5 and 8, indicative of developing consensus within the group, or early stage team formation.

Figure 9.5: 2-mode network graphs for the Year 12 history session



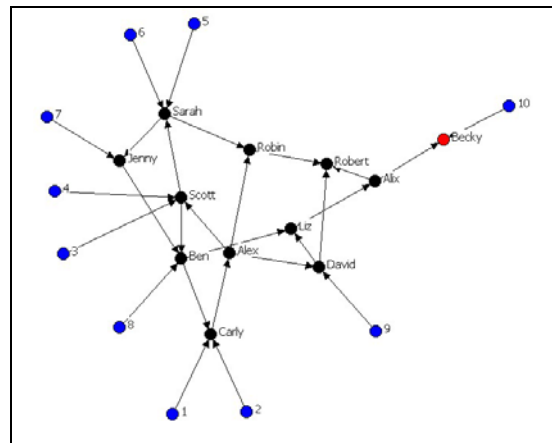
	<p>Question 2, a level 4 Bloom’s analysis task, asked the students “what do you feel about the local Parish priest Porrick? Three cliques developed, each of which missed the main point, that the priest was frequently drunk. One clique of five students focused on 2: <i>the priest was never at the church</i>, a clique of six cited concept 3: <i>not a good representative of the church</i> and a clique of three focused on 6: <i>a womanizer, sleeps around</i>. One of the students, David did not contribute.</p>
	<p>The responses to question 3, a level 4 Bloom’s analysis task, “You are writing for the Catholic Chronicle, describe your ideal service” were concept 2: <i>spoken in latin</i> supported by six students and concept 5: <i>delivered by a priest who is present</i>, which was supported by four students and 3: <i>God’s teachings</i> supported by four students. This graph shows that the participants generated between three and five concepts each, many the same, so there was considerable potential for the discourse streams to intersect.</p>
	<p>Question 4, a level 6 Bloom’s, synthesis task, which has many of the features of a Level 1 knowledge reproduction task, asked the participants to “write a rhyming poem criticising the conduct of the papacy” achieved a trivial result which contributed little to the student’s understanding. There were three cliques clustered around concept 1: <i>that Pope Alexander was “on the nose” with lay people</i> supported by six students and 2: <i>the priests were womanizers</i> supported by five students.</p>
	<p>The student responses to question 5, a level 2 Bloom’s comprehension task, “You are Pope Alexander, what is the most important thing in your life?” were highly interconnected, with a clique of eight participants contributing concept 2: <i>the pope’s children</i>, a clique of six who contributed concept 3: <i>power</i> and two cliques of four participants each clustered around concept 1: <i>money</i> and concept 4: <i>women</i>. The lack of outliers and high interconnectivity between the cliques appears to be consistent with emerging consensus.</p>

	<p>Question 6, a level 2 Bloom’s comprehension task, “Which living or dead people do you, Pope Alexander, most despise?” resulted in the formation of two small cliques and the generation of a large number of outliers. One clique of four students clustered around concept 7: <i>non-catholics</i> and a clique of three students supported concept 8: <i>everyone</i>. Most of the outliers were generated prior to the formation of the two cliques, which suggests that the students were struggling to recall the “correct” response, and were probably guessing.</p>
	<p>Question 7, a level 2 Bloom’s, comprehension task, “What have been the toughest challenges for the Papacy over the last two hundred years?” generated three overlapping cliques, one of five participants focused on concept 1: <i>the great schism</i>, four participants focused on 4: <i>the emergence of rival religions</i> and four participants who contributed 5: <i>fresh ideas</i>. The three cliques represented just half the class. The other class members contributed widely divergent concepts which no other members of the group adopted, possibly because the concepts were regarded as either irrelevant or incorrect.</p>
	<p>Question 8, a Bloom’s level 6 decision-making task, asked the students to write a 50-word summary of the achievements of the papacy. Four cliques, the largest being nine persons focused on concept 2: <i>the authority of the church teachings</i>, concept 1: <i>the church survived the great schism which is now over</i>, five focused on concept 3: <i>the threat of going to hell/purgatory</i> and two smaller cliques. The response pattern indicates a high level of consensus around at least one concept, with developing consensus around two other concepts.</p>

Directed graphs analysis: The analysis of the sequence of the contributions using the directed graphs approach (see Appendix V, Figure 2, page 441) revealed 3-core networks that developed during five of the eight question cycles, in which two ties connected the participants. A large core (black nodes) developed at question 8 (see Figure 9.6) in which eleven of the 12 participants were connected by two ties. This is

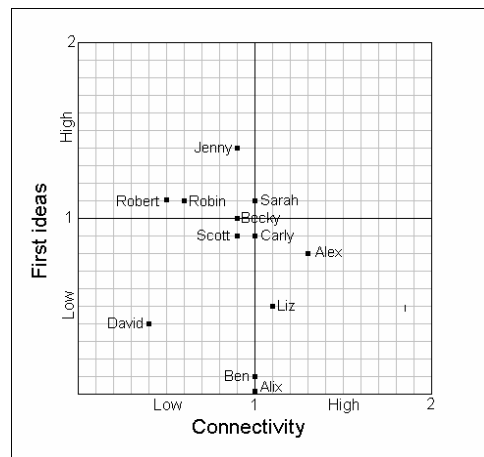
indicative of both a moderately high level of cross connectivity in the group's discourse and a high level of consensus. The cross-connected networks developed when there were multiple discourse threads and the participants were influenced by more than one of their peers.

Figure 9.6: Directed graphs analysis: Large 3-core at question 8



Generators and adopters analysis: The further analysis of the directed graphs data for the entire sequence of seven questions of Year 12 history (see Figure 9.7) showed that Jenny was consistently the first to contribute concepts, but was only marginally more productive than a group of six of the students, whose scores were clustered around the intersection of the x and y axes.

Figure 9.7: First concepts vs. connectivity of Year 12 history



Sarah, Becky, Carly, Scott, Robin and Alex, who were moderately productive first concept generators, were also involved in at least half of the discussion threads.

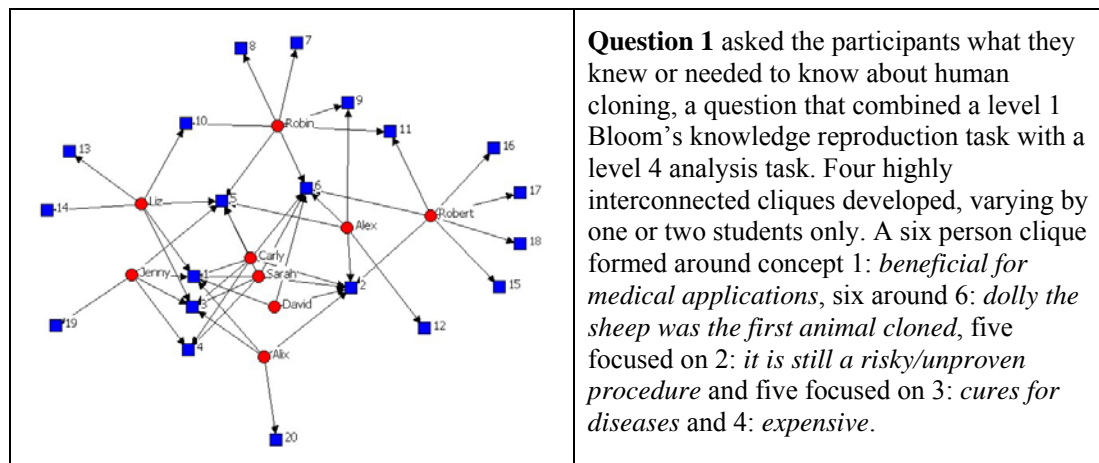
Alex was the most connected but only marginally more so than the other participants. Three poorly connected participants, Alix, Ben and David were rarely the first to initiate an idea. David, who scored low on both the connectivity and concept generation scales, was usually the last person to contribute, or had little to contribute.

Year 12 cloning social network analysis

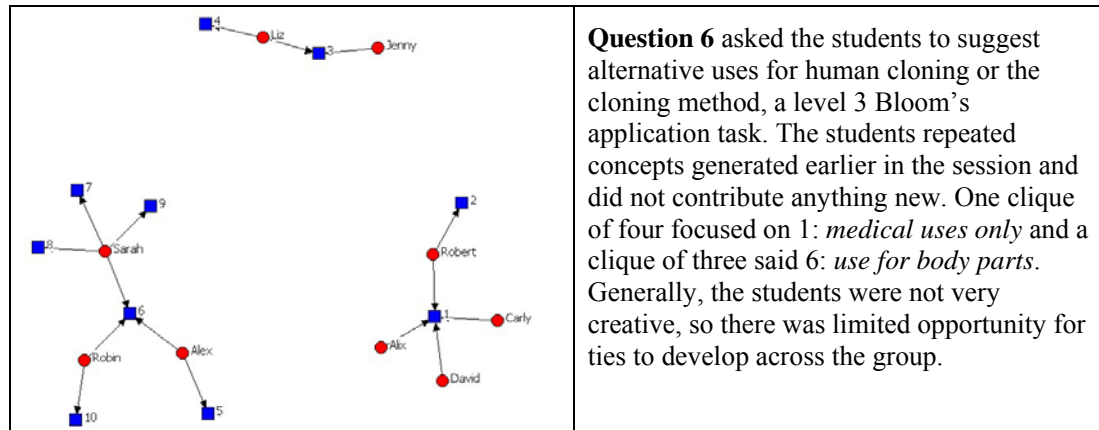
The social network analysis of the Year 12 cloning activity showed that the group was highly cross-connected at the start of the session, but their discourse became more diffuse as the session progressed. This was probably partly due to the researcher asking a pointless question requiring a yes-no answer with no elaboration (as reported in Chapter 8, pages 282-283) followed by a divergent question at the end of the session. Six questions were analysed. Two voting activities were excluded from the analysis.

2-mode network analysis. The analysis of the Year 12 cloning question sequence revealed a variety of patterns (see Figure 9.8) including highly connected networks at questions 1 and 3 that had the features of an emerging large component, a star network at question 5, similar to the star network in the Year 12 history session (see page 327), also in response to a closed question, and the formation of distinct cliques at question 2 and 4, where there were clear differences of opinion.

Figure 9.8: 2-mode network graphs for the Year 12 cloning session

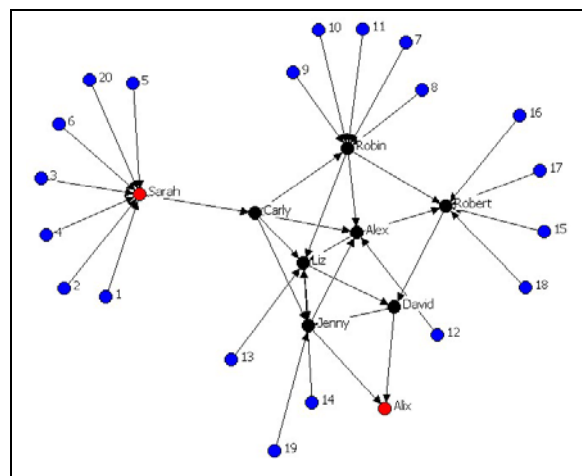


	<p>Question 2 asked the participants to describe the benefits of human cloning, a level 4 Bloom's analysis task. Two separate factions emerged. In the largest faction, a four-person clique formed around concept 1: <i>offers cures for diseases</i> and a three-person clique focused on concept 14: <i>for harvesting body parts</i>. The students contributed a large number of outlier concepts relevant to the discussion, but, typical of divergent questions, few of the concepts were adopted by others.</p>
	<p>Question 3 asked participants to describe the dangers or difficulties with human cloning, a level 4 Bloom's analysis task. Three overlapping cliques formed. A clique of six formed around concept 7: <i>scientists overstepped what was morally appropriate</i> and two small cliques each with four members focused on 3: <i>possible discrimination against clones</i> and 1: <i>uncertainty about the safety of the method</i>.</p>
	<p>Question 4 asked the participants to express how they felt about human cloning, a level 6 evaluation task requiring the students to make judgments. The group split into two factions. In one faction (left), a clique of four students supported concept 2: <i>there were many problems to be solved</i>, three students supported 1: <i>cloning is unethical</i> and three students responded with 3: <i>a qualified yes, provided safeguards were put in place</i>. The second weakly connected faction (right) lacked cross-connectivity.</p>
	<p>Question 5 was a closed question that resulted in the formation of a star-shaped network indicative of closed questions. Six members of the group contributed 1: <i>yes</i>, for which there was no need for discussion or elaboration. Although the question was ostensibly a level 5 Bloom's evaluation task because it asked participants to make judgments, it was trivial because it did not ask the participants to give reasons for their opinions.</p>



Directed graphs analysis. A directed graphs analysis of the Year 12 cloning session (see Appendix V, Figure 3, page 442) showed some evidence of group development, including high levels of cohesion between eight members of the group at the beginning of the session. However, the cohesion disintegrated as the session progressed, when the group split into two factions. The division occurred at question 3 when the participants were asked how they felt about human cloning. The division developed further when the facilitator (the researcher) asked a pointless closed question 5, about whether they felt strongly about their opinion, which reinforced their positions. The session concluded with a divergent question 6, which ensured that a rift persisted, rather than a more appropriate question which should have asked the group to reach a joint decision and justify their position.

Figure 9.9: Directed graphs analysis: Large 3-core at question 1

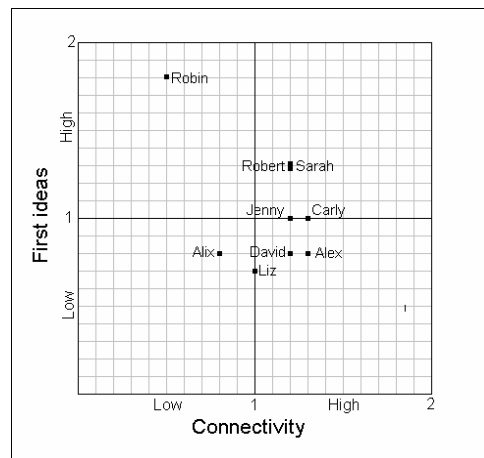


At question 1, eight of the 11 members of the group were connected by two ties into a 3-core network (see Figure 9.9). Three members of the group, Sarah, Robin and

Robert generated a large number of ideas before any other participants, and although Robin and Robert were well connected to the remainder of the group, Sarah remained isolated. Sarah is the same student who preferred to work alone, as reported in Chapter 7 (see page 248). Small 3-core networks formed at questions 2, 3 and 4 which may be indicative of early stage group development. There was however, no cross-connectivity at question 5, a closed question, or question 6, a creative divergent question, where the participants offered different opinions.

Generators and adopters analysis: The directed graphs of the Year 12 cloning session were analysed further to determine whether there were any differences between the concept initiators and the concept adopters. Figure 9.10 shows that one participant, Robin, generated many more original concepts than others in the group and could be regarded as an innovator (Rogers, 1993) or a Gladwell's (2002) salesman. Sarah and Robert were concept generators and were moderately well connected.

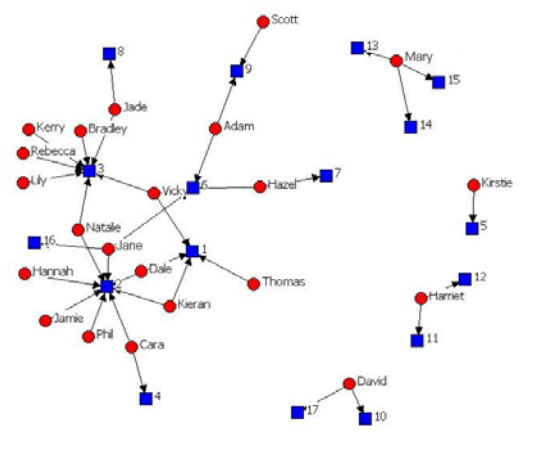
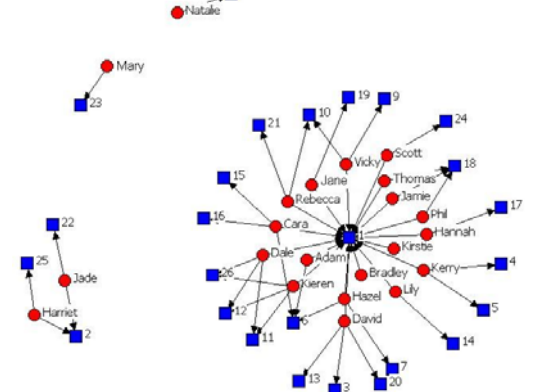
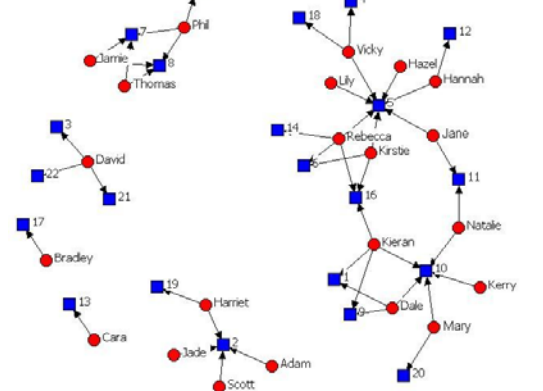
Figure 9.10: First concepts vs. connectivity of Year 12 cloning

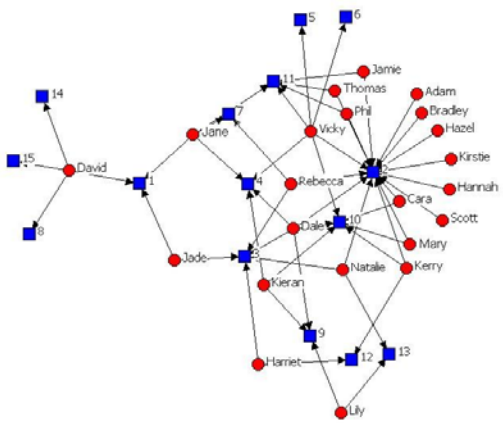
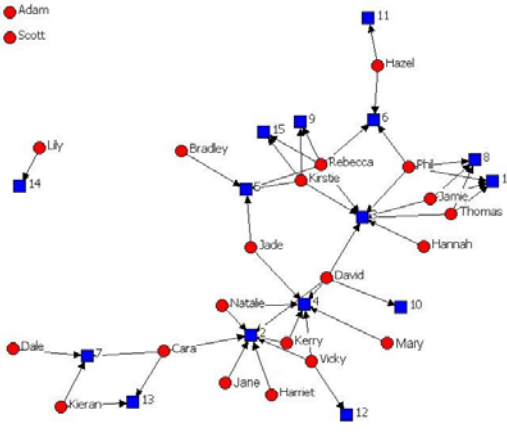
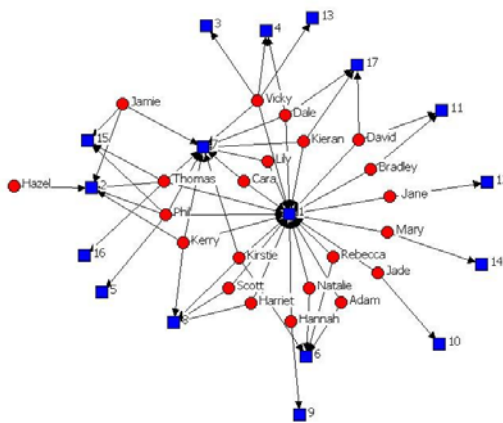


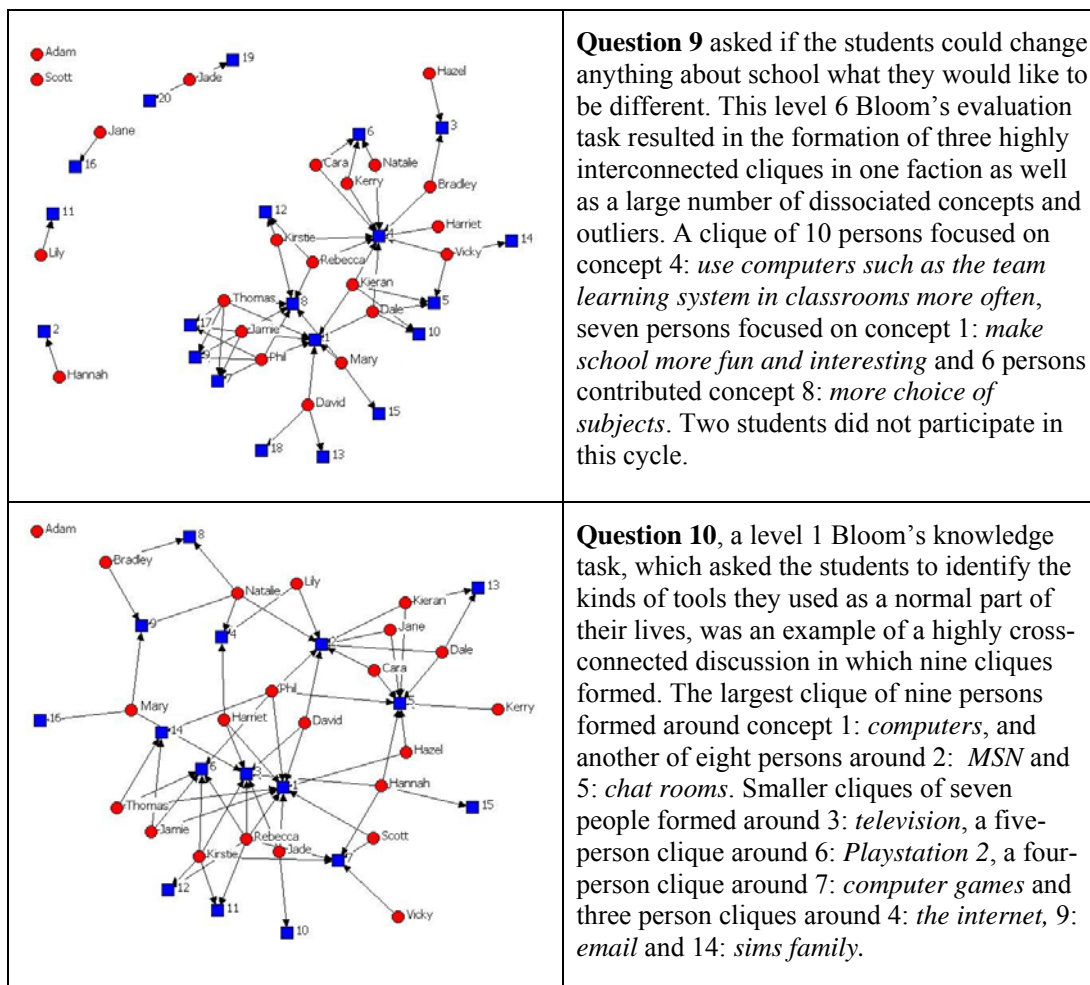
The majority of the students were clustered around the intersection of the x and y axes both as moderate generators of first concepts and adopters of concepts. David played a more active role in the cloning session than he did in the Year 12 history session.

Year 8 feedback social network analysis

The first ten questions from the Year 8 feedback session were selected for social network analysis, which revealed a high level of cross-connection in some of the sessions consistent with an emerging large component. There were also indications of a

	<p>Question 3 asked students “what did you not like about the session with your teacher, what could have been improved?” This level 4 Bloom’s analysis task resulted in the formation of four small cliques in a single cluster as well as numerous isolates. Two cliques of seven students formed around concept 3: <i>there were not enough keyboards for everyone</i>, and another clique of seven around 4: <i>everyone should have their own keyboard</i>. Four person cliques formed around concept 2: <i>nothing much was wrong about the activity</i> and concept 5: <i>the room was too small and cluttered</i>.</p>
	<p>Question 4 was a closed question with a supplementary open-ended level 4 Bloom’s analysis component. When asked, “would you have liked to facilitate the session? Give your reasons” an 18 person star-shaped clique formed around 1: <i>Yes</i>. The students offered numerous elaborated and diverse responses. Some students were not connected to the main cluster, indicating they had a different opinion, or were uncertain about how to respond to the question.</p>
	<p>At question 5, the students were asked, “When you work and learn this way, how does it change your role and the teacher’s role? This level 4 Bloom’s analysis task generated five cliques, a seven-person clique at 5: <i>less burden or work for the teachers</i>, a Five-person concept 2: <i>not much</i>, which was isolated from the main cluster, and a 3-person clique at concept 17: <i>less work for the teacher to control the class</i>.</p>

	<p>Question 6 asked the students to reflect on “What are the rules for the normal classroom? What is expected of you?” This level 4 Bloom’s analysis task resulted in the formation of one very large star-shaped clique and six much smaller cliques. The largest clique of 16 persons formed around concept 2: <i>work silently</i>. Six persons supported concept 10: <i>listen to the teacher</i>. Five persons supported concept 3: <i>raise your hand for permission to contribute or speak</i> and a different clique of five persons supported concept 11: <i>do not misbehave or mess about</i>. Four person cliques formed around concept 4: <i>do not speak when others are speaking</i> and three person cliques around concept 1: <i>do not raise your voice</i> and 9: <i>listen attentively to the teacher</i>.</p>
	<p>When asked at question 7 to describe the rules for the team learning system classroom, a level 4 Bloom’s analysis task, seven cliques formed, which stretched as filaments across the network in a series of cliques with weak ties. Seven person cliques formed around concept 2: <i>sensible ideas only</i> and 3: <i>no silly ideas allowed</i> and a six-person clique at concept 4: <i>everyone is able to/expected to have a say</i>. Small cliques formed around concept 5: <i>say what you think when you want</i>, 1: <i>no poking fun at people</i>, 6: <i>encouraged to talk, share and discuss ideas</i> and 8: <i>share the keyboard with your partner</i>. Two students did not participate in this cycle.</p>
	<p>Question 8 asked which sets of rules – the normal or team learning system classroom – was closest to the culture that young people experienced in their lives and to explain how it was different. This level 5 Bloom’s evaluation task resulted in three cliques. A 20 person clique formed around concept 1: <i>the team learning system culture was closest to the student culture</i>, concept 6: <i>because it allowed everyone to share ideas</i> and concept 8: <i>because everyone gets their turn</i>, a 10 person clique focused on concept 7: <i>everyone was able to enjoy themselves</i>, and a five person clique focused on concept 2: <i>it was new or novel</i>.</p>

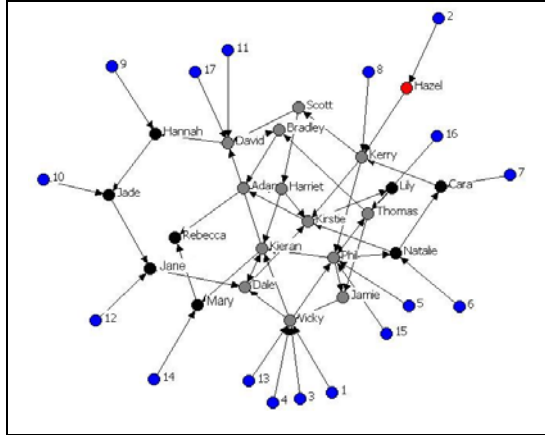


Directed graphs analysis: The directed graphs analysis of the Year 8 feedback discourse showed there was a high level of cross-connectivity. Three-core networks developed during every cycle, where two ties linked participants’ concepts (see Appendix V, Figure 4, page 443).

A very large 4-core network developed at question 8 (see Figure 9.12), where 13 of the 22 participants were connected by three ties (grey nodes), and eight participants were each linked by two ties (black nodes). Only one person, Hazel, who was one of the main concept generators, was excluded from the core. This is the best evidence from the study of the formation of a large component (Newman, 2002). The ratio of nodes to edges clearly exceeds 0.5 at which point a large component forms and the system changes state to a new level of order. The high level of connectivity is also consistent with the findings of Losada (1999) who found that a change in the state of the relationships between the participants, consistent with team formation, occurs when the

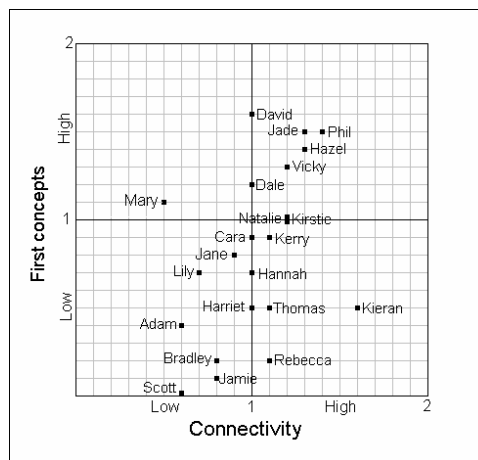
connectivity in a group as measured by the number and strength of speech acts between the members, becomes extremely dense.

Figure 9.12: Directed graphs: 3-cores and 4-cores of question 8



Generators and adopters analysis: The directed graphs data for Year 8 feedback was subjected to further analysis to determine whether there was any differences in the concept generation and adoption activity of the participants. The analysis (see Figure 9.13) showed that five participants, Dale, David, Hazel, Jade and Vicky, were the first to initiate concepts more often than other participants, and were also well connected to others, which suggests they were influential in both the knowledge creation and adoption processes.

Figure 9.13: First concepts vs. connectivity of Year 8 feedback



Another group of students, Kieren, Rebecca, Thomas and Kerry were also highly connected with others, but generated few first concepts, a group that could be classed as

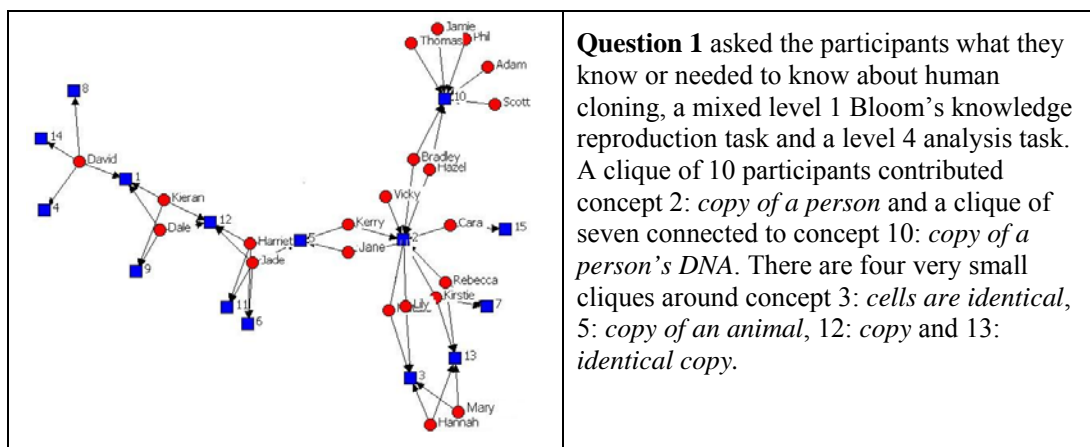
mavens (Gladwell, 2002) or adopters (Rogers, 1993). Adam, Bradley, Jamie and Scott contributed few first concepts and were poorly connected which suggests they were less engaged than the remainder of the group, or less able to respond to the questions.

Year 8 cloning social network analysis

The social network analysis of the Year 8 cloning session exhibited a range of interaction patterns that reflected the different stages of the knowledge creation process, commencing with divergent thinking, progressing through a stage where concepts were resolved into a model, and concluding with a decision-making step.

2-mode network analysis. The 2-mode network analysis of the Year 8 cloning session (see Figure 9.14) revealed a variety of patterns, including distinct cliques at questions 2 and 5 indicative of a split opinion in the group, long filaments connecting cliques at questions 1 and 4 which seem to capture a “linking” process underway in the group as participants from one clique showed interest in and adopted concepts from other cliques, a densely connected network at question 3 indicative of the formation of a large component and a change in the state of the group, and a twin-star shaped split decision at question 6.

Figure 9.14: 2-mode network graphs for the Year 8 cloning session



	<p>Question 2 asked the participants to describe the dangers or difficulties of human cloning, a level 4 Bloom's analysis task. Six cliques developed in two clusters. The large cluster comprised a clique of nine students formed around concept 5: <i>donor organs and body parts</i>, a clique of seven clustered around concept 3: <i>babies for childless couples</i> and a clique of four clustered around concept 9: <i>an end to animal testing, test the clones instead</i>. A 6-member clique formed a separate cluster that comprised concept 1: <i>immortality or live longer</i>, concept 2: <i>cure diseases</i> and concept 4: <i>perfect tissue match of organs to avoid rejection by the body</i>.</p>
	<p>At question 3, the students began to incorporate outlier concepts from earlier sessions. Question 3 asked the participants to describe the benefits or advantages of human cloning, a level 4 Bloom's analysis task. The network has the features of an emerging large component. Five highly connected cliques formed, two each of 18 students. A large clique developed around concept 2: <i>the process could fail and result in deformities</i>, 7: <i>the clone could die during the process</i> and 24: <i>the clone could be treated cruelly if clones were regarded as inferior</i>. The second large clique formed around concept 11: <i>inherited diseases</i>, 16: <i>wrong to use clones for testing</i> and 17: <i>wrong to use for body parts</i>. A small clique developed around concept 13: <i>that the clones could rebel, if treated as slaves</i>.</p>
	<p>Question 4 asked the participants how they felt about human cloning, a level 6 evaluation task requiring the students to make judgments. A large clique of 15 students coalesced around concept 1: <i>should not allow cloning</i>, 2: <i>morally wrong</i>, 3: <i>risky</i>, 6: <i>unacceptable activity</i> and 7: <i>unfair on the clones</i> and second cluster of 10 students. The second large clique formed at concept 4: <i>cloning should proceed</i>. Three smaller cliques separate from the main cluster were five students who contributed 11: <i>could use the clones for experiments</i> and a clique of four people who contributed concept 10: <i>clones feelings would be hurt</i>. This graph appears to show a stage of cluster development where participants from cliques holding different opinions, adopted ideas from other cliques.</p>

	<p>Question 5 asked the students to suggest alternative uses for cloning, a level 5 Bloom's synthesis task. There were four widely dispersed small cliques. Four people contributed concept 1: <i>no idea</i>, five contributed 3: <i>find a cheaper and more reliable process</i>, 4 contributed 5: <i>clone only smart people</i> and six contributed 13: <i>adopt a health-oriented approach to cloning</i>.</p>
	<p>Question 6 asked the students to decide whether to proceed with human cloning and to provide justification for their decision, a level 6 Bloom's evaluation task. Although the question has the topology of a simple yes-no question, the supplementary justification component raised the complexity of the task. Two large cliques formed; representing 13 student views around concept 1: <i>no</i> and 8 views clustered around concept 7: <i>yes</i>. Radiating out from the star-shaped networks were as many differing opinions justifying the decision, as there were students. There was little cross-connectivity between the concepts. The justifications built on concepts that were developed earlier in the session.</p>

Directed graphs analysis. The directed graphs analysis for the Year 8 cloning session could not be carried out because the data did not accurately identify all of the participants in two of the cycles.

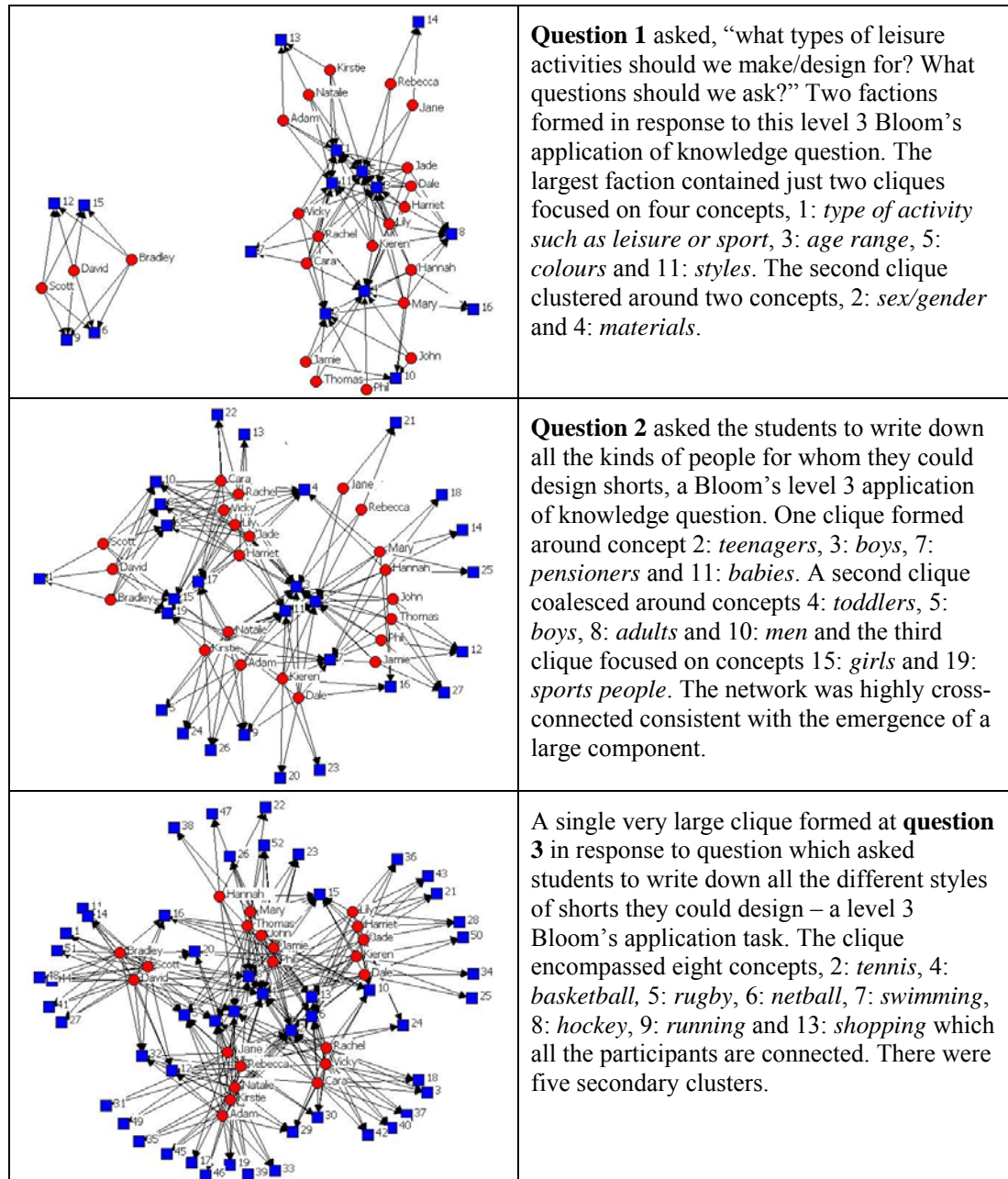
Generators and adopters analysis. In the absence of the directed graphs analysis for Year 8 cloning, the analysis to determine whether there were differences between concept generators and adopters could not be performed.

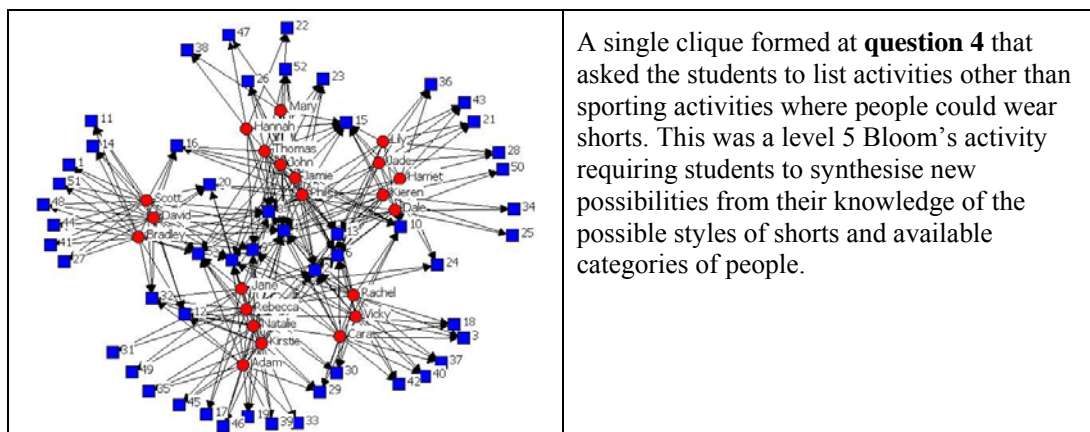
Year 8 textiles social network analysis

Individual data was not available for the Year 8 textiles session which would have allowed a direct comparison with the other sessions. This case has been included because the analysis of the rate of idea generation (see pages 315-320) showed this group appeared to produce a very large number of ideas in a short time, indicative of a runaway reaction. Two warm-up questions were excluded.

2-mode network analysis. The 2-mode network analysis revealed a progressive movement towards a highly connected central cluster of concepts. Figure 9.15 shows the progressive evolution of the network from two distinct factions towards a single clique that has the features of a large component (Newman, 2002) at questions 3 and 4 where the concepts in the centre of the graph are the group’s “shared knowledge”.

Figure 9.15: 2-mode network graphs for the Year 8 textiles session





Directed graphs analysis: Complete individual data was not available for this session that would have allowed a detailed analysis of the roles that participants played and whether 3-core or 4-core clusters developed.

Generators and adopters analysis. In the absence of the directed graphs analysis for Year 8 textiles, the analysis to determine whether there were differences between concept generators and adopters could not be performed.

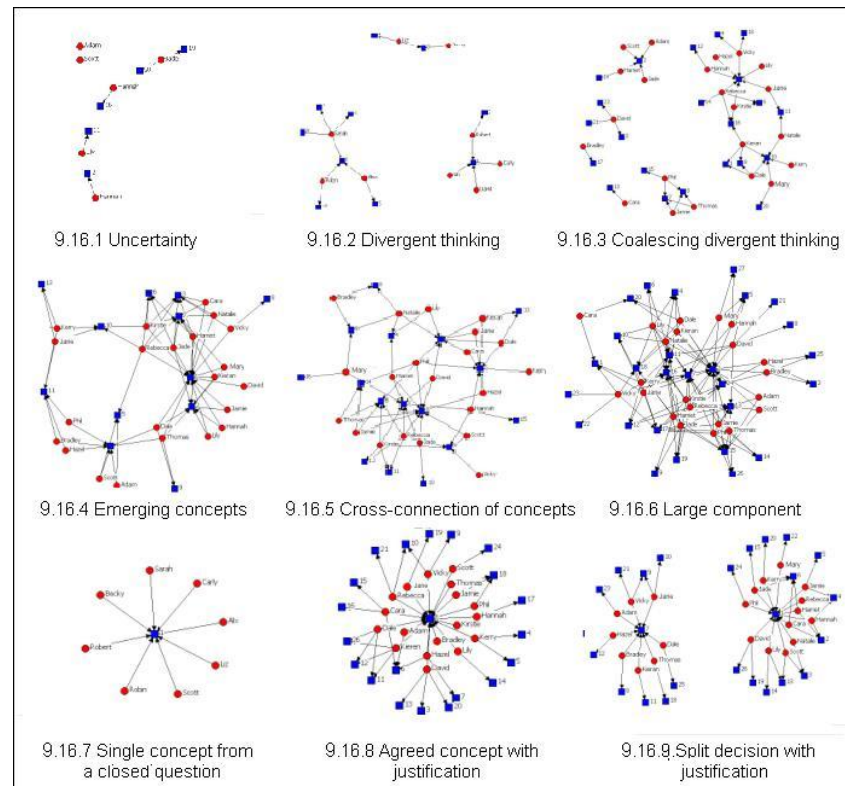
Questions as catalysts for concept generation

A review of all 39 of the 2-mode network graphs revealed a relationship between a pattern of discourse and certain types of questions, as well as a pattern in the concept development, decision making or learning process. A summary of the discourse patterns in shown in Figure 9.16.

Types of questions and graph types. Uncertainty or lack of knowledge in response to any kind of question resulted in the generation of isolated or fragmented responses as shown in Figure 9.16.1. Divergent questions tended to promote diverse clusters of concepts as shown in Figures 9.16.2 and 9.16.3. Open-ended discussible questions, particularly those asking participants to offer explanations, analyze information or construct arguments, which were typical of the mid level Bloom's tasks (level 3 or 4), appear to have stimulated the most responses, as shown in Figure 9.16.5 and 9.16.6. Closed questions, to which there was only one response known to the participants, typical of low-level Blooms knowledge reproduction (level 1) or comprehension tasks (level 2) resulted in a star-network, as shown in Figure 9.16.7. Single star networks with numerous outliers formed when participants reached agreement about an issue and justified their decision with an argument, as shown in

Figure 9.16.8. Double star networks formed when the group split into two factions that supported different points of view as shown in Figure 9.16.9.

Figure 9.16 Summary of the network graphs associated with concept generation



Knowledge creation model and graph types. I have developed a tentative model based on the social network analysis to explain how concepts develop within a group and acquire support. The process begins with a few isolated concepts typical of uncertain thinking (see 9.16.1). Some of the first concepts act as cues or catalysts for the remainder of the group, who then generate similar or related concepts, which then form into isolated clusters typical of divergent thinking (see 9.16.2), and coalesce into larger formations or clusters involving more than one concept (see 9.16.3). At this point, strong support develops for popular, obvious or appropriate concepts within several clusters or factions. Participants from opposing factions then observe novel concepts different to their own thinking and begin to articulate the same or similar concepts. Weak ties develop between the factions (9.16.4). Some of the participants generate “new”, for them, concepts that expand or fill the gaps in the concept field, which also attracts new adherents (see 9.16.5). Eventually, the multiple discussion threads become so highly cross-connected, that a large component (Freeman, 2000; Kauffman, 1995)

forms consistent with a phase transition (see 9.16.6). The cluster of inter-related concepts at the heart of the giant cluster represents the emerging “new” knowledge for the group.

Concepts as catalysts of further concept generation

Although the questions were the initial stimulus or catalyst for the generation of concepts, there was also some evidence that the concepts stimulated the development of additional concepts, via the team learning system screen or in discussion with other participants.

If the questions alone acted as the catalysts for concepts, then unique concepts contributed by only one person should have been evenly distributed throughout the record. If the concepts generated by the participants also acted as catalysts for further concepts, then unique concepts should have been more frequently represented late in each question cycle.

A series of independent sample t-tests was conducted to compare the means of the sequence order of connected concepts, supported by two or more people, with the means of the sequence order of unique concepts contributed by just one person. The analysis was undertaken for each of the five facilitators group questions, the eight Year 12 history questions, the six Year 12 cloning questions, the six Year 8 cloning questions and the 10 Year 8 feedback questions. A summary of the analysis is displayed in Table 9.5. The results of the complete analysis are shown in Appendix VII (see page 446).

Table 9.5 Summary of t-tests of means of isolated and connected concepts

Case	Catalyse ideas (higher)		Do not catalyse ideas (lower)	
	Significant	Not significant	Significant	Not significant
Facilitator	4	1		
Year 12 history	3	4		1
Year 12 cloning	3	3		
Year 8 cloning	4	1		1
Year 8 feedback	7	3		
Total	21	12		2

The analysis showed that the mean of the sequence order of the isolated or unique concepts was higher in 35 of the 39 sessions, of which 21 were statistically significant. This finding supports the observation by Ms. Debbie (see page 234) and Ms. Zoe (see page 244) that concepts, as well as questions, catalyse concepts.

Concept generation and verbal, mathematical and non-verbal skills

To determine whether there was a relationship between concept generation and four school-defined measures of academic ability, five of the 12 sessions - Year 12 feedback, Year 12 cloning, Year 12 history, Year 8 feedback and Year 8 cloning - were subjected to Pearson correlation analysis.

Participant contributions were calculated from the concept analysis. The five measures comprised the number of concepts generated by a participant before other participants in any one question cycle (first concepts), when a participant was the only person to generate a concept during a question cycle (unique concepts), the total concepts contributed by a participant (total concepts), the frequency of first concepts contributed by a participant to a cluster of three or more concepts (maverick concepts) and the frequency of second or later concepts contribute to clusters of three or more concepts (maven concepts).

The school provided a series of individual scores for an attitude to learning rank, verbal ability, quantitative ability and non-verbal ability. The five sessions were selected because they were the only sessions where each unique concept could be attributed to an individual person and data about the participants' academic ability. The attitude to learning rank is a score developed by the school to rank individual student performance. The mean of the scores given by every teacher in the student's current year from 1 to 9 (1 = very poor attitude, 10 = very good attitude to learning) is generally consistent with the student's overall academic achievement. The verbal, quantitative and non-verbal skills data administered by the school for each student via the Cognitive Abilities test (nferNelson, April 2007) in Year 7. A histogram of the consolidated academic scores was created to determine whether the data was normally distributed, as individual data samples were too small (nine data points) for meaningful results. A Pearson correlation analysis was then conducted.

This preliminary analysis suggests there is unlikely to be a relationship between the frequency with which participants generated first concepts or unique concepts and attitudes to learning, verbal ability, quantitative ability and non-verbal ability of the

students. There was no relationship between any of the four measures of academic schools and the frequency of total concepts contributed by participants, or concepts that became supported by cliques of three or more people, or were included in the cliques.

Attitude to learning. A Pearson correlation analysis found no significant consistent correlation between attitude to learning rank of the participants and the frequency of first, unique, total, maven and maverick concepts that each student generated for each of the five sessions that were subjected to the analysis – Year 12 cloning, Year 12 feedback, Year 12 history, Year 8 cloning and the Year 8 feedback. The results are reported in Appendix VI, Table 1, page 444. There was a moderately significant correlation between academic rank and creators of first concepts for the Year 8 cloning session as shown in Table 20, ($r = .466$, $DF = 24$, $p < .05$).

Quantitative ability. The Pearson correlation analysis of quantitative (numerical) skills of the participants and the frequency of first, unique, total, maverick and maven concepts generated by the participants is reported in Appendix VI, table 2, page 444. The analysis showed no consistent significant correlation with one exception, a moderate correlation between quantitative skills and following concepts for the Year 8 cloning session.

Verbal ability. A Pearson correlation analysis between verbal ability of the participants and those who generated the most first, unique, total, maverick and maven concepts showed a significant correlation in just one of the cases, the Year 8 feedback session. The results are displayed in Appendix VI, table 3, page 445. There was a significant correlation between verbal skills of the participants and those who generated first in cluster concepts ($r = .574$, $DF = 22$, $p < .01$) and moderate negative correlation between the verbal skills of participants and those who generated unique concepts ($r = -.466$, $DF = 22$, $p < .05$).

Non-verbal ability. A Pearson correlation analysis found no correlation between non-verbal ability of the participants and those who generated the most first, unique, total, maven or maverick concepts. The results are displayed in Appendix VI, table 4, page 445.

The results tend to indicate that all the participants were active contributors during most of the question cycles, which is consistent with the regularity of participation findings on page 316.

Concept generation and preferences for change or certainty

Kirton (1994) shows that people who are more at home with novelty and change are more likely to play an active role in the process of generating and implementing new ideas. An innovation index based broadly on the Kirton (1994) model (see page 209) was administered to the teachers and students to determine whether there was any difference in the frequency of concepts generated by those who preferred novelty and change compared with those who preferred certainty. The scale ranged from 0 to 10, where 0 = low preference for novelty and 10 = high preference.

Table 9.6: Relationship of concept generation with innovation index

Group		First	Unique	Total	Maven	Maverick
Year 12 Cloning	Correlation	.870**	.935**	1.0**	-.010	.250
	Sig. (2-tailed)	.002	.000	.000	.979	.517
	N	9	9	9	9	9
Year 12 feedback	Correlation	.086	.455	.455	.071	-.290
	Sig. (2-tailed)	.826	.219	.857	.372	.448
	N	9	9	9	9	9
Year 12 History	Correlation	.561	.344	.269	-.028	-.076
	Sig. (2-tailed)	.058	.273	.399	.930	.815
	N	12	12	12	12	12
Year 8 feedback	Correlation	.007	.014	-.189	-.252	.065
	Sig. (2-tailed)	.975	.952	.401	.258	.774
	N	22	22	22	22	22
Year 8 Cloning	Correlation	.067	.016	.007	.034	.204
	Sig. (2-tailed)	.766	.942	.976	.882	.363
	N	22	22	22	22	22
Facilitator Group	Correlation	.366	.232	-.064	-.443	-.647**
	Sig. (2-tailed)	.298	.518	.860	.200	.043
	N	10	10	10	10	10

** Correlation is significant at the .01 level (2-tailed).

A histogram of the consolidated Kirton indices was created which determined that the data was normally distributed, as individual data samples were too small (nine data points) for meaningful results. A Pearson correlation analysis was then conducted to see whether there was a link between higher preference for novelty and participant contribution of first concepts, unique concepts, total concepts, following concepts and first in cluster concepts for each of four sessions - Year 12 feedback, Year 12 cloning,

Year 8 feedback, Year 8 cloning and the facilitators group. These results are shown in Table 9.6.

For the Year 12 cloning session there was a significant correlation between the participant's innovation index and the frequency of generation by participants of first concepts ($r = .910$, $DF = 12$, $p < .01$). There was no correlation between the participant's innovation index and individual frequency of unique concepts ($r = .963$, $DF = 12$, $p < .01$). There was no correlation between the participant's innovation index and the individual frequency of total concepts ($r = 1.0$, $DF = 12$, $p < .01$). For the facilitators group there was a significant correlation between the participant's innovation index and the individual frequency of generation of the first concepts in a cluster ($r = .647$, $DF = 10$, $p < .01$).

In all other cases, there was no correlation between the individual innovation index and the individual frequency of generation of first concepts, unique concepts, total concepts, following concepts and first in a cluster concepts.

The results tend to indicate that most of the participants, no matter whether they preferred change or certainty, were active contributors, consistent with the regularity of participation findings on page 316.

Question types and concept frequency and elaboration

A Pearson correlation analysis was conducted to further explore the apparent relationship between types of questions and participant productivity in terms of idea frequency, idea length and a combined measure of idea contribution (frequency x length of ideas).

Three raters assigned a rank to the 140 questions on a six-point scale based on Bloom's taxonomy (Bloom & Krathwohl, 1956; Limbach & Waugh, 2000). Questions that interrogated the participant's *knowledge* by asking them to recall facts or make lists were assigned a rank of 1. *Comprehension* questions that asked them to demonstrate they understood the informed was given a rank of 2 and questions about the *application* of the information was allocated a rank of 3. Questions that expected students to *analyze* and compare information were given a rank of 4. The highest level thinking skills asking participants to engage in the *synthesis* of ideas and put forward hypotheses was

given a rank of 5 and questions that called for *evaluation* including making judgments and decisions was assigned a rank of 6.

A test of the reliability of the Blooms' scale rank assigned by the three raters showed only moderate agreement between Raters 1 and 2 (Chronbach = .65) and less agreement with Rater 3.

Table 9.7 shows the results of the Pearson correlation analysis of the Blooms' ranks assigned to the questions by each of the raters and the frequency of the ideas generated for each question, the length of the ideas, and a measure of the contribution (frequency x length), and of the participants. For rater 1, there is a significant correlation between the Bloom's rank for each question and the length of ideas ($r = .289$, $DF = 119$, $p < .01$), with the frequency of ideas generated by each participants per session ($r = .333$, $DF = 119$, $p < .01$) and with the contribution (frequency x length) ($r = .445$, $DF = 119$, $p < .01$).

Table 9.7: Relationship of Bloom's type to question length and frequency

Rater		Contribution (Frequency x length)	Length	Frequency
Rater 1	Correlation	.445(**)	.289(**)	.333(**)
	Sig. (2-tailed)	.000	.001	.000
	N	119	119	119
Rater 2	Correlation	.213(*)	.168	.148
	Sig. (2-tailed)	.020	.108	.168
	N	119	119	119
Rater 3	Correlation	.057	.199(*)	-.075
	Sig. (2-tailed)	.538	.030	.419
	N	119	119	119
** Correlation is significant at the .01 level (2-tailed)				
* Correlation is significant at the .05 level (2-tailed)				

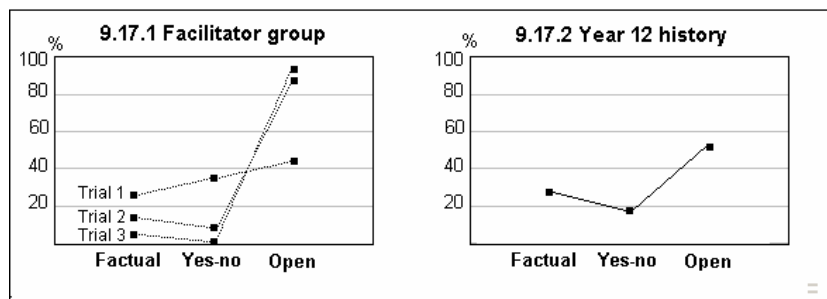
The analysis of the Bloom's rank coded by Rater 2 shows a moderate correlation between the Blooms rank for each question and the participants contributions ($r = .213$, $DF = 119$, $p < .01$) but no statistically significant correlation between the rank and length or frequency of ideas. There was a moderate correlation for Rater 3 between the rank of the question type and the frequency of the ideas ($r = .199$, $DF = 119$, $p < .05$) but no statistically significant correlation between the rank and length of ideas or contribution. The results are interesting, sufficient to justify further investigation.

Teacher and student question crafting abilities

An analysis of the types of questions generated by two different groups – the facilitators and the Year 12 students – was undertaken to determine whether there was a “culture of closed question asking” in the school. The purpose of the analysis was to confirm the findings of chapter 6 that some of the teachers (Mr. David, p. 245; Mr. James pp. 259-260; Ms. Zoe, p. 269-270) were unable or reluctant to craft or ask open-ended discussible questions although they said they knew the difference. Both Miettinen (1999) and Baumfield and Oberski (1998) show that schools have a culture of closed question-asking to assess how well students memorize information and to control student behaviour.

The researcher conducted the first question writing activity with the facilitators group as part of the training program. The participants comprised a mix of teachers and senior students, who were asked to construct a sequence of open-ended questions for their first solo meeting.

Figure 9.17: Attempts at constructing open-ended questions



The participants made three attempts to craft open-ended, discussible questions. At the first attempt, Trial 1 (see Figure 9.17.1), 25 percent of the questions were closed questions, such as “What is the main ingredient of Guacamole?”, 33 per cent sought a yes-no response such as “Do you believe it should be compulsory for Years 7-11 to wear uniforms?” and 42 percent were open and discussible, such as “How could we create a more altruistic society?”, although all of the questions lacked scaffolds. At the second attempt, Trial 2, 78 percent of the questions were discussible, and at the third attempt, Trial 3, 94 percent were discussible. A second question crafting activity (see Table 9.17.2) was conducted by the researcher with the Year 12 history group about a history topic, the Second World War. Thirty percent of the questions crafted by the students called for yes-no responses such as “Was the Sherman tank the best?” and “Did

Hitler's power hungriness lose him the war", 19 percent involved the recall of memorized information such as "Why was Hitler able to come to power?" and "Why did Germany invade Russia not England?" and 52 percent were discussible, and called for the re-interpretation of the information in new contexts, "What would have happened if Germany not England had won the war?" and "Why has Hitler such a bad reputation?"

Participant engagement and enjoyment

Studies of student engagement and attention (Hidi & Harackiewicz, 2000; Eccles & Wigfield, 2002) have found that teenagers are increasingly bored, lack motivation and feel disconnected with school. Sousa (1998) says the problem is that secondary school classrooms are dull, non-engaging places where students have difficulty focusing for extended periods and are easily distracted.

To determine the extent to which participants were bored or engaged by the team learning activities, participants completed a questionnaire before (*Flowbefore*) and after (*Flowafter*) each session to measure eight aspects of the flow experience (Csikszentmihalyi, 1975). Flow is a state of engagement and enjoyment midway between states of boredom and anxiety. Flow occurs when the match between challenge and skills is high, and there is rapid feedback.

The measure of the group flow was calculated by taking the mean scores for seven of the eight aspects of flow across each group. The analysis of the modified consolidated Flowbefore and Flowafter indices showed that when students used the team learning system a change occurred consistent with the onset of flow, with one exception. In this single case, Year 12 history, the students appeared bored by the activity. Figure 9.18.2 shows the mean of Flowbefore and Flowafter for the class.

A reliability analysis of the flow data, both before (Flowbefore) and after the sessions (Flowafter), was undertaken to determine whether all eight or only some items should be included in a consolidated flow index. A Chronbach $> .8$ is considered satisfactory. After the removal of one item, the alpha reliability of the Flowbefore items increased to Chronbach = .78, indicating that the scale was generally reliable. The reliability of the Flowafter items increased to Chronbach = .82 after the removal of the same item, indicating the scale also had good reliability. The reliability analysis is shown in Appendix IV, page 438-439.

The excluded item asked participants to respond to the statements “I felt unaware of my surroundings/I felt very aware of my surroundings” using a five point scale. The main response was that the participants felt very aware of their surroundings, which is inconsistent with flow. In flow, people become so deeply absorbed in the activity they become oblivious to the world around them (Kubey & Larson, 1990).

Instead, people felt more aware of what was happening around them, and of each other, which is consistent with empathic response during team development (Nesbit, 2000; Wegerif, 2002) or team formation (Schein, 1988).

The facilitators group. The teachers and students who trained to become facilitators enjoyed their first experience with the tool. The results were indicative of a change in the group flow state. Figure 9.18.1 displays the results. At the start of the session the flow index for the group was 2.5 on a five-point scale ($M = 2.50$, $SD = .73$), and during the session this increased to 4.2 ($M = 4.18$, $SD = .61$), a significant change ($t = -4.85$, $DF = 9$, $p < .001$). Factors that may have influenced the result in a positive way were the novelty of the session and the discovery of common interests across the group.

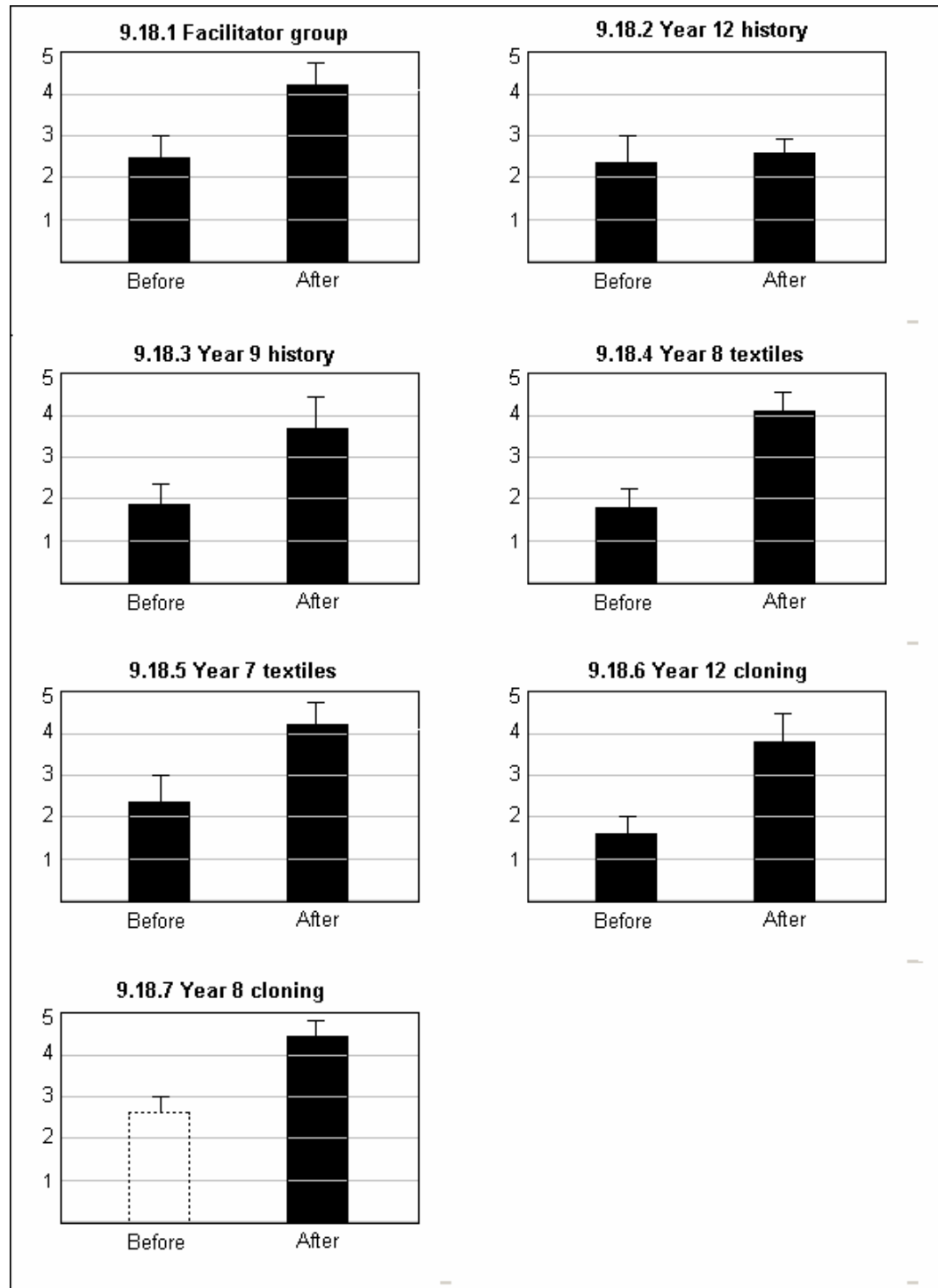
Year 12 history. In chapter 6, I showed that the Year 12 history students were not impressed with their session with their teacher Mr. James, or his performance as a facilitator. Figure 9.18.2 displays the results of the flow analysis, which indicates little change in enjoyment and attention during the session, consistent with the chapter 6 findings. Before the meeting the flow index for the group was 3.5 ($M = 3.45$, $SD = .43$) and during the meeting was 3.6 ($M = 3.61$, $SD = .90$), representing no significant change ($t = -.527$, $DF = 20$, $p < .53$). Factors that appear to have negatively contributed to this result were the “boring” nature of topic, the questions that required largely factual recall rather than opinions and the lackluster leadership provided by the uncertain performance by Mr. James, the facilitator.

Year 9 history. Most of the Year 9 history students appear to have enjoyed their session with their teacher Mr. James. The topic was the parallels between Word War II and the “war on terror”. Figure 9.18.3 shows a significant change ($t = -5.96$, $DF = 14$, $p = .000$) in the flow index for the group from 2.5 ($M = 2.51$, $SD = .90$) to 4.1 ($M = 4.05$, $SD = .56$).

Year 8 textiles. The Year 8 textiles students were the most focused of any of the participants in this study and had the most fun. Their session with Ms. Zoe began as a traditional classroom activity, but the mood changed when she began the team learning system activity. Figure 9.18.4 shows the results. At the start of the session the group

flow index was 2.8 on a five point scale ($M = 2.84$ $SD = .60$) and rose by 1.3 points to 4.1 ($M = 4.07$, $SD = .53$), indicating a significant change ($t = -6.24$, $DF = 21$, $p = .000$) in the flow state.

Figure 9.18: Changes in the flow state of groups using the team learning system



Factors that may have contributed to this result were the affinity the students felt for their teacher, the novelty of the tool, the freedom of being able to talk openly to each other about a topic and the “edutainer” role adopted by the teacher when she began to revel in the enthusiasm and responses of the students.

Year 7 Textiles. Ms. Zoe asked the students to reflect on their experience of the Year 7 textiles course and to suggest improvements. Figure 9.18.5 shows that the flow index for the group rose 1.4 points from 2.4 on a five point scale ($M = 2.39$, $SD = .67$) at the start of the session to 3.8 ($M = 4.08$, $SD = .55$) during the session, a significant shift ($t = -9.04$, $DF = 19$, $p = .00$) indicative of a change in the flow state.

Year 12 cloning. The students who participated in Mr. James Year 12 history class also participated in a session facilitated by the researcher. Figure 9.18.6 shows the flow index for the group rose from 1.8 on a five point scale ($M = 1.78$, $SD = .67$) by 1.4 points to 3.2 ($M = 3.22$, $SD = .97$) which is indicative of significant shift in mood and attention ($t = -4.27$, $DF = 8$, $p < .03$). No information is available about the factors that may have influenced the result.

Year 8 cloning. The researcher also conducted a session with the Year 8 textiles class on the topic of the ethics of human cloning. No flow data was collected before the start of the meeting. The after the meeting data are shown in Figure 9.18.7. At the conclusion of the session the flow index for the group was 4.5 on a five point scale ($M = 4.47$, $SD = .70$) consistent with flow. The Flowbefore data from the earlier session facilitated by Ms. Zoe is shown for completeness.

Summary and conclusions

The analysis showed that all of the groups, with one exception, were very productive and highly engaged when they used the team learning system in the school classroom. All groups remained on task for every cycle of every session. The participants contributed ideas at a rate of greater than .8 ideas per person for the entire 12 sessions and 140 separate activities, which is consistent with a high level of engagement. The younger students tended to generate the most ideas, whereas the older participants tended to generate ideas that were more elaborated.

The directed graphs analysis revealed a highly cross-connected pattern of discourse in some of the sessions consistent with the emergence of a large component (Newman, 2002) where the ratio of threads to nodes exceeded 0.5, which appears to be

consistent with a change in structure of the group, at a higher level of order (Kauffman, 1995, p. 57). The new order is the “new” knowledge the group created. This result was particularly evident during the Year 8 feedback, Year 8 cloning and Year 8 textiles sessions. The questions appeared to act as the initial catalyst for concepts. The concepts contributed by the participants also performed the role of autocatalysts. Within a question cycle, the discourse that began as disconnected and isolated concepts, developed quickly into large clusters of concepts, which became more densely connected as the support of the participants increased. Where the participants had little knowledge of a topic or had divergent views, islands of concepts developed which remained disconnected from each other.

There was considerable variation during sessions between question cycles, which appeared to be determined by the nature of the question and the group’s knowledge, tacit and otherwise. Closed questions generated few responses and little cross-connectivity, with most participants connected to a single concept, in a star shape, equivalent to a point attractor (Losada, 1999). Decision-making questions also had the topology of a point attractor, and if there was a difference of opinion, two or more attractors formed. Open-ended, richly worded questions, particularly Bloom’s mid-level to high-level questions that required explanation, justification or analysis, led to the generation of a the largest number of concepts.

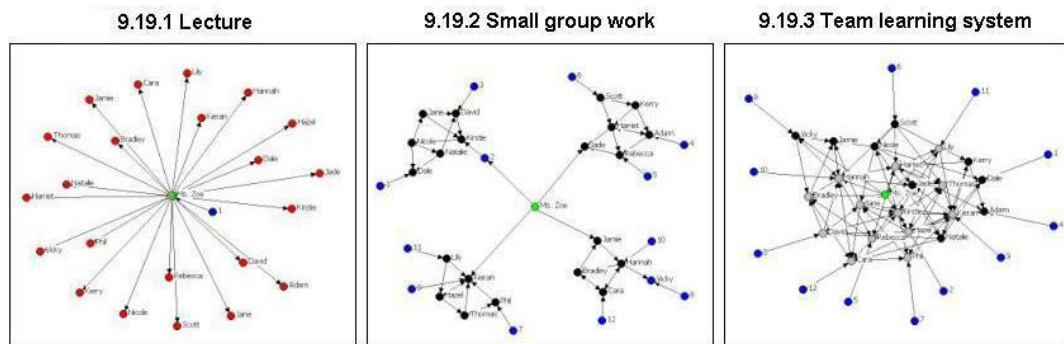
Most participants were actively engaged in the sessions but played different roles. Some participants were the first to generate concepts, most tended to be idea adopters, and one or two persons remained disengaged. However, these findings are indicative only. Some idea generators created a large number of concepts that were only occasionally adopted by others, and could be regarded as Rogers (1983) innovators, whose radical solutions are often ignored. The participants who adopted concepts are consistent with either Gladwell’s (2000, p. 41) mavens who give credit to worthwhile concepts or Roger’s early/late adopters (1983). A separate detailed analysis of a possible relationship between participants who generated concepts first and a personal interest in novelty and change, and between a propensity to be an adopter of concepts and a personal interest in certainty, showed no significant relationship. In addition, there was no significant correlation between academic ability and the propensity of students to generate first concepts, most concepts or unique concepts or be represented in the concept clusters.

An important finding is that, at the same time that new knowledge was created by groups that used the team learning system, there was a change in state of all the groups except one, consistent with the onset of flow (Csikszentmihalyi, 1997). The exception was the Year 12 students, who showed no change in the flow state, and appeared bored by the way their teacher used the tool to assess what they knew. The participants from all the other groups become more aware of their surroundings and each other, perhaps because they had a shared focus, or they developed greater empathy for the people around them, whereas in normal flow, the participants become so immersed in the activity, they are oblivious to their surroundings. I have characterized this peak collective experience as *groupflow*. The emergence of flow in an entire group appears to be commensurate with the team state (Senge, 1992) and tertiary intersubjectivity which Tomasello, Kruger, & Ratner (1993) say leads to the formation of a new culture.

An important learning from the social network analysis is that the team learning system supported a significant increase in student discourse, in the form of “written speech” when compared with the traditional classroom. The participants were not only able to locally discuss ideas, but could also see ideas appear on the screen from participants who were geographically remote from their own small discussion groups, via the simultaneous contribution and simultaneous view feature. As a result the students were exposed to many more concepts than might have developed in local conversations.

I have developed a social network view of three discourse models (see Figure 9.19) to illustrate the differences between a traditional classroom in which monologue dominates (see Figure 9.19.1), the small group classroom in which local conversations are permitted (see Figure 9.19.2), and the team learning system classroom that involves discussion as well as some dialogical and dialectical discourse (see Figure 9.19.3). The green circle represents the teacher, the red circles represent nodes (participants) that are not connected by any ties to other participants (other than the teacher), the black circles represent nodes (participants) that are connected by two ties and the grey circles are nodes (participants) connected by three ties. The lecture opens many channels of one-way communications, but does not allow any cross-connectivity within the group that would result in new ideas being developed. Small group work opens up a few locally confined channels of communication, and makes use of discussion or dialogue, allows some new concepts to form and be tested, but not by the whole community.

Figure 9.19: Directed graphs of three classroom models



The team learning system allows numerous local conversations to be shared among the entire community, which promotes the wider adoption of the ideas or reminds people of many more ideas. However it is probably the respectful listening aspects of dialogue and the integrative aspects of dialectical thinking that appear to contribute to the team learning system success as a tool for “knowledge creation”.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

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Overview of the chapter

The aim of this study was to investigate how differences in the original acculturation of teachers and their students into society account for differential use of a tool for collective knowledge creation. The study was conducted through the lens of a complexity-activity theoretical model, based on activity theory but informed by the principles of complexity theory and other theories of personal, group, organisation, societal and tool development. The findings contribute to the practical knowledge of present and future generations of educators about collective knowledge creation in rapidly changing cultural frames.

A secondary aim was to resolve contradictions in activity theory in order to create a more robust and testable theory of learning and development and to attempt to answer some of the questions raised by Davydov (1999) about the differences between incremental and transformational change and the relationship between individual and collective activity. The findings contribute to theory development at the intersection of

activity theory with other theories of development particularly complexity theory, flow theory, small group theories and innovation theory.

The analysis was undertaken as a series of case studies supported by a mixed methods research approach using both qualitative and quantitative data in the form of session transcripts, videotape records, surveys, focus groups, personal interviews and academic ability tests. In chapter 7, I presented a series of case studies, which analysed the transcripts of the students' and teachers' feedback through the lens of a tentative complexity-activity theoretical model. The case studies demonstrated significant differences between the teacher and student aspirations, their use of the team learning tool, their roles and relationships and the rules of engagement. In chapter 8, I reported on the facilitators' use of speech and motor skills by analysing the videotape record. The analysis showed there was a conflict between inner speech and other forms of speech such as authority speech, which interfered with the successful establishment of automatic operations necessary to routinely use the team learning system and fluently coordinate the group activity. A fear of losing classroom control as a consequence of a poor public performance could account for the unwillingness of teachers to use technology in the classroom. In chapter 9, the transcripts of all the sessions facilitated by the teachers, students and the researcher were repurposed as quantitative data to show how the questions and ideas promoted the flow of interactions between participants. The data were also used to show evidence of a pattern of idea generation consistent with autocatalytic effects and a change in the state of the activity systems.

The chapter is in six parts. In the first section, **Summary of the major findings**, I show that young people were able to successfully use an advanced knowledge-creating tool with little help from their teachers. I show that the teachers tend to use pedagogical approaches from earlier cultural periods rather than the present cultural period. I also show there is a pattern to human development that occurs as a consequence of a partnership between humans and their tools, where development occurs in a series of epochs with the topology of a period doubling cascade. The second section, **Incremental, transformational and regressive change**, presents activity as a trajectory to offer explanations for the differences between incremental and transformational change in activity systems, one of the key questions raised by Davydov (1999). It also explains regressive activity, about which activity theory is generally silent. The fourth section, **Transformations in human activity**, reports on the evidence for transformational change at three levels, the cognitive, collective and the cultural.

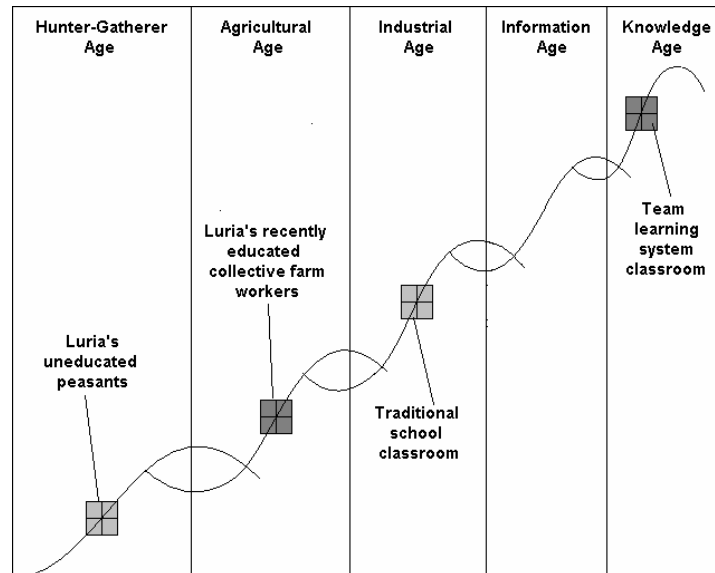
The fifth section, **Autocatalytic mechanisms in activity**, discusses the role that rich questions, ideas and the user interface of the team learning system play in bringing concepts close together so they function as autocatalysts. Section six, **Learning as a discontinuous or spiral process?** explores whether the topology of the learning process, in view of the study's findings, is spiral or discontinuous. The seventh section, **Collective objects and individual aspirations**, explores some of the proposed revisions to activity theory including a new method for classifying activity according to discourse models (monologue, discussion, dialogue and dialectical discourse) and in relation to the power disparity between the participants in an activity system (teacher-student, manager-worker, facilitator-participant and other role combinations). The remaining sections put forward suggestions for further research, discuss the implications of the study's findings for teaching and learning, reflect on the limitations of the research and offer some concluding thoughts.

Summary of the major findings

The main finding of the study is that when teachers and students use an advanced knowledge creating tool, such as a team learning system, the students are able to create their own knowledge with minimal assistance from their teachers, whereas the teachers struggled to use the tool because they were unable to transition from a teaching role to a facilitation role, having been acculturated into a much earlier stage of human development. The gap in tool use between the team learning system classroom, which most of the students and the teachers identified as consistent with youth culture, is larger than the gap in tool use between Luria's peasants and educated workers (see Figure 10.1), which is two cultural periods apart. In their early years 21st century children become immersed in a Knowledge Age culture and routinely engage in a lively autonomous and multi-way discourse with other young people elsewhere in the world as "producers" of rapidly evolving cultural tools that are transforming what it is to be human. Young people are then subjected to a compulsory school-going regime for 10 to 12 years of their lives, in many cases, where they are expected to remain silent instead of engaging in the dialogical and dialectical discourse which provide young people with the necessary complex thinking, relating and process skills for the rapidly evolving world. At school, students gain limited access to the types of tools they routinely use in their home lives, while their teachers, who, in this study, demonstrated their roles as

knowledge tellers and behaviour controllers, use more primitive pedagogical tools such as the lecture and closed questioning which leaves one sixth of the students unable to read, write, or count.

Figure 10.1: Activity systems and cultural periods

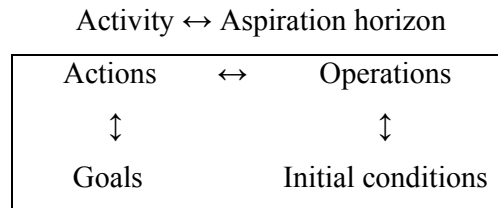


The secondary conclusion is there is a large scale pattern to human development, similar to that originally considered by Luria (1976) which can be explained by the evolution of tools in a symbiotic relationship with the human brain, that is a consequence of both conscious goal-directed actions – at a cognitive, tool or cultural level - which results in incremental or step-wise change, and autocatalytic interactions, which results in transformational change. The result is generally consistent with the revised and tentative complexity-activity theory model proposed in chapter 5 (pages 188-194).

The study provides support for the idea that large-scale cultural changes unfold in a period-doubling cascade which seems to occur as a consequence of transformations of the tool-brain system (signs, language, symbols, psychological processes, physical artifacts and cultural systems) in which each successive period is considerably shorter than the earlier phase (see page 149). The changes occur spontaneously, when the tool system reaches a highly interconnected stage of development, as occurred when the students' concepts sparked other concepts, and eventually coalesced into a cluster of concepts. Similar spontaneous changes to a new kind of order seemed to occur when the

teachers mastered the art of facilitating group interactions using the team learning system and during group development as occurred when the participants in the team learning sessions began to collectively perform in a highly orchestrated manner.

10.2: Revisions to the triarchic model of activity



The revised complexity-activity model employs a simplified model of human activity. Unlike the Leont'ev triarchic view that regards automatic operations as subservient to conscious actions, the revised model (see Figure 10.2) gives equal weight to the interplay between the left and right frontal lobes, with the right playing the major role in goal-directed activity and the left the main role in automatic operations. The revised model, is more consistent with and respectful of the contribution of Luria (1973) to the Cultural Historical Activity theoretical field than the widely adopted Leont'ev triarchic model and a more solid basis from which to conduct research which I suspect will require less need for convolutions in order to achieve consistency.

The revised complexity-activity acknowledges that human activity in the form of automatic operations is determined by the “initial conditions” (Guastello, 1995, p. 18) of the activity system in the same way that dynamical systems are sensitive to initial conditions. The constant shifting of cognitive control from the right frontal lobes to the left frontal lobes and from conscious to automatic, for recently mastered complex tasks is in my opinion, what differentiates humans from other animals. This shift is exemplified in this study by the mastering for the first time of the facilitators speech and correct sequencing of the motor tasks by the teachers, Ms. Zoe and Mr. James. Human progress and tool development would not be possible if actions could not become automated, simply because every day would be a Groundhog Day (Ramis, 1993), in which the brain would forever be compelled to deal repeatedly with the same complex or difficult situations.

The logic of my argument is that cultural progress parallels tool speciations and extinctions, for which there is clear evidence. It does not rely on genetic or biological difference, or the effects of attending school, for which Griffin & Cole (1984) showed

evidence to the contrary. It does not consider that any tribe, race or culture is more primitive or advanced genetically than any other, which is the usual argument against such a theory of cultural progress (Griffin & Cole, 1984; Scribner & Cole, 1985; Engestrom, 1999). Nor does the model reduce “the “rich diversity of socio-cultural forms to a one-dimensional scale” (Engestrom, 1999, p. 25). The logic is that societies merely adopt new tools at differential rates. Over the past 200 years the OECD countries have raced ahead. Asian countries, particularly China, have played leapfrog, jumping from an agricultural society to a knowledge-based society in a single bound, without having to make the same sequential investments in Industrial Age or Information Age infrastructure as their competitors did, who invented their way to the future. They are copying their way to the present leading edge of technological development.

The adoption of increasingly more powerful tools depends on the extent to which our “stone-age” human brains are “programmed”. The difficulty that humans now face is that each wave or cultural period is becoming progressively shorter, by a measurable factor which approximates the Feigenbaum number. This pattern of change is difficult to see from within the system. The pattern has only become evident in the past century as one major discontinuity after another has swept through the leading edge of human society. Acculturation into earlier cultural periods and tool use becomes a barrier to the adoption of new tools, roles and rules consistent with a later cultural period. Traditional teaching methods use language that is designed to maintain control whereas facilitation uses language that gives away some control to students. In this study, some teachers struggled to use the latest “we” type technologies in the school classroom. They found it hard to do “we” because they have learned to frame what they say in terms of “I” and “you”.

The shift from a more primitive way of thinking/performing to a new higher level and more sophisticated way of thinking/performing could perhaps be explained by a neuronal equivalent of speciations and extinctions, which are the hallmarks of self-organisation. We now know that synaptic connections are created and strengthened throughout the life of an individual in response to new and repeated activity, and that the least used synaptic connections are pruned from time to time, as they fall into disuse. The wider adoption of interactionist “facilitated” approaches to learning requires more than learning about the practice cognitively. It requires practise, so that the methods become embodied and automatic as “kinetic melodies” (Luria, 1973), in the

same way that learning to become a ballet dancer, kung fu master, surgeon or pilot becomes routine.

Incremental, transformational and regressive change

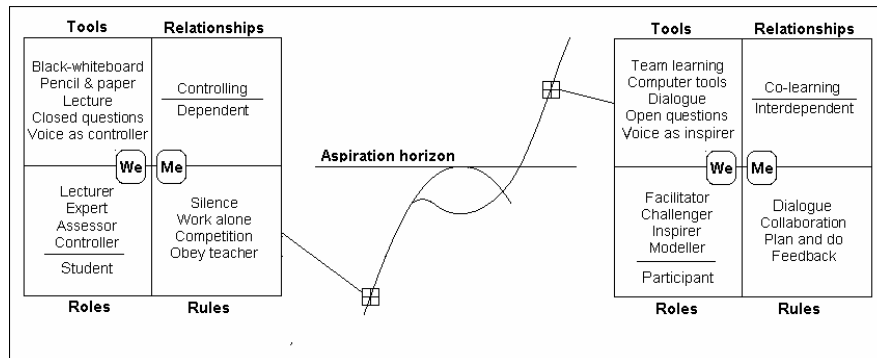
A comparison of the Year 8 textiles and Year 12 history classes showed a clear distinction between incremental and transformational change in activity systems, while the gap between traditional school and modern home settings, for some students, offers an example of the regression to an earlier tool culture. The revised complexity-activity model considers activity systems to have a trajectory that can be traced out over time to reflect the increasing or declining complexities of a system.

Transformational change. When the Year 8 textiles teacher decided to allow her students to use the team learning system as part of the research project what she did not plan for, and was surprised by, was the enthusiastic reception, not merely for the tool, but for the new rules and more equal roles that accompanied its' use. Both the students and the teacher reported that the tool (and its' associated rules) transformed both the teacher's role and the students' role, but also the culture of the classroom. The teacher was doubly surprised by the high levels of student productivity by comparison to the normal classroom. It was as if the inherent rules of dialectical/dialogical discourse helped release considerable potential energy stored up within a monological activity system. The students became active joint knowledge creators instead of passive listeners. They experienced a significant positive change in their levels of enjoyment, engagement and attention.

Figure 10.3 illustrates the change in the structure of the activity system in the Year 8 classroom, from a traditional model on the left, to a more complex structure on the right. During the transformation, all aspects of the activity system were transformed - the roles, rules, tools and social relationships - entered into new relationships with each other, at a higher level of order. The new tools (instant idea exchange provided by the team learning system and the open-ended discussible questions) and the new rules (fun, dialogical discourse) led to the emergence of new interdependencies including new roles for the teacher (facilitator) and the students (participants) which were more equitable. The new activity system entirely displaced the previous system. Gone were the previous tools (lecture, closed questions) and the associated rules (no speaking, obey

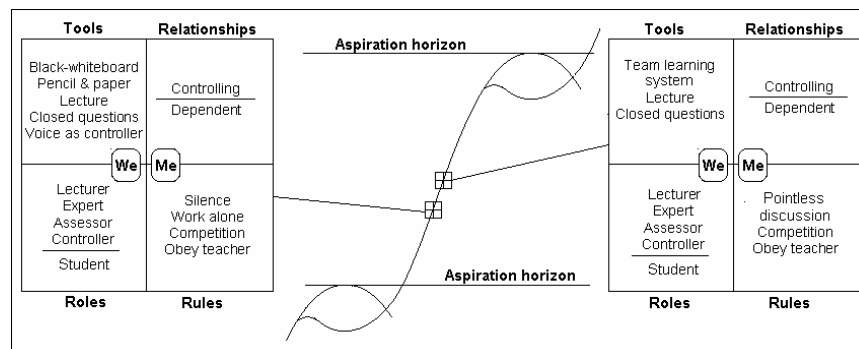
teacher, raise hand for permission to speak), the very unequal roles (teacher vs. dependent student) and the previously distant relationship.

Figure 10.3: Transformational change in Ms. Zoe's Year 8 textiles classroom



Incremental change. In marked contrast, the Year 12 history experience offers an example of incremental change in an activity system involving minor adjustments to the rules, roles or tools (see Figure 10.4) without a significant commensurate change in all other elements of the system or the structure of the system. The teacher chose to use the tool to evaluate the student's recall of memorized information rather than use it for the intended purpose of collective knowledge creation.

10.4: Incremental change in Mr. James' Year 12 history classroom

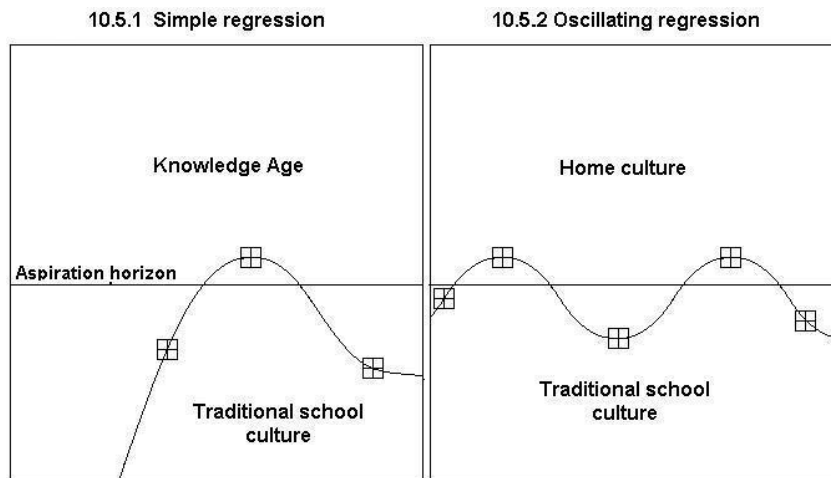


Although the students enjoyed the novelty of the session, they saw little difference between their normal classroom and the way the teacher used the tool. The use of the tool introduced contradictions (Engestrom, 1999) which diminished its' value to the users. One student pointed out it was a slow way to transmit information. The teacher acknowledged that the session was not as successful as the workshops where he employed open-ended questions and acted as a facilitator.

Regression. I pointed out in chapter 3 (see pages 80-81) that most interpretations of activity theory ignore the possibility of regression, the fate of people who make the shift from freedom to imprisonment or suffer a traumatic accident which results in mental impairment. Ms. Zoe’s textile’s class suffered such a setback when she chose not to use the team learning system in the classroom ever again, and reverted to a traditional pedagogy. This simple regressive trajectory is shown in Figure 10.5.1.

The oscillating trajectory (see Figure 10.5.2) is another form of regressive activity in which young people transition daily between a rich Knowledge Age socio-technical culture which values the mobile phone, the computer, the internet, simulations and games and the older school-going culture based upon a more primitive set of tools.

Figure 10.5: Regressive cultural change



Transformations in human activity

Three kinds of transformations, consistent with a quantum shift in the structure of an activity system, were observed during the study at individual, collective and cultural levels in which ideas in the form of “written speech” acted as catalysts for other concepts leading to a runaway reaction both in terms of ideas and heightened emotional response.

Individual. In chapter 8 (see pages 296-306) I showed that the transformation of the textile teacher’s performance occurred in response to the amplified student performance at which point she became unconsciously competent as a facilitator. Ms. Zoe’s first efforts were a muddle of previously learned speech routines, parts of the required facilitator speech of clear instructions, and authority speech designed to control

the students, interspersed with inner speech used to sequence motor skills. During the session the teachers became more competent as users of the computer software, more fluent in giving instructions and better able to sequence the activity. The facilitator's performance imitated a remembered model of the ideal activity via the internal plane of action (Hasan & Gould, 2001). The teacher's desire to perform well can be categorised as conscious goal-seeking on the part of the teacher. However, the transfer of control from right to left frontal lobes by the orchestration of a new "kinetic melody" for the ideal facilitator role appears to be an unconscious process, unpredictable and beyond the subject's control which only seems to occur once the feedback about the performance resonates with the image formed of the goal.

Collective. At a collective level, autocatalytic effects were observed when the groups of students and their teachers or facilitators (except one group, Year 12 history) achieved extraordinary levels of productivity, enjoyment and resonance. None of the facilitators, either the teachers or the researcher, sought a peak experience for their participants, but it occurred anyway. None of the facilitators anticipated a run-away reaction in terms of productivity, but the huge surge in ideas and the strong positive emotional response offers clear evidence for a collective flow experience which seems to be an indicator of a change in the state of the group. The exception to the pattern was the Year 12 history group who became bored or anxious by the traditional approach adopted by their teacher who used the tool for a low-level memorisation task. At least half of the sessions exhibited an avalanche of ideas, which were catalysed by the questions and by the ideas. The participants appeared to operate on the same "wavelength" through a collective version of Gabora's "rememberings". When the students were asked closed questions, they responded with just one idea each, generally a "right" or "wrong" answer, typical of the traditional classroom. When the students were asked rich, open-ended questions, the contributions sparked further possibilities and the activity became infectious. At the same time, the participants responded with considerable enthusiasm as they "hunted down" further possibilities. Some students, often the same students, generated a large number of ideas, some of which were adopted immediately by other students. Generally the students who were the first to contribute ideas were also the most likely to contribute the most ideas and the most unique ideas. There was no significant relationship between those who generated the first, most or unique ideas with either academic skills or personal preferences for change or certainty. Like a rising tide, the process seemed to raise all boats.

Cultural. The study offers some evidence for the emergence of a new culture for the classroom, albeit temporarily. All the teachers and most of the students observed a spontaneous change in the classroom culture, from a traditional model of teaching and learning to a new, more advanced cultural model, generally aligned with youth culture. This change occurred outside teacher control, when the facilitators began to use the collective pronoun “we” to coordinate the session instead of personal pronouns “I /me and you”. Mr. David said the team learning system classroom was the “antithesis” of the chalk-and talk classroom. Ms. Debbie described it as a shift from a “them and us” feeling to an “us feeling” and Ms. Zoe said the students and teachers were on a “more equal footing” which was more like “working alongside” than the normal classroom. There was also evidence that the highly engaged student activity led to a change in the teacher activity, and their separate activities became synchronised (entrained) when both the teachers and the students adopted the etiquette, and the sequencing of their activities became automatic.

Autocatalytic mechanisms in activity

Three processes appeared to play a key role in the idea generation process that helped the participants to rapidly locate memories of related concepts, bring them into close proximity and develop prototype combinations of concepts:

- The rich questions, particularly those that contained prompts and scaffolds, directed the attention of participants to possible candidates for retrieval from memory;
- The simultaneous contribution-view feature of the team learning system facilitated the rapid sharing of ideas and the detection of patterns so that the 20 or 30 brains in the room were able to think in parallel, and
- The ideas prompted the participants to think about related concepts or to explore similar categories

There is strong evidence from the study that concepts act as autocatalytic sets, and cross-catalyse the recall of other concepts. Questions with semantic content or specific labels helped to direct attention to the most relevant neuronal pathways for the topic under consideration. Although most of the questions were devoid of

metaphorically powerful concepts, most contained cues or scaffolds, which seemed to perform the same kind of function. The simple act of bringing distinctly different concepts into close proximity helped to direct attention to new combinations of ideas. The division of the thinking or decision-making tasks into sequences of questions arranged in a logical sequence, reduced the cognitive load, and helped participants complete tasks they could not have performed unaided. The step of asking participants to identify the themes from within many of the cycles, also helped retain relevant ideas in working memory from one cycle to the next. This also helped to bring novel or similar ideas into close juxtaposition and assisted the processes of differentiation, combination, integration and further exploration.

The team learning system helped to foment and evolve a rich conceptual soup capable of a large burst of speciations (Kauffman, 1995) and the potential for the emergence of new order. Participants were able to see their own ideas forming on the shared screen keystroke-by-keystroke together with the ideas of all other participants who were typing at the same time. The videotape record showed the students paid close attention to the ideas as they were formulated by their peers both during the typing stage and when the ideas were read aloud. They appeared curious to see what others had to say but also to see how other students reacted to their own ideas. Some students created novel possibilities in order to provoke a reaction from their peers. The participants tended to generate more ideas and also longer and more complex ideas in response to open-ended questions than they did closed questions. They contributed the most responses to questions that were higher on the Bloom's scale that demanded divergent and rich responses. When teachers asked open-ended questions the students said they felt valued as persons. Some students said they preferred being asked their opinion rather than respond to factual questions, because they did not like being embarrassed in front of their peers. Some of the teachers said it was normal practice to use closed questions to maintain control of the classroom, although they also recognised that the students became anxious when subjected to this type of questioning.

Rapid attention set-shifting that leads to the heightened enjoyment and satisfaction that is the flow experience was promoted by the rapid cycles of question asking. Asking a new question every four to five minutes and cycling through the type-talk-read-review etiquette in achievable chunks ensured the students remained on task and made progress in the Wittgensteinian-style "language game". There were clearly

some parallels between the way the tool worked and how video and computer games provide intrinsic rewards for achieving success at progressively higher levels.

The study found that the collective flow experience of the students was different to individual flow in one respect. The students reported they became more aware of their surroundings and each other, whereas in individual flow, people become so deeply immersed in a task, they were oblivious to their surroundings. The conditions for entering what I have termed the *groupflow* state appear to be a reciprocal interest in, and openness towards other ideas (depending upon the discourse model used by the participants) and the cross-catalysis of those ideas. The achievement for each other of individual goals, and sometimes, but not necessarily, the achievement of a group goal as well, may contribute to groupflow. The groupflow experience seemed to occur when the participants were really “listening to” each other, as occurs in dialogue or dialectical discourse, or watching ideas develop on the screen. It also occurred while students were attempting to find overarching patterns in the ideas, when the ideas were read aloud or when the common themes were identified, which has a dialectical aspect. The groupflow state did not emerge by consciously setting and pursuing a group goal. It developed when the discourse became highly interconnected. Such peak group effects may be difficult to achieve when engaged in monologue, except when great orators provoke an outpouring of emotions, but much easier to achieve in dialogue or dialectical discourse. In retrospect, it would have been useful to have the foresight to also track the flow experiences of the facilitators during their first sessions to compare with the student experiences.

Learning: A discontinuous or spiral process?

I have already shown there is a discontinuous transformative element to learning and development in addition to the incremental or continuous aspects. This finding is at odds with a long-held view by activity theorists that learning occurs (Vygotsky 1978, p. 56) “not in a circle but in a spiral passing through the same point at each new revolution while advancing to a higher level”.

I contend that the guidance of a child by an adult, through the zone of proximal development is a serial process such that development takes place, largely by the accumulation of numerous small changes, similar to the incremental changes that occurred in Mr. James Year 12 class. However, these incremental changes are

punctuated occasionally by transformative changes, similar to what occurred in Ms. Zoe's Year 8 class. This view is consistent with Vygotsky's overall view of development as an incremental and transformational process as Vygotsky (1978) points out:

Child development is a complex dialectical process characterized by periodicity, unevenness in the development of different functions, metamorphosis or qualitative transformations of one form into another, intertwining of external and internal factors and adaptive processes, which overcome the impediments the child encounters. (p. 73)

Vygotsky (1978) also developed a model of collective learning through play, which has many of the autocatalytic and transformative features that are typical of the way complex systems evolve. In most, but not all sessions, the students raised *themselves* up as "if they were a head taller" (Vygotsky, 1978) and in the process invented new rules, played new roles and created "new" knowledge. Generally, the students regarded their interactions as approximating that of play, which many of them described as "fun" or "fun, fun, fun..." The participants' interactions created a "soup" of new possibilities, largely without the assistance of their teacher, whose main role was to maintain the talk-type-read-review or the modified (talk+type)-read-review etiquette for the duration of the session. As novel concepts were brought into contact with other possibilities, this helped to spark in the minds of the participants, further possibilities or extensions to the language game. The rules that guided the interaction between the participants, when using the team learning system, were also a quantum apart from, and in some ways the antithesis of, the rules of the traditional classroom. In the traditional classroom, the students were expected to listen, refrain from talking, raise their hands to be invited to speak, and speak only when the teacher asked a question. The rules of the team learning classroom encouraged the students to discuss the questions, contribute ideas, acknowledge and make sense of the contributions, which equated to the freedoms available in collective play. The participants also engaged in abductive thinking by reflecting on their observations of their own interactions with each other. The participants were then able to abstract their own knowledge about what happened in their activity and raise that knowledge to a higher level of conceptual order, beyond what they already knew.

Collective objects and individual aspirations

The study showed that the use of the shared tool by the students and teachers reduced the power differences between them compared with the power differences when using the traditional classroom tools of the lecture and closed questioning.

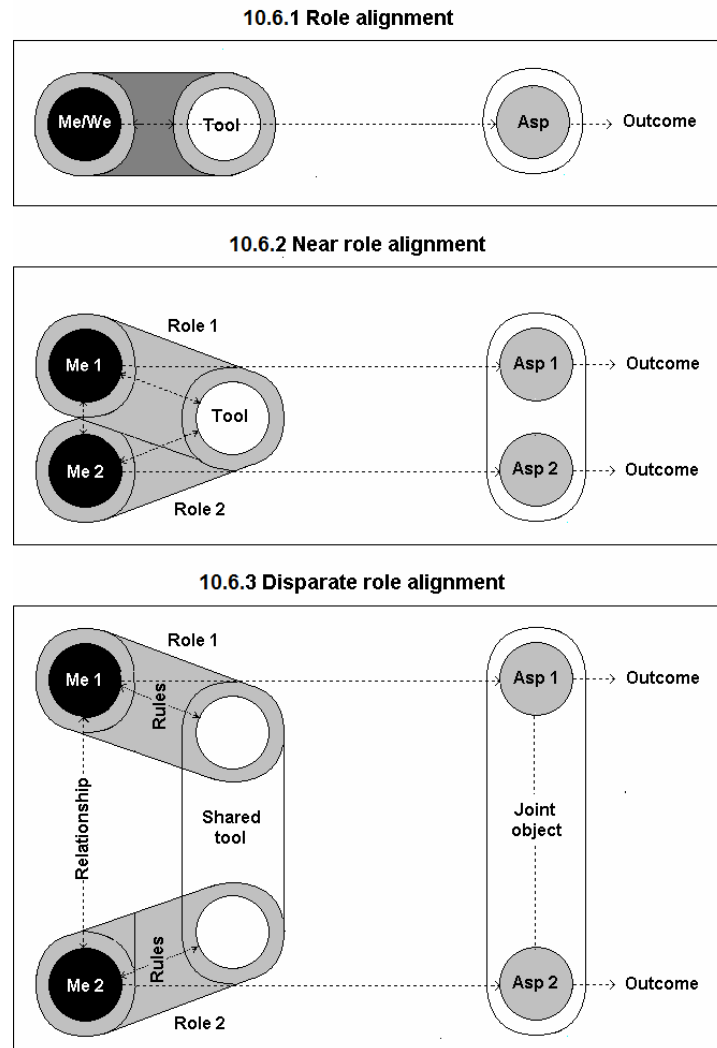
The study provides support for the new model of joint activity first presented in Chapter 5 (Figure 5.2, page 190). The new model takes into account the disparate interests of people when engaged in joint activity, and to acknowledge the micro internal and external politics that is normal in intersubjective relations. Figure 10.7 illustrates three conditions of tool and role mediation, which endeavours to deal with multiple relations with an object of activity.

The collective object of activity as it is currently understood, only exists under ideal conditions, because groups rarely act this way, except perhaps when they become a highly coordinated team, where their joint individual interests, such as playing inspiring music in an orchestra, winning a football game, or performing life saving surgery, become highly aligned in the collective context. Most of the time collective activity is about individuals pursuing different objectives within a group context, and obtaining the best deal they can under the circumstances. More often, we lump people together because it is convenient or expeditious to think of nations or organisations as consistent wholes, and groups of students such as Year 12 history as a single entity.

In this new model of activity, a role is regarded as the subject + tool, to indicate that tools extend the power and capability of an individual, but also the collective, if harmonized, aligned or orchestrated. The collective subject is represented by two or more individuals who make use of a shared tool. *High role alignment*, as shown in Figure 10.6.1, occurs when disorganized groups become coordinated teams, where all participants use the tools in the same way; they follow the same rules, share a common aspiration and generally achieve the same individual outcome or a shared collective outcome. *Disparate role alignment*, as shown in Figure 10.6.3, is more common and occurs when the participants have conflicting aspirations, use the tool in different ways, apply dissimilar rules and often achieve contradictory outcomes. For example, in the case of the joint activity of incarceration, criminals and society use jails for different purposes. The criminal's goal may be to escape so he can return to his normal work. Society's goal is to keep the criminal in prison to achieve a safer society. For completeness, Figure 10.6.2 illustrates the case of *near role alignment*, as occurs when

groups use tools in a coordinated way, according to an agreed set of rules, but their individual aspirations are not fully aligned.

Figure 10.6: Model of joint activity: Collective subjects and objects



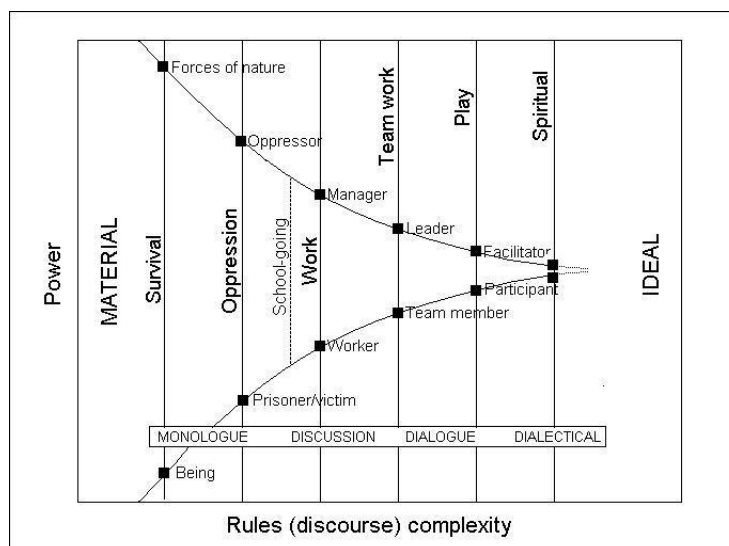
I will explain the new model in the context of Ms. Zoe's Year 8 textiles class and Mr. James Year 12 classes. At the start of the Year 8 textiles lesson, the teacher and the students aspired to quite different outcomes and closely approximated two intersecting activity systems, illustrated by the disparate role alignment (see Figure 10.6.3). The teacher set out to survive the research activity involving the use of the team learning tool. The students set out to do whatever Ms. Zoe expected of them. During the course of the team learning activity, as the students pointed out, the respective roles of teacher and learner become more congruent. The object of activity was transformed by

the activity, but the outcomes were quite different. The teacher learned how to facilitate; the students learned they could learn from each other. The role/power gap between the teacher and students was reduced by the use of higher-level discourse model/rules of engagement that was more empathic and integrative, as illustrated by the near role alignment model (see Figure 10.6.2).

By comparison, the unequal exercise of power in Mr. James Year 12 history classroom ensured there was little congruence between the aspirations of the students and the teacher. The teacher set out to test the students' memorisation of previously learned material; the students aspired to survive the session. The role distance between Mr. James was little different from a normal lesson as illustrated in Figure 10.6.3. The use of the team learning system made little difference to the outcome, except perhaps to raise/dash the students' hopes for a possibly entering a different world or frustrate the students because its use was pointless. The teacher remained confused about how to use the tool in the classroom, and the students were bored by a repeat of material covered in an earlier lesson. The role/power gap between the teacher and the students remained much the same as before.

From this understanding of the relationships between power, roles and rules I have developed a model (see Figure 10.7) to explain the differences in power exercised by participants in collective activity and rule or discourse complexity, ranging from large power differences, as experienced in the material world to the smallest power differences as might be experienced in an ideal world.

Figure 10.7: Classification of activity based on roles and rules



On the power scale, there is a gap in power exercised by one or more of the participants in a relationship compared with the other participants which I have termed *role distance*, which is similar to Hofstede's (2001) concept of power distance. *Discourse complexity* is defined as the types of discourse and the rules of intersubjective interactions arranged in ascending complexity.

The cruder the type of discourse, the more unequal is the relationship, and the less likely that the objects of activity will be aligned. Each type of collective activity is associated with a higher or lesser degree of role-congruence, which in turn is determined by the differences in power between the participants, including:

- **Survival:** Nature in the form of the weather resulting in flooding rains or drought and natural phenomena such as tsunamis or earthquakes exercises considerable power over humans and other life, and thus there is a large role disparity.
- **Oppression:** There is a large power gap between a prisoner and guards, between dictators and their subjects, or bullies and their victims. One seeks to exercise control, the other to avoid or escape it.
- **Work:** Work activity can range from managerial control of employees where there is high object disparity as is the case with dysfunctional work groups or low object disparity as can occur with autonomous work groups with distributed leadership.
- **School going:** School-going, particularly in its most traditional form, has some of the features of incarceration and the least autonomous forms of work activity, as was observed at the start of Ms. Zoe's session and different times during Mr. James' classroom sessions.
- **Playing a game:** Participants in a team who pursue a common objective - of playing or winning a game - and become highly coordinated by reliably adopting fixed rules and a shared common tool, exhibit high object congruence. This form of activity was observed in Ms. Zoe's textiles classroom.
- **Play:** When the roles are generally on an equal footing, as in children's collective play, there is likely to be high object/aspiration congruence.

- **Teamwork:** Autonomous work groups appear to have some features in common with groups engaged in play because they generally have distributed or shared leadership and are able to self-organise.
- **Spiritual:** Another form of activity contemplated but dismissed by Davydov (1999, p. 40) as merely a subset of work, is spiritual activity. Mintzberg (1991) points out that the members of religious organisations such as the Kibbutz coordinate their activities based on their beliefs. Spiritual activity could be regarded as near perfect (or ideal) congruence between roles, rules and tools which in terms of inter-subjective relations, could be considered to be the occasionally referred to but ill-defined, quaternary inter-subjectivity.

Each form of activity appears to be associated with a type of discourse such as monologue, discussion, dialogue, dialectical and ethical dialectical discourse or one of their many variants. The rules, as expressed in terms of discourse models, ascend from coarse, minimally interactive and dismissive communications to rich and highly interactive and respectful communications that are empathetic of other individuals in the group. These forms of communication are essentially rules for the conduct of inter-subjective relations in activity system as understood by Engestrom (1999), which I have shown elsewhere to be equivalent in complexity theoretical terms to “initial conditions” (Guastello, 1995, p. 18) and thus play a major role in determining the outcomes of the process of interactions. War waged unilaterally can be shown to be the equivalent of monologue. Using a weapon to strike another person is also a monological gesture. Empathising with a loved one by embracing them has a dialogical aspect.

In this study, the rules embedded in the team learning system were not always followed yet the rules provided enough process structure for the tool to be used effectively in the classroom. Sometimes the tool enabled dialogical and dialectical discourse. At other times, it was used to collect information from the participants, a form of parallel monologues. In the least successful sessions, the Year 12 history sessions, a combination of monologue and discussion proved to be minimally engaging.

Suggestions for further research

The purpose of this study was to draw together ideas from many different fields and ascertain whether the integration of these ideas would lead to a new model of activity to inform teaching and learning. If, as I have argued, large scale cultural periods

in society reflect a pattern of tool automation over the past 10,000 years, which has the characteristics of a period-doubling cascade, then each period should be shorter by a factor approximating the reciprocal of the Feigenbaum number (Cohen & Stewart, 1994). The revised complexity-activity theory of learning and development may now be testable. Although not considered in this study, the Feigenbaum constant may be present in the pattern of development in childhood, and also in how the brain develops. I suspect, however, that tool evolution is the fundamental system that undergoes autocatalytic transformation, and that new patterns of development overlay old patterns. The stages of child development or cultural development may merely be resonances of the main pattern of transformations that occurs in either the tool “ecosystem” as a result of tool or activity speciations and extinctions.

The study has opened up other avenues for research of which the most interesting are:

- A study of concept or knowledge content, density and ancestry in primary, secondary and tertiary tools to confirm there is a pattern to tool evolution;
- A pilot study of students who design and facilitate their own learning activities to see whether there are any significant changes in student engagement, enjoyment and learning outcomes;
- A study of the “contagiousness” model of learning in a school classroom to ascertain whether, why and under what circumstances some; participants, more than others are responsible for the generation, communication or affirmation of ideas;
- A longitudinal study of learning outcomes that compares student groups using a team learning system and students learning via traditional methods;
- An action research study to see if a new “performing as a facilitator” model of teacher development achieves a shift to student centred learning, greater user dialogue and dialectical discourse in the classroom, and fluency with and adoption of collaborative technologies.
- A detailed study of student engagement and recall to establish whether students generate more ideas, more elaborated ideas and make improved

connections to information in response to questions higher up the Bloom's scale.

- A study that explores whether there is a link between the stages of tool development and childhood development.

Implications for teaching and learning

My interest in this research began when I first started working with schools and school teachers in the late 1990s when a school relocated to the Australian Technology Park where I work and we began experimenting with how the team learning system could be used in classroom learning. During that time, we were visited by many schools, their teachers and their students. Some became users of the tool. I noticed, however, that although teachers enjoyed using the team learning system for their own professional development or to workshop with parents and citizens, most studiously avoided using the tool in the classroom. At the same time, their students were clamouring to be allowed to learn this way. The lights went on for me when a colleague gave me a copy of Csikszentmihalyi's book "Beyond boredom and anxiety: The experience of play in work and games" and said, "Read this. This is what is happening for the kids". And...thus began this journey.

For me, this study has helped shed some light on why teachers avoid using technology in the classroom or pedagogy that involves discourse. It has also stimulated a whole raft of ideas for how we might explore the issue further, or even take action.

In the same way that the work of hunter-gatherers, farmers, artisans and office workers has been automated by new generations of tools, the work of professional knowledge workers such as programmers, teachers, facilitators and leaders appears to be suffering the same fate. I believe that in the very near future, leadership roles that were once impossible for ordinary men and women or their children will be routinely available to all people through the use of smart collaborative tools.

In this new context, the locus of learning needs to shift from memorisation to knowledge creation. Schools need to be connected with the rest of society to be in tune with the emerging needs and requirements of society, not past needs. Schools need to engage in learning innovation and teachers need to embrace emerging tools at the same time as their students. We need to shift responsibility for the design and facilitation of learning activities to young people who each come well equipped with frontal lobes

with incredible untapped power to manipulate and play with motor and speech routines associated with novel ideas.

The role of teaching needs to change. The role of learning facilitator as envisaged by Green & Hannon (2007) is already outdated. In the future we will need educators who are able to be good role models for their students through their multiple roles as designers, innovators, facilitators, provocateurs, inspirers, "edutainers" and evaluators for these are the kinds of roles for which future citizens need to be prepared in order to be successful in a world of accelerating change. Educators need to be in the world, not separate to the world of work, play or whatever realm they purport to represent pedagogically. They need to cater to the discourse needs of those who start school lacking the language skills required to "reprogram" their brains. They need to become fractally equivalent participants in the learning system. Educators need to be rewarded for innovation rather than attendance. However, judging by the high level of resistance to change observed in this study, it is unlikely that teachers will quickly change their teaching practices. Until they do, far too many teachers will deprive far too many of our future citizens of the ability to achieve their full potential in society and some of our citizens could become even more toxic for civilisation as we know it.

Universities and other teacher training institutions need to begin to model what we expect teachers to become rather than continue to practice "broadcast" models of teacher training. Trainee teachers need numerous opportunities to practice their new roles until what they say and do is automatic. They need to learn how to "perform" the role of being a facilitator or inspirer, learn how to use technology confidently and reliably, arrange classrooms so students can engage in dialogue and dialectical discourse in groups, design exciting and infectious learning activities and get out of the way once the students know how to work and learn this way!

We could begin to break the pattern by expecting young teachers to acquire and practice a "performance" model of teaching before they enter the classroom so their new roles become so automatic they are able to resist the temptation to regress to earlier and less appropriate models of classroom practice. We must remain forever vigilant, for inherent in any new idea, are the seeds of "concretisation" in the next phase of its' history. Whatever new approach we adopt today, must be subjected to reinvention tomorrow, otherwise it too will become a cultural fossil like today's teaching practices.

In this new world in which ever more powerful tools continue to be created, we need a new model of the learning process itself. "Contagious learning" has some appeal.

The metaphor donates to the classroom and pedagogy considerable new energy by way of virulence, social interaction, infection, rapid spread and wide-adoption of new and better ideas and the new tools from which new knowledge will be created. Indeed, it may be possible to make use of the autocatalytic nature of “concept sets” and immerse young people in a sea of cultural artifacts – movies, songs, books, comics, websites and simulations – and have them discover or invent new Wittgenstein’s language games for themselves. They would use rich question sequences that act as the initial catalysts, to uncover the hidden relationships between webs of concept families, and “raise the demand on themselves and with that bring themselves into the *zone of proximal development*” (Brostrom 1999, p. 250-251) and so become a collective “head taller”(Vygotsky, 1978, p. 102). This is what I mean by “**Learning as a Game**”, which is the title of the study.

Another desirable goal would be to consider learning strategies that are beyond the current gold standard of metacognitive thinking. Although this is a desirable skill, and necessary for students to develop independence as learners, it does not go far enough. I regard metacognitive thinking is merely a sub-set of “learning activity design” of which many, if not all students, are capable. In this new role, the learners become more like their ideal future teacher. They might learn how to influence others, to use session design, facilitation and high level thinking and relating skills routinely as a way of transforming their own world and the world of their peers. They may even learn to use all kinds of discourse models so they know when and how to use them appropriately – monologue, discussion, dialogue and dialectical discourse.

Limitations of the study

A study of this breadth did not easily fit within the confines of a doctoral dissertation. Ideally, the study should have dealt exhaustively with the literature in all the fields it touches. However, it has not been possible in the time or the limited resources available to delve deeply into every related field. In many ways, the study has breadth at the expense of depth. However, it was important to show how ideas from other fields could inform both activity theory and pedagogy.

Secondly, the research was undertaken in a single school in the United Kingdom with only a small number of teachers and students at the commencement of their use of a new tool. The study would have benefited from a longitudinal approach that tracked

not only a significant size group of teachers, but also the students and their further development or regression.

Thirdly, the study would have benefited from a cross-cultural perspective. It should have included schools, teachers and students from different cultures. During the course of my work with consultants to schools in Australia, Europe, Asia and North America, it has become obvious that schools on all continents may be stuck in the same paradigm as the school in this study as I shall explain in the personal concluding remarks.

Concluding personal thoughts

I believe that one day in the not too distant future we will probably regard 21st century educators as remiss in their duty of care to their students in the same way that we now regard slavery as a crime against humanity or denying women the vote or an equal place in society as “backward”. If one sixth of all students are disenfranchised by the education system, then there is something seriously wrong.

The literature on teachers, schools and education tiptoes around the failures of our educators as if we were “treading on eggshells”. Some children are bored by the present system, but the literature is mostly silent. Some teachers make learning drudgery, but the literature speaks mostly of positive outcomes. Some teachers take all the fun and excitement out of our potentially most creative years but few studies focus on the potential foregone. As Edwards (2000) points out, teachers fill young people’s lives with “blah”. To make up for their failings some teachers savage our children in order to maintain control in the classroom, yet few studies report on this kind of unacceptable behaviour.

Focus groups with students on four continents show children are universally bored by their teachers’ lectures and are fearful of closed questions because they are used as a behaviour control method. The students regard copying from the blackboard or making notes from lectures as time wasting. They say they are excited by problem solving, doing and making things, working in groups, engaging in discussions and using technology. Until we admit to the failings of our education system, little will change and we will continue to put our entire civilisation at serious risk. These are critical times and we need more people who can think and act differently or be open to new ideas, new modes of thought and different ways of becoming what we can be.

We are also now at a stage of human development where we have acquired the ability to not only control nature, but to replicate or replace it, often with unintended and unfortunate results. We have devised exceedingly powerful tools at small and large scales that are potentially capable of transforming whole systems that would seem to our ancestors as somewhat “god-like” in scope and power. The opportunity to work the levers of tools with such immense power is not yet available to all but if the pattern of tool evolution and work automation continues into the future, it will not be long before ordinary mortals will have access to this kind of capability as well.

If the idea that human culture is self-organising is correct, and we have already passed through the fourth or fifth bifurcation (see Figure 4.2, page 139), we could be in for a wild ride, for it is at this point, that system-wide chaos emerges in complex systems. This means there is nowhere else to go within the system as it is currently structured. Each new period between transitions is now so short that successive future transformations must be measured not in decades or years, but in months, weeks or even days. The contradictions in the system – the aspects of human activity that do not function as well as they might - are already accumulating at an accelerating rate.

We have a limited range of options. Governments could forcibly require society to regress to an earlier stage of cultural development as did Pol Pot, the Khmer Rouge leader in Cambodia, in which case we could arrange for governments everywhere to compulsorily destroy all our tools and revert to a hunter-gatherer lifestyle. Alternatively, humans could regulate research and development so that it becomes illegal to achieve progress in academic, technological or developmental fields and thereby postpone the next autocatalytic transition or extend the length of the remaining cultural/tool cycles. Neither seems a sensible solution. A more rational alternative would be to embrace change and transform our symbiotic relationship with our tools into a new more intimate relationship. We could perhaps become a joint species of humans/tools, a change that may be already underway.

In this case, if we are to retain our humanity, we must continue to also make use of the simplest of the tools at our disposal – signs, symbols, language, drama, dance, literature, music and art – as well as the new technologies, which we should not simply accept as a panacea for the problems we have yet to face. We must learn live in the rich ways of what it is to be human and not the automated dullness and rigidities of the presbyters, the puritans and the fundamentalists of any kind. We must ensure that creative thinking and playful activity that propels us forward as a species is not

prohibited by those who would take us back to a romantic, more rigid version of a distant but often uglier past.

Human societies have progressed at different speeds towards an “ideal world” and the universal goal of a “better life” for us and our children. It is this ideal but more perfect world of Hegel that I prefer to the materialist world of Marx, for I believe that we humans and our fellow organisms on planet earth - and perhaps elsewhere in the universe - are simply in the process of becoming something more amazing...yet to be imagined and automated. The thinking that we automate then becomes a tool which takes its place in the physical universe alongside or instead of natural organisms or objects, and joins with other tools and our brains in an ever cleverer web of tools that feeds back into the system to generate yet another cycle of period doubling, extinctions and speciations. If only we can learn to deal with the blindingly accelerating speed of change. If we can, then the universe might just become a “physical” instantiation of our best past, present and future collective imaginations. The possibilities are both enticing and frightening. But dialectically frighteningly fantastic, for which the frontal lobes of our “stone-age” brains are perfectly designed.

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APPENDIX I

Participant survey form

STUDENT RESPONSES

Name:

Age:

Class:

Session Topic:

Name of the Facilitator:

Date:

SURVEY 1: COMPLETE ONCE BEFORE THE FIRST SESSION

Think about a classroom activity that you least enjoy. Circle a number closest to how you felt during that session.

I knew what I was doing	1	2	3	4	5	I was not sure what I was doing
The activity was fun and enjoyable	1	2	3	4	5	I was not enjoying this activity
I felt connected to the task	1	2	3	4	5	I did not feel connected to the task
I felt connected to other people	1	2	3	4	5	I did not feel connected to other people
I felt comfortable	1	2	3	4	5	I did not feel comfortable
The time went very quickly	1	2	3	4	5	The time went very slowly
I felt in control of my destiny	1	2	3	4	5	I did not feel in control of my destiny
I felt unaware of my surroundings	1	2	3	4	5	I felt very aware of my surroundings
The task was worth doing	1	2	3	4	5	The task was not worth doing
The task was challenging but doable	1	2	3	4	5	The task was not challenging or doable
We were very creative	1	2	3	4	5	We were not very creative
We had a common goal	1	2	3	4	5	We had individual goals
We all reached similar conclusions	1	2	3	4	5	We all reached different conclusions

SURVEY 2: TO COMPLETE AFTER EACH ACTIVITY

Circle a number closest to how you felt during this activity.

I knew what I was doing	1	2	3	4	5	I was not sure what I was doing
The activity was fun and enjoyable	1	2	3	4	5	I was not enjoying this activity
I felt connected to the task	1	2	3	4	5	I did not feel connected to the task
I felt connected to other people	1	2	3	4	5	I did not feel connected to other people
I felt comfortable	1	2	3	4	5	I did not feel comfortable
The time went very quickly	1	2	3	4	5	The time went very slowly
I felt in control of my destiny	1	2	3	4	5	I did not feel in control of my destiny
I felt unaware of my surroundings	1	2	3	4	5	I felt very aware of my surroundings
The task was worth doing	1	2	3	4	5	The task was not worth doing
The task was challenging but doable	1	2	3	4	5	The task was not challenging or doable
We were very creative	1	2	3	4	5	We were not very creative
We had a common goal	1	2	3	4	5	We had individual goals
We all reached similar conclusions	1	2	3	4	5	We all reached different conclusions

SURVEY 3: COMPLETE ONCE BEFORE THE FIRST SESSION

Please choose one of each of the following that is nearest to what you believe.

Tick one:

- ☐ I accept challenges
- ☐ I like to redefine the problem

Tick one:

- ☐ I like to do things better
- ☐ I like to do things differently

Tick one:

- ☐ I like solving problems
- ☐ I like finding problems

Tick one:

- ☐ I question the reasons given
- ☐ I accept the reasons given

Tick one:

- ☐ I invent new ways to solve problems
- ☐ I use existing ways to solve problems

Tick one:

- ☐ I am methodical, thorough and precise
- ☐ I am creative, original and unconventional

Tick one:

- ☐ I am capable of routine work
- ☐ I take control and help others

Tick one:

- ☐ The big picture is most important
- ☐ The parts are the most important

Tick one:

- ☐ I like to discover how things work
- ☐ I just want to use things that work

Tick one:

- ☐ I like change
- ☐ I like certainty

SURVEY 4: COMPLETE BEFORE EACH SESSION

TOPIC TITLE:

Make a list of everything that you now know about the topic.

Why are you participating in this activity?

In what ways could you benefit from participating in this activity?

SURVEY 5: COMPLETE AFTER THE ACTIVITY

TOPIC TITLE:

Make a list of everything that you now know about the topic.

Make a list of everything about the activity that was useful, interesting or enjoyable

What could be done to make the session more interesting, useful or enjoyable?

Appendix II

Feedback questions for Year 8 textiles and Year 12 history students

What is the difference between using this and normal lessons?

What was your first session with teacher like? How did you react to it?

What did you not like about the session with your teacher...what could have been improved

Would you be liked to facilitate the session after some training? Give your reasons.

When you work/learn this way, how does it change your role and the teacher's role?

What are the rules in a normal classroom? What is expected of you?

What are the rules using the Zing tool?

Which sets of rules is closest you the culture you as young people live in and why?

If you could change the way school is organised what would you do?

What kinds of tools do you use e.g. chat rooms as part of your normal social life, or just the way you live and relate to others?

How much opportunity is there in school to use the tools that you use in your home life? e.g. phone, MSN etc.

Describe some ways that you might use some of these tools in how you learn within the school?

How much time do you spend at school using computers in your learning and how much time at home?

What is your preferred way of learning?

Describe the kinds of activities in which you feel really highly engaged, so that time flies.

Which was more important to your first experience with Zing? The tool or how your teacher used it and why?

What are your hobbies, sports, interests?

What do you excel at?

What kind of student are you academically?

What kind of career do you think you will pursue?

Appendix III

Feedback questions for teachers

Describe in detail what you use the team learning system for? How often, number of people, setting, purpose?

How did you learn to use the team learning system?

What are the main difference between the team learning system and conventional lessons or meetings?

What are the barriers to the use/increased use of the team learning system?

At what stage in your use of the team learning system did it become easier to use? What happened?

Why is play so important?

Under what circumstances does the team learning system not work?

Describe everything the facilitator must do to ensure a successful meeting?

Thinking about the different kinds of questions that you ask in TLS meetings, what works and what does not?

How did you learn to write the kind of questions that work in TLS meetings?

What changes occur in a group when they meet or learn using the TLS?

In what ways does the TLS fit/not fit with the culture of school?

In what ways does fit/not fit with youth culture?

How would you explain the high levels of enjoyment and engagement by students/participants in a TLS session?

Explain how the following aspects of the TLS contribute to its successful use. Etiquette, parallel thinking, reading out aloud, discussion in dyads, theme/summarising, simultaneous view/contribution of ideas, open-ended questions etc.

At what stage does the facilitation process become automatic and how does this come about?

What are the rules for using the TLS?

How did the participant activity influence the facilitator activity?

Appendix IV

Reliability Statistics for Flow before

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.784	.788	8

Item Statistics

	Mean	Std. Deviation	N
FBKNOW	2.76	1.222	79
FBFUN	1.85	1.014	79
FBCONTSK	2.34	.946	79
FBCOMF	2.71	1.134	79
FBTIME	1.72	1.120	79
FBCONT	2.70	1.090	79
FBAWARE	2.23	1.109	79
FBWORTH	2.38	1.233	79

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
FBKNOW	15.92	24.892	.418	.200	.773
FBFUN	16.84	24.191	.627	.446	.739
FBCONTSK	16.34	24.536	.645	.470	.739
FBCOMF	15.97	25.589	.401	.270	.774
FBTIME	16.96	24.345	.532	.400	.753
FBCONT	15.99	25.577	.427	.252	.770
FBAWARE	16.46	27.431	.242	.139	.798
FBWORTH	16.30	22.189	.669	.486	.726

Reliability Statistics for Flow after

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.738	.805	8

Item Statistics

	Mean	Std. Deviation	N
FAKNOW	4.71	.510	79
FAFUN	4.48	.714	79
FACONTSK	4.39	.706	79
FACOMF	4.42	.841	79
FATIME	4.27	.843	79
FACONT	3.99	1.019	79
FAWORTH	4.53	.765	79
FAAWARE	2.91	1.398	79

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
FAKNOW	28.99	14.679	.700	.606	.690
FAFUN	29.22	13.299	.743	.665	.662
FACONTSK	29.30	14.137	.573	.458	.691
FACOMF	29.28	13.306	.597	.447	.680
FATIME	29.43	14.146	.445	.405	.709
FACONT	29.71	12.953	.502	.361	.696
FAWORTH	29.16	15.293	.300	.174	.734
FAAWARE	30.78	14.504	.114	.066	.820

Appendix V

Figure 1. Facilitator group directed graphs with 3-cores

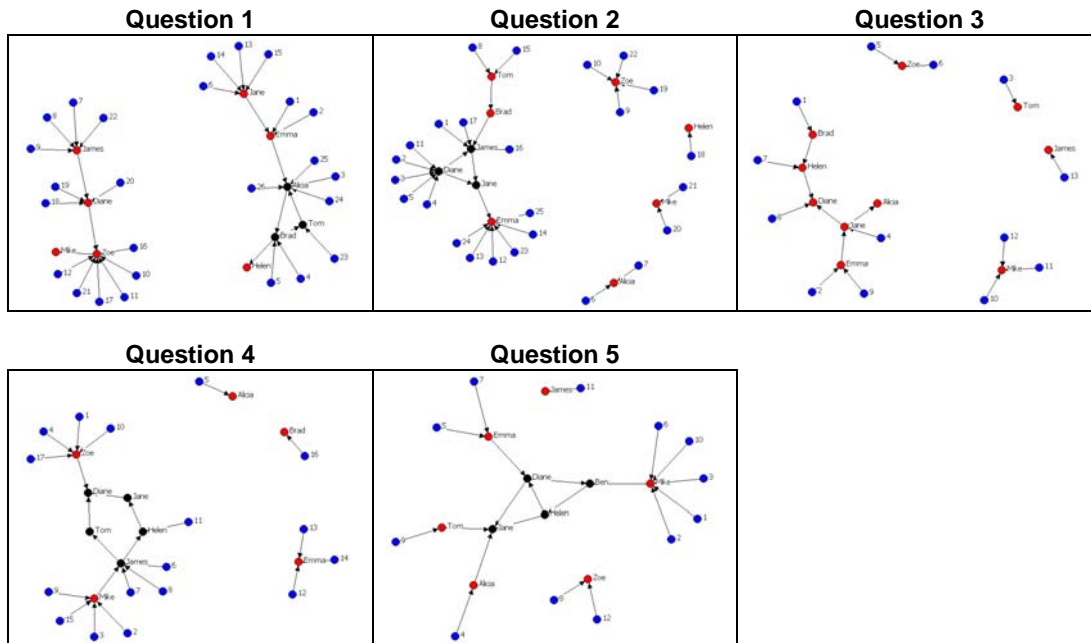


Figure 2: Year 12 history directed graphs with 3-cores

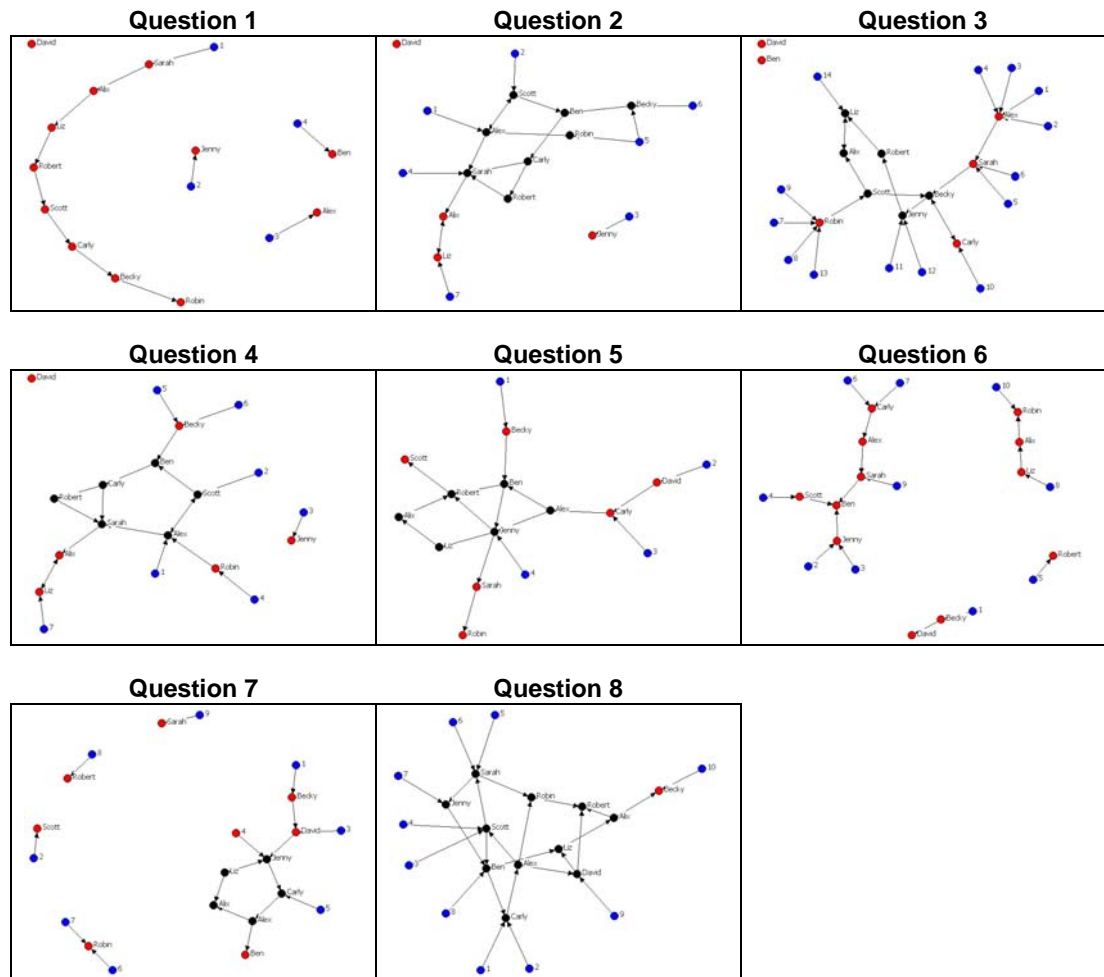


Figure 3: Year 12 cloning directed graphs with 3-cores

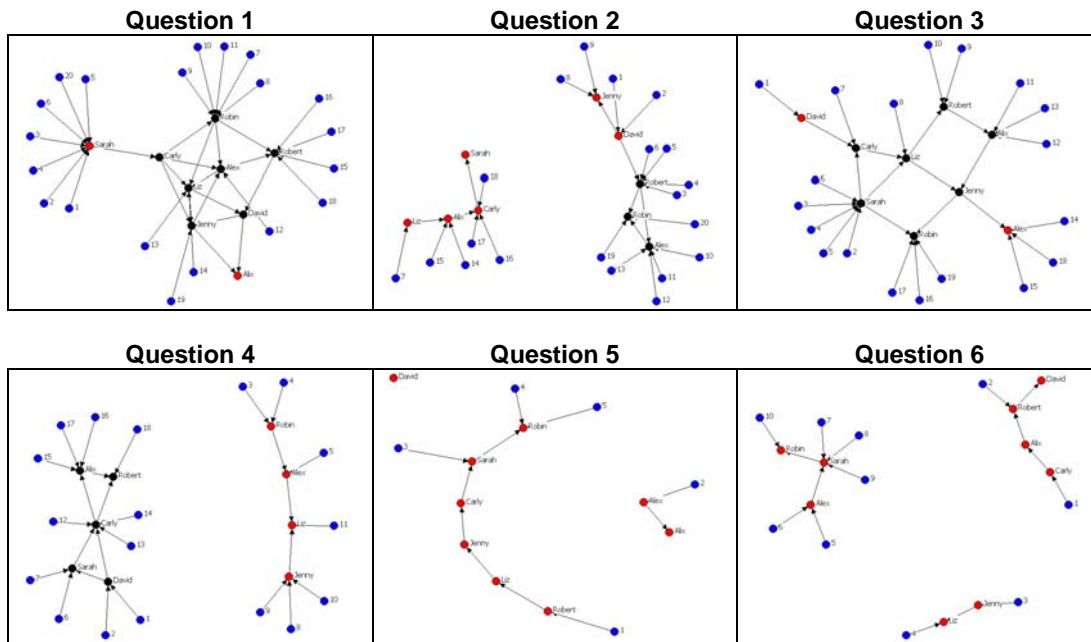
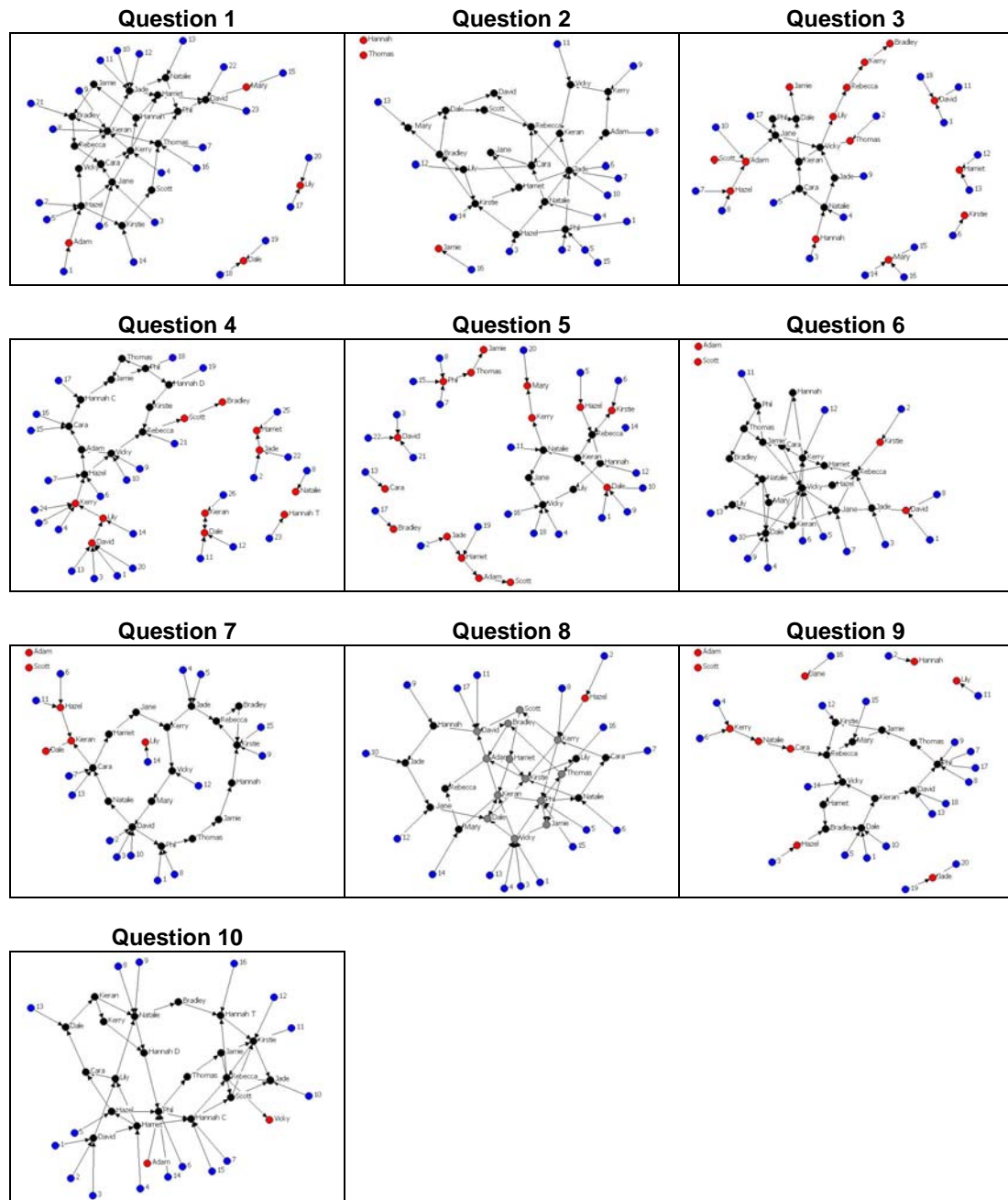


Figure 4: Year 8 feedback directed graphs with 3-cores and 4-cores



Appendix VI

Table 1: Relationship of attitude to learning and first, unique, total, maven and maverick concepts.

Group		First	Unique	Total	Following	Cluster
Year 12 Cloning	Correlation	-.025	.158	.075	-.501	-.040
	Sig. (2-tailed)	.950	.685	.848	.169	.919
	N	9	9	9	9	9
Year 12 Feedback	Correlation	-.402	-.245	-.395	-.225	.170
	Sig. (2-tailed)	.284	.525	.293	.561	.663
	N	9	9	9	9	9
Year 12 History	Correlation	.180	-.063	.401	-.293	.447
	Sig. (2-tailed)	.576	.845	.196	.355	.145
	N	12	12	12	12	12
Year 8 Feedback	Correlation	-.101	.243	.188	-.008	-.373
	Sig. (2-tailed)	.656	.277	.403	.973	.087
	N	22	22	22	22	22
Year 8 Cloning	Correlation	.530*	-.239	-.272	-.252	.130
	Sig. (2-tailed)	.011	.284	.220	.258	.563
	N	22	22	22	22	22

* Correlation is significant at the .05 level (2-tailed).

Table 2: Relationship of quantitative ability and first, unique, total, maven and maverick concepts.

Group		First	Unique	Total	Maven	Maverick
Year 12 Cloning	Correlation	.163	.242	.214	-.100	.158
	Sig. (2-tailed)	.675	.530	.581	.798	.686
	N	9	9	9	9	9
Year 12 Feedback	Correlation	.112	-.099	-.183	-.083	-.427
	Sig. (2-tailed)	.774	.799	.637	.831	.252
	N	9	9	9	9	9
Year 12 History	Correlation	.043	.183	.193	.111	.062
	Sig. (2-tailed)	.894	.529	.548	.732	.849
	N	12	12	12	12	12
Year 8 Feedback	Correlation	-.066	-.081	.075	.261	-.080
	Sig. (2-tailed)	.771	.720	.739	.241	.723
	N	22	22	22	22	22
Year 8 Cloning	Correlation	-.167	.308	.286	.226	.464*
	Sig. (2-tailed)	.458	.167	.197	.312	.029
	N	22	22	22	22	22

** Correlation is significant at the .01 level (2-tailed).

Table 3: Relationship of verbal ability with first, unique, total, maven and maverick concepts

Group		First	Unique	Total	Maven	Maverick
Year 12 Cloning	Correlation	.240	.196	.116	.383	.206
	Sig. (2-tailed)	.534	.613	.766	.309	.594
	N	9	9	9	9	9
Year 12 Feedback	Correlation	-.152	-.128	-.424	-.240	-.048
	Sig. (2-tailed)	.697	.743	.255	.535	.903
	N	9	9	9	9	9
Year 12 History	Correlation	.238	.338	.273	.102	-.030
	Sig. (2-tailed)	.456	.282	.391	.751	.926
	N	12	12	12	12	12
Year 8 Feedback	Correlation	-.288	-.466*	-.192	.249	-.574**
	Sig. (2-tailed)	.194	.029	.392	.263	.005
	N	22	22	22	22	22
Year 8 Cloning	Correlation	-.284	.072	.136	-.160	.234
	Sig. (2-tailed)	.200	.749	.547	.478	.294
	N	22	22	22	22	22

** Correlation is significant at the .01 level (2-tailed).

Table 4: Correlation of non-verbal ability and first, unique, total, maven and maverick concepts.

Group		First	Unique	Total	Maven	Maverick
Year 12 Cloning	Correlation	-.220	-.055	-.094	-.305	-.008
	Sig. (2-tailed)	.570	.889	.810	.425	.983
	N	9	9	9	9	9
Year 12 Feedback	Correlation	-.039	-.124	-.287	-.251	.130
	Sig. (2-tailed)	.920	.751	.454	.515	.738
	N	9	9	9	9	9
Year 12 History	Correlation	-.304	-.006	-.231	.125	-.183
	Sig. (2-tailed)	.338	.985	.470	.699	.569
	N	12	12	12	12	12
Year 8 Feedback	Correlation	-.247	-.122	-.108	.104	.120
	Sig. (2-tailed)	.268	.588	.632	.645	.595
	N	22	22	22	22	22
Year 8 Cloning	Correlation	-.092	.172	.156	.060	.168
	Sig. (2-tailed)	.682	.443	.488	.789	.456
	N	22	22	22	22	22

** Correlation is significant at the .01 level (2-tailed).

Appendix VII

Independent sample t-tests of isolated concepts and concepts in cliques

Facilitators	Concepts in cliques M(SD)	Outlier/unique concepts M(SD)	T	DF	p <
Question 1	5.00(2.64)	13.05(6.61)	-2.05	21	.053
Question 2	4.00(2.65)	14.74(7.21)	-2.52	24	.019
Question 3	1.50(.71)	7.50(3.03)	-2.69	10	.023
Question 4	5.00(4.23)	9.53(5.03)			Ns#
Question 5	2.50(.71)	9.87(4.71)	-2.15	15	.049
Year 12 history					
Question 1	3.00(1.58)	8.00(1.58)	-5.00	8	.001
Question 2	1.00	3.00(1.00)			Ns#
Question 3	3.00(1.58)	7.00(1.00)	-3.87	6	.008
Question 4	3.67(3.08)	9.93(4.59)	-2.23	16	.040
Question 5	2.75(1.71)	5.67(1.53)			Ns#
Question 6	4.35(1.29)	-			Ns#
Question 7	7.50(.71)	4.75(2.85)			Ns#
Question 8	3.33 (2.08)	5.83(2.79)			Ns#
Year 12 cloning					
Question 1	3.50(1.87)	13.5(4.18)	-5.56	18	.000
Question 2	1.00	11.00(5.63)			Ns#
Question 3	3.80(2.59)	12.21(4.66)	-3.79	17	.001
Question 4	2.00(1.00)	10.5(4.18)	-3.42	15	.004
Question 5	1.00	3.50(1.29)			Ns#
Question 6	3.50(3.54)	6.00(2.93)			Ns#
Year 8 cloning					
Question 1	6.57(9.90)	4.99(3.67)			Ns
Question 2	4.00(2.83)	7.75(1.71)	-2.35	8	.046
Question 3	12.62(6.04)	15.80(9.45)			Ns#
Question 4	5.44(3.43)	10.50(2.38)	-2.65	11	.023
Question 5	6.43(4.89)	12.69(5.35)	-2.57	18	.019
Question 6	4.00(4.23)	13.78(7.09)	-1.90	23	.070
Year 8 feedback					
Question 1	6.00(5.96)	13.79(5.98)	-2.59	22	.017
Question 2	5.00(4.32)	9.09(4.18)			Ns#
Question 3	2.75(1.71)	10.50(4.18)	-3.56	13	.044
Question 4	1.00(13.00)	13.00 (6.78)	-1.73	22	.097
Question 5	8.00(4.78)	12.81(6.69)			Ns#
Question 6	5.88(3.87)	10.43(4.04)	-2.23	13	.044
Question 7	3.83(2.48)	10.78(3.07)	-4.61	13	.000
Question 8	4.80(3.11)	10.75(4.71)	-2.57	15	.021
Question 9	7.29(5.06)	12.23(5.78)			Ns#
Question 10	4.29(2.69)	11.78(3.07)	-5.10	14	.000

Ns = not significant, # Higher mean

Appendix VIII

Sample of the session reports: Page 6 of the teacher's feedback session

1.10. *What changes occur in a group when they meet or learn using the TLS?*

1. Debbie: tend to get excited
2. David: individuals come on board and become part of the team
3. Zoe: they develop ideas from one another - work more collaboratively
4. Debbie: like to talk to someone else before they type in the result almost seek approval from another
5. James: Locus of control changes within a class, dynamic changes and becomes far more student centred than teacher centred. Class gets louder as discuss what to type, more engaged, collaborative approach
6. Zoe: they laugh more together
7. David: groups go through eh storming, forming norming and performing of the session is long enough and if the facilitator sets out the intended outcomes
8. Debbie: fear of useage of the tool turns to enjoyment
9. Zoe: they aren't so afraid to take risks with their answers
10. James: Those students that usually dominate if allowed actually appear to become more subdued
11. David: ideas become shared and copied
12. Debbie: students become quite adventurous with their ideas
13. Zoe: they are eager to respond and take part (on the whole)
14. David: lower ability become more engaged as they are not laughed at
15. James: Group becomes more creative, especially after the first couple of lessons
16. Extra Question: Who were the inventive ones in your classes and what did they normally do?
17. James: (name of student) was probably the most inventive and I would suspect that she was probably slower than usual at inputting the data - spent time thinking
18. James: She was dominant normally in class

1.11. *In what ways does the TLS fit/not fit with the culture of school?*

1. David: anti chalk and talk stage on the stage
2. David: not the normal way of downloading content into children
3. Zoe: students are usually expected to make their own notes to keep for later use
4. David: removes the dominance of the teacher
5. James: It is more student centred than probably most lessons. The students will probably say that they do not normally have the freedom to express themselves in lessons - due to culture of our examination system rather than the institution
6. Debbie: the students can control the lesson more by their answers rather than having to do exactly as the teacher says
7. Zoe: if the session is anonymous then we wouldn't be able to assess their understanding and involvement
8. David: asks the teacher to be a facilitator of learning not the sage of all learning

1.12. *In what ways does fit/not fit with youth culture?*

1. Debbie: it does fit with the culture
2. David: fits very well as student voice is part of the process we are developing
3. David: they like technology
4. Zoe: it fits because it allows them to all talk at once
5. David: it is inter-active learning

Sample of the video transcript: Page four of Ms. Zoe's workshop with Year 8 textiles

30.34	Notices some typed comments appearing on screen. Points to comments, wiggles finger to indicate the typist should backspace	Teacher: Number ten. Who is number ten. Who is just pressing. Now take it back. Is that you David? Right, whose number 10? We'll find out in a minute but it would be better if you would just own up now.
31.03	Walks around classroom as students complete surveys.	Teacher:(Series of comments regarding the process of collecting preliminary data)....
37.35	Standing next to the wall-mounted monitor, then goes back to walking around front of classroom	Teacher: ...apart from it takes me an awfully long time to set it all up but it helps me because I don't have to keep writing on the board, and if any of you can remember what my writing is like...sometimes it is a little bit difficult to read. OK.
37.49	Approaches wall monitor and points to the screen, and sweeps hands in an arc around the screen. Then uses hands to emphasise points made.	Teacher: So what is it all about? We use this....we use this hardware for meetings and similar sorts of things because what happens is it allows all of you to put in all of your ideas all at the same time. If you look in front of you, you've got a keyboard in front of you, and each of those keyboards relates to one of these boxes. I don't want you to do anything with it now. I want you to take turns and play nicely and share rather than one of you...one of you with keyboard skills can take over. I want you to share between you. And what we are going to do is I'm going to take you through the process of how you use them, and we are going to have a few fun questions and a few different things and then we are actually going to brainstorm our design brief, ie. your shorts, so it should help you in producing your first piece of work. Alright. So what I want you to do to begin with, is I would like you to just type....the first one first...type in what you had for breakfast this morning. Yes. Not yet. Not yet. I want you to type in what you had for breakfast this morning. And what you will see is it will come up in a little box. Once you have typed it in and you are happy with that...can you all locate the F9 key on your keypad and Yeh...because what would happen is...
39.20	Moves to one of the tables and types on a student keyboard	Teacher: Say for example I just come over here and take over Kirstey's and I typed in, OK, check up there, is it working, Students: (chorus of Yehs, and Yes, No. 1) Teacher: ...cornflakes. And if I pressed F9...can you watch it...for me.
39.35	Monitor view of the software.	Teacher: And what happens is its gone in cornflakes, which is wrong...and...
39.38	Teacher goes over to her computer on the teacher's desk and starts to make changes with mouse and keyboard	Teacher: So we will just change that (inaudible) quickly. So we need to...um....bear with me... Student: inaudible comment Teacher: ...no we don't want to....
39.55	Teacher finishes making the changes, and looks up at the wall-mounted monitor to see if the change is reflected there.	Teacher: that one...it won't let me...I'll type it from here...if I type F9 it goes up there....
40.01	View of the screen	Teacher: Yes...If I write I had porridge...and I realised I spelt it wrong...you can use the backspace...the backspace deletes...and if you move your cursor with the little directional arrows down the bottom, it will take you back a and forwards...

Sample of the concept analysis: First two questions of Year 8 Feedback

1. What are the differences between the TLS classroom and your normal classroom?																					
Student	More Fun	Share views	Work together	Quiet get a say	Inclusivity	View is heard	Sense of belonging	Less noise	Keyboard skills	No raising hand	Turn not controlled by teacher	No shouting out	Concentrate on ease	Time goes faster	No handwriting	Better/superior for	Recognition	Better for theory	Not for practical	Teacher sees your ideas	Immediacy
	3													1	2	6		1	1		
	7		1	2	2	1							1			4					
	1	4			6																
	10					3					1	1				3	7				
	4			1	3	4					2					5					
	6			3																	
	2																				
	5		2			4										2					
	2		1			1										1				1	
	11				7	2											1				
	8																				
	9				5															1	
2. What was your first session with your teacher like? How did you react to it?																					
Student	Fun	Brave learning	Novel, new (idea)	Not like class	Good, great idea etc.	Strange	Easier	Expensive	Learned a lot	Different	Not used (keyboards) before	Exciting, interesting	Wanted repeat	Share/heard ideas	Teacher not strict	Better than sewing					
	14		2									4			1						
	12										5	5									
	4			1																	
				3	4																
	6							1													
	16									2	4										
	15																				
	7								1												
	5				2	1	1							2							
	2		1		3											1					
8					1						1										
9						2					2										
1																					
3			1																		
11																					
10																					
1																					
13				2																	

Appendix IX

Information letter to parents

Research Project: Information Sheet and Consent for Parents of Students

During the next few weeks Mr. John Findlay of Sydney Australia will be visiting the school to undertake research into how our teachers and students use our Zing team learning system for classroom activities.

Mr. Findlay is undertaking the research for his doctoral thesis at the University of Wollongong in Australia. He is a regular visitor to the school in his capacity as the CEO of Zing, a supplier of learning systems to the school. He has facilitated many learning and planning activities with the staff and students over the past three years he has been associated with us. The results of the research will be used to develop a new theoretical model that may help learners and teachers be better prepared for increasingly rapid social, technological and workplace change.

The sessions will be recorded on audio and video and observed at the time of reporting in a special classroom set up for the purpose. A transcript of the student responses will also be recorded and reviewed. Students will also complete a short test of their prior knowledge of the topics to be covered during the sessions and a further test after the activities are completed. They will also be asked to complete questionnaires about how they prefer to adopt or use new technology and ideas. The learning activities will be facilitated by the student's classroom teacher or a student who has been trained as a classroom facilitator. There will be a series of learning activities in mathematics, English and science as well as cross-curriculum activity dealing with topics the students have or will be studying this year.

Should any students be unable to participate in the research activity for whatever reason, they will be provided with equivalent work to undertake as a private study activity.

If you are happy for your son/daughter to participate in the sessions, to respond to the confidential questionnaires, and for an audio and video record to be made so the student-student and student-teacher interaction can be observed and reviewed and used as the basis for academic publication, would you please sign a copy of this letter and return it to the school.

I give my consent to.....participating in the research project, and give permission for the video and audio record to be made and used as the basis for academic publication..

Signed.....

Name:.....

Address:.....

Relationship to student:.....

Date:.....

Important note: If you have any queries or complaints about the research, you may contact the Ethics Officer at the University of Wollongong, (Tel: +61-2-4221-3386) or by email, office_research@uow.edu.au.

Research supervisor: Dr. Katherine Crawford, Faculty of Commerce, University of Wollongong