SUPPORTING CHILDREN'S WORKING THEORIES IN EARLY CHILDHOOD EDUCATION:

WHAT IS THE TEACHER'S ROLE?

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Victoria Hargraves

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Abstract

'Working theories' are recognised as a significant outcome within the early childhood curriculum Te Whāriki (Ministry of Education, 1996), and yet there is a notable lack of research into how this particular way of constructing knowledge is understood and informs teachers' roles.

This thesis documents the growth in understanding and practice that occurred as a result of my self-study, as an early childhood teacher, into teaching practices which support children to articulate and develop their 'working theories'. Theoretical perspectives considered for the illumination of this under-theorised concept include cognitive constructivism, sociocultural theory and complexity theory. Drawing on the findings from the observation of my own teaching over four episodes, some insights about the way that children seem to form working theories in this context, and the nature of their working theories are put forward.

The methodological approach was informed by complexity theory, which recognises teaching as a complex act in an 'open' system (C. Robson, 2002), and 'living theories' methodology (Whitehead & McNiff, 2006, p.9). Both supported me to reject the possibility of any one view of best practice (B. Davis, Sumara, & Luce-Kapler, 2000) and instead offer a personal account of the way that I am seeking to realise my educational values through my practice (McNiff, 1993).

Important concepts which helped me to explain and understand my own teaching practices in supporting children to develop working theories are offered, with key teaching roles conceptualised as 'supporting visibility' and 'extending depth and breadth', within 'open and focused themes' and a 'context for sharing ideas'. A metaphor is introduced, and the findings of the research related to conceptions of thought as a rhizomatic act (Deleuze & Guattari, 1987). The study thus offers multiple possibilities to support teachers to reflect upon their own practice engaging with children's emerging theories.

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Supporting children's working theories in early childhood education:

what is the teacher's role?

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What about if the shaking came from somewhere else?

A monster shaking in the house!

What about if a monster was inside the house shaking it?

No it lifted up the house and shook it!

(Exploring working theories on earthquakes, Vicki, Sabrina, V1, 012)

Chapter 1: Introduction

The generation and modification of working theories is stated as a key component of New Zealand's early childhood curriculum, *Te Whāriki* (Ministry of Education, 1996). Working theories are defined in this study as tentative and provisional ways of connecting knowledge and experience in order to make sense of the world and act effectively within it. My research shows that children have particular ways of constructing theories, and an awareness of this has the power to transform teaching. This research also demonstrates my learning through a self-study of my personal pedagogy, and develops my own working theory of the kind of teacher role that supports children to develop working theories. There are parallels between my processes of theorising and those of the children.

This research is sited within debates about how best to conceive the teacher role in our current sociohistorical context. Research seems to agree that neither instructional approaches of "mindless drill or academic seatwork" (Farquhar, 2003, p.31) nor free-play without teacher involvement are optimal approaches for supporting children's thinking. Instead, a mediating role for teachers is suggested, in which teachers interact with children's learning and are involved in, plan for and initiate activities for children (Hedges, 2007; Siraj-Blatchford, 2004). Yet this mediating role seems to require development and elaboration for many early childhood teachers (Anning, Cullen, & Fleer, 2004). My research makes an attempt at exploring and articulating a possible approach.

This chapter begins by outlining perspectives on the role of teachers in young children's learning, and introduces *Te Whāriki ,* the New Zealand early childhood curriculum, from which the concept of working theories is drawn. I also introduce myself as the researcher, as well as the research questions, and methodology.

1.1 Teacher role in early childhood education

Both the historical development of early childhood education and the theoretical frameworks available to early childhood professionals have influenced the ways in which the teacher's role has been constructed (Dalli, 2002; Marsh, 2003; Nuttall, 2003). At present there are several theoretical perspectives on children's thinking and teacher role which are productive in determining both early childhood institutions and teachers' work (Dahlberg, Moss, & Pence, 2007). The two most dominant in Aotearoa New Zealand are developmental constructivism and sociocultural theory (Cullen, 1996; Nuttall, 2003). These theoretical discourses are resources for the shaping of teacher identity (Marsh, 2003) and thus are a powerful influence on how teachers teach and interact with children.

1.1.1 The historical context and theories of thinking

The historical alignment of early childhood provision with care rather than education (Powell & Bingham, 2002) has perhaps been an important factor influencing the teacher's role in early childhood education today. In New Zealand, the first forms of early childhood provision were concerned with the survival and physical health of young children (May, 2005). Post-war, ideas of freedom and democracy became very important, and, alongside a perceived need to ensure children developed into well-adjusted and happy adults, were translated into notions of free play (May, 2001). At this time, the pedagogical work of early childhood teachers was informed by Piaget's developmental constructivism (May, 2001). Children's cognition was seen to naturally develop through several stages and required only opportunities for independent exploration at the appropriate stage.

Piaget's stage theory, with its implications for developmentally appropriate practice and a diminished role for the teacher, remains influential today, despite the academic critique of this theory for generalising children (Hedegaard & Fleer, 2008; Janzen, 2008) and for downplaying the important role of the social and historical context in development (Donaldson, 1978). Where Piaget believed that children construct their own schema and mental modelling through their own experience and only later are socialised to use conventional signs (Venger, 1988), socioculturalists, while agreeing with the constructivist nature of cognition, argue that all experience is socio-historic and therefore mediated. This introduces a dynamic into development, and offers teachers a mediating role in shaping learning, increasing their role from that of bystander (Tayler,

2001). The sociocultural perspective creates a place for teachers' pedagogy, which can be defined as involving "informed interpretations of learners, knowledge and environments in order to manipulate environments in ways that help learners make sense of the knowledge available to them" (A. Edwards, 2001, p.163). The concept of pedagogy, however, is somewhat at odds with Piaget's constructivist perspective that sees development as predetermined and naturally unfolding.

Vygotsky's sociocultural model of cognitive development has been expanded in recent decades and its application to early childhood education has been widely promoted, although this has not been without critique (see, for example, Lambert & Clyde, 2000). However, it has been suggested that the tradition of free, child-initiated and uninterrupted play is a barrier to further development of the role of the teacher and prevents newer sociocultural ideas, such as socially constructed and mediated learning, informing pedagogical practice (Nuttall, 2003).

1.1.2 Current 'working theories' for the role of early childhood teachers in young children's thinking

Research shows teachers' beliefs are often based on developmental constructivist theory (Jordan, 2004) and so teachers are reluctant to take an interactive or more proactive role to stimulate children's learning (Meade, 2000). This perhaps contributes to low levels of "effective spontaneous mediation" (Kozulin, 2003, p.20). Fleer and Raban (2006) agree that the traditional non-interventionist philosophy is an issue, and argue that there is a need for a more active role in developing cognition. Mediation is associated not only with developing children's thinking but with wider societal goals such as reducing inequality, while the non-interfering approach to early childhood education is associated with maintaining the status quo. Thus "those who restrict their work to facilitation are neglecting their civil duty to teach in a society where there is social injustice and inequality" (Siraj-Blatchford, 2004, p.137).

Mediation needs to respect "children's decision chains" (Meade, 2000, p.22) yet incorporate teaching support into those learning pathways to help them become longer and more complex. Although sociocultural theory seems to support teachers' involvement in learning, Fleer, Anning and Cullen (2004) argue that "enacting socio-cultural theory into practice requires active re-conceptualisation on the teacher's part" (p.188). This is recognised as a process which requires much effort and time and

presents several challenges for early childhood teachers (Tayler, 2001). My research entails such a process of re-conceptualisation.

Further reason for developing socioculturally informed pedagogical roles in early childhood is the inclusion of sociocultural theory in the national curriculum document, *Te Whāriki* (Ministry of Education, 1996). Nuttall (2003) describes this curriculum document as having "sociocultural, constructivist theoretical assumptions" (p.162), placing these two major perspectives side by side. However, it may be the tension between sociocultural and developmental perspectives in the curriculum document (Cullen, 1996) that leads to difficulties with the implementation of sociocultural approaches. This confusion makes it necessary for teachers to engage in making their assumptions, as enacted through practice, more explicit and to develop knowledge about their teaching role (Nuttall, 2003).

It is suggested that in order to deconstruct and reconstruct teaching roles in early childhood education, qualitative studies of children's learning and pedagogical practice are needed (Meade, 2000), which merge theory, research and practice-based knowledge (Hedges, in press, November 2011). This self-study therefore attempts to synthesise concepts developed through my practice with the theory and research developed in the field. The teacher's role is considered in relation to a specific outcome for children in early childhood education in New Zealand, that is, the construction of working theories.

1.2 Outcomes for early childhood education in New Zealand: working theories, dispositions and *Te Whāriki*

Te Whāriki is a non-prescriptive, child-centred curriculum, which, instead of listing learning outcomes and knowledge for acquisition, identifies two broad aims of 'working theories' and dispositions for learning (Hedges, 2007; Meade, 2008; Ministry of Education, 1996). This early childhood curriculum invites complexity and uncertainty in refusing to specify discrete learning outcomes and in embracing relationships, communities and a range of contexts for learning. The curriculum document aims for children to become "capable and confident learners and communicators" (Ministry of Education, 1996, p.9), and seems to suggest that this occurs through children developing both particular dispositions and the ability to think for themselves.

In our current sociohistorical context, in which information is easily accessed, the ability to think creatively and critically is regarded as important. Learners in today's

context have to "cope with super-complexity, uncertainty, and the need to produce, as well as use knowledge" (A. Edwards, 2001, p.174). Research internationally, and across sectors, demonstrates an increasing emphasis on thinking skills, both in policy and teachers' professional development (Taggart, Ridley, Rudd, & Benefield, 2005; G. Walsh, Murphy, & Dunbar, 2011). Working theories as an outcome for early childhood seems to reflect this emphasis on thinking and knowledge production.

However, the curriculum concept of working theories is under-theorised and under-explored. This is further underlined by the volume of research and professional development on dispositions, which has led to a situation which is "out of balance, with little focus on working theories" (Meade, 2008, p.3), and little research on how teachers interpret and implement this curricular aim (Hedges, in press, November 2011). The sparse research focuses on teacher role (K. Davis & Peters, 2010a, 2010b, 2010c; Peters & K. Davis, 2011; Simmons, Schimanski, McGarva, Cullen, & Haworth, 2005) and only one researcher (Hedges, 2007, in press, November 2011) has attempted to theoretically position the term. My research contributes to both streams of this work.

It is suggested that research which stimulates an increased focus on the concept of working theories can lead to richer pedagogical practices (Hedges, in press, November 2011) as well as better understanding. This research offers one example of how the notion of working theories has been interpreted and utilised in pedagogical practice.

1.3 Conceptualising the problem and an initial 'working theory'

The present research recognises the challenges for pedagogy that the notion of 'working theories' presents early childhood teachers, and seeks to explore the implications of this form of knowledge creation for practice. Further, some specific tools and concepts for the teacher's role are put forward to help further develop and highlight sociocultural pedagogical techniques which are under-utilised in early childhood education in New Zealand. This study tentatively puts forward one set of ideas around the teacher's role and seeks to contribute to the beginning debate.

1.3.1 Delimiting the study

This research considers what working theories look like, how they might be recognised, and which teacher actions are most supportive in my specific early childhood environment, according to my context and my personal values. The underlining processes by which children create and modify working theories are not fully explored,

but the focus is on that which, as an early childhood teacher, I can influence most effectively, that is, the social and cultural environment that I create.

1.3.2 My research questions

What strategies do I use to encourage thinking and theorising? Which appear successful in engaging children's thinking and theorising?

What concepts support me to articulate teaching practices in this area?

How can these strategies be aligned with, and informed by, my personal values, to improve my teaching?

1.4 Methodological approach: modifying my working theory

I theoretically position myself within a postmodern perspective that questions the possibility of objective knowledge or truth (Dahlberg, et al., 2007; Gergen, 2001; Janzen, 2008). Instead of objectivity, multiple perspectives and positions are possible as a result of the fact that all action, knowledge and indeed subjectivities are socially and culturally produced (Dahlberg, et al., 2007; Gergen, 2001). I acknowledge the complexity and diversity as well as the specificities of real situations (Dahlberg, et al., 2007; B. Davis, et al., 2000). These understandings are reflected in the methodology, which sought to embrace complexity, multiple interpretations, and be guided by values rather than the possibility of accurate truths. Thus a detailed, and small-scale, personal study was undertaken.

A qualitative self-study of my practice as an early childhood teacher working with young children was informed by a 'living theories' action research methodology (Whitehead & McNiff, 2006). Possibilities for action were informed by current literature and ensured that my actions were both anchored in, and contributed to, a strong theoretical knowledge base. The methodology of action research into personal living educational theories, while subscribing to the view that practice can inform theory, inevitably creates theory that is highly personal and contextualised. Complexity theory, which recognises teaching as a complex act in an 'open' system, also supports this approach in rejecting the possibility of describing an independent, definite and singular reality (Law, 2003), or any one view of best practice (B. Davis, et al., 2000).

The research focused on detailed study of four different activities, carried out over four months. Grounded theory analysis techniques were used inductively to uncover

concepts and possibilities from the data. Much care was taken to ensure that the data was thoroughly interrogated for alternative meanings, to ensure that my research, being a self-study justified by my personal values, could still be recognised as having wider relevance and significance. Further, grounded theory analysis enabled me to integrate and synthesise the many concepts and influences identified within this complex area of study, in order to be able to offer a simple and more effective way to conceptualise a pedagogical strategy for supporting children's working theories.

1.5 Introducing myself as a researcher: My value base

As a personal 'living' theory of how I might further support children in the construction and modification of working theories, the strategies proposed are deemed appropriate against my particular set of ontological, epistemological and pedagogical values. These values have therefore deliberately shaped the findings and interpretations. Articulating my values provides context for the research, offers insight into me as the researcher, and also contributes to rigour (Darlaston-Jones, 2007; McNiff, 1993; Meade, 2000).

Ontological values: theories of being

I believe that people are social and cultural beings, and are created by, and in response to, their interactions and circumstances. Unique life journeys entail differences, which should genuinely be respected as contributing to a diversity of perspectives that expand and increase our knowledge. Through communication, and in particular, through listening, I believe people should seek to understand each other. I value democracy, which involves enabling participation, and finding possibilities for collaboration and ways forward generated by the interplay of different perspectives. This requires relationships of equality and often means actively working to reduce the power differential. Being open to other perspectives means we can see our own perspective as one alternative, be critical of our own thinking, and be more purposeful in the ways we choose to think and act.

Epistemological values: theories of knowledge

I take a postmodern view in recognising knowledge as multiple perspectives which are all valid, as a consequence of the plurality of social and cultural experiences (Gergen, 2001). No one perspective can claim objective, singular truth, instead, many truths exist, and all knowledge is provisional and contestable (Dahlberg, et al., 2007).

While often children are positioned as knowledge-less, my belief in many knowledges legitimises children's knowledge: my experience has been that, from their point of view, and through their lens of experience, children's theories make sense. I value the activity of individuals creating their own autonomous theories and of being open to the theories of others as a part of a democratic learning community. I believe education should encourage children to develop their own creative theories about how the world works, to participate and communicate, to think critically (McNiff, 2007) and yet also respect other viewpoints while tolerating uncertainty and disagreement (Dahlberg, et al., 2007).

Pedagogical values
I believe these values and beliefs combine into a coherent pedagogy. Therefore in my teaching role I aim to listen and seek to understand children's theories and perspectives. I aim to create an open and safe context for the expression of difference, showing respect, and openness to many possible theories, while seeking more equitable participation.

Interrogating my values and their impact on the research
I have questioned my values and identified their connection to my social and cultural contexts, as well as determined how they might influence the processes of the research and interpretations of the findings. This process also enables me to improve the rigour of my research.

I questioned my understanding and valuing of democracy and difference in relation to my background of privilege, growing up in a white, middle-class family in England, which puts me in a position of dominance across the world through widespread processes of colonisation. Yet it is perhaps this implicit link to such undemocratic processes, coupled with travelling and meeting people from very different backgrounds, that commits me to values such as respect and democracy.

I am aware I hold beliefs around teaching which relate to beginning my early childhood teacher education and career in England, where teaching focuses much more on concepts and learning outcomes. As the UK's Foundation Stage curriculum (Department for Education and Employment, 2000) is much more specific, the teacher leads the learning and attempts to manipulate children's play activities to achieve the prescribed learning outcomes. I believe my experience in England, while leading me to

embrace the freedom of emergent and interest-led curriculum (Hedges, 2007) in New Zealand, also leads me to conceptualise the curriculum often offered in early childhood settings as lacking rigour and direction. My motivation for this research project comes from seeking to find respectful, child-focussed ways of teaching that enhance and challenge thinking.

I must also recognise the impact of my learning about the pedagogy of Reggio Emilia, itself a product of its own social and cultural context (for an overview, see Maldonado & Winick, 2003), which interested me because it challenged children to articulate theories about complex issues such as light and shadow (Malaguzzi, 1996). I loved the way that these teachers saw the children with the potential to construct elaborate knowledge. I have considered that my motivation may be one of emulation. I may be attracted to the aesthetics of the children's theories, which are often poetic, intelligent and beautiful. Yet another reason this approach resonates so deeply with me is because although as a child my 'working' theories were respected by my parents, I poignantly remember being ridiculed by an older cousin. This experience propels my respect for children's thinking potential.

1.6 The significance of my contribution to evolving 'working theory' theory

In being an account of my attempt to improve how I, as a teacher, support children to create and develop working theories for understanding and acting in the world, this research has much to offer those interested and involved in the cognitive development of young children. Through examination of the concept of working theories, a synthesis of literature and observations of children constructing theories, I am able to suggest some specific strategies that early childhood teachers might find useful, but also suggest possible future directions for the way we conceive of children's thinking and the teacher's role within it. Like the children in this study, I am creating my own working theory. While cognitive constructivism and sociocultural theory are common bodies of knowledge utilised by teachers in the construction of their own working theories about pedagogy, this research adds some new resources from complexity theory and from poststructuralist philosophy that can also inform our working theory on teaching. My working theory is provisional, and open for modification; I welcome critique and debate.

1.7 Outlining the thesis

Chapter Two begins with a review of literature on working theories, and provides a synthesis of the meaning of this term in *Te Whāriki* (Ministry of Education, 1996) while seeking to develop further understanding with reference to wider literature on theories. Both constructivist and sociocultural pedagogical techniques are reviewed for potential to inform teacher support for working theories, and then complexity theory is introduced as a way of integrating the competing and complementary aspects of these theories. The insights of complexity theory are considered in relation to pedagogy.

Chapter Three details the methodological approach taken in the research. It draws on complex, postmodern and sociocultural perspectives in seeking to highlight the culturally and historically situatedness of the research, and the impossibility of prescribing a formula or recipe for teacher action. This chapter introduces living theory, action research, complexity theory and grounded theory in order to develop an appropriate research method.

The following two chapters outline the findings from the research, regarding children's construction of working theories, and the teacher's role in this, respectively. The findings in Chapter Four suggest particular features of children's working theories and contexts for their deployment, whilst the findings about the teacher's role in supporting working theories in Chapter Five are synthesised into a model of supportive practice. A simple metaphor is then presented which highlights the principal features of my practice.

Chapter Six discusses the findings in relation to the literature reviewed in chapter two, then introduces new literature sought for my developing understanding of the nature of children's thinking and theorising. This literature supports me to argue for new possibilities for conceiving the teaching role.

Chapter Seven concludes the thesis and demonstrates how this work, in connecting and interrogating the literature, the observations of children's thinking, and of teacher action, develops its own working theory that has much potential for increasing our understanding of how to support children's working theories. Finally, possibilities for further modification of the theory both through practice and through future research are discussed.

Chapter 2: Literature review

This literature review unpacks the notion of working theories, and attempts to define the concept. For this, it draws principally on *Te Whāriki* (Ministry of Education, 1996), although some other sources are useful to further the definition. An attempt is then made to link the concept of 'working theories' to theories of human cognition and cognitive development. One of these theories is cognitive constructivism as led by Piaget's work, which explains cognition as an internal (within the individual) process. A further set of theories are explored which are indebted to the work of Vygotsky and sociocultural theory, and have a particular focus on the cultural and historical (Holland & Lachicotte Jr, 2007): distributed or situated cognition perspectives, communities of practice theories, and cultural-historical activity theory. These theories are linked in their insistence on complexity, local diversity and mutual and dialectical influences, however, some differentiation is attempted because the term 'sociocultural' is ambiguous (Seifert, 2002) and conceals "a myriad of different positions" (Daniels, Lauder, & Porter, 2009, p.3). After comparing and contrasting cognitive constructivism and sociocultural theories of cognition, a complexity theory perspective is then explored. Each perspective, the constructivist, sociocultural and complexity view, offers different strategies and principles for supporting children's thinking and construction of knowledge. These are then applied flexibly, with regard to context as well as educational values, in the research study.

2.1 Defining 'working theory'

"Working theory" (Ministry of Education, 1996, p.82) is a term relatively unique to New Zealand's early childhood document *Te Whāriki*. This document forms the principal source for understanding the term, while the wider literature on theorising as a cognitive process offers further resources to support a definition. Thus far, few researchers have attempted to unpack the potential meanings of the term 'working theories', (a notable exception is Hedges, 2007, and in press, November 2011), although an understanding of the theoretical positioning of the concept would support teacher's practice (Hedges, in press, November 2011).

2.1.1 'Working theory' in early childhood curriculum

Working theories are described in the curriculum document as being formed of knowledge, skills and attitudes, used for making sense of the world, for control over what happens, for problem solving and further learning (Ministry of Education, 1996).

By synthesising this description of working theories with the document's aspiration statement for confident and capable children, it seems working theories describe the tentative and provisional way that knowledge (including skills and attitudes) is mobilised by children to make sense of the world and to effectively act upon it and within it. There are three points worthy of mention in this synthesis.

The first point to be made is that there is an expectation of agency in the child. Simmons, et al., (2005) also recognise that working theories are linked to a view of the child as rich, powerful and competent, and they make comparisons to the practice and philosophy of the preschools of Reggio Emilia. The agency of children points to the constructivist notion of children developing their own knowledge and theories, a notion which underpins the concept of working theories according to the curriculum writers (Hedges, 2008). However, the concept of capable and competent children can be critiqued as a rather idealised notion that does not take account of the distribution of power and control which affect the development of competencies (Bernstein, 1996).

A second important point is that in this definition the development of theory serves particular functions. The early childhood assessment exemplars suggest that working theories are useful (Ministry of Education, 2007) while the wider literature on theorising defines theory by function. The specific functions served include explanation, prediction (Christmann & Groeben, 1996; Gopnik & Meltzoff, 1996; Inagaki & Hatano, 2002) and technology (Christmann & Groeben, 1996), so that a theory involves making connections between experiences and events, identifying causal relationships (Anderson, et al., 2001; Gopnik & Meltzoff, 1996; Inagaki & Hatano, 2002), and connecting concepts to "an at least implicit argumentational structure" (Christmann & Groeben, 1996, p.48). Working theories are also seen as being made up of links between experiences, and specifically linked to the use of knowledge to make sense of the world (explanation) by Hedges (2008), and Peters and K. Davis (2011). However, in being comprised of skills as well as knowledge, I would suggest that working theories aid not just understanding, but effective action. Because of this, they are likely to be modified according to purpose; theories are likely to be constructed in particular ways, for particular aims and motivations. Hedges (2008) supports this view by noting that working theories are transformed into actions within sociodramatic play, for example.

The final point is that children's theories are 'working' theories, which suggests that the way that knowledge is used and applied in a child's theories is not fixed, but in progress and subject to modification. 'Working' is interpreted by Peters and K. Davis (2011) to mean "something being elaborated, developed or tuned" (p.11). The curriculum document *Te Whāriki* refers not only to the generation of theories but also their modification (Ministry of Education, 1996), while the assessment exemplars suggest working theories reflect dynamic exploration (Ministry of Education, 2007). Refinements and extensions are made as a result of new learning, experience and information (Hedges, 2008; Peters & K. Davis, 2011) and occur slowly over time, so that at a given moment the theory can seem to be relatively stable (Peters & K. Davis, 2011).

Wells (1999) too argues that theorising is an important activity in an ongoing process of developing knowledge. The theory becomes an artefact or tool that mediates further knowing and further theorising, by the creator and by others (Wells, 1999). 'Working theories' may be an appropriate way to conceive of young children's development of knowledge, because, as Hedges (2007) suggests, due to their relatively limited knowledge and experience, children are unlikely to develop knowledge in a "coherent way" (p.18).

Hedges (2007) identifies Claxton's work on minitheories as an influence for the notion of working theories in *Te Whāriki.* Claxton suggested that many theories are tacit, implicit, and intuitive and individuals are likely to hold a number of piecemeal theories rather than a coherent body of theories (Hedges, 2007). With more experiences and more knowledge and skills, children's theories become broader, more widely applicable and also interconnected (Ministry of Education, 1996). This is also exemplified through Claxton's "island analogy" (K. Davis & Peters, 2010c, p.20) in which islands of knowledge can connect (and also divide) as more knowledge is gained. Again, working theories are unlikely to progress in a coherent or linear manner (Peters & K. Davis, 2011).

However, an understanding of 'working theories' is complicated by broader definitions of theory available in which all knowledge is seen as a theory (Giacopini, 2009), and *Te Whāriki* equally may be taken to refer to this postmodern perspective. The early childhood assessment exemplars suggest "working theories is another name for

knowledge" (Ministry of Education, 2007, p.4). Postmodernists recognise knowledge and truth as partial, local and situated (B. Davis, et al., 2000), and so theories are understood as representations of the world and products of the frames chosen for interpretation (B. Davis & Sumara, 2006). Carr et al. (2009) concur with this view:

> "There is a recognition in this early childhood curriculum that much knowledge is couched as 'working theory' with the implication that it is uncertain and may look different depending on one's prior experience and the context" (p.7)

The curriculum document seems to recognise that many theories and constructions of knowledge are possible, which is further underlined by the fact that the document avoids codifying and listing the knowledge to be learned. Knowledge is thus negotiable, changing, constantly re-created by each individual's encounters with the world (Alexander, 2000), and also multiple, varying in perspective. However, this aspect of the concept was seen to create a dilemma for some parents in Peters and K. Davis' (2011) study, related to perceived issues around telling the truth and being correct, while teachers in Hedges' (in press, November 2011) study were cautious of parental criticism for accepting flawed theories.

2.1.2 Links to theories of cognition

Exploring these current understandings of working theories indicates that children have an active role in constructing theories from their knowledge, and suggests that constructivist processes of accumulating and organising knowledge can support an understanding of the concept. Yet the description of working theories also firmly ties theorising to a social and cultural context within which children must act, and from which they gain further knowledge to incorporate into their theories, suggesting that a sociocultural perspective will also be useful to understanding.

The term 'working theories' implies both constructivist and sociocultural understandings. 'Working' draws from a constructivist perspective, as *working* theories imply potential progression in the construction of knowledge toward a singular end point, the current most accurate knowledge that humans have reached so far. Yet a postmodern and sociocultural inflection in the use of the plural, working *theories*, represents knowledge not as an accurate representation, but as one possible interpretation of the world among many.

It has been recognised that *Te Whāriki* draws on both constructivism and sociocultural theory (Cullen, 1996; Nuttall, 2003), and this is also seen in the advice given in the document for supporting children's working theories. This advice includes supporting skills such as enquiry, research and exploration that highlight a constructivist belief that children's knowledge is increased through independent discovery, as well as introducing cultural narratives, fictional and informational forms which provide social and cultural influences (Ministry of Education, 1996).

Researchers attribute the concept of working theories differently. Carr (2001) and van Wijk (2008) interchange working theories with schemas and suggest assimilation and accommodation are relevant processes. However, Hedges (in press, November 2011) suggests that sociocultural theories form the theoretical basis of the concept of working theories, although the teachers she interviewed were more likely to draw on Piaget's theory for their understanding.

The following sections explore understandings about, and strategies for supporting, children's thinking and theorising from both constructivist and sociocultural perspectives.

2.2 Cognitive constructivist approaches

2.2.1 Interpreting working theory with cognitive constructivism

Cognitive constructivism is an action-driven learning theory, which stresses an objective, knowable world out there to be discovered through action; it is from action that children construct theories. Children's cognitive development is largely attributed to their own independent experience and discovery (Stetsenko & Arievitch, 2002), as lone child-scientists (Gopnik & Meltzoff, 1996; Mercer & Littleton, 2007). For constructivists, thinking is primarily a logical and systematic activity aimed at coherence and equilibrium between one's understanding of the world, and what is experienced: "young children as theory builders try to construct a causal explanatory structure that can explain a set of observations consistently" (Inagaki & Hatano, 2002, p.127). Research identifies children under five years old as constructing knowledge when they systematically explore and represent concepts (Athey, 1990; Gopnik, Meltzoff, & Kuhl, 1999; Meade & Cubey, 2008; van Wijk, 2008). Thus theory building is a concept that resonates closely with constructivist accounts of learning and development.

For Piaget, thought was "internalised action" (Athey, 1990, p.33); a representation of action so the individual becomes less dependent on physical experience (Mercer & Littleton, 2007). These representations are known as schema. Schema, perceived as a kind of knowledge structure in the mind, are formed to assist in the interpretation of new experiences (Middleton & Brown, 2005), and are adapted in the light of experience. Furthermore, they are perceived as active, information-seeking structures (Athey, 1990). As the learner has an experience, their 'thoughts' about it are held in mind until further experiences connect with it and form a pattern (Gopnik & Meltzoff, 1996; Inagaki & Hatano, 2002; Meade & Cubey, 2008). New evidence is thus assimilated into the preliminary model or conclusions (Athey, 1990; Meade & Cubey, 2008). However, where there is "cognitive conflict" (Mercer, 2000, p.136) and experience does not fit with the child's model of the world, accommodation occurs so that the model is changed according to the new evidence (S. Robson, 2006; Seifert, 2002; D. Wood, 1998). The restructuring of knowledge through accommodation plays an important part in moving children's understanding forward (Alexander, 2000). *Te Whāriki* may be referring to these processes of accommodation in identifying the generation and modification of working theories as a principal outcome of the curriculum (Ministry of Education, 1996).

Van Wijk (2008) and Carr (2001) link the use of the term 'working theories' in *Te Whāriki* to schema development, an assertion that might be backed up by Athey's (1990) definition of schema as "internal constrictions that have form" (p.41) which enable generalisations, and by extension, perhaps theories. However, schema are seen as having limited complexity, useful only for stereotypical conclusions and processes such as recognition (Daniels, 2001). Further, although schema learning theory supports an understanding of how children develop working theories about things, it also does not address how children learn about other parts of their lives (Meade, 2000).

2.2.2 Constructivist roles in supporting theorising

Within a constructivist approach, children construct their own knowledge and understanding through their self-directed activity; consequently, there is only a minor and indirect role for the teacher (Mercer & Littleton, 2007; Seifert, 2002). In fact, for Piaget, interacting with adults was "at best seen as irrelevant, or at worst as detrimental" (Mercer & Littleton, 2007, p.9). Consequently, constructivist approaches focus on the indirect "pedagogical framing" (E. Wood, 2004, p.20) of the environment and routines.

The belief is that an environment can be "developmentally-instigative" (Voss, 1996, p.21), and "rich in motivations [to] effortlessly ensure a child's development" (Poimenidou & Christidou, 2010, p.81).

While children self-direct their experiences, experiment and generally construct their own learning (Carr, et al., 2009; Giacopini, 2009; Meade & Cubey, 2008), teachers influence the "cognitive opportunities that children encounter" (Gauvain, 2001, p.25) and in so doing initiate children's construction of knowledge (Hedegaard, 2007). That much time and repetition of activity is required for this construction is well documented in the schema literature (Athey, 1990; Gopnik & Meltzoff, 1996; Meade & Cubey, 2008; van Wijk, 2008). Thus, continuity is recognised as a vital factor in developing concepts (Athey, 1990), but in schema research, continuity is seen as often child-led (with or without adult support) as children naturally seek out experiences which feed their developing schema (Meade & Cubey, 2008).

The teachers' role involves "orchestrating" (Claxton, 2002a, p.69) by arranging materials and equipment to fit children's interests (Meade & Cubey, 2008). For example, teachers who are aware of schema development tend to respond to children's schemas through the addition of objects in the environment (Meade, 2000; Meade & Cubey, 2008). Interestingly, Seifert (2002) points to a paradox in that the way it is felt teachers must structure the environment actually suggests children lack ability in constructing their own effective learning experiences.

Recent research on schema development highlights a more active role for the teacher in helping children construct their own knowledge, with teachers being recognised as able to support the important skills of paying attention, perception and representing information (Meade & Cubey, 2008). For example, providing language is important for supporting the process of symbolically fixing objects and processes into stable representations to be observed, measured and reasoned about (Bodrova & Leong, 2003; Wells, 1999). Learning and experience is thought to be embedded more securely if teachers engage children in discussing experiences, and through talk, make links between new experiences and earlier experiences and between the ideas of different children (Jordan, 2004; Meade & Cubey, 2008; Tayler, 2001; van Wijk, 2008). Pointing out cumulative "threads of actions and thinking" (Meade & Cubey, 2008, p.90) helps to consolidate and co-ordinate a new cognitive structure.

Another strategy proposed by these recent contributors to schema theory is the use of documentation, to develop memory (S. Robson, 2006; van Wijk, 2008), and also enable reflection (Wenger, 1998). Both memory and meta-cognition, the ability to reflect on previous thinking, are essential for learning (Bodrova & Leong, 2007). However, considering development is an irreversible process in which cognitive structures are transformed, the importance of memory to this process can be questioned. Documentation serves to draw attention to important points of the experience and the learning involved (Carr, et al., 2009). In New Zealand, however, observation and documentation are most likely to focus on learning dispositions (Millikan, 2003).

Involving children in creating their own representations of their learning and thinking also supports schematic thinking. Representation offers opportunities for repeating experiences with variation provided in the use of different media (Meade & Cubey, 2008). Artistic thought, which "helps to investigate and highlight the hidden patterns of reality" (Vecchi & Giudici, 2008, p.138) is most emphasised in the pedagogy of Reggio Emilia.

2.3 Sociocultural approaches

2.3.1 Interpreting working theory through sociocultural theory

Theories are not always constructed from direct experience, but also include, or are derived directly from, what others say and do. Therefore theories may not be individual constructions, but social ones. A sociocultural perspective suggests children do not invent all of their knowledge and understanding but they make use of the knowledge accumulated in their culture (Bodrova & Leong, 2007). Language provides access to the community's knowledge resources and the theories and thinking generated from the historical nature of human experience are passed onto newer members (Daniels, 2008; Mercer, 2000), although not without revision. Knowledge is only ever constructed for the purpose of mediating further collective activity, thus the concept of 'theory' takes on a sociocultural dimension (Daniels, 2008).

Whilst maintaining cognition is a constructivist process, Vygotsky argued that the construction of knowledge is a social activity (B. Davis & Sumara, 2006; Mercer & Littleton, 2007). Sociocultural research has gone on to show that thinking involves not only individual processes, but also interpersonal and community processes (Rogoff,

2003). It is easy to recognise further that thinking takes place in the context of activity, and thinkers use tools (including language, actions and resources) that aid and influence their thinking (Fleer, Anning, & Cullen, 2004; Wells, 1999). Sociocultural approaches broadly agree mental processes are "transformed and internalised material actions that involve cultural tools" (Stetsenko & Arievitch, 2002, p.88), linking the individual formation of cognitive structures to the social and cultural organisation of practice (A. Edwards, 2007).

Thus the situated or distributed cognition perspective locates thinking in activities and experiences (Lave, 1988). Whereas Piaget saw creativity as inhered in the working mind, outside of culture (Bernstein, 1996), situated cognition proponents argue that new creations, discoveries, and knowledge contributions are not created at the level of cognitive processes but at the level of practice (Lave, 1988). Moreover, rather than simply recalling a knowledge item stored in the brain, individuals attempt to re-know or reconstruct knowledge in the present situation, supported by connections activated by that situation (Wells, 1999). This means that thinking cannot be studied in one individual's brain, but as a process that occurs between brains and between brains, objects and settings. Thus cognition is distributed among, or "stretched over" (Lave, 1988, p.1) people, activities and settings (Daniels, 2008; Lave, 1988; Wells & Claxton, 2002). It involves co-ordination between internal and external resources (Daniels, 2008) that are "socially organised in such a fashion as to be indivisible" (Lave, 1988, p.1).

According to sociocultural perspectives, none of the processes required in theorising can be abstracted from context. For example, categorisation is not an abstract cognitive strategy, but "a situated interactional activity" (Pontecorvo & Sterponi, 2002, p.132) because categories are flexible and meanings depend on their context. The historical and social context gives structure and meaning to our actions (Wenger, 1998) as well as having psychological implications (Daniels, 2001; Gauvain, 2001; Voss, 1996). This context is constantly changing so both children and their theories evolve (Vecchi & Giudici, 2008).

The focus on cognition as an active practice carried out in settings means that feelings and emotions are naturally part of cognition (Lave, 1988; Powell & Bingham, 2002; Seifert, 2002; Sussman, 1989); the logical rationalism of cognitive constructivism is argued to be impossible. Further Wertsch (1998) shows that utterances are made to

express self and identity and to assume power and authority, and are perhaps better seen as "strategic moves tailored to the speaker's assessment of the exigencies of the immediate discursive situation" (Wells, 1999, p.105). In relation to exploratory behaviour specifically, Sussman (1989) (who incidentally took a constructivist perspective) argues it is possible to engage in exploratory or inquiry behaviours for motives other than gaining information about the world, and gives the example of a child rolling a ball to get a positive response from mother. In fact, Carr (2001) suggests that social intent is a more compelling factor for action than the affordances of the environment. According to different social goals and intents, individuals make use of different meanings and different implications of words for argument and reasoning (Pontecorvo & Sterponi, 2002) and use different forms of knowledge and procedures (Carr, 2001; Hedegaard, 1999). This perhaps more than anything else, points to the social shaping of thought and discourse (Wells, 1999). Working theories, then, might be one procedure for mobilising available knowledge for social purposes.

2.3.2 Sociocultural supports for theorising

The social and cultural environment provides resources for thinking and learning, as thinking is achieved through interpersonal processes, particularly co-operation with others, in a whole range of social settings, and through the symbolic resources of the child's culture (Smith, Cowie, & Blades, 2003). Social, cultural and historical factors influence psychological formation (Daniels, 2001), so pedagogy is a social practice of great importance for the development of cognitive processes.

Social mediation approaches within sociocultural theory focus on people, tools and practices as mediating agents in supporting the development of cognition (Daniels, 2001, 2008; Kozulin, 2003). Some emphasise interactions, with language and other forms of semiotic mediation as the primary mediational means (de Oliveira & Rossetti-Ferreira, 1996; Rogoff, 2003), whereas others highlight cultural tools (Wertsch, 1998) or the practice or activity (Lave, 1988; Lave & Wenger, 1991). Despite the tendency to focus on one element such as the individuals, settings, or tools for the purpose of analysis, mediated action approaches understand these elements to be complexly interlinked as a system of elements in dynamic relationships of mutual influence (A. Edwards, 2007; Lave & Wenger, 1991; Wertsch, 1998).

Whereas social mediation approaches maintain a more traditional understanding of internalising knowledge, the conceptions of learning as participation in practice and the distribution of cognition across activity, resources and people represent a significant departure from this approach (Seifert, 2002), as thinking is an integrated part of social activity (Hedegaard, 1999). Development is considered a transformation of participation, which involves changed responsibility for the activity, changed identity and membership in the community of practice, and includes transforming the activity itself (Daniels, 2001; Rogoff, 2003; Wenger, 1998). Rather than focusing on the construction of knowledge, the focus is on patterns of participation and agency with which knowledge is deployed in activity (Greeno, 2006).

Sociocultural theory invites consideration of several aspects of context which are likely to mediate children's theorising and have implications for teaching. This section examines participation as a key concept, and briefly considers the way identity and dispositions both influence, and are influenced by, the possibilities of participation. It then looks at the way tools and resources mediate cognition, and finally, several practical approaches for mediating children's thinking through interpersonal interactions are explored.

Participation

As learning and development take place through participation in social activity, a sociocultural approach to supporting children's working theories would provide opportunities for children to participate alongside other children and adults in the processes of creating theories. *Te Whāriki* suggests that children develop working theories through "observing, listening, doing, participating, discussing and representing within the topics and activities provided in the programme" (Ministry of Education, 1996, p.44). Participation in real and meaningful activities is highlighted as a key strategy for improved outcomes in Farquhar's (2003) *Best evidence synthesis*. Adults focus on enabling the child to participate in the skills and practices required, through guidance and structuring (Rogoff, 2003; Wells, 1999). Shared attention on tasks directs participants' observations, imitation guides participants' action and guided comprehension influences their interpretation (Inagaki & Hatano, 2002). Participation in meaningful, shared activities provides an essential base for conceptual learning (Hedegaard, 1998; Hedges, 2007), in particular, within "intentional participation in

activities where communication and action are tightly interwoven" (Hedegaard, 2007, p.262).

Likewise, situated cognition approaches suggest learning and thinking are facilitated by individuals participating in 'communities of practice' (Lave & Wenger, 1991). Objects, images, concepts and perspectives are understood, and made available (according to particular expectations of their use) through participation in social communities (Carr, 2001; John-Steiner, 2007; Wenger, 1998). There is an emphasis on action and activity. Within practice, concepts are defined not as fixed knowledge, but as "action capacities with artefacts" (Hedegaard, 2007, p.262).

Although perhaps unable to engage in the activities of professional communities of practice at the same level, children should be offered the opportunity to participate in simpler forms of such practices and even to recreate the cultural–historical development of professional practices (Wells, 1999). Historically, cultural tools or concepts were created in response to a specific problem or practice (Geist & Lompscher, 2003; Hedegaard, 1999) and thus conceptual development is best promoted through reconstructing these problems (Stetsenko & Arievitch, 2002).

Wells (1999) argues that it is instrumental and procedural knowledge that children come to appropriate through participation in communities of practice, while it is specifically a 'community of inquiry' that supports the construction of theoretical knowledge. Mutual engagement for enquiry in an interests-based curriculum is a common pedagogical model for early childhood (Hedges, 2007), and joint attention is an important pedagogical strategy (Carr, et al., 2009; Siraj-Blatchford, 2004) that can support attentive awareness, thought and action in activity. Siraj-Blatchford's (2004) term "sustained shared thinking" highlights the collaborative cognitive activity involved, although in New Zealand the term 'co-construction' is more often used (Peters & K. Davis, 2011). Working theories are formed and strengthened when children engage with others in thinking (K. Davis & Peters, 2010b), and in particular, adults make an important contribution to the modification and refinement of children's working theories (Hedges, 2007; Meade, 2000).

Strategies to improve participation become important from a sociocultural perspective. For example, it is suggested documentation can act as a "conscription device" (Cowie & Carr, 2004, p.95), and by being accessible and open, encourage children and families to

suggest ideas, develop alternatives and clarify interpretations. Documentation may also be necessary for sustaining involvement (Wenger, 1998).

Participation is also enabled through relationships between teachers and children. Episodes of deep engagement are maximised by (Wenger, 1998), and "sited in" (Carr, et al., 2009, p.219) relationships. Teachers' relationships with children were found to invite the children's interest and engagement in activities at the centres in Carr, et al.'s (2009) research. Further, emotional security is an important influence on cognitive development (Mahn & John-Steiner, 2002), encouraging complex reasoning and cognitive processes (Pontecorvo & Sterponi, 2002) and thus personal relationships are supportive of cognitive development (Miller, 2003).

Dispositions and identity

The concept of 'communities of practice' is useful when we consider the learning climate as part of the environment that teachers provide, created in routines, practices and "responses-in-the-moment" (Carr, et al., 2009, p.140) and including cultural and historical resources, perspectives and frameworks (Wenger, 1998). This sociocultural environment can support the development of identities and dispositions (Carr, et al., 2009; Miller, 2003; Wells, 2002) for theorising. Dispositions are intimately connected to working theories (K. Davis & Peters, 2010c) as a framework within which working theories can be developed (Ministry of Education, 1996). Rather than just knowing how to think, children should develop the disposition to inquire, and believe that "thinking is possible, permitted and productive" (Fisher, 1999, p.55). Achieving insight and understanding through thinking and theory building has a positive affective dimension (Athey, 1990; Csikszentmihalyi, 1990; Daniels, 2001), which might further strengthen dispositions for thinking and theorising.

Dispositions as a framework for analysing cognition has been critiqued for underemphasising the importance of pedagogical relationships, instead focusing on individual inclinations, such as curiosity (Hedges, 2007). The disposition to inquire, however, may address this, as it recognises the dialectical relation between the skills, knowledge and attitudes of the child, and the qualities of the environment. An inquiring disposition involves an ability to make best use of the affordances of the environment (Bertram & Pascal, 2002; Carr, et al., 2009; Claxton, 2002b) or community (Lemke, 2002), to initiate and orchestrate projects (Carr, et al., 2009), as well as "off-load"

(Claxton, 2002b, p.29) or distribute some of the cognitive effort by using tools and creating artefacts.

Sociocultural theory would suggest that in a community of practice, children acquire positive dispositions for thinking "by being 'apprenticed' to a community within which such dispositions are naturally manifested" (Claxton, 2002b, p.32). The community should provide a model of thinking behaviours, such as questioning, making links, reasoning, imagining, planning and revising (Carr, et al., 2009; Claxton, 2002a), although G. Walsh et al. (2011) suggest that this has limited effect and teachers may need to directly prompt children. Further, the dispositions to learn, and to develop working theories about the world, develop "when children are immersed in an environment that is characterised by well-being and trust, belonging and purposeful activity contributing and collaborating, communicating and representing, and exploring and guided participation" (Ministry of Education, 1996, p.45). K. Davis and Peter's (2010b) research highlights the importance of a culture of taking children's theories seriously, and of encouraging children to think differently, while Jordan (2008) suggests children's inquiry increases when adults trust in children's efforts.

However, roles and status play a crucial role in motivating children to engage in a cognitive activity such as theorising, as children must accept the dialogic positioning of the adult and desire to be the adult or who the adult wants her to be (Litowitz, 1993; Wells, 1999). Identity thus affects the child's intent and motivation to participate in a community of practice. If children and adults engage in learning "in the service of an identity" (Wenger, 1998, p.215), then learning activity must offer identity trajectories that appeal to children.

Sociocultural mediation: Tools and resources

Sociocultural theory recognises cognition is developed through interaction and involvement with the shared sociohistorical tools and resources of the community (Gauvain, 2001; Kozulin, 2003; Mercer, 2000; Wenger, 1998). Tools are both material and ideal (Daniels, 2008), and "amplify and modify" (Claxton, 2002b, p.21) our thinking, leading to more elaborate kinds of thinking (Stetsenko & Arievitch, 2002). Tools can be internalised, restructuring and transforming our mental processes (Bernstein, 1996; Daniels, 2001; A. Edwards, 2007; Kozulin, 2003; Mercer & Littleton,

2007; Seifert, 2002; Wertsch, 2007) as well as our practices (Wenger, 1998), while at the same time, we shape and reshape our tools (Daniels, 2008; A. Edwards, 2007).

Within distributed cognition perspectives, tools and objects take on some of the thinking work, hold intelligence, and are thus seen as part of a system of cognition (Daniels, 2008). However, outside the culture which attributes them meaning and purpose, tools or objects have no meaning; guided experience is required (Carr, 2001; Kozulin, 2003; Wells, 1999). Nevertheless, constant interaction with other people and with objects means that our cognitive competence is heavily dependent on them (Inagaki & Hatano, 2002; Middleton & Brown, 2005).

The use of artefacts and objects supports and develops thinking over time, as "meaning is sedimented, accumulated or deposited in things" (Daniels, 2001, p.23) and thus remembered. Lemke (2002) argues that memory, rather than being an autonomous, internal system, is "an interactive process of engagement with an environment that re-evokes past similar engagements" (p.40). Thus material objects become meaningful and provide a link between different moments of time, leading to continuity over time (Lemke, 2002). Hedegaard (2007) identifies the way that objects hold meaning and ways of perceiving and acting with them as both supportive and restrictive of children's learning.

It is suggested that creativity and the expression of ideas offer opportunities for the development of working theories (K. Davis & Peters, 2010a). In early childhood education, productive activities and resources (blocks, clay, drawing) are plentiful to encourage children to create schematic representations and model relationships (Bodrova & Leong, 2003), as well as to focus on the sensory qualities of the object they are trying to represent or reproduce (Venger, 1988). Drawing is a mediating tool (Brooks, 2009) that informs and inflects thought, and supports the development of a cognitive competency relevant to theorising in the generation and use of models (Bodrova & Leong, 2003). Visualisation enables children to work at a more conceptual level, manipulating and linking concepts rather than just reciting them (Brooks, 2009).

There are two approaches to the provision of tools and objects to support children's play and thinking. One focuses on providing familiar materials, which then provide certain affordances to encourage children to enact well-known scripts (de Oliveira & Rossetti-Ferreira, 1996). In contrast, the teachers of the preschools of Reggio Emilia believe that

the provision of 'intelligent' materials, that are not associated with a particular use or tied to particular ideas or ways of thinking, will spark research and avoid the mere replication of ideas (Filippini, 2010; Giacopini, 2009).

As the affordances of the social, cultural and historical environment create "the stage on which the development of new and improved forms of thought is enacted" (Daniels, 2001, p.26), teachers should be aware that the material affordances of the environment may be perceived in particular ways by children who then select and edit what is on offer (Carr, 2002), and further, that children's personal histories of interaction offer constraints as well as possibilities (A. Edwards, 2001). As the way in which activity unfolds depends on children's perceptions, and the resources they have available (Wells, 1999), teachers may need to introduce new modes of perception or new resources or tools. Material affordances may need to be followed with invitations, suggestions and provocations (Carr, et al., 2009).

Language is one particularly important tool for restructuring cognitive development, transforming perception, attention, memory, thinking and imagination (Bodrova & Leong, 2003; John-Steiner, 2007). For example, perception is mediated by the culturally-defined sensory standards that we use to discern sensory properties of materials (Venger, 1988) and so, through language, perception transforms "from a set of diffuse and disorganised sensations into the system of stable representations with culturally determined meanings" (Bodrova & Leong, 2003, p.158). The relation is reciprocal; as we use language to express thoughts, language socialises us to attend to and conceptualise things in specific, cultural, ways (Bernstein, 1996; Gauvain, 2001; John-Steiner, 2007). As people work together, their ways of thinking, acting and talking embody their accumulated cultural values constructed by previous groups of people working together, over many generations (Hasan, 2002; Mercer, 2000; Wells, 1999; Wells & Claxton, 2002). Thus children appropriate not just language, but the ways of making sense of experience that are encoded in the discourse used (Wells, 1999).

As concepts and labels are important tools for theorising, the teacher should tie language to action by making both her own and the children's actions verbally explicit: describing, labelling, and modelling new vocabulary and language structures (Arnold, 2003; Bodrova & Leong, 2007). Daniels (2007) argues that teaching must aim to "foster conscious awareness of conceptual form and structure and thereby allow for individual

access and control over acquired concepts" (p.312). Yet Fleer and Raban's (2006) study found that although practitioners were aware of the concepts being formed in areas of play, they did not make these conscious to children. Teachers can also model language used for thinking; for example, Miller's (2003) research suggests that the questions and strategies that teachers promoted to support older students to make meaning from literature were cognitive tools that were later internalised.

Sociocultural mediation: Interpersonal interactions

The concept of social mediation is important for pedagogy, particularly pedagogy seen as "responsive interactivity" (A. Edwards, 2001, p.166). Shared understanding, or intersubjectivity, is important for rich and meaningful interaction, and for teachers to be able to unfold the ways children are thinking (Tayler, 2001).

In sociocultural theory knowing is seen as a social activity (Wells, 1999) of representing knowledge to self and others, through speech, writing, drawing, and the creation of tools. Through interactions, meanings are negotiated (Kalish & Sabbagh, 2007; Lave & Wenger, 1991), thereby creating interpersonal understandings and making a contribution to the evolution of cultural meanings (Callahan, Siegel, & Luce, 2007). Knowledge and meaning are thus distributed across participants, time and space, re-interpreted and re-negotiated in each context (Daniels, 2001; Seifert, 2002), and only ever present in dynamic relations of participants and contexts (Wenger, 1998). Further, the possibility of shared understanding through unambiguous communication is contested, as while meanings can be transmitted with a view to making these meanings agreed and shared, this communication can also trigger new meanings, conflict and difference. Instead, it may be more useful to consider both information-transmission or intersubjectivity, and dialogic thought-generation, termed alterity (Wertsch, 1998).

Primarily intersubjectivity is achieved through shared participation, action and communication, while common and complementary knowledge supports reciprocity, engagement and collective goals (Carr, et al., 2009). Thus one role for teachers involves creating shared experiences as sources of shared conversations and understandings (Farquhar, 2003; Tayler, 2001). The teacher needs to be able to take the child's perspective (Aasen, Grindheim, & Waters, 2009; Fleer & Pramling-Samuelsson, 2009), but equally, children benefit if they can understand the teacher's perspective (Mercer, 2002). Teachers should aim for "full, two way intersubjectivity" (Jordan, 2004, p.41) as

they share their own ideas and interests with children. However, Hedges (2007) argues that often children just want to test out their ideas and theories with adults, and want no more than for the adult to listen and reflect their ideas back to them.

As one cannot determine exactly what our words mean for others, we are "employing a sign system that forces us to say more (as well as perhaps less) than what we understand or intend" (Wertsch, 2007, p.187). Rather than this being a hindrance to communicative acts, Wertsch (2007) considers that it enables the less-experienced to enter into some form of intersubjectivity with more experienced experts within which learning and instruction can proceed. Vygotsky argued that individuals come to understand signs and symbols through their use (Wertsch, 2007).

Dialogue provides opportunities for children to process their range of experiences while engaging children in the cognitive challenge of expressing and responding to ideas (Poimenidou & Christidou, 2010). Research shows that young children can be encouraged to express their viewpoint and this results in an increased capacity to acknowledge alternative views as equally valid (Bertram & Pascal, 2002). Wells (1999) argues that knowledge building dialogue and theory construction occur most frequently in a problem-solving context, in which solutions are proposed, extended, and objected to with counter-proposals.

To encourage dialogue, teachers need to welcome and solicit children's ideas, follow up on children's responses, refer constantly to children's ideas and actions, and refrain from evaluative feedback (Mercer & Littleton, 2007; Poimenidou & Christidou, 2010; J. Walsh & Sattes, 2005). Particular kinds of questions are useful for discovering what children are thinking and for stimulating their thought processes (Daniels, 2001; Epstein, 2007; Hasan, 2002). In particular, questions should be open, led by children's interests rather than teachers' pre-emptive knowledge (Simmons, et al., 2005) and aim to clarify children's meanings (Pontecorvo & Sterponi, 2002). "Authentic" questions (Wertsch, 1998, p.120) are preferred, asked to find out what another is thinking or feeling, and oriented towards meanings (Hasan, 2002) rather than pre-specified answers (Mercer & Littleton, 2007) or particular knowledge outcomes (Jordan, 2004).

Adults must listen carefully to children (Epstein, 2007; Jordan, 2004; Meade & Cubey, 2008), which involves observing, listening, reflecting, conversing and jointly participating with children (Mayall, 2000), and making "every attempt to actually hear

what is being said" (Cannella, 1997, p.165). It has been found that teachers can easily claim a false intersubjectivity and in doing so "hijack" (Peters & K. Davis, 2011, p.12) the activity or discussion. Another area for caution relates to the fact that teachers have more power and rights in interactions with children; including the power to intervene in conversation without permission, or to ignore and dismiss children's attempts to initiate conversation (Tayler, 2001).

Rowe (1986) describes an important strategy to be used with questioning, that of wait-time. Wait time promotes thoughtfulness both for students and teachers, and has been proven to have value in all settings including early childhood (J. Walsh & Sattes, 2005). Wait-time gives children more time to think about what was said and elaborate or expand upon it, and gives teachers more time to formulate ways to extend children's thinking (J. Walsh & Sattes, 2005). Wait time is associated with more coherent discussion, as not only the teacher, but also the children, listen more intently to each other, and with more complex cognitive processes such as speculative thinking and inference (Rowe, 1986). K. Davis and Peters (2010b) link "sufficient wait time and spaces for children's ideas to emerge" (p.28) directly to the development of working theories.

Teaching and learning episodes with high intersubjectivity and participation have been linked to working theories. For example, K. Davis and Peters (2010b) identified creating opportunities for children to share ideas as important, in particular, setting up a scenario for the exploration of working theories (although it was found that often adults planned for only one aspect of a child's working theory and missed subtle or more complex nuances). An important issue for supporting working theories was seen as determining whether the child was currently trying to make sense of a phenomena, or was repeating a stable theory, and this required intersubjectivity between the adult and child (Peters & K. Davis, 2011). Simmons et al. (2005) identified the use of scaffolding and co-construction as strategies for the complex and sustained learning required for working theory development. The following sections discuss scaffolding, co-construction, dialogic teaching and inquiry as pedagogical strategies for mediation within participative, intersubjective teaching situations.

Scaffolding

Within sociocultural theory, development is seen as a process that is supported by someone or something else, and this idea of assisted development has led to a focus on scaffolding as a pedagogical technique. Vygotsky believed that children should receive teaching according to their potential (Chaiklin, 2003; Mercer, 2000) within the zone of proximal development of the child's maturing or emerging cognitive abilities (Chaiklin, 2003). Scaffolding takes place in the zone of proximal development and involves challenging the child's thinking in a sensitive and appropriate way for that child (Meade & Cubey, 2008), based on careful judgements about what the child understands at that point in time (Mercer, 2000). Scaffolding is seen as a key technique in the guidance for developing children's thinking in the latest report into promoting thinking in the UK (G. Walsh, et al., 2011), and highlighted in a New Zealand best evidence synthesis report (Farquhar, 2003) for raising cognitive outcomes. Scaffolding is perhaps most relevant to enabling participation in activities and to procedural and instrumental knowledge (Wells, 1999), although Peters and K. Davis' (2011) research suggested that scaffolding might be an important strategy when children's working theories are disrupted, in supporting them to draw on related experiences.

The adult or expert guides the child to successful understanding or problem-solving (Jordan, 2004) through prompts (Claxton, 2002a), hints (Epstein, 2007) and clues (Bodrova & Leong, 2007), reminders, suggestions, encouragement and demonstrations (Mercer & Littleton, 2007) structured and sequenced questioning, or a well-timed explanation or carefully orchestrated discussion (Alexander, 2000). Prompting on 'how to do it' is at first explicit, then the prompts are gradually weakened and the support removed (Claxton, 2002a). Conceptions of scaffolding are critiqued as a process in which the adult or expert (who knows the intended answer or solution) holds control and power and therefore directs the process (Hedges, 2007; Jordan, 2004; Mercer & Littleton, 2007; Singer, 1996). It provides a step-by-step method towards predetermined conclusions, rather than involving the child in creating novel solutions (Langer, 1997).

Co-construction

Co-construction, also referred to as "sustained shared thinking" (Siraj-Blatchford, 2004, p.147), involves joint contribution to the thinking and development of the discourse to solve a problem, extend a narrative, or clarify a concept. Co-construction as a pedagogical technique is linked to quality teaching and improved outcomes for children

(Farquhar, 2003), and is perhaps a relevant pedagogical strategy when the topic is open-ended (Jordan, 2004).

Outcomes for children are more empowering when teachers co-construct rather than scaffold understanding (Hedges, 2007; Jordan, 2004), as children construct their own learning (Jordan, 2004; Meade & Cubey, 2008). The focus is on developing shared meanings (Jordan, 2004; MacNaughton & Williams, 2004) and on acquiring knowledge through discussing and sharing meanings (Carr, et al., 2009), rather than the adult supporting children towards a particular concept or outcome (Peters & K. Davis, 2011). Adults are also involved in learning from children about their interests (Meade & Cubey, 2008). Reciprocal and responsive pedagogical relationships are required so that teachers can provide meaningful responses (Hedges, 2007; Pascal & Bertram, 1999), however, the balance of power required for genuinely co-constructed, negotiated meaning might be difficult to achieve (Alexander, 2000).

The co-construction of meaning, or meaning-making (Carr, et al., 2009; Fleer & Pramling-Samuelsson, 2009), occurs when people collaborate together around the use of mediational means and cultural tools (Daniels, 2001; Wenger, 1998). Documentation may be particularly supportive in developing shared meanings (MacNaughton & Williams, 2004; Wenger, 1998), and yet, must be recognised as selecting, even perhaps deflecting, reality (Daniels, 2008).

Play is one obvious context for meaning-making (Fleer & Pramling-Samuelsson, 2009; van Oers, 1996). Understanding is built with others as ideas about the world are exchanged and negotiated in play (van Oers, 1996), so teachers should both be close to children in their daily play and activities as well as know the children well to support their meaning-making (Fleer & Pramling-Samuelsson, 2009). It is a complex process as "presenting, receiving, understanding, distorting, misunderstanding, generalising, sometimes even pretending knowledge are real elements in this negotiation process of making meaningful knowledge" (van Oers, 1996, p.221). Drawing is also a powerful meaning-making tool (Brooks, 2004).

Meaning-making as a pedagogical approach relates to a democratic pedagogy in which children's own understandings and meanings are respected (Alexander, 2000). Yet one worrying consequence of this democratic approach might be "the removal of the

cognitive structures by which children's thinking is supported and advanced" (Alexander, 2000, p.507). However, if teachers attempt to manipulate children's cognition towards particular theories and knowledge, this can be seen as a "subtle form of imperialism" (Whitehead & McNiff, 2006, p.77), while respecting alternative meanings has more potential to encourage new ways of thinking and new forms of knowledge. Because of this, in K. Davis and Peter's (2010a) research, it was important that the adult's focus was only to encourage ideas, not to move children towards a specific concept. It appears important that knowledge should be treated as a "source of ambiguity" (Langer, 1997, p.132) not as something to conform to. Therefore, language such as 'could be' is recommended to invite students to think of alternatives, rather than the use of 'is' which is an authoritative form which has to be grasped (Claxton, 2002a). Tolerating incompleteness, expressing doubts and confronting ideas (Giacopini, 2009) and asking for a range of ideas and theories (Ramage, 1997) are important teaching strategies. Uncertainty opens up possibilities (Langer, 1997) and provokes imagination (Carr, et al., 2009).

Dialogic teaching

Dialogic teaching relates to co-construction as it is a pedagogical approach in which both teachers and children make significant and substantial contributions which help move thinking forward (Mercer & Littleton, 2007). Collective discussion and understanding support individual children's constructions of knowledge, as children reformulate what others say in the process of continuing, integrating or rejecting what another has said. Daniels (2008) allows for the probability of conflict, as well as agency and transformation, in arguing that "personal meaning struggles with, acts upon and is shaped by collective understanding" (p.93). Repeating, recycling or rephrasing children's contributions can bring these contributions into such a "dialectical confrontation" (Pontecorvo & Sterponi, 2002, p.133). Mercer and Littleton (2007) suggest that teachers should encourage children to find a way to agree as the option of not reaching agreement, or just simply going with the majority, effectively ends the debate.

This cumulative construction of knowledge recognises Bakhtin's observation that all utterances have "dialogic overtones" (Bakhtin, 1986, cited in Wells, 1999, p.104); that is, they are linked to other utterances in a complex chain of utterances. Many metaphors are given for this process of the cumulative building of ideas. Metaphors of "building

blocks" (Mercer & Littleton, 2007, p.53) and "piggy-backing" (J. Walsh & Sattes, 2005, p.105) suggest the cumulative building up of separate ideas or pieces of knowledge, while images of "a continuous dialogic spiral" (Brooks, 2004, p.49) suggest a more dialectical and recursive process. These ideas can be seen as related to working theories in the sense that knowledge accumulates and theories improve.

Drawing and other expressive forms also enable dialogicity in providing a means for externalisation of an idea or thought, so that children can dialogue with and through their representation (Bodrova & Leong, 2007; Brooks, 2004, 2009). Van Oers (1996) describes making models as a supportive activity for participation in dialogic teaching and learning.

The pedagogic approach of dialogic teaching includes the ideas of negotiation of meaning, (Mercer, 2000); co-narration and orchestration of the children' contributions (Pontecorvo & Sterponi, 2002); respecting all contributions (Bertram & Pascal, 2002; Hasan, 2002; Mercer, 2000; G. Walsh, et al., 2011); valuing difference as a subject for shared exploration (Filippini, 2010; Mercer, 2000; Seifert, 2002), and developing quality relationships for sharing ideas (Bertram & Pascal, 2002; Mercer & Littleton, 2007; Pontecorvo & Sterponi, 2002; Powell & Bingham, 2002).

However, as with co-construction, concerns can be raised regarding the lack of a structured development of knowledge. Poimenidou and Christidou's (2010) research showed that where there was a total adherence to dialogic communicative style, some of the teacher's questions were left unanswered, and the evolution of scientific understanding was non-existent. These authors suggest that systematic planning and the use of other communication styles at certain stages may be necessary, while Alexander (2000) charges the teacher with "making and keeping classroom talk dialogic, structured and enquiring, rather than loosely conversational" (p.522). Further, there is widespread agreement within this literature that the skills needed to engage in dialogic discussion must be taught (Alexander, 2000; Mercer & Littleton, 2007; J. Walsh & Sattes, 2005) and issues such as the handling of turn-taking considered (Alexander, 2000).

Communities of inquiry
Building further on these ideas, Wells (1999) suggests that Vygotsky's sociocultural theory proposes "a collaborative community in which, with the teacher as leader, all

participants learn with and from each other as they engage together in dialogic inquiry" (p.xii). The community of practice is specifically designated a community of inquiry.

Within this approach, teachers need to actively guide, even limit or select, suggestions that will bring the group together as a cohesive learning community (Brooks, 2009). In relation to working theories, this means selecting the theories that are worthy of delving into (K. Davis & Peters, 2010b). Further, the goal of the group and the interactions required should be made clear, because the social situation of the group is complex (Bodrova & Leong, 2007). Topics for investigation should be connected to children's interests and experiences, and supported by the tools, practices and experiences distributed within the community, including knowledge artefacts (Wells, 1999).

An inquiry curriculum involves a "spiral of knowing" (Wells, 1999, p.91) which links to incremental learning, and to working theories (Hedges, 2007) as further information and experiences are accrued in a spiral fashion. The inquiry itself, while guided by long-term goals, is "in its moment-by-moment unfolding, both dynamic and emergent" (Wells, 1999, p.83).

A curriculum of inquiry constructs children as agents of change (Oldfather, West, Wilmarth, & White, 1999) rather than passive receivers of knowledge and socialisation. It is also likely to invite involvement from home and families (Jordan, 2004), as the term community implies many more actors than the teacher and child dyad (Lave & Wenger, 1991). In Jordan's (2004) study, children in the early childhood centre case studies were empowered to make decisions and carry out their own experiments in ongoing projects and authentic learning experiences which resulted in higher-order thinking.

2.3 Putting perspectives together: a complex view

While constructivist and sociocultural explanations of thinking and cognitive development offer some insights relevant to an understanding of working theories and how they might be supported by teachers, there are also limitations. Each theory seems to offer a different perspective, or explain one facet comprehensively while being unsatisfactory in other ways.

The constructivist theory of cognition is rather narrow in scope, focusing mainly on observable, tangible knowledge present in the environment. Abstract thinking is

extracted from material actions (D. Wood, 1998), and not from social or cultural experience. Yet without social support, independent exploration might lead to the development of immature concepts (Kozulin, 2003).

While the constructivist processes of assimilation and accommodation are vague and not adequately explained (Gauvain, 2001; Seifert, 2002), sociocultural accounts offer even less precision in describing the processes of cognition (Daniels, 2001). Sociocultural theory expands in more detail the range of experiences and influences on children's thinking, but it doesn't specify whether the child uses these to construct meaning in a constructivist fashion, or whether there are other means. The child just develops through participation. Further, while rejecting developmental theory and suggesting the possibility of educative influence, sociocultural approaches still require some translation in explaining what practice will look like (S. Edwards, 2003).

There are also dimensions that neither perspective adequately explains. Sociocultural theory would suggest that because learning is social, it is inextricably tied up with ethics, values and politics (MacNaughton, 2004), yet these dynamics remain implicit. Whereas the constructivist perspective presents children as free to construct their own meanings, critical theorists show that children construct meanings only within certain conditions, conditions that they do not have control over or agency within, and that distort, limit and silence the meanings possible (MacNaughton, 2004). Further, the knowledge and information available for theorising is selected and represented in a particular way by both institutions and participants (Smith, et al., 2003).

Wertsch (1998) notes that as different theories attend to different parts of activity, any one perspective in isolation will not be adequate, and he argues for the co-ordination of different perspectives in some way. Seifert (2002) agrees that the "blurring"(p.16) of boundaries is healthy while Daniels (2001) argues for using the debates between perspectives as "sites for the generation of tools which may inform pedagogic innovation" (p.41), rather than deciding on one or the other.

Moreover, many argue for the complementarity of Piaget and Vygotsky's work (Cullen, 2001; Fleer, et al., 2004; Mercer & Littleton, 2007). It is likely that adding the complexity of sociocultural approaches in recognising the pluralities of meanings available in a given context, to the constructivist concept of children constructing

meaning from available experiences, forms a foundation with which to work. For example, a constructivist perspective can be adopted, while also recognising socio-cultural influences as a framework for the construction of knowledge (Smith, et al., 2003), so that "other people and tools surrounding the developing individual are essential constituents of the construction process" (Inagaki & Hatano, 2002, p.138). S. Edwards (2003) and Wells (1999) identify this as a "social-constructivist" pathway. Malaguzzi, the founder of Reggio Emilia preschools, describes a "interactive-constructivist" (S. Edwards, 2003) approach, which links to a further possibility that knowledge is constructed by groups rather than individuals. This is perhaps a constructionist rather than constructivist view, suggesting another possibility. Social constructionism emphasises the way in which people are shaped by being part of a social group that share an experiential world (Lock & Strong, 2010) and the ways in which they construct that world together (Gergen, 1999). In contrast, the approach of the New Zealand early childhood curriculum document *Te Whāriki* has been described as socio-constructivist (Nuttall, 2003), maintaining an emphasis on the individual construction of knowledge using social resources.

The field of complexity science is seen as relevant as it encourages the integration of many different and competing aspects of a complex phenomena such as cognition, and therefore can incorporate the insights of different theories. Further, it seems that in order to develop a more comprehensive understanding of processes of cognition and knowledge development, a complex view may be required.

2.3.1 Complexity theory

Complexity theory is an ecological theory that focuses on the complex co-evolution of phenomena within larger systems. Applied to education, it sees classroom collectives, schools and bodies of knowledge as complex emergent phenomena that constantly modify their own structures in response to experiences (B. Davis & Sumara, 2006). Both knowledge, distributed across minds, and individual minds, are emergent and developing (Morrison, 2008).

However, as Horn (2008) reminds us, the capacity of a system to organise itself and to emerge spontaneously does not mean that it does so; there are, in fact, many ways in which control mechanisms are put in place in the management of social activity (the actions of teachers might form control mechanisms, for example!). However, the

description of the emergence of complex phenomena is useful for developing an understanding of working theories as a complex form of knowledge production.

2.3.2 Working theories in complexity theory

Complexity thinking insists on interlinking, in mutual influence, all systems and kinds of knowledge, so working theories would be linked to, influenced by and influencing, other kinds of knowledge. This adds complexity to constructivist explanations of cognition. Constructivist theories separate an objective knowledge (a knowledge that has form in and of itself) from the subjective knowledge the individual constructs in their mind (what might be termed the 'working theory'). Social constructionist theories argue that knowledge is socially constructed, so, without challenging the idea that the individual adapts his subjective knowledge, the collective knowledge is not objective but simply intersubjectively agreed. In a complexivist view, rather than a one-way relationship, subjective understanding and objective or collective knowledge are mutually-specifying; and the result of this mutual co-adaptation is what might be seen to lead to working theories. Knowledge is "subject to continuing tinkering to maintain viability" (B. Davis & Sumara, 2006, p.62).

Therefore, knowledge is a constantly adapting phenomenon that does not accumulate toward a fixed, knowable point but becomes more expansive, with the emergence of ever-branching interpretative possibilities (B. Davis & Sumara, 2006). This too, resonates with the concept of working theory, which is ever subject to improvement and modification. Rather than transmitting or moving knowledge in a particular direction, learning is understood in terms of "adaptive reorganisation in a complex system" (Hutchins, 1995, p.289).

2.3.3 Supporting theorising from a complex perspective

As knowledge and theory develop through interactions, connections and ongoing adaptation, complexity theory suggests that the addition of new elements to a complex system increases the number of possible connections (Mason, 2008b). This connectedness is supported by a view of knowledge as distributed throughout a system, and thus in order to make use of dispersed knowledge, communication and collaboration are essential elements in complexity theory (Morrison, 2008). A key aim for teaching, then, is to support learners to make connections (Morrison, 2008) and associate ideas with other events in their lives, either through structuring rich, open

activities, or by pointing them to related events (B. Davis, et al., 2000). Morrison (2008) also suggests that curriculum should be recursive, an idea that has similarity with Wells' (1999) notion of a spiral curriculum.

Complexity thinking aims for an ever-expanding knowledge and ever-expanding possibilities, rather than the perpetuation of "entrenched habits of interpretation" (B. Davis & Sumara, 2006, p.135), so teaching strategies focus on providing optimal conditions for the emergence of the "as-yet unimagined" (ibid.). There should be sufficient openness and ambiguity to broaden ideas (B. Davis & Sumara, 2006), and so theories, even scientific theories, should be presented as "cultural narratives that are subject to ongoing revision" (B. Davis, et al., 2000, p.47). To support the emergence of new ideas, a language of possibility is necessary (Morrison, 2008). Encouraging children to seek to vary their perspective and look for novelty helps them to be open to more options (Langer, 1997). Complexity thinking also highlights the importance of what are termed "neighbour interactions" (B. Davis & Sumara, 2006, p.135), but this term refers to the exchange of ideas and theories rather than social interactions. Teachers must ensure that ideas can stumble across one another, which, because there are many different ways to achieve this, will depend on the issues, contexts and group members.

Diversity is essential for the spontaneous evolution of any system (Morrison, 2008), and so rich and open activities are important. However, providing rich, explorative activities without the use of "pointing, telling, highlighting" (B. Davis, et al., 2000, p.10) as in discovery-learning approaches, means that the possibilities of interpretation are too wide and it is unlikely that learners will discover the quality or interpretation intended. Alexander (2000) confirms that many-layered, multiple-themed lessons within a loose timeframe succeed if they are skilfully orchestrated and conducted, but found these lessons were more likely to lose pace and coherence, as well as pupils' attention. Similarly Poimenidou and Christidou (2010) found that the systematic evolution of ideas into scientific concepts went unrealised within 'discovery learning'. Lobato, Ellis and Munoz (2003) describe "focusing phenomena" (p.2) as aspects, including the teacher's behaviour, use of language, materials and artefacts, that direct students' attention to certain properties and patterns. Moreover, diversity is more easily harnessed

with particular purposes in mind, thus a shared orientation for action is important (B. Davis & Sumara, 2006).

The concept of "enabling constraints" (B. Davis & Sumara, 2006, p.136) is also useful. Related to ideas around striking an optimal balance between chaos and order, the teacher needs to impose order through providing constraints, that at the same time allow for some diversity of activity (B. Davis, et al., 2000). Limits can actually enable possibilities. By taking on, and working within conventions, individuals can then bend and stretch and begin to move beyond them (Alexander, 2000). Constraints provide starting points for a range of possible paths (B. Davis, et al., 2000), and delimiting the topic is thought to increase the diversity of responses. With a good knowledge of the subject teachers can create flexible tasks and feel confident to follow children's leads (B. Davis, et al., 2000).

To develop complexity, the teacher plays an important role in occasioning opportunities and happenings if he or she is open to surprising events while being attentive to curriculum purposes (B. Davis, et al., 2000), and takes advantage of "random contextual noise" (B. Davis & Sumara, 2006, p.149) to trigger possibilities. This attentiveness requires teachers to be able to see more than they expect to see which is an attitude that can be practised (B. Davis, et al., 2000). It is combined with a "flexible-responsiveness" that accepts that "all complex engagements involve adjustment, compromise, experiment, error, detour and surprise" (B. Davis, et al., 2000, p.144). The teacher becomes a co-learner and both facilitates and co-constructs meaning with pupils, thus dialogic inquiry, problem solving and an emphasis on challenging received knowledge are necessary (Morrison, 2008).

2.4 Conclusion

This chapter has provided many resources for understanding working theories and made suggestions for suitable pedagogical approaches. In many ways, each subsequent theory builds on the ideas of the earlier theories, with constructivism providing a basic underlining metaphor for the development of knowledge as construction, with sociocultural theory expanding (while also limiting) the range of resources on which children draw to construct theories, and complexity theory adding and encouraging diversity and complexity in highlighting a range of possible interactions between

diverse aspects of process. This chapter also begins to outline an epistemological orientation for research, which is further articulated in the next chapter.

Chapter 3: Methodology

3.1 Introduction

An appropriate research methodology for exploring how I as a teacher support children's working theories had to be congruent with my evolving knowledge of how people develop working theories, and my values as a researcher and a teacher. With an emphasis on sociocultural and complex processes of constructing knowledge, and on postmodern understandings of knowledge as subjective and plural (Dahlberg, et al., 2007), the methodology drew upon living theories action research (Whitehead & McNiff, 2006). This methodology enabled me to develop a study that could embrace the complexity of lived experience and to realise particular values within my own practice, while providing resources for others to do the same.

3.2 Epistemological orientation

Epistemological orientation influences research design (Darlaston-Jones, 2007; Gergen, 2001) and influences what is discovered (Gergen, 2001). Postmodernisum, sociocultural theory and complexity theory have been especially important for me in conceptualising the phenomena of children's thinking and theorising, and in developing my values about pedagogy. These interlinked perspectives also orient my research methodology.

3.2.1 Postmodernism

In adopting a postmodern orientation, I accepted the impossibility of objective, universal knowledge (Dahlberg, et al., 2007; Gergen, 2001; Janzen, 2008) and generalisable findings (Sellers & Honan, 2007). I also maintained the uncertainty of my research findings as the idea of ever being certain is fundamentally rejected in postmodernist thought (Hughes, 2001).

Rather than attempt to explain the social reality of teaching and learning, this research sought only to offer one contextually-specific and personal perspective. The social and cultural nature of language mitigates against the possibility of objective research, because "a linguistic forestructure is essential to direct and interpret whatever observations one does make" (Gergen, 2001, p.806). Although postmodern approaches recognise that meaning can be made, meaning is tied to a particular cultural milieu (Gergen, 2001). While recognising that research and researchers are culturally and historically situated, postmodern research gives credence to the perspective of those involved as valid interpretations. A postmodern orientation also involved recognising

and addressing the role of power in producing knowledge (Whitehead & McNiff, 2010), and empowering participants with a voice in the research.

3.2.2 Sociocultural theory

Postmodernist research requires a qualitative, interpretivist research methodology that can focus on detail and on the sociocultural context (Darlaston-Jones, 2007). Recognising that all knowledge is culturally and historically situated leads also to a sociocultural perspective that "presents a complex, layered, dialectical view of human engagement with the world" (Daniels, 2008, p.11). This involves recognising that there are many interacting influences on both children's and teacher's action when interpreting research findings, while also being aware that the findings are a product of a sociocultural context that is not replicated anywhere else.

3.2.3 Complexity theory

A complex view of the phenomena of teaching and learning was necessary, given the sociocultural and postmodern stance adopted. Complexity theory offers an ecological framework for understanding the organisation of social phenomena as interrelated, complex and emerging (B. Davis & Sumara, 2006), and focuses on interactions and unpredictable adaptive responses (Mason, 2008b).

In a postmodernist way, these ideas cast doubt on the possibility of describing and representing an independent and definite reality, because reality is instead dependent, indefinite and multiple; in other words, it is messy (Law, 2003; C. Robson, 2002). The complexity of a situation such as teaching and learning means that many representations of it are possible; further, meaning itself is evolving (Radford, 2008). Complexity theory suggests it is difficult to achieve any certainty in research, or specific guidelines for policy or practice (Radford, 2008). Moreover, written reporting creates further constraints in fixing meaning (Law, 2003; Sellers & Honan, 2007) therefore other forms (such as allegory and metaphor) may be more appropriate (Law, 2003).

3.3 Research methodology

With knowledge understood as socially constructed, multiple and participating in ongoing complex interrelations with other social and cultural phenomena, the most appropriate methodology was qualitative action research self-study. This recognised my position as a unique individual, with my own personal set of understandings and behaviours, that reflect my experiences and my learning, and that are involved in

complex co-evolution with the children I teach. Further, self study represents a specific and personal account of how learning and teaching can be improved through a process of investigating values to turn them into lived practices. A. Edwards (2001) argues that "teaching doesn't need disengaged scientific knowledge" (p.168) but a better understanding of knowledge in use. The methodology of action research into personal living educational theories is becoming widely credited in teacher education and teacher improvement (Grey, 2010; Whitehead & McNiff, 2010).

3.3.1 "Living theories"

As knowledge is understood to be constructed within a perspective and influenced by values, educational practices, likewise, are recognised as being values-based. It is well accepted that "education always presupposes values" (Daniels, et al., 2009, p.2). Further, development is a process in which both competencies and values are integrated (Hedegaard & Fleer, 2008). "Living theories" (Whitehead & McNiff, 2006, p.11) is an approach to research that both recognises and legitimates the fact that teachers make choices in their teaching practice, according to their values; therefore multiple perspectives are recognised. Values can become living standards of judgement (Whitehead & McNiff, 2006) that legitimise the knowledge that practitioners produce (McNiff, 2009). Knowledge is not reified as something that can stand apart from its context and its producer, instead it is linked to an active knower and a social context. Thus "accounts that aim to communicate that knowledge need to be personal narrativised accounts" (McNiff, 2007, p.6).

This methodological approach argues that knowledge is to be found in lived practice, so my research sought to develop knowledge and understanding through studying my own practice for supporting and promoting children's thinking and theorising. Yet I also sought to uncover and develop a philosophy and value base, because, as Johnston (2001) reminds us in regards to teaching, "philosophical positions are sometimes imposed, other times taken for granted; seldom are they debated" (p.21). Careful examination of practice is necessary because pedagogical traditions become common-sense scripts for teaching and learning behaviours, even when these are no longer productive or fit our values.

Selecting and evaluating pedagogical techniques for teaching thinking involved engagement of my personal educational values (Alexander, 2000). With awareness that

my meanings and interpretations are related to the social, economic and political conditions of my life (McCarthy, 1991), and as such, are "historically embedded" (Hedegaard & Fleer, 2008, p.8), my research findings represent one possible way to approach children's working theories. Rather than seeking a universal practice that will hold true as the best for all teachers and all pupils across the world (an imperialistic practice), I can only research what is appropriate for myself, my values and my sociocultural situation (McNiff, 1993). My personal theory can, however, still be offered to others for consideration and critique, as a specific example of lived theory.

The 'living theories' approach assumes an action research methodology, for specific enquiry into finding ways of acting "in the direction of one's values" (McNiff, 2009, p.6). Chandler and Torbert (2003) agree that action research can support integrity as "experimentation toward authentic translation of intent through strategy and practice into effect" (p.142).

3.3.2 Action research

Action research is practical, outcomes-focused and credited with generating "powerful understandings that inform strong educational practices" (Stringer, 2004, p.44). The perspective of action researchers on the relationship of action (practice) and theory is interesting, and differs from traditional views of research. First, it must be noted that the term combines action with research, seeing these as inherently intertwined (Chandler & Torbert, 2003), so that theory questions practice and practice questions theory (Winter, 1989). This is understood as a creative practice in that "practice and theory fuse and interchange" (McNiff, 1993, p.39).

Further, practice is seen as the grounds for theory (Whitehead & McNiff, 2006), because all action is informed by (albeit implicit) theory. It is the tacit theory and knowledge already implicit in teacher's work which the action research process helps to draw out and make tangible (Whitehead & McNiff, 2006). Thus practice leads theory. Johnston (2001) describes in her personal account of educational change, "other times practices came first, and then we had to evaluate them and construct theoretical arguments to support them" (p.23). Likewise Wenger (1998) argues that practice is not "mere realization of theory or an incomplete approximation of it" (p.48) but something with its own merit.

Action research also holds particular strength in its ability to be grounded in the values and culture of the researchers and participants, and be responsive to local context (Somekh & Zeichner, 2009). It also has potential for specifying general learning to share among the wider community (Elden & Chisholm, 1993), or for developing a theory which supports understanding of other cases or situations (C. Robson, 2002). Hedegaard and Fleer (2008) argue that methodology "must be anchored in a concrete historical setting and at the same time contribute towards and understanding of the *general conditions* that support child development" (p.4, italics in original) by developing specific concepts that can transcend settings. However, the primary aim of action research is about creating change or understanding in a specific situation rather than producing generalisable results (MacNaughton, Rolfe, & Siraj-Blatchford, 2001).

Action research differs from other social science research methods because it aims to understand the dynamics of interactions in which the researcher is participating (Chandler & Torbert, 2003). Indeed, Hedegaard and Fleer (2008) suggest that to research the child's social situation the researcher has to be a participant in that social situation. I thus participated in the research situation in two roles: as a social actor (the teacher) and as a researcher. This had an advantage in that I had insight into the teaching role, and it also meant that I could link my everyday reality as a teacher to the research concepts and theories because "there has to be consistency between conceptual constructions and social reality" (Hedegaard & Fleer, 2008, p.42). Rather than aiming for the objective observer role of traditional research, I aimed for more dialectical and interactive methods (Hedegaard & Fleer, 2008) which included experimenting with different potential roles and interactions that I hypothesised were supportive of children's working theories.

An important outcome of the research was "first-person, subjective data about oneself while in action that one can use in the present to act differently" (Chandler & Torbert, 2003), and which can improve future teaching actions (Southward & Conner, 1999). Action research involves the application of the knowledge gained, so that action is "informed and not indiscriminate" (Whitehead & McNiff, 2006, p.112). The action research model is generally seen as cyclical and dynamic (Stringer, 2004) involving a spiralling of steps for designing, data collection, analysis, action and evaluation (Berg, 2007). Change takes place in order to investigate the topic (Kemmis & Wilkinson, 1998).

3.3.3 Complexity research

Living theories action research methodology is complemented by a complexity theory perspective. Complexity theory suggests research methodologies that involve detailed descriptive accounts (Horn, 2008; Morrison, 2008), particularly case study methodology and qualitative, participatory, interactionist research involving many perspectives (Morrison, 2008). The unit of analysis is the entire ecosystem that arises from a specific topic (Morrison, 2008), and the researcher is recognised as an element in the research (Horn, 2008).

Complexity research in education can involve creating change and noting its effect in the complex teaching and learning system (B. Davis, et al., 2000), as in action research. A classroom is seen as a "sensitive learning ecology whose directions can be altered by small changes" (Horn, 2008, p.141), and thus connectionist, holistic analyses are important (Radford, 2008). However, some argue that as a descriptive science which avoids moralisations or values, complexity research cannot offer lines of direction for education (Morrison, 2008).

Further, as even virtually identical complex structures will respond differently to the same stimulus, and the same structure will respond differently to the same stimulus from one moment to the next, the identification of 'best practice' is impossible. In fact, complexity theory suggests that when there is a large amount of complexity present in a situation, new and unforeseen properties will emerge that might not even be suggested in the constituent elements (Mason, 2008b). Complexity theory cannot offer prescribed rules, recipes or guidelines (B. Davis, et al., 2000; Morrison, 2008; Radford, 2008) but intentions or principles.

The intuitive application of research findings might then be important for practice within complex systems (B. Davis, et al., 2000). Intuition is highly situation-specific, based on sensory, holistic or subtle evidence and thus is difficult to articulate (Claxton, 2000). In fact detailed explication of practice might inhibit intuition (Claxton, 2000); and while conscious and strategic behaviour is essential, rules or maxims may not be understood by anyone with limited experience.

Yet Mason (2008b) argues that specific findings are useful, as long as we are realistic about their predictive utility, knowing that any particular relationship between practice and outcomes occurs within a complex and unpredictable context where many other

elements are interrelated. In particular, the use of many, rather than singular, interventions based on research findings would be more likely to affect educational change.

3.3.4 Grounded theory

Grounded theory methodology presents a systematic strategy for doing research that is flexible and evolving and is seen as particularly useful in areas with a lack of concepts and theory (C. Robson, 2002). Its focus is "the discovery of theory from data" (Glaser & Strauss, 1967, p.1) and therefore it also subscribes to the view that theory is grounded in practice (Whitehead & McNiff, 2006). Grounded theory is an inductive approach, focused on theory generation rather than theory verification (Punch, 2005). Once a theory emerges, however, deductive approaches and verification of the theory are applied (Kelle, 1995), so that the analysis becomes "a series of alternating inductive and deductive steps, where by data-driven inductive hypothesis generation is followed by deductive hypothesis examination for the process of verification" (Punch, 2005, p.196).

Grounded theory is a research method that seems to fit well with the cyclical action research approach, because it too is guided by emerging directions from data collection. Subsequent data collection is guided by the theory that seems to emerge in the analysis of the prior set of data, giving opportunity to test the emerging theory (Glaser, 1978). Although postmodernists would object to this focus on the empirical verification of hypotheses, grounded theory analysis differs from empirical methodologies because rather than accepting or rejecting hypotheses, disconfirming data are used to modify and enhance the generated theory (Kelle, 1995). Thus grounded theory approaches are in many ways linked to the concept of working theories, theories that refined and modified with further experience and knowledge. Grounded theory, too, is "an ever-developing entity" (Glaser & Strauss, 1967, p.32), which suits the postmodern and complexivist epistemological orientation of this research.

However, this research departs from the usual methodology of grounded theory in two respects. The first is in the use of literature. Grounded theory argues that reviewing the literature before starting a study influences the researcher when working with the data (Punch, 2005). The review of literature should therefore take place after the theory takes shape, and is sufficiently grounded and developed (Glaser, 1978). However, in taking the postmodern and sociocultural perspective that all research and indeed, all

perception, is influenced by prior knowledge and experience, I agreed with C. Robson (2002) that it was not possible to set out to do research without some pre-existing theoretical ideas and assumptions. As a neutral, objective stance was unattainable, I took the approach of attempting to widen my resources for interpretation by reading as much, and as widely, as possible. Glaser (1978) provides some support for this view by arguing that "ideas make one theoretically sensitive, and the more ideas and the more they connect tend to make the analyst sensitive to what he may discover in his data" (p.32), although his argument pertains to reading the literature after theory formation.

Secondly, I did not (and I believe I could not) set out at the beginning of the research without a hypothesis, as claimed is necessary in grounded theory methodology. In accordance with the living theories method, I recognised that I already had implicit theories in my practice from my ongoing experience as a teacher; the reason for the research was that I believed that I had some insight into the teaching strategies that support children's theorising and I wished to investigate these.

My research methodology thus investigated 'theories-in-use' (Marshall, 2004, p.315), articulated values and acted politically towards their realisation, in line with living theories methodology, and involved acting, evaluating and modifying my action, in line with action research methodology. Analysis drew on grounded theory methodology to discover new insights, and on complexity theory to recognise the interconnected nature of all elements, as well as the individual and highly contextual nature of the findings.

3.4 Research method

The procedure I used for investigating my living theories, or theories-in-use, began with articulating the values and beliefs that were to inform my teaching and my research interpretations. These values and beliefs formed the basis for value judgements of the quality of my actions (Whitehead and McNiff, 2010). For example, identifying a postmodernist orientation meant that positive teacher actions were those that encouraged children to consider a range of possible theories and perspectives, rather than a more modernist project of, perhaps, scaffolding children's construction of an 'official' theory. Data collection took place in the early childhood centre in which I teach, and focused on video-recording my own teaching with three and four-year-old children. Twelve children in total participated, with up to eight children involved in each activity. Only one child participated in all four activities. I chose to video teacher-

initiated activities which were intended to develop children's working theories in relation to their current interests ('earthquakes' and 'shopping'). Four activities were videoed over the course of the research. Intensive observation such as that provided by video is reported to help teachers to bring to consciousness, formulate and articulate the "framework of beliefs, theories, dilemmas and decisions of which his or her professional thinking is constituted" (Alexander, 2000, p.384), and suited a living theories methodology. Analytic approaches such as reflective memoing and reflective fieldnotes, alongside the process of writing my research journal, also supported the process of investigating my practice.

A flexible design (C. Robson, 2002) was necessary in line with action research and grounded theory methodologies. Therefore, after each data-gathering sequence, the data was reviewed, according to my (value-based) standards of judgement, and, as necessary, a change of strategies or a new strategy was planned (Coleman & Lumby, 1999). Further data was then gathered to evaluate the change. My research proceeded in a developmental way (Whitehead & McNiff, 2010) so that new questions emerged and were addressed throughout the process.

3.4.2 Ethics

The ethical principles of partnership, participation and protection were considered in the research design. I was studying myself in the context of my interactions with the children I teach, so partnership, participation and protection were important for the children. Others present in the research context were teaching colleagues, and the video camera operator. In focusing this research on my own teaching practice, I intended to reduce risks for my colleagues and for my relationships with them. I therefore enlisted support for conducting the research from someone outside of my immediate teaching team, an early childhood teacher currently contracted in our centre to provide teacher registration support. She was paid from the research funding to video me. Aside from payment, another benefit for her included an opportunity for a unique insight into the research through being present at these primary data collection moments.

Children were invited to participate formally through an informative leaflet (see appendix 1) which gave an opportunity to assent to the research. Without being able to ensure children understand the implications of the research fully, it can be difficult to legitimise research about very young children (Giacopini, 2009). However, as I sought

to improve the way I supported the children to develop working theories, working in partnership with children was a necessity; further I intended to realise values which included listening to and empowering children. In analysis of the findings, I focused on what the children were able to teach me about effective interactions that promoted their theorising. Partnership was also offered in inviting children to view the video with me.

Ethical decisions ultimately reside with researchers, and involve both personal (Bogdan & Biklen, 1998) and context-specific values (Degotardi, 2008). An important ethical consideration was to continually ensure that the research took place within a clear context of advocacy and support for young children, and support for their needs around thinking and theorising, rather than teacher or curricular needs. I had to recognise that any transformation of my practice and the children's learning was "necessarily a deeply ethical matter that must be undertaken with caution, humility and care" (B. Davis & Sumara, 2006, p.131). Thus there was a focus on looking through the child's eyes, and on the here and now rather than for the future needs of consequent stages.

Further protective measures were employed around the use of the video camera. Although the use of video for pedagogical documentation and assessment is already a common practice in our centre, the video camera is associated with intrusion and surveillance (Tobin & Davidson, 1990). It was not considered appropriate during sensitive moments such as nappy changing, (Degotardi, 2008) and a protocol for the use of the video camera was produced (see appendix 2).

Parent's written permission was also sought, and parents were well-informed about the nature of the research, what it entailed, how their child would be involved and how their child's confidentiality would be protected through an information sheet (see appendices 3 and 4). In this sense, the parents helped guard against the risks involved for the child. Those parents and children who decided not to participate were not video-recorded, and filming was stopped or moved if those children came within the video frame. For those children and families who consented, identifying details are not included in the data.

Children were given a pseudonym to disguise their identity. Alexander (2000) discusses the merits of pseudonyms as opposed to letters of the alphabet, and recognises that letter names depersonalise the participant, whereas a pseudonym can be chosen to reflect gender and ethnicity (although social associations vary). I felt that pseudonyms helped

maintain the narrative style of my research, which was important to emphasise the social and cultural context of the research.

Before analysing the videos, I invited families to view the video and edit it as they wish. The parents were also invited to comment on the video if they so wished (see appendix 5) and a designated box was provided to enable anonymity. Children who were video-recorded were also invited to view the video. A presentation of the research findings is planned for the teachers, parents and management of the centre.

As the data consisted of video segments, storage and disposal of the data was very important. Data was stored electronically on my password protected network drive within the university. My written reflective journal was kept as an ongoing text document on my (password protected) personal laptop. After analysis of the data, I transferred the data and transcripts to an external storage device which was placed securely within the locked filing cabinets of the post graduate programme administrator in the School of Education, to be destroyed after 6 years. The videos were not seen anywhere other than within the early childhood centre, and only by myself, and the children and families involved.

3.4.1 Addressing research validity

Despite the dominance of a positivist epistemology in scientific research, other perspectives do not lack rigour but redefine in a broader way what counts as scientific endeavour (Darlaston-Jones, 2007; C. Robson, 2002). Validity is created through the way the research is conducted and analysed rather than through replicability and generalisability (MacNaughton, et al., 2001). Thus rigour in qualitative research includes being clear about the researcher's philosophical position and theoretical frameworks, the sample used, sufficient evidence (using triangulation in smaller samples), and publication of the findings (Meade, 2000). The evidence should also be tested against value-based criteria (McNiff, 2007).

I was aware of my personal stake in a study exploring my own practice, as the researcher's "life, career and self-concept are always intimately tied to seeing what he or she is doing in a particular way" (Bogdan & Biklen, 1998, p.36). Therefore, the systematic investigation of my values and exploration of their effect on the researcher and the research process was seen to support rigour (Darlaston-Jones, 2007; Meade, 2000). I recognised that I had an important role in selecting and framing the

observation, transcription and analysis as I was "knitting the fabric of relations through which observations are rendered sensible" (B. Davis & Sumara, 2006, p.70). I had to scrutinise and challenge my understanding and interpretations and reflect on how my own experience and perspective might affect all aspects of the research process (Darlaston-Jones, 2007).

Winter (1989) offers six useful principles for ensuring that the data and the commentary are thoroughly interrogated for alternative meanings, perspectives and theoretical bases, to increase the validity of the research. Most important are those of reflexive critique and dialectical critique. Reflexive critique demonstrates an awareness that any comment or observation refers back to a subjective system of meanings and so it is important to make this reflexive basis explicit (C. Robson, 2002; Winter, 1989). Dialectical critique involves understanding an object as within a set of relationships (with other elements with which it is unified or opposed to) rather than in isolation. Winter also identifies collaboration as a resource, taking risks, using a plural structure of multiple viewpoints, and the interrelationship of practice and theory as essential principles. An important consequence of his approach is that the account presented is not a statement of objective fact, but is open and questioning, requiring the reader's interpretation. In this way, Winter feels, the report will have objectivity, which he defines as "relevance and plausibility for readers with widely varying concerns" (p.65).

I had access to several viewpoints, including my subjective 'insider' perspective as a participant, and a more detached perspective in watching myself on video. Observation of the children supported me to access their viewpoint, and was enabled by my insider and participant status. As well as improving validity, the children's perspective was essential because I agreed with Hedegaard and Fleer (2008) that children contribute to their own developmental conditions. Hedegaard and Fleer (2008) argue that particularly useful examples for reflection include conflicts between the child's projects and my (teacher) demands indicating different perspectives, and indeed I found this a productive area for close analysis. It was also important from my values-based perspective. Winter (1989) suggests that in order to challenge partiality, each viewpoint is seen a resource, and none is final, so that "differences between viewpoints constitute serious challenges or questions posed from one to the other' (p.56).

Inviting the scrutiny of my ideas, emerging analysis and theory, as well as my role in the research and the research process, from others (Darlaston-Jones, 2007), such as my supervisor, is what C. Robson (2002) refers to as scepticism. This research will further be presented as a knowledge claim for the critical scrutiny of others (McNiff, 2007). Being sceptical also meant subjecting my findings and conclusions to disconfirmation, particularly through negative case analysis (C. Robson, 2002), which involved actively seeking data that didn't fit the theory, from within the data I had collected.

Other techniques for widening the interpretative possibilities included "decentering" (Whitehead & McNiff, 2010, p.17), and approaching the data holding the point of view of each child as central. I also focused on comments and actions that didn't make sense or seem to fit with the other data, and generally followed up puzzling or surprising findings (Punch, 2005). I used other theories and perspectives to enhance validity through theoretical triangulation (C. Robson, 2002) and I added some quantitative measures of the relationships between the data sets for methodological triangulation (C. Robson, 2002).

Data analysis methods were systematic and disciplined and are transparently described below (Punch, 2005), charting the steps taken in interpreting the data and generating my theory (C. Robson, 2002).

3.4.3 Data collection

Reflective journal

Seeing action research as the development of a living educational theory (Whitehead & McNiff, 2006) meant that it was important to demonstrate how my learning influenced both further action and further learning. As I read widely around my topic, I found that my learning influenced my daily practice in subtle ways which were important to record. This was the function of my research reflective journal, in which I also attempted to "stand back and offer [my] own critical commentaries" (Whitehead & McNiff, 2006, p.118).

In line with the living theory methodology proposed by Marshall (2004), the reflective journal was used to articulate the ideas or 'theories in use' around how to support children's theorising that I began this research with, so as "to open them to review, critique and development" (p.309), as well as to explore examples and ideas from my

other learning. Spontaneous and unplanned instances relevant to my research question were recorded as soon as possible after observation. This recognised that my learning and the development of my practice took time, and the cumulative nature of learning and thinking could not be captured in full within a video observation.

Observation

As well as informal and spontaneous observation being recorded in my reflective journal, observation was also formally planned, through monthly videotaped interactions. One half hour of my teaching was observed and recorded by video camera, on four separate occasions. The monthly videotaped interactions recorded planned and focused activities in which I specifically aimed to engage children in theorising.

Video recording supported detailed description in order to "portray the meaning of the event for the participants in terms that capture local... goals and practices" (Rogoff, Mosier, Mistry, & Goncu, 1993, p.231). Video recordings also offered repeated viewing opportunities, and more data with each viewing (Bary, 2009; Gillham, 2000). Video data has been found to support teachers' reflection and development of pedagogical knowledge. In particular, it has been found to help bridge the gap between theory and practice (Bary, 2009) and to help the teacher "become aware of the children's competence, as well as his or her own involvement and role" (Fleer & Pramling-Samuelsson, 2009, p.183). The use of video also supported a focus on the easily missed non-verbal nuances of young children's responses to my teaching. One particular disadvantage of video recording was that the wider context was lost (Glesne, 2006). However, spontaneous observation and reflection recorded in my reflective journal attempted to address the wider context, particularly the impact of interactions over time. The limitations of the video camera in being able to record only what is in the frame also meant that I was often not able to view the actions of the current speaker, as well as the non-verbal response of the listeners. I found, like Sellers and Honan (2007), that "inevitably there are frustrating moments of invisible happenings off the screen" (p.148). Further, the number of video-recordings to be made and analysed had to be limited, because of the amount of time needed for analysis.

An impact on the validity of findings was that of the presence of the videographer. Many instances of children staring straight into the camera were recorded, suggesting children were aware of the practice. Further, the process of being recorded had an

impact on my behaviour, yet rather than the camera, I felt that the human operator was a more influential factor! Having much respect for this teacher, and desiring her respect, I felt a certain compulsion to make sure that the observation was successful. This led to occasions when I did not feel 'natural', and might have pushed towards a certain outcome more than I would have if I was not being watched. Further, having to agree to a time for the observation was an extra difficulty. This meant that I had to engage children in thinking and theorising work whether it was an appropriate time for the children or not (always unpredictable), whereas in my everyday practice, I usually 'pick the moment' for these kinds of interactions.

Transcription

I transcribed the video observations myself, and met an immediate problem in deciding how to turn a multi-dimensional video recording (visual and auditory) into a written text. Alexander (2000) gives a good account of these dilemmas, which include whether to attempt to transcribe the manner in which words are spoken and whether to attempt to include notes to summarise historical references to previous conversations. These aspects are key knowledge resources for the construction of meaning (Mercer & Littleton, 2007). Given my intimate knowledge of the research situation, I felt that transcribing the manner in which words are spoken, and providing historical context, was a legitimate act, although I also supplemented my description with other possibilities. Not using this information would diminish the interpretation (Mercer & Littleton, 2007); however, this information is necessarily subjective, and is noted as a possible limitation to the research study.

3.3.4 The action research / grounded theory cycle

The research methodology was designed to improve my knowledge and my action as a teacher, specifically, in exploring ideas and pursuing my 'working theories' about what might be most supportive for children's theorising work. I thus moved between observation, transcription, analysis and literature review, and as my ideas changed direction, I sought further literature for theoretical resources that could help me make sense of my discoveries.

As I began the data collection, I had an idea that I wanted to explore the notion of teachers orchestrating opportunities to revisit children's working theories. I hypothesised that bringing the theories into dialectical confrontation, and offering

opportunities to represent theories, as well as open encouragement of the plurality of knowledge, would support the children in generating further theories. The first video was made, and subsequently analysed.

I discovered that there were many theorising instances and opportunities missed, particularly those that were unanticipated, while I kept revisiting the previous working theories of children that I had documented and knew well. My initial theory was that the narrow parameters I had in my mind about what would be explored, and the structured plan of how we would investigate these ideas, had limited my ability to be responsive to children's emerging theorising or other opportunities for theorising. Looking at the data with a view to discovering the children's perspective (Hedegaard & Fleer, 2008), I felt the children's intentions had been ignored and suffocated by my interaction, which was not congruent with my values. In line with grounded theory, I planned the next observation to test an emerging hypothesis that being very open in structure would support a diverse range of theorising, and I wanted to explore the possibilities for asking children how they would like to progress ideas and theories.

However, the second and third observations disproved the hypothesis. The open approach of offering a selection of ideas was not successful, in fact no coherent line of enquiry was pursued. Further, I was still unable to be open to children's ideas, because even though I provided a range of documentation for children to discuss, I led the discussion to produce (my) particular interpretations of the documented events.

There was one piece of data in the second observation that suggested a way to be alert to new ideas and pathways, that of a conscious strategy to pause, repeat the child's contribution, and actively think about how it connected to our discussion. This was proposed as a strategy to explore in the third observation, and was developed further through the ideas of Rowe (1986), and Walsh and Sattes (2005) about wait-time. However, pausing and thinking in the moment of teaching was both unsuccessful and difficult, although there may have been many other contributing factors to the failure of this strategy including a poor choice of topic and lack of preparation. The third observation was very challenging in that one child became so highly disruptive that videoing was stopped and the observation was deferred to another occasion. Nevertheless, I was developing some clearer ideas, that both the strategies of being prepared, and thinking in the moment were required, alongside ideas about an optimal

amount of structure. I also had more knowledge about the children's processes of developing working theories to draw upon.

Without realising that I was making any progress towards the kind of teaching and learning opportunity I was seeking to investigate, the fourth observation was an epiphany in which many of the ideas I had been reflecting on came together in my understanding and in my practice. This was fortuitous, because the data collection set was already quite large, and, in order to keep within the requirements for a Masters degree, I probably had enough data. Perhaps the relative success of this observation can be credited to the process of action research, which enabled me to transform my action in the moment by developing my awareness and understanding of a range of possibilities for action, rather than allowing habit or patterns of thought to determine practice (Chandler & Torbert, 2003).

3.3.4 Data analysis

Data analysis methods were carefully considered to ensure that the approach was appropriate for its purpose (Punch, 2005). Using grounded theory for data analysis was considered important to ensure that I had a grounded understanding of how my teaching impacted on children's theorising to inform the choices that I made to improve my action. This was also considered essential to the validity of my findings, so that the actions that I advocate as a result of this research have some evidence base.

Data analysis was ongoing throughout the four months of observation, so that each observation could be tailored to the development of the research, with data collection, coding, and tentative theorising all occurring at the same time (Glaser & Strauss, 1967) and influencing each other. I used both deductive and inductive approaches to theory formation. Developing a definition of children's theory-making and using this to identify working theories involved deductive analysis. Inductive approaches involved "initial, systematic discovery of the theory from the data" (Glaser & Strauss, 1967, p.1) and aimed to find out, rather than to prove or disprove existing ideas.

The analysis moved back and forth between close analysis of data and a broader view about what seemed to be happening in the data as a whole. The first form of analysis was that of writing the equivalent of fieldnotes after each video was recorded, as recommended by Erickson (2004), and identified broad themes (see appendix 6).

Data analysis focused concurrently on teacher practice and child activity (Hedegaard & Fleer, 2008), in line with improving the validity of the research by taking multiple perspectives. This first level of coding used "descriptive, low-inference codes" (Punch, 2005, p.200). As many codes as were necessary were created, in order to ensure that categories had fit with the actual data; further, the data was coded in everyway possible (Glaser, 1978) relevant to the research topic of children's theorising and teacher role. The aim was to be "sufficiently searching to probe beyond the observable moves and counter-moves of pedagogy to the values and meanings which these embody" (Alexander, 2000, p.266). Further, the children's utterances were analysed for thought-level, for example whether repeating knowledge, or representing conceptual, theoretical or abstract thought, to support evaluation of my teaching action (see appendix 7).

Interpretative notes were made against sections of data in order to map out what kinds of strategies I was using. I then reflected on how satisfied I was with those in terms of acting within my values (the 'living theories' approach) and the impact that they seemed to have on children's theories (grounded theory), in order to identify new strategies for action (the action research approach). Thus this first round of analysis also involved the writing of memos, the "theorising write-up of ideas about codes and their relationships as they strike the analyst while coding" (Glaser, 1978, p.83). These memos, as a "creative-speculative part of the developing analysis" (Punch, 2005, p.202), were very powerful in determining new possibilities for practice for the next observation. Writing memos also supported an understanding of the data in context, thus mitigating data fragmentation (Dey, 1995).

Once the four observations were complete and analysed in this way, I attempted to stabilise the coding categories by establishing which data indicators were associated with which codes. Through constant comparison of the data which illustrates the concept (C. Robson, 2002), each concept could be elaborated in terms of its properties, and thus the concepts became more clearly articulated (Punch, 2005; Sibert & Shelly, 1995). For example, it was clear that some categories, such as 'extending' and 'probing' were not clear and through constant comparison of the data in these categories, I was able to articulate a definition for each (see appendix 8). At this stage I was able to change my mind about some code labels, and make some choices about which codes were going to be most useful in generating theory to avoid over-coding, following

Glaser (1978) who suggests that too many codes, which add only minor variations, dilute the impact of the theory.

I then revisited each transcript, checked and improved its accuracy against the video recordings, and then re-coded it, with the clarified definitions for each code. This provided a means of checking results and accounting for observer consistency (C. Robson, 2002), and any disagreements in coding between the two scripts were carefully considered.

Later coding attempted to integrate data using higher-order concepts (Punch, 2005) so that, for example, 'describing', 'focusing', 'repeating', 'clarifying', 'verbalising / reformulating theories' became linked within the code of "visibility" (see appendix 9). In this way, categorising enabled me to discover and order ideas and themes (Richards & Richards, 1995).

I was concerned, as a single researcher researching my own practice, about theoretical sensitivity. Open coding, like most grounded theory analysis, is best done in a small group for thorough coverage of all theoretical possibilities in the data (Punch, 2005) yet this was not possible within my ethics consent. In order to enhance theoretical possibilities, I attempted to apply other researcher's codes to the data (see appendix 10). Grounded theory is usually seen as an approach which consciously avoids other theory. However, Glaser and Strauss (1967) argue that the use of other theory is possible once substantive concepts and hypotheses have emerged by themselves, and as long as categories earn their way into the theory but are not forced (Glaser, 1978). Moreover, using another theoretical perspective helped ensure triangulation (C. Robson, 2002). I chose the revised Bloom's taxonomy (Anderson, et al., 2001). This tool was designed primarily for analysing curriculum content and writing specific teaching and learning objectives, yet it is suggested as a possible tool for assessment.

As suggested by Glaser and Strauss (1967), the 'borrowed' codes did not quite fit. I felt sometimes I was ascribing a higher level of thinking than was actually appropriate. For example, the planning of procedural knowledge (a higher order thinking process) that was identified in the third observation was simply a case of children putting up their hands to volunteer for the task of cutting out a photo (V3, 004). There were also examples of coding using the revised taxonomy that didn't do justice to the quality of thinking demonstrated, particularly when children used associative thinking. When Izzy

refers to the dragon she made with glue and wood (V4, 009) as proof of the strength of these materials (theorising glue and wood must be strong because her dragon is strong), the taxonomy analyses Izzy's statement as 'recalling factual knowledge'.

However, the taxonomy framework was useful, as its authors suggested, for supporting my understanding of what children had to be able to do in terms of cognitive processes. It prompted me to think about the sequence of thinking skills that leads to theorising, and develop more precision in my use of terms associated with cognitive processing. The use of the taxonomy also supported me to identify further instances of theorising that I had missed. The differences which came up between my analysis and Bloom's analysis were delved into, revealing some interesting points (discussed in the findings). I now felt that I had achieved greater theoretical sensitivity and had more trust in my own coding! Returning to the development of my grounded theory, I further investigated the links between teacher actions and children's thinking.

Coding is only supportive of theory generation when the links and connections between categories are explored (Richards & Richards, 1995). Connecting the categories of teacher action to children's thinking and theorising resulted in around 50 propositions or hypotheses (see appendix 11). As Erickson (2004) argues, it was important to determine whether the analytic categories constructed were related to the meaning perspectives of the participants, and this meant looking more systematically at what happened next in the interaction. To help me with this, I chose to re-organise the data to view it through a different lens (Sibert & Shelly, 1995). Punch (2005) argues that displaying data organises and compresses information, and moves the analysis forward. For example, for each working theory expressed, I identified what was the significant preceding comment or event that led to the theory (see appendix 12).

I attempted to quantify both the types of thinking children engaged in (including the number of working theories expressed) and the number of times particular teacher actions preceded a child's thinking or theorising (see appendices 13 and 14). Although imprecise because of the number of intervening and mitigating circumstances, quantitative approaches are often combined with qualitative approaches in social research, in order to capitalise on the strengths and mitigate the weaknesses of each (Punch, 2005). Yet I had to ask, as Kelle (1995) does, what the co-occurence of codes could tell me. I agreed in fact that this practice was found to fragment the data and

resulted in the loss of information about context and process (Dey, 1995). Thus I repeated the analysis by extracting from the transcript a variety of relevant preceding and subsequent comments and actions, linking text and context (see appendix 15), drawing on an approach described by Dey (1995) and using co-occuring codes as a heuristic device (Kelle, 1995). This was labour-intensive, so I worked on this until I identified a pattern. In line with grounded data analysis, from then on I coded only those examples that offered new relationships or connections, as including those that did not "only adds bulk to the coded data and nothing to the theory" (Glaser & Strauss, 1967, p.111).

A final round of analysis critiqued my assumptions and interpretations so far, to improve research validity, and looked for negative cases of the propositions and relationships between categories. The negative cases enforced me to revise my propositions until they could account for all cases (C. Robson, 2002). I used Winter's (1989) principles to develop alternative meanings and question my assumptions, producing a second interpretation for each line of the transcript (see appendix 16). This opened up my analysis to be more questioning; with multiple interpretations, no one interpretation could be given without hesitation. This approach widened the possibilities, and identified my biases. For example, in the first rounds of analysis, I had not recognised children's actions as theories, which I realised was evidence of a personal bias to focus on words.

Finally, I considered whether a broader theoretical concept could make my particular and local case "typify more than itself" (Alexander, 2000, p.266). I believed it was worth trying to take the analysis to another level, agreeing with Luke (2005, cited in Carr, et al., 2009) that "radical overskepticism towards metanarratives – and oversensitivity to the local and the individual – can lead to fragmentation and paralysis" (p.195). This also linked to the third and final stage of grounded theory analysis which involves the selection of a "core category" (Punch, 2005, p.211), around which the data can be integrated (C. Robson, 2002). Two particular concepts were seen as central, and were further elaborated through reference to the literature.

3.4 Conclusion

In combining action research approaches with grounded theory, the research methodology attempted to draw on the strengths of practitioner research (including the

depth of understanding and the value base of action) while mitigating the possibility of self-legitimisation by allowing the data to lead theory. This allowed me to be open to surprising findings, and led me to make a significant shift in the way I saw children's thinking processes and the teacher's role. Grounded theory was congruent with a living theories action research methodology as it enabled me to demonstrate considerable growth in my understanding and my practice, and supported the ongoing modification of my personal working theory.

Chapter 4: Findings on children's theorising

This chapter considers some of the major findings from the study about the nature of children's working theories. Four activities form the data set for the findings: in the first activity, children looked at a documented case of one child building and creating an earthquake, then were invited to create their own earthquakes. This was March 2011, after a large earthquake had occurred in Christchurch and dominated both news' broadcasts and adults' conversations. In the second activity, children reviewed documentation from the first activity, then engaged in drawing on the topic. In the third, children were invited to create their own documentation poster about a recent trip to a shopping centre; while the fourth activity returned to the earthquake theme and, after reviewing photographs and videos, invited children to try to make a house that didn't fall down in an earthquake. The activities took place in the early childhood centre and children participated as they so wished; therefore the group of children varied across the four videos.

The children (aged 3 and 4 years) were discovered to be expressing working theories around the concept of earthquakes, and also social theories such as how to control each other's actions or how to allocate resources. In terms of understanding how and when working theories occurred, the findings suggest several different types of thinking as being key to the production of 'working theories'. The findings also suggest that there are particular 'cognitive contexts' in which children are more likely to engage in the creation or expression of working theory. Finally, the chapter concludes by recognising the differences in the number of incidences of working theories in each observation, while the following chapter on the role of the teacher explores the reasons for these differences. The data is referenced by the session number (Video 1-4) and by the video segment within that session (001).

4.1 Theorising

4.1.1 Working theories

Working theories were identified by both functional and structural features, drawing on these key points from the literature:

- Theories are predictive, explanative and/ or inferential (Christmann & Groeben, 1996; Gopnik & Meltzoff, 1996; Inagaki & Hatano, 2002);

- Theories make connections between concepts (Christmann & Groeben, 1996; Ministry of Education, 1996; van Wijk, 2008) thus theories can be broken down into a series of linked assertions.

For example, when Sabrina says the earthquake was caused by a monster who "lifted up the house and shaked it" (V1, 012) she is creating a theory [A monster can make an earthquake happen because he can lift up the house and shake it] based on several premises: earthquakes involve shaking; to shake something you have to pick it up; monsters are big and can pick up houses; earthquakes occur because a monster lifts up the house and shakes it. Her theory is explanative and she connects several concepts which can be recognised as a series of linked assertions. The table (appendix 17) shows all examples found in the data.

Theories were often enacted, and, sometimes, without articulation, as for example, when the children created earthquakes by shaking their buildings back and forth with their hands (V1, 003), demonstrating a theory that 'shaking a building makes an earthquake'. Some theories were communicated through drawing. Sarah draws a spinning monster that breaks all the houses down and then adds "spiky bits" (V2, 015) modifying her theory: 'houses break down because a monster with spikes is spinning'.

Thus children's theories were often implicit, and without discussion or further observation only assumptions can be made. For example, Liam (V4) builds houses with several storeys: is that because he holds an implicit theory that the more storeys there are the more spectacular the crashing down will be?

Not all theories were related to the scientific or engineering domain; many theories were theories of social behaviour, for example, who should be included in the activity and why (Sefa, V2, 001; Tilly, V4, 002&3), as well as several strategies demonstrated for obtaining blocks (V1), a new pen (V2), or particular photos from the teacher (V3).

Interestingly, the theories generated from secondary sources were harder to analyse into constituent parts, for example, that earthquakes occur "when pipes wobble and shake" (Damien, V1, 024), and to keep safe "we go rolled the ball like that" (Sefa, V1, 032). Presumably Damien has seen video footage of wobbling pipes, connected to video footage of the earthquake, and so he has connected the two concepts, whereas Sefa's knowledge might have been remembered from a group reading of an earthquake safety

leaflet. The children found it harder to express these theories; it is possible that the concepts may have been put together without full understanding.

4.2 Other cognitive activity important for theorising

As well as theorising, other cognitive processes were identified, which may be linked to the development of working theories.

4.2.1 Creating verbal descriptions

Children were considered to have created a verbal description when they put into words, or named, an object or phenomena. This included labelling of objects and actions in the documentation and descriptions produced to accompany representation, as children authored their own actions. Further, children often produced verbal descriptions to draw attention to the results of experiments or surprising actions, which could then be theorised about.

4.2.2 Creating representations with materials

There were two different ways that children created representations with materials. One seemed to be related to generating ideas, in that particular materials or actions suggested ideas to the children and children then applied a symbolic label to the material or action. Another seemed to work in the opposite direction; here children seemed to start with an idea and search for a material to represent it. It seemed further that children may have been using representation to connect their knowledge, as children drew on all available (material and ideational) resources in representation.

Theorising commonly accompanied representation. When children ascribed objects with meanings, they also often offered theories as they attempted to justify their representation or elaborate it, seemingly led by a desire to make it more 'real' or to make it make sense. For example, after deciding her construction looked like an aeroplane, Tilly then attributed meanings to the pipe cleaners she had stuck on it by developing theories about the kinds of buttons aeroplanes need (V4, 023). Children not only seemed to use the materials to suggest meanings, they also took meanings that were circling in the discussion around them and developed theories to story them into combination. Damien's narrative "now my bears going to drive away because he hears an earthquake coming brrrrmmm" (V1, 014) showed this well: the bear protagonist was a provided material, the driving was suggested by the road tile (material), the earthquake was an idea that had been circulating in the dialogue, and other children had

been enacting the sound of the earthquake through loud bangs. When theorising didn't accompany representation, it is possible that children were actually satisfied that their representation was whole or complete.

Representing ideas in materials seemed to support children to articulate and develop new concepts and new theories. Theories may have supported children to decide on the principal features to represent (for example, making an earthquake by snipping with scissors (V3, 011) suggests a focus on the breaking that occurs). It seemed too that the children expanded theories because they asked themselves 'what else do I need to represent?'

Drawing was another medium for interpreting concepts and expressing ideas, for example, Sarah's drawing of the monster that makes earthquakes (V1, 014). Often the act of drawing encouraged children to expand their ideas, such as when Eloise drew the wood and nails as the solution for 'strong houses', after a pause she adds glue (V4, 009). This might have been because drawing gave thinking time, as it seems quite natural in drawing to pause and consider one's drawing so far, and ask oneself 'what else do I need to draw?'

On the other hand, it seemed that often the children's drawings made their own suggestions as to what they represented, as children drew and then later attributed representational meaning to the marks. For example, Darren attempted to draw a boy on a ladder and then decided his drawing looked like a "funny tiger on the ladder" (V2, 016).

Using language to talk about earthquakes was another form of representation, and where some children were comfortable to use the term 'earthquake' assuming some shared understanding, others had their own terminology ("earthshake": Izzy, V1, 014; and Benson, V1, 024) or, like Sefa, took their time to pick up the new vocabulary, verbalising his understanding of earthquakes as "break it" (V1, 011) and "broken" (V1, 014). Narratives also outlined children's understanding, for example, Izzy said "an earthshake go bang" (V1, 014). Other representations may have accompanied spoken language to support children to express their meaning, for example, when Darren suggests "lock a gate" (V4, 147) he also wraps his arms around his building in demonstration.

The ideas that we were discussing were physical phenomena, and as such could be actively represented by the children. Verbs such as 'shake' invited the children to do just that: when I first described Wesley's theory that "the earth shakes itself" (V1, 003), Sabrina shakes her body in response. Damien shakes his body when Eloise shows him a card "no shaking" (V1, 027); and Sarah shakes her body as she tells us "your house might wobble" (V2, 001). Likewise, the imagined monster that destroys the houses can be role-played in all of his physicality, kicking, jumping and punching (Sefa and Izzy, V1, 013).

4.2.3 Repeating

Repeating the ideas and representations of others was differentiated from recalling (discussed next) because where recalling functioned to remind, repeating seemed to be related to the aim of trying out ideas and representations for oneself (and excluded repeating oneself to be heard). Children usually repeated and then extended, or perhaps defied, a contribution, and in this way repetition was found to lead to theorising. Where this didn't occur, it was perhaps due to an interruption or perhaps related to a perception in the child that the theory or representation was the best it could be.

4.2.4 Recalling

Recalling supported the development of ideas across time. With the aid of the documentation, children could describe previous activity: "I'm making an earthquake" (Sefa, V2, 002) and "I putted a card in and I said its [pause] its not for crashing" (Eloise, V2, 003). What was recalled was indicative of children's interests, like when Darren asks for a particular photo taken on the trip "Where where's the ice cream shop?" (V3, 003).

Recall could also provide a starting point for theorising. For example, Sabrina recalled Timothy's idea of an earthquake being caused by "a monster shaking in the house" (V1, 012), and immediately modified the theory "No it lifted up the house and shaked it" (V1, 012). This generated a long sequence of theorising by several children about what the monster did.

Interestingly, children seemed to draw on their memories of previous events and engage in similar actions when in the same location, with the same people and resources. During Video 3, while making a poster about our shopping trip, Sefa recalls drawing the

earthquake (V3, 010), as if perhaps the same people, places and resources triggered his memory.

4.2.5 Making connections and associations

Making connections with other similar phenomena supported theorising, perhaps because they served to enrich the knowledge base from which theories were being constructed. For example, Sefa connected the 'no shaking' sign on the table next to Eloise's building with a sign in the centre telling you not to put your bags on the table in the eating area, "like the kai area" (V1, 028). This connection helped him to come up with a solution to put the buildings on the ground (V1, 029) as in the kai area bags go on the floor. Other associations supported the building of theories through links between concepts, such as when Izzy links the concept of strong to the consequence "can't fall down" (V4, 009). Expanding ideas often occurred in the case of narrative, discussed as an important cognitive context for theorising below.

4.3 Cognitive contexts for theorising

Analysis using the revised Bloom's taxonomy

The analysis of the transcripts according to the revised version of Bloom's taxonomy (Anderson, et al., 2001) revealed insights about the different cognitive processes that provide a context for the children's theories. For example, I interpreted Wesley's explanation of why Damien had not eaten the lollies on our shopping trip as a theory: "you're not allowed to at the shop" (V3, 006). The revised taxonomy identified it as 'critiquing'; indeed, this is what Wesley uses the rule or theory for. So I began to recognise that theorising took place for specific purposes, including, for example, 'classifying' earthquakes as a procedure for breaking things (Sefa, V1, 011); 'planning' how to keep safe in an earthquake (Sefa & Sarah, V1, 032); and 'checking' whether her aeroplane is strong (Tilly, V4, 019).

Bloom's revised taxonomy also helped me discover further examples of theorising such as when children drew on experience to predict what would happen to specific buildings when the table shook (Tilly, V4, 013&020) and argue "No! I don't want mine to break" (Damien, V1, 026).

Despite the inappropriateness (described in the previous chapter) of the taxonomy for this data, its use was helpful in enabling me to put forward some ideas about important

cognitive contexts which encourage children to generate and apply theories. These were the evaluation of ideas, problem-solving, planning, prediction, and the creation of narratives.

4.3.1 Evaluating ideas

There were examples in the data of children expressing disagreement when theories were verbalised or enacted, suggesting they were evaluating the theories. In these cases, often children would supply an alternative theory: "No because earthquakes, no earthquakes are when are when earthquakes are when pipes move wobbly like this" (Damien, V1, 024). Evaluation offered an opportunity for higher level thinking, for example, when Izzy tested her construction for strength by trying to pull it apart (V4, 014), and made a prediction based on this test "this one won't break" (V4, 016).

4.3.2 Problem-solving, planning and prediction

Problem-solving was also recognised as a higher level form of thinking. Imagination was an important skill required, as thinking about solutions seemed to involve a visualisation of the processes. For example, as Eloise considers the idea of gluing her building together, she realises she could then take it home, but wonders how she will move it to the glue-gunning table (V4, 015).

Planning strategies and solutions could be related to some kind of theorising: "I'm gonna glue it" (Izzy, V4, 010). However, it was often hard to assess whether planning was occurring unless it was verbalised, for example, building strategies could have been intentional and linked to working theories, or could have been playful and exploratory. Plans were linked to theories when there was a problem to be solved (as in Video 4), as perhaps were strategies, but these often went unexplored, perhaps because they were harder to 'spot' in the moment.

Prediction was closely connected to theorising as it required children to draw on a theory or make a generalisation. Predictions included the actions carried out on buildings to show what happened when the monster jumped (V1, 013) and what would happen to buildings when the table shook (V1, 013, 024, 026, 031), or when they were carried (V4, 016).

4.3.3 Narrative

Toys such as bear counters (Damien), a toy cockerel (Izzy), a dragon (Izzy), an aeroplane (Tilly) and a car (Darren) were brought into the building play, to inhabit the constructions. The use of narrative seemed to be related to this theme of making the work 'come to life'. Tilly invented lots of meanings for her aeroplane, which was a kind of theorising work as she revealed her theories about what buttons a plane needs and how planes might work (V4, 023), for example, she seemed to have a theory that aeroplanes run on timers: "How long you want it to fly you press that" (V4, 023).

When the cockerel became a protagonist in the earthquake work, the narrative enabled the questioning to focus on a different perspective: Sabrina theorised the chicken would be "sad" when the house broke (V1, 013). Characters increased the motivation of some children, particularly Izzy, who was most engaged when she had a character (the cockerel, V1, or the dragon, V4) to consider the problem in relation to. Specific characters generated specific solutions, for example, to keep a car safe, you "lock a gate" (Darren, V4, 147).

Narrative was used by Sefa to draw together all the ideas he had about earthquakes, which were partially formed at that point. He seemed to draw on experiences like the table shaking that has just occurred, the monster discussion, the earthquake drill that was carried out a few weeks earlier in the centre (rolling into a ball), and his knowledge of Samoa and he tried to integrate these into a story (V1, 032-33). He may also have knowledge about tsunami or floods as natural disasters (the water) and he associated dangerous things like these, and dangerous animals like sharks, with earthquakes.

4.4 Other findings

4.4.1 The importance of theorising around identity

Children seemed to use the documentation of their learning not only to recall experiences and reflect on discoveries but also to explore their own identity; it may be that an important area of theory generation from their perspective was theories about themselves. The children's first response to their documented learning is to identify the participants: "that's you Damien" (Sarah, V1, 002); "Sefa!" (Sefa, V2, 002);"Me me me" (Izzy, V2, 002), yet children never identified places, equipment or even toys.

Some theories seemed to be related to belonging. Participation, and the documentation of participation, seemed to create belonging. Children policed the participation of those who belonged and didn't belong based on their past participation: "Only me, only me and Izzy and Timothy and Benson" (Sefa, V2, 001) and, when another child comes near the group "No Darcy's not in the earthquake" (Sarah, V2, 003). Tilly makes a similar claim in the fourth observation when she says "if you were on the picture then you have to come and watch it" (V4, 002).

4.5 Comparing each observation by thinking and theorising activity

	Describing	Repeating	Recalling	Representing	Theorising
Video 1 (25 min)	57	19	5	43	49
Video 2 (22 min)	55	4	17	13	11
Video 3 (12 min)	44	0	4	10	7
Video 4 (27 min)	71	15	9	25	63

Table 4.1 Thinking behaviours by type, and by observation number

The quantitative analyses summarised in table 4.1 show that Videos 1 and 4 have higher incidences of 'working theories' than Videos 2 and 3, and correspondingly perhaps, more instances of other key thinking behaviours such as describing, repeating, recalling and representing. A quantitative analysis using the revised Bloom's taxonomy (appendix 13) shows that, generally, across the first and fourth observations, children are engaged in a range of cognitive processes and in factual, conceptual and procedural knowledge. In the second and third observations, the range is more limited: fewer kinds of cognitive processes and mainly factual knowledge. To consider the difference between data sets, it is interesting now to turn to the findings about my role in the observations, and determine which teacher actions were associated with higher levels of thinking and theorising for children.

Chapter 5: Findings on teacher role

This chapter explores the impact of teacher actions on children's theorising. The first important element discussed is that of providing *a context for sharing ideas*, suggested by the fact that children's theorising was supported by the availability of social, material and ideational resources which could be connected to construct theories. The second element, related to this, is the organisation of activity enabling a *focus on an open theme*. As previously noted, there were significant differences between observations in terms of the number of thinking and theorising occurrences; this was attributed to differences in the context and organisation of activity. The final two elements considered relate to my specific discourse practices which supported theorising across the range of observations. These were discourse practices that *supported the visibility* of ideas, and that worked to *extend the depth and breadth* of children's thinking.

The contexts and strategies suggested here are informed as much by unsuccessful moments, and teacher reflection on these, as on successful moments, and examples are given of my reflection and alternative interpretations to both justify and critique my findings. Here my ongoing journey towards teaching in line with my values is demonstrated: towards multiple perspectives and knowledges; respect for, and openness to, diverse ways of thinking; and towards more equal power relationships.

5.1 A context for sharing ideas

The organisation of activity within group work, facilitated by an adult who is interested in thinking and ideas, was seen to create a context for sharing ideas which supported theorising. This was seen to be supported by children engaging in the activity of representation.

5.1.1 Working in a group

The first important element of context was group work. Working alongside other children, observing their strategies and listening to their ideas, seemed to be both a prompt and a resource for theorising. For example, Eloise's response to the group's shaking of the table to make an earthquake is to push a small card over to Izzy's building, saying "This says no shaking" (V1, 027). Despite children engaging in predominantly individual work, a sense of shared activity was created through my constant commenting on each child's actions and thinking for other children. There were several occasions where children dialogically developed a theme, with each

contribution building on the previous one, so that the knowledge became more complex (V1, 012; V1, 030; V1, 032-3; V2, 015-6; V4, 008). Repeated occasions of being in the same or similar group seemed to support children's memory of past activities and experiences, particularly where the space and resources were also similar.

However, group work was sometimes challenging to facilitate, as children had different agendas and explored different ideas at different stages. It seemed I was only able to follow one line of thinking, so divergent interests tended not to be noticed or supported.

Working in a group: Examples from my study

Collaboration seemed to support theorising. For example, working together, Sefa and Darren created a concept, a technique and a product: what Sefa calls "scribble earthquake" (V2, 016). Group activities became shared procedures for action in new situations, as, for example, by Video 4, the children collectively understand that doing "one of those earthquakes" means shaking the table (V4, 015).

Co-ordinating individual activity was difficult, for example when children created individual buildings for group earthquakes. A major theme of conversation was being ready: "We're not ready" (Eloise, V1, 018, and Sefa, V1, 022); "You guys ready?" (Vicki, V1, 024). Yet, it is possible that this waiting time encouraged theorising, with examples including Izzy extending the house for her dragon (V4, 019), and Liam finding another way to break down his building by removing a block at the bottom (V4, 016).

5.1.2 An interested adult who respects all ideas

An important part of the context was created through my attitudes and values towards the children's activity and thinking, although it is difficult to measure their impact on children's theorising. It could be that 'being interested', specifically being interested in thinking and ideas, and valuing children's suggestions for the thinking involved rather than their correctness, supported theorising.

An interested adult: Examples from my study

It was clear that some children were keen to establish close, perhaps affirming, relationships with me, often sitting on my lap (V1, 013; V4, 002; V4, 020). Therefore my presence and interest in the activity might have promoted children's interest. It was

also possible that my invitation to children to participate contributed to and strengthened the sense of relationship.

My many questions showed my interest in outcomes: "what happened?" (V1, 013); "what are you drawing?" (V2, 014); but also in children's thinking "what do you think?"(V1, 013, 024; V2, 013, 014; V4, 013). I also showed my interest in children's ideas "that's quite interesting" (V1, 003), with "interesting" as my preferred evaluative response to children's work (V2, 001, 003; V4, 009, 013, 016) which valued children's ideas for thinking rather than correctness. Aside from my verbal comments, pausing and giving children time while watching their work showed interest and respect for their ideas and actions (V2, 010; V4, 019).

In Video 3, the least successful video in terms of encouraging thinking and theorising, I was definitely over-occupied with concepts of 'good behaviour': "if you'd like to use the pen you have to ask first" (V3, 007). I also tended to focus on the technical issues of cutting and sticking photos: "it looks to me like the shoes are upside down if you carefully peel it off you might be able to turn it the other way" (V3, 012). An alternative interpretation is that I found it easier to focus on technical issues rather than thinking. In this observation, children soon learnt what the hidden intentions were, and politeness became more prominent: "Please can I do this one?" (Izzy, V3, 013).

Poor organisation led to more interruptions, and tasks such as clearing up a prior activity (V2, 005), or requests for pens, paper (V2, 016) and chairs (V2, 008), left me in a facilitative role during the experience: "Can you get me another piece of paper?" (Sophie, V2, 016). In order for me to focus on ideas and concepts, I discovered that resources need to be plentiful so that if necessary, each child can have the same resources. However, competing for resources could also lead to theorising!

I also wondered whether I slipped into a facilitative role (such as obtaining more pens) because it was easier than engaging children in thinking and theorising. This facilitative role is a well-established and uncontested role for teachers, whereas the role of challenging and provoking thinking is not. Further I may prioritise reducing conflict over encouraging thinking, as I quickly provided more resources to prevent conflict rather than recognise conflict as an opportunity to use theories to claim resources from each other (V4, 014).

5.1.3 Activity: opportunities to represent

The representation of ideas was discussed in the previous chapter as being strongly related to children's theorising and implies an important role for the teacher in providing resources and opportunities for representation. The use of resources for representation gave rise to a range of diverse plans and representations, and suggests the importance of selecting appropriate resources in accordance with an intimate knowledge of children's interests. Further, children seem to need to be quite familiar with the representative medium before they are able to use it in more than an explorative way.

Opportunities for representation: Examples from the study

Children retained control over what they wanted to represent, yet certain objects led to predictable meanings, such as the road tiles which were used to create roads (V1, 009), the presence of a car leading to the construction of a garage (V4, 022) and the idea of trying to take one block away without tipping the structure when using Jenga^{TM} blocks (V4, 016). This suggests that teachers can influence the progression of activity through the resources provided, but so can children in choosing to bring other resources in.

Drawing could involve an exploration of the drawing tools and their effects. Several girls in the group seem to focus on decorative mark-making and blocks of colour (V2, 014), rather than depicting specific content. It is difficult to know whether this is because of the pens or because of the subject matter. Perhaps a specific culture and practice is needed in which pens are associated with drawing rather than decoration (and possibly black pens rather than coloured pens might support this notion). Although I attempted to outline my expectation that children were trying to express thinking ("what have you been thinking about while you've been drawing?" V2, 014); this may have implied that children's drawings and actions are not valued or seen positively, or somehow 'wrong'.

5.2 Focusing on an open theme

One set of teacher behaviours that seemed to support children's theorising were those that enabled a clear theme to be followed throughout the activity: when ideas were connected, and followed on from or expanded one another. More theorising was noted when activities were focused on a theme (Videos 1 and 4). Open organisation with many choices led to very little focus, and also less theorising (Videos 2 and 3). This section thus continues the focus on the difference between videos 1 and 4; and videos 2

and 3, suggesting that a particular kind of organisation of activity ('focused on an open theme') supports thinking and theorising.

Teacher actions that were supportive of being both 'focused' and 'open' were selecting a relevant and interesting starting point (requiring sensitivity to children's concerns and patterns of thought); preparing mentally for a number of variations and 'off-shoots' in order to be responsive in the moment with children; making links and connections between ideas, and being responsive to interesting 'interruptions'.

5.2.1 Selecting a starting point

Selecting a starting point for the activity seemed to be strongly related to the amount of thinking and theorising that took place in the activity. Children seemed to have theories and ideas when they were offered a topic to respond to; they were able to make connections among diverse pieces of knowledge to form theories, but they required a starting point.

Of the four videos made, two offer clear topics for exploration (video 1: ways of making earthquakes; video 2: houses that don't break in an earthquake) whereas two offer only an opportunity to look at and think about documentation, with the intention that this would spark direction ("which [idea] would you like to think more about?" V2, 004). Inviting children to think without offering a context which made thinking relevant and meaningful can be seen as one of the reasons for the low number of occurrences of thinking and theorising in these activities. An alternative explanation is that the activity did not connect to children's strengths or interests. The activities in videos 1 and 4 were both structured with particular proposals offered as invitations to children, and in particular, drew on problem-solving as a cognitive context for theorising. Specific invitations may have generated more thinking and theorising than non-specific invitations.

Documentation was a relevant starting point for activity, both for me prior to interaction with the children to identify potential themes, and as a starting point for children, to set the scene, and provide context for our ongoing thinking and investigation. In videos 1 and 4, where theorising occurred more often, documentation was used to introduce a starting point. However, this raised ethical dilemmas for me as I considered this approach in line with my valued aim to minimise the power differential in my teaching;

selecting and presenting documentation to children was a clear example of using power to define the children's ideas and activities.

Selecting a starting point: Examples from the study

Children were generally interested in the discussion and action, and this was taken to indicate that selecting the focus for activity was appropriate. A critical analysis focused on areas where children had a conflicting purpose, as recommended by Hedegaard and Fleer (2008), to indicate their different perspective. Children did have conflicting interests, such as creating constructions that were not for breaking down (Damien, V1, 010, 011; Eloise, V1, 017), yet these might have added to the richness of discussion and engendered more working theories.

A possible reason for the relative failure of Video 3 might have been that the topic for theorising (our trip to the shopping mall) was not very meaningful. Alternatively, it might have been that theories around shops were self-evident and universally accepted, rather than provisional and contestable. Despite the difficulties in selecting a theme that was truly relevant, interesting and meaningful, selecting a theme for the children was more successful than asking them to choose their own. In fact, the research process may have aided me to identify the themes that were important to the children! In Video 4, children were keen to suggest and act upon ideas for houses that didn't break down. It was also possible that clear outlines and goals supported children to take ownership and control of problems and solutions. When invited to contribute to the written list of ideas by drawing items, Eloise expanded ideas from how to draw wood, to how to draw nails, and even glue (V4, 008), thereby taking leadership of the problem.

The focus on 'starting point' has been chosen to facilitate responsivity to diverse and multiple pathways of thinking. I was concerned (in relation to my intent to act in line with my values) about the amount of power that I was exerting when I selected a theme with a predetermined path for children. Noted in video 1, when I had the entire activity mapped out, I was likely to use my power to influence the activity in the direction I expected it to occur and was unable to be responsive to ideas I hadn't anticipated.

Use of documentation: Examples from the study

One issue might have been that documentation reified children's theories, making them seem less suggestive and this fixing of meanings might have stifled further theory-making. However, the documented theories were modified and re-interpreted, and new

theories were generated in subsequent activity. When describing documentation, it seemed that "something you told me last time was / you told me the monster did a jump" (V2, 002) seemed less definite than direct, but unacknowledged, quotes from children, which sounded like 'facts'. I seemed to hold fixed meanings and want to scaffold children towards these meanings, for example I insisted on discussing "how did you keep your chicken safe Izzy?" rather than exploring Sefa's claim in relation to the same photo "I scared the chicken" (V2, 003).

In Video 2, I ran quickly through the documentation without pausing or questioning the ideas which may have indicated to children that they were being informed of knowledge, and unable to question it. It was probably not that there were too many ideas (after all, children can generate and explore many in quick succession) but not enough support to consider them. Rather than assuming that the meaning of an event or action remained fixed in the past, I could have explored what meaning the documentation held for children in the present, and allowed for new and contrasting meanings.

The fact that documentation enabled me to select ideas (increasing the exposure to some ideas) raises an ethical dilemma, and is further complicated by the fact that children cannot choose to be part of the documentation; the teacher documents them. In critique of this practice, we can imagine an analogous situation for ourselves. However, while we might be distrustful and even cynical, children might enjoy feeling noticed and celebrated, effectively becoming stars of the teacher's stories. This attitude is suggested by the children's responses to the documentation, in which they expected to be represented and were annoyed if they were not (Eloise, V2, 003).

5.2.2 Making connections

Making connections throughout the interaction and activity seemed to be an important role for me, as I sought to make links forwards and backwards in time through the activity, and between different children's contributions. As described, Videos 1 and 4 are examples of the sustained focus and development of ideas, and are associated with more theorising from children.

A strategy of making connections as a way of 'focusing on an open theme' is put forward here to replace an earlier idea about maintaining a theme which seemed to involve 'sticking to the plan in my head' (Video 1) and led to a more linear and fixed

progression. Moreover, making connections forced me to slow down and be more responsive to children's words and actions, in the time it took to stop and wonder: 'how does this connect to what went before, to the working theories and to our shared activity?' Children's digressions, when thoughtfully pursued, were relevant and supportive of thinking and theorising, and could be connected to create clear lines of thought.

Maintaining a theme and making connections: Examples from the study

Holding a theme in mind did seem to make me less responsive to children, particularly if their intention was different to mine, and it also led to ethical issues around who was controlling the discourse and the activity. In Video 1, I pursued the idea of shaking the table, even when the children pursued other ideas "when I made my earthquake, the car didn't come out" (V4, 012). My focus was on how earthquakes are made, and particularly on earthquakes made by shaking actions. The constant "are you ready?" questions (V1, 017) may be seen as putting pressure on children to comply. Alternatively, they may be seen as an attempt to generate anticipation. Nevertheless, it seems children recognised the pressure to conform, given their repeated comments indicating "I don't want my building to shake" (Eloise, V1, 017) and "But I don't want to" (Damien, V1, 017). When Izzy suddenly started pushing her building down with her hands (V1, 017), instead of accepting and exploring her chosen action, I decided to accelerate the learning toward my intended outcome and started shaking the table. My determination to enact my own plan had overtaken all my other sensibilities of responsive respectful teaching. Also, it seemed that my theme overlaid the children's themes and although I acted as if the children explored and were aligned with my theme, this was a pretence!

However, rather than limiting children's thinking and theorising, instead it seemed rigid plans provoked children to create further theories (Damien disagreed "no an earthquake is when... pipes move wobbly like this", V1, 024; Eloise invented theories on how to stop the earthquakes, V1, 027). When I started to explore why children didn't like earthquakes, there was much more theorising and thinking than when I mindlessly pursued my own agenda.

In Video 2's drawing activity the children adopted some highly divergent ideas: for example, Darren draws a ladder. However I was able to make a guess at what he might

be meaning and how it might be linked to his other activity: "Your one is a ladder [pause] Hmm because before you drew a man eh who fell down the ladder" (V2, 014). This seemed to encourage the children to expand the activity further. When Sefa and Darren start to scribble sideways across the drawing, my question is carefully worded: "What's this going sideways and sideways [excited tone] what's that?" (V2, 015) and accompanied with a shaking action. This perhaps scaffolded Sefa to make a link: "Earthquake!" (V2, 015).

The number of interruptions was considered relevant to my ability to maintain a connected thread through the activity. There were many examples of interruptions where ideas are left half-expressed, which did not support the development of clear, focused lines of thought. My initial data analysis code of 'dealing with interruptions' was very revealing of my attitude towards interruptions as distractions from my line of discourse rather than interesting avenues to explore. I even seemed able to automatically repeat and comment on children's ideas and actions and return to my line of discussion without thinking: "yeah the chicken was scared. Can you see what Izzy did with her building?" (V2, 003). That I was unable to recognise interesting interruptions was disappointing. This might have been because I was fixed on what I was going to say next; however, it could have been the fact that I did not allow time for children's response or perhaps even I wanted to avoid opportunities for children to hijack the discussion.

So for the third observation I formulated a strategy for 'letting myself be interrupted' which was repeating, pausing and thinking during the pause. However, it seemed that the pausing enabled more opportunities to change the topic, or get distracted, and to lose coherence; further, I found it difficult to think in the moment.

The fact that there were fewer missed opportunities in the fourth observation and yet a clear focus was maintained and a coherent thread of thinking created, show that it was possible to hold a line of thought while addressing the children's digressions through making connections. For example, in discussion of strong buildings, Izzy remembered a dragon she made with wood and glue, so I commented "that looks very strong" and Izzy expanded "can't break eh?" (V4, 009). Perhaps the lack of missed opportunities represented both that I had less of a fixed agenda (I had an agenda to use when appropriate, and otherwise an intention to be responsive) and that I was using a strategy

of giving time for children to respond, listening, and seeking to make connections. Alternatively, perhaps I was more responsive in the fourth observation because I was more aware of the children's different tendencies and ideas by then, through the research process of observing and analysing, which served as preparation to support responsivity in the moment.

5.2.3 Teacher's mental preparation

It seemed that mental preparation supported me to be responsive to children's ideas, and so forms another important teacher action for focusing on an open theme. First, mental preparation was required in the form of reflection on what the children were saying as the basis for further activity, which may have contributed to the successful proposal made in Video 4. Further, mental preparation was needed to anticipate possible directions to support responsivity in the moment.

Teacher's mental preparation: Examples from my study

I noticed that when I hadn't mentally prepared for particular possibilities, such as Benson's apparent evaluation of each theory at the beginning of the first observation (V1, 001), I was not able to respond to or even acknowledge these possibilities. This pointed to the need for me to consider multiple possibilities in preparation to be ready to respond to a variety of scenarios. In Video 3, the trialling of pausing and thinking about children's contributions to the dialogue in the moment might have been easier if I had previously considered possibilities. By Video 4, with a much clearer sense of the diversity of ideas among the children, I had a better awareness of how they tended to respond (for example, bringing in a character) and it seemed my awareness of these tendencies made me much more receptive to them in moment.

5.3 Supporting the visibility of ideas

This set of strategies supported me in making ideas and concepts visible to children, which possibly supported children's theorising, as theories are made up of connected concepts. Also, increasing the visibility of ideas and concepts tended to be linked with, and followed by, children's descriptions, repetition, and representation, which in themselves are cognitive activities that may support theorising (described in the previous chapter). From the children's perspective, the fact that I made their thoughts and ideas visible might have indicated that I was 'in tune' with their thinking and increased their willingness to share ideas. Documenting ideas and theories made them

repeatedly visible, and was also a context for other strategies to support visibility such as focusing, describing, clarifying and questioning for recall.

5.3.1 Focusing attention strategies

Focusing children's attention on specific qualities and consequences may have supported children to develop working theories. Another benefit of this strategy might have been that focusing supported responsivity to children's ideas, encouraging close attention to what the children were saying and doing. Focusing as a teacher behaviour was noted to be a significant precedent to children's theorising twice in the data (4% of all examples of focusing), and 6% of examples led to representational work. However, as might have been expected, focusing was mostly linked to children's description, with 21% of all focusing behaviours being followed with children describing.

Focusing: Examples from my study

In the first observation, the ongoing focus on actions (pushing, shaking) led to children coming to understand earthquakes in these terms: Eloise imagined a card said 'no shaking' to prevent the destruction of any more buildings (V1, 032). When I noticed and commented on particular features children often made use of them: "Ooo that was a big bang wasn't it?" when Izzy (as monster) banged the blocks on the table (V1, 013). My use of the word 'bang' was repeated in Izzy's narrative "What happened again an earthshake go bang" (V1, 014). It is possible that I closed down possibilities to notice other features in doing this.

Questions also encouraged children to focus on a particular action or consequence "And what happened to the blocks?" (V1, 027); and "do you see what happens to the blocks?" (V4, 008). To enact my value of respect, genuine questions such as "do you see?" were preferred.

5.3.2 Describing strategies

Describing children's actions led to children offering more information or expanding on my description, but the occasions were few: 11% of my descriptions led to children's descriptions or recall, while 4% led to the development or articulation of a working theory. It seemed that offering my own contribution to the discussion could invite other contributions and here it seemed important to be 'in tune' with children.

Describing: Examples from my study

It is possible that describing my observations made key features visible to all children in order to help them construct theories about what was happening. Describing actions was a strategy that could have supported children's construction of cause-effect theories: "I saw you just took [out] one block at the bottom" (V4, 016). Describing actions did serve to encourage children to expand on an idea or explain further what they meant. When I look carefully at Izzy's building and comment "you didn't build it on the table did you Izzy?" (V1, 036), Izzy explained "no 'cause it can't break eh? So when it very when it moves very faster so very faster it won't break" (V1, 036). Describing what I thought was happening invited children to agree or disagree and encouraged explanation (an example is "You really don't like earthquakes do you?", V1, 030).

Some of the descriptions were presented in a way that fixed the meaning of the event and this might not have been desirable. For example, I present the fact that the buildings kept getting broken in the documentation and videos of Video 4 as "that's a problem" (V4, 008) when for some children, it might actually not have been a problem at all, but rather fun! Although I said "isn't it?", this phrase invites agreement; I think I needed to specifically invite children to disagree. Perhaps further, the children found my descriptions complete and therefore description led to less need to engage in description or theorising themselves.

5.3.3 Verbalising or reformulating theories

Another important role that I believe I took in relation to supporting theorising was that of verbalising the theory. 14% of my verbalisation of theories did lead to children developing new theory. More often it was the case that my verbalising the theory was treated as clarification, and so it sometimes led to modification. Verbalising theories also led to children noticing and taking up ideas of others.

Verbalising theories: Examples from the study

Putting the theory into words often supported the clarity of the theory. Izzy's theory of "well it won't [break] 'cause I'm gonna glue it" was reformulated by me as "you're gonna glue it [pause] so it won't break because it's got glue on it" (V4, 020). Sometimes verbalising the theory was important because the theory was represented in action instead of words. For example when Tilly shook her plane up and down in

response to my question about whether it was strong, I expressed her idea as "when you shake it it doesn't break" (V4, 019).

At times verbalising the theory created an opportunity for other children to consider it and evaluate the theory in relation to their own thinking. When I summarise "Izzy's worried that if she doesn't put glue on then it might break when the earthquake comes" (V4, 023), Tilly then adds "And me too thats why I glued on it" (V4, 023).

5.3.4 Repeating and clarifying strategies

As with describing action and verbalising theories, repeating a child's ideas supported their visibility to other children. Also, children often expanded on an idea after I had echoed it back to them, as 12% of my repetitions led to further description from children, while 6% led to children expressing working theories. Repetition sometimes served as clarification; otherwise questions were used to clarify children's ideas and comments. Clarifying questions also supported the visibility of ideas and 40% of clarifications generated further description, with 34% leading to working theories.

Repetitions also seemed to demonstrate to children that I had heard their contribution. The many times that I repeated a comment, but neither they nor I extended on it, indicated that that was all that children needed. However, repetitions might have at times contributed to closing down thinking in cementing the ideas so forcefully that there was no need to look for further ideas.

Repeating and clarifying: Examples from my study

Repetition drew attention to particular features of the activity, and often invited children to expand on their original contribution. When Sarah answers that her monster is "spinning like that" (V2, 014), after my repetition "a spinning monster!" (V2, 014), she adds "breaking all the houses down".

Clarifying generally encouraged children to continue and therefore were often followed by theorising. As I struggled to understand Sefa's theories about hiding to keep safe, I asked for clarification "does that keep you safe?" (V1, 032) to which Sarah suggested "How about in your room? You can lie in your cupboard" (V1, 032).

It seemed possible to come to rely on repetition as an easily executed strategy for responding to children, as in Video 3, where my constant repetition seemed to be used because I couldn't think of other responses. Here constant repetition of comments that

did not have much potential for extension, modification or for disagreement ("you want to eat all the blue lollies" V3, 006) might have contributed to disengaged behaviours. Further, after repeating the ideas of 'wood' and 'nails' several times in Video 4 (009), it seemed that there was no more stretch in these ideas. It is even possible that repeating them was then serving to cement them as the only ideas and closing down thinking and theorising. Repetition might need to be used carefully.

5.3.5 Questioning to support recall

Although questioning for recall led to recall (42% of all recall questions) but not theorising, it seemed that questioning to support children's recall is an important strategy for making past ideas and experiences visible.

Questioning to support recall: Examples in my study

Verbal questions were one way in which children were encouraged to recall events, with the aid of visual documentation or video. Some of these question are phrased "what are you doing [in the photo]?" (V2, 002) although I preferred "do you remember seeing the soccer shop?" (V3, 010) as a more genuine question in line with my values. One word responses were common, yet 'do you remember' questions could be successful in encouraging expansion: "I know [pauses, looks at Darren] we know, eh Darren? 'Cause there's a soccer ball" (V3 010). Other verbal prompts included cues, such as sharing a small part of the story and inviting the children to continue, such as "She put her arms around her building ... she picked it up .... and she put it" to which Sefa responded "under" (V2, 003). Although questioning for recall represented an important activity in terms of the explication of knowledge for the benefit of the group, it also may have felt like a test of memory! As later discovered, pausing was a better strategy for encouraging children to expand on their recall.

5.4 Extending depth and breadth

A final set of strategies supported children to extend the depth and breadth of their thinking which led to new theories and more complex theories. It was felt that children's thinking could be stretched in several directions: by considering the consequences of actions and ideas, thus moving 'forwards' from an idea; by considering which ideas and experiences had led to the present theory, thus probing 'backwards'; and finally by considering different perspectives and alternative possibilities, conceptualised as 'sideways' thinking. It was found that specific questions supported

thinking, whereas open opportunities to think, such as "so there's lots of ideas there we can think about" (V2, 003), without support or stimuli for thinking, were not successful. As well as through questioning, the simple strategy of pausing was discovered to lead to children's self- initiated extension of ideas and theories. Modelling thinking, and openly 'wondering' were tried to encourage theories, but there were no examples of comments or actions that showed that this was the case.

5.4.1 Extending: forwards

'Moving forwards' questions were those that asked children to carry on a line of thinking and served to generate new theories. Often extensions to children's thinking were encouraged through questions and challenges; however, they also could be encouraged when I added an observation or idea of my own for the children to consider. 57% of attempts to extend thinking forwards were followed by the expression of working theories.

Extending forwards: Examples from my study

A simple way I extended children's thinking was through encouraging them to continue a narrative, ("And what happened to the buildings [points to buildings] when the monster jumps?" V1, 013), or to predict future consequences ("what's gonna happen to Izzy's one when we shake the table?" V4, 020).

Another way in which I extended children's thinking was by adding further information. When Tilly shared a theory that if your photo is in the documentation then you need to come and watch the video, and I repeated her theory and added "I think Sabrina went home, didn't she?" (V4, 002), and point to her photo. Minutes later Tilly has adapted her theory and added that people who have gone home or don't want to come can be replaced by someone else.

All extending questions needed to be used carefully though, and some did not achieve an extension of thinking but were ignored. It seemed as if conversational ways of talking that are familiar to children were more successful than a formal questioning style. My question to Tilly about the strength of her aeroplane ("How can you find out if it is strong?") is made more natural by tagging "can I have a look?"(V4, 019) at the end. It suggests that the thinking will be collaborative, and hence sounds less threatening. Unsuccessful comments or questions included those that, like "can you draw an earthquake?" (V2, 014), ask about capability and imply judgement. A better

question might have been 'and what would happen if there was an earthquake in your drawing now?'

5.4.2 Probing questions: extending 'backwards'

Probing questions were characterised as those that asked children to go backwards from their assertion and explain the reasoning behind the action or theory. These seemed more difficult for children perhaps because they involved 'unpacking' theory. 4% of probing questions preceded the expression of theories, while 27% preceded further description.

Probing 'backwards': Examples from my study

Probing questions were seen as those that tried to uncover children's theories or reasoning, such as 'why' questions: "why don't you want an earthquake?" (V4, 005); and "why are you putting so much glue on?" (V4, 023). Children were generally very able to make predictions, but the follow-up question "what makes you think they will fall down?" (V4,013) was not successful; this might have been because this question is more difficult, or because children were not given enough time.

Sometimes when the probing 'why' question was not successful, making a comment or observation was. For example, asking "why don't you want any earthquakes?" (V1, 030) received no response, while commenting "You really don't like earthquakes do you?" (V1, 031) launched a long discussion about the Christchurch earthquake and how many people had died.

5.4.3 Questioning to think in diverse directions: extending 'sideways'

There were two principal ways of extending children's thinking in diverse directions: thinking of different possibilities, and thinking from different perspectives. Both questions that suggest or insist upon many possibilities, and questions that invite consideration of new perspectives, are followed with the application or generation of working theory (13% of all examples). Considering a phenomenon from different perspectives seemed to broaden ideas and concepts.

Extending 'sideways': Examples from the study

One extension used was that of challenging children to find another way, or another answer: "let's see how many, if we can think of another way to make an earthquake" (V1, 004). However, perhaps enough time had not been given for exploring the idea of

making an earthquake by pushing over blocks. It seemed to take a line of questioning that encouraged the children to vary their viewpoint to generate some new ideas: "What about if the earthquake came from somewhere else?" (V1, 012). Sabrina seemed to interpret this question as 'what if the earthquake came from some*one* else?' and answered "A monster" (V1, 012) leading to a whole new line of theorising.

A simpler version of this was to just keep asking for more solutions: "What else?" (V4, 016). Expecting more than one answer, as in this section in Video 4, generated a rich range of possible solutions. This was also supported by my use of 'could', which affirmed each solution but in no way suggested we had *the* solution: "we could not shake the table"; and "you could put glue on there" (V4, 015) as well as the aim to find a mutually acceptable solution "But Liam wants to shake the table" (V4, 015).

To explore diverse perspectives, I asked questions about the perspectives of the characters involved in the children's earthquakes, which linked to children's natural use of narrative to explore theories, and seemed to be generally relevant to children. For example, when Sefa and Darren were 'scribbling' the earthquake, they paused when I asked "what does this boy think?" (V2, 015), before Sefa responded "naughty" (V2, 015). As well as different perspectives, another strategy was considering other scenarios, such as "what about if the earth was shaking, would it fall down then?" (V4, 009).

5.4.4 Pausing strategy
Pausing was an important strategy which was often followed with thoughtful comments and theorising from the children, and could be combined with all the strategies suggested in this and the 'supporting visibility' section. There seemed to be an optimal length of pause; two or three seconds seemed to be required before children offered another contribution. It is also possible that pausing is also useful for slowing down, and enables higher teacher responsivity. Certainly a higher number of pauses correlated with better teacher responsiveness in Video 4.

Pausing: Examples from my study
Pausing encouraged children to expand. After I asked "what do you notice about these lollies?" after one second, Damien responded "they're making they're making them" and then after three more seconds Sefa commented "that's a blue lolly" (V3, 004). In contrast, in Video 2 there were also long segments of discourse in which I dominated,

by stringing every phrase onto the last, without pausing, which didn't provide the space for thinking that children appeared to need. There are indications in the data that a one-second pause was not generally long enough thinking time for children. Often after pausing for one second, as I began to speak again, children interrupted me to respond to my question because I hadn't waited long enough.

Pauses of two or three seconds were generally taken as time for thinking. The exceptions were when the questions were confusing or too open such as the "which one would you like to think a bit more about?" (V2, 004) segment in Video 2. Perhaps pausing did not work if the children's thinking had not been engaged; comments such as "so let me just think about what Sefa said" (V3, 003) didn't offer children anything to stimulate thinking and theorising.

5.4 Putting it together: models and metaphors

The ideas outlined in this section have been organised by four key concepts: 'creating a context for sharing ideas', 'focusing on an open theme', 'supporting visibility' and 'extending depth and breadth'. These ideas can be further condensed as 'focusing in' and 'stretching out', and linked to the metaphor of a yo-yo.

5.4.1 'Focusing in' and 'stretching out'

The central concern in the development of my practice supporting children's working theories was getting the balance right between maintaining a clear focus (a sufficiently closed topic with boundaries) and being open to new ideas for the development of theories (being sufficiently open). Thinking about my practice as both 'focusing in' and 'stretching out' ideas seems useful. Each of the strategies and suggestions in this chapter can be characterised as either supporting a 'focusing in' on ideas and themes, or as 'stretching out' ideas or moving into new arenas for thinking. For example, I consider that 'focusing on an open theme' and techniques for 'supporting visibility' encourage children to 'focus in', while 'creating a context for sharing ideas' and strategies for 'extending depth and breadth' support ideas to 'stretch out'.
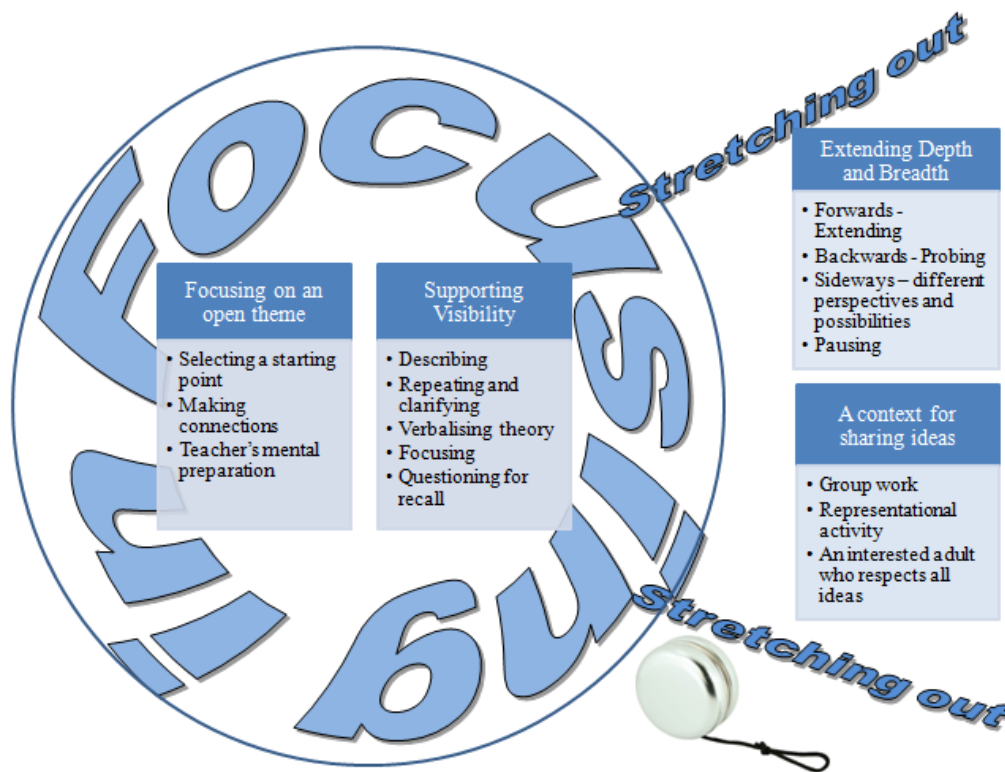
Figure 5.1: A metaphor for the teacher role in supporting children's working theories

5.4.2 A yo-yo metaphor

The diagram displays and condenses the findings about teacher role in supporting working theories. A deliberate visual link is made to the metaphor of a yo-yo, which seems to represent the need for teachers to support thinking to be able to move off in various, diverse directions, and yet, also highlights the need for teachers to maintain a thread of thinking. It is hoped that this metaphor has the memorability to be a useful tool for conceptualising the role of the teacher in supporting children's working theories, yet is capable of application in diverse ways.

5.5 Conclusion

These findings suggest a range of strategies, which overlap, interact and combine to create a complex network of possibilities. This is not a model for prediction, explanation, or determination of practice, but a range of strategies that are likely, in various ways, to enhance the children's generation of working theories. The following chapter explores support for these findings in the literature, and articulates a strong theoretical framework within which they can be understood.

Chapter 6: Discussion

6.1 Introduction

This chapter discusses the research findings and assesses how successfully I was able to develop my practice according to my aims and my values, as well as develop knowledge about teacher practice that is supportive of children's working theories. My findings on the role of the teacher are compared to the current research knowledge as outlined in the literature review, however, new literature is sought for theoretical resources that seem to better explain the processes of thinking that appeared to be prevalent for children in this study. The new image of thinking presented here has implications for teaching and learning interactions, which both relate to, and challenge, my developing and personal model of teacher practice. Also in this chapter, the findings on teacher role are framed by a postmodern perspective which suggests that there are no universal 'truths' (Dahlberg, et al., 2007) and from a complexity theory perspective which suggests that the results of new inputs into complex situations cannot successfully be predicted (Mason, 2008b).

6.1.1 My 'working theory'

The research findings suggest a number of possible supports for children's theorising. Investigation of the children's theories suggested a number of 'cognitive contexts' for theorising, and indicated other cognitive behaviours that support theorising, while the findings on teacher role were organised by four broad themes: creating a context for sharing ideas, focusing on an open theme, supporting visibility, and extending depth and breadth within children's thinking. A context for sharing ideas was considered in the instance of this study to be constituted by group work, opportunities to represent ideas and the teacher's attitude of interest. These contextual features were considered to be accompanied by the organisation of activity ('focusing on an open theme') including selecting a starting point and making connections, both of which were supported by the teacher's mental preparation. Finally, the acts of making children's thinking and action visible (through describing, focusing, repeating, clarifying, verbalising theories and questioning for recall) and of extending the depth and breadth of children's thinking (through lines of questioning taking children's thinking forwards, backwards, or in divergent directions, and through the strategy of pausing) were particular pedagogical strategies achieved through discourse that seemed to influence children's theorising in

positive ways. These strategies are summarised as functioning to 'focus in' and 'stretch out' children's thinking.

6.1.2 Reading my findings against my values

My findings around useful teacher practices for supporting children's working theories are the product of a process in which I sought to realise my values through my teaching practice. The ideas presented in the findings of supportive teacher actions reflect my values for education, including listening, communication, identifying many perspectives, equal participation and respect, and critical, imaginative engagement. Thus my theory is a theory about how to enact these particular values.

Not only can my values act as the standards of judgement for legitimating my findings (McNiff, 2009; Whitehead & McNiff, 2006), they, alongside my prior knowledge and experience, are recognised as co-determining the results of the research. Some selection in a complex situation is necessary, and, rather than the emerging concepts being entirely grounded in the data, they emerge through the complex co-interaction of my values and beliefs, knowledge and experience, the literature and the data.

6.2 Children's working theories: Comparing my theory with other theories

Children's working theories were identified through the use of a definition synthesised from the literature. A return to the literature with the children's examples in mind offers further conceptual tools with which to consider the phenomenon of working theories.

Working theories were discovered, as suggested in the curriculum document *Te Whāriki*, to consist of knowledge, skills, strategies, attitudes and expectations (Ministry of Education, 1996), as well as (my personal synthesis of the statements in the curriculum document) to be tentative and provisional ways of connecting knowledge to make sense of the world and act effectively within and upon it. This is also the cultural-historical explanation for the development of knowledge as put forward by Wells (1999). Many of the theories around earthquakes appeared to try to make sense of the phenomena, or generate strategies for action such as to solve a problem. Thus children's working theories in this study link to the way that knowledge is seen to have developed historically, through the motivation to solve a particular and meaningful problem (Stetsenko & Arievitch, 2002; Wells, 2002).

Working theories, despite clear links to a constructivist paradigm of children independently making sense of the world, in this study can be better explained through sociocultural concepts. For example, working theories can easily be interpreted as sociocultural tools to support effective action, such as planning (who should be involved, how to build a house) and prediction (whether it will break), and to influence practices such as techniques for construction. It is further possible to suggest that working theories become part of a distributed system of cognition, taking on some of the thinking work and holding intelligence (Daniels, 2008).

Moreover, my research found that working theories were often deployed to meet social and emotional desires, and to influence a particular outcome. This interpretation is supported by previous research such as Wertsch's (1998) study, which found that much discourse aims to express self and identity or to gain power, rather than provide accurate information or answers. Likewise, Sussman (1989) adds a cautionary note to her interpretation of her research into children's exploratory behaviours that might have been performed for motives other than gaining information about the world, such as developing relationships with adults.

As argued by Bodrova and Leong (2007), in this study children did make use of images, concepts and knowledge from their communities and their culture, suggesting not all knowledge is personally constructed. Children sometimes held theories that could be considered as influenced by adult or official knowledge, but often the more official information about earthquakes was not well integrated with their emerging personal understanding; official theories seemed to be regurgitated rather than constructed. This might be because of the children's inability to fully understand the nature of adult conceptions of earthquakes, or, drawing on K. Davis and Peters' (2010c) work, because children were still at a stage in which their working theories consisted of 'islands' that had yet to be connected.

Links to cognitive contexts

My research found that certain cognitive tasks, or cognitive contexts were more likely to involve children generating and using working theories, and included evaluating, problem-solving, planning, prediction and narratives. Problem-solving is also identified by Wells (1999) as the most frequent context for theory construction. Other research confirms the importance of story and make-believe play for children to develop thinking

skills (Taggart, et al., 2005), and K. Davis and Peters' research (2010a) found that children's stories often contained working theories.

Links to other cognitive processes

This study found that other cognitive processes, specifically creating verbal descriptions and representations, repeating, recalling, and making connections or associations, were found to be present alongside, or prior, to theorising cognitive work, which suggests that these skills might also need to be supported by teachers.

Two of these findings, that verbal description and repetition support theorising, are unsurprising given the theories of cognition outlined in the literature review. For example, that children were found to repeat their own and each other's actions, ideas and theories might lend support for constructivist theory that children are actively forming concepts themselves rather than just internalising them. A theoretical basis for the claim that verbal description supports theorising can be found in the sociocultural literature (for example, see Wells, 1999; Daniels, 2001). Language is seen as the means of developing a set of stable representations with which to think (Bodrova & Leong, 2003; Wells, 1999), although the stability of verbal representations could be usefully contested through ideas such as the difficulties of intersubjectivity, and postmodern understandings of multiple meanings. The example of Sefa's gradual use (and implied gradual understanding) of the word 'earthquake' (V1) lends support for Vygotsky's theory that children come to understand signs and symbols through their use, and the idea that intersubjectivity grows through shared use of new words and concepts (Wertsch, 2007).

Further, bodily representations of phenomena were found to be regularly enacted; this might be in part due to the nature of the topic of earthquakes. A possible explanation was sought and it was found there might be some basis in the fact that children in their second year tend to respond to adult utterances that contain an action by performing the action (Marinac, Woodyatt, & Ozanne, 2008), although these children are in their fourth and fifth years. Alternatively, perhaps the concepts as "internalised action" (Athey, 1990, p.33) are not quite secure, and the children are not yet entirely independent of physical experience.

It was found in this study that the use of materials provoked the children to articulate theories to explain their representations. This resonates with K. Davis and Peters'

(2010a) suggestion that creativity and the expression of ideas offer opportunities for the development of working theories. Materials either suggested, or were conscripted for, particular representations, and the children used working theories to connect these different materials and parts into a coherent representation. Bodrova and Leong (2003) argue that children use productive materials to create schematic representations and model relationships; however, this research suggests there might be two processes at work. Children seemed to search their knowledge to make connections in order to incorporate more materials, thereby actively expanding their concepts, as well as at other times having a concept with all its various parts in mind, and seeking materials to fulfil their mental image. Children seemed to naturally wish to expand their concepts and understandings in many different directions, so that they appeared to attempt to incorporate all the materials and the ideas circling around them, and generate as many ideas as they could think of with which to fuel the continuing expansion. Likewise, while drawing, children naturally seemed to ask themselves 'what else do I need or should I include?'

These findings led me to consider some relatively new conceptions of thinking, as although sociocultural resources were clearly important influences on children's theories, the processes by which theories were constructed, particularly associative and imaginative processes, were not well explained by cognitive constructivism. Further, while children tended to increase the complexity of their theories by incorporating more concepts and ideas, constructivist schema theory emphasises the development of abstract, generalised concepts where the detail is omitted, allowing thinking to become more automatic, but also perhaps more narrow and stereotypical (Daniels, 2001). The chance finding of a journal article which utilised rhizomatic imagery (Sellers & Honan, 2007), influenced me to return to the literature with a new impetus, to explore this more relevant conception of the thinking process.

6.2.1 Introducing new images of thinking

A rhizomatic image of thinking comes from the work of Deleuze and Guattari (1987), postmodern (more specifically, poststructuralist) philosophers who contributed a great number of innovative concepts to philosophy (Olsson, 2009), some of which have been usefully applied to early childhood education (Olsson, 2009; Sellers & Honan, 2007). Deleuze and Guattari argue that there are no knowledge truths, and knowledge is not fixed, rather it is created anew in each act of knowing and thinking. Thinking is thus

active and creative, nomadic (Dahlberg & Moss, 2009), and it creates itself as it goes: "thinking proceeds by laying out its ground at the same time as it thinks" (Olsson, 2009, p.51). Thinking thus is conceptualised as being in constant movement, in unpredictable directions, like a rhizome, ceaselessly seeking connections between diverse acts (Deleuze & Guattari, 1987). This conception has much explanatory power to account for the nature of thinking noted in the children within this study. It made sense of children's active expansion of concepts and ideas, in incorporating almost everything around them, or in creating chains of associations, as well as the way recalled events and theories sparked new theories and the way that resources carried many connections to other ideas. It seems to best account for the dynamism that the term 'working theories' intends to convey (Ministry of Education, 2007).

The work of Deleuze and Guattari offers a suitable conception of thinking that also aligns with the complexity theory perspective this study adopts. Their work offers a way to conceive of thought as in constant emergence and self-production, evolving through connections (Deleuze & Guattari, 1987) in line with complexity theory's focus on emergence. In complexity theory, meaning itself evolves through interconnections; "definition is continuous, open and expanding" (Radford, 2008, p.153). Like complexity theory, in which change and complexity is made more likely with more numerous connections (Mason, 2008b), the conception of thought as an active, nomadic rhizomatic root also suggests a strategy of augmenting connections and encounters (Dahlberg & Moss, 2009). The challenge then, is to seek teacher actions that will promote and nurture this expansion as the most effective support for children's thinking and theorising.

6.3 Teacher support for working theories: Comparing my theory with other theories

My working theory for the teacher's role in supporting children's working theories involves two principal ways of supporting children to develop theories. Thus 'focusing in' and 'stretching out' can be conceived as ways to negotiate the complexity of the learning and teaching scenario, by both limiting perception and thinking (focusing in) and by taking advantage of diverse elements for connection to expand ideas (stretching out).

6.3.1 'Focusing in'

Focusing on an open theme

This area of my findings relates several strategies discovered to support the aim of maintaining a theme and making connections between ideas in order to develop a coherent body of accumulating knowledge. Other research in education (Alexander, 2000) and in early childhood education (Poimenidou & Christidou, 2010) shows that child-centred, loosely structured and slow paced activity often fails to ensure coherent progression in knowledge construction. In particular, the many-layered and multiple-themed activities that are likely to occur in open, child-led and dialogic teaching contexts need to be skilfully orchestrated and conducted (Alexander, 2000).

While observational episodes in my study that had fewer examples of thinking and theorising were seen to be less well-connected to a coherent theme, this finding is complicated by the recognition that the teaching and learning episodes took place in a complex setting and there may have been many contributing factors. An alternative explanation offered by the literature is that the dialogic discourse may have been inhibited through the unique interactive dynamics and skills of each group. Such dialogic discourse relies very much on skills such as effective turn-taking, which may need to be taught (Alexander, 2000; Mercer & Littleton, 2007; J. Walsh & Sattes, 2005).

Selecting a starting point

As in my research, K. Davis and Peters (2010b) discovered that one strategy used by adults was the provision of scenarios for exploring working theories, and, as with my research, these scenarios had mixed success (K. Davis and Peters found sometimes planning was superficial and failed to respond to the complexity or subtlety of children's theories).

However, teacher selection of a starting point is supported in the literature (Brooks, 2009); in relation to working theories, it is suggested this means selecting theories that are worthy of delving into (K. Davis & Peters, 2010b). Earthquakes seemed to be a worthy topic for the children in my study. Selecting a relatively closed starting point or theme was more successful in supporting children's theorising than leaving the topic relatively unbounded. This can be explained through the identification of the teaching and learning situation as complex and through the theoretical resources of complexity

theory within which delimiting the topic is argued to actually increase the diversity of responses, as 'enabling constraints' (B. Davis & Sumara, 2006). Although diversity is important for the generation of new knowledge, so is a shared orientation to guide action in complex situations (B. Davis & Sumara, 2006) and so, therefore, is careful explanation of the goal of the group (Bodrova & Leong, 2007). My findings suggest that clear outlines and goals support children to take ownership and control of problems and solutions, and in this way support what is described in the literature as a transformation of participation, which involves taking responsibility for the activity, and can include transforming the activity itself (Daniels, 2001; Greeno, 2006; Rogoff, 2003; Wenger, 1998). Perhaps a transparency of purpose is more enabling for children to put knowledge and theories to good use.

Documentation was found to be a way of presenting the starting point to the children. Other researchers suggest documentation can act as a "conscription device" (Cowie & Carr, 2004, p.95), and this was certainly true for my study. Children were highly motivated to see themselves in documentation in my study. Sociocultural theory, in seeing documentation as a tool for further action, suggests that the documented experience becomes a concrete material object over which meaning can be further negotiated (Wells, 1999; Wenger, 1998). Documentation is uncritically advocated by the early childhood literature as being a useful tool for encouraging discussion (Meade & Cubey, 2008), with Cowie and Carr (2004) arguing that documentation can be accessible and open and invite clarification. This was, however, difficult to enact in my study, as documentation more often served to select and to fix meaning rather than support the shared development of meaning, and these issues associated with the reification of knowledge are recognised in the wider sociocultural literature (Wenger, 1998; Wells, 1999).

My research explored the idea that a particular proposal or problem, within one of the cognitive contexts that seemed to engage children in creating working theories, can provide an effective starting point. This pedagogical strategy is supported by the proposal of cultural-historical theory, that children should be supported to develop knowledge, theories and concepts through solving specific problems, in a similar way to their discovery in the history of knowledge creation (Geist & Lompscher, 2003; Hedegaard, 1999; Stetsenko & Arievitch, 2002; Wells, 1999).

Although this approach insists on a contextualised, specific focus (B. Davis, et al., 2000) and for concepts to be developed through their meaningful application (B. Davis, et al., 2000; Geist & Lompscher, 2003; Hedegaard, 1998), my research adds to these principles that meaningful problems come from the children. The activities that were most successful in my study in motivating the generation of theory were those that made sense to the children in the context of their narrative and the problems they had identified themselves. It might be that it is the children's experience, and their particular perception of what was important in that experience, that offers the problems, and a sensitive teacher is responsive and alert to these, and can formulate them in a way that invites group consideration.

However, from this starting point, the progression of activity should be, argues Wells (1999) "both dynamic and emergent" (p.83). So within the idea of focused starting points, the focus should be seen as an enabling constraint which supports a range of possible paths.

Making connections

In relation to the importance of maintaining coherence and focusing talk and activity on a specific problem, it was at first hypothesised that returning to and maintaining a theme would be an important teacher action. Sociocultural theory might suggest that tightly scaffolding a more structured experimental approach to testing working theories about earthquakes is to be encouraged as participation in an adult, real-world activity (Singer, 1996; Wenger, 1998), where children gain understanding of the approach by participating (Kalish & Sabbagh, 2007; van Oers, 1996). Further, an adult-structured approach might possibly offer more cognitive challenge through the opportunity to learn a more sophisticated strategy (Bodrova & Leong, 2007) and might be necessary for the development of theoretical knowledge (Wells, 1999).

Thus the technique of scaffolding children to reach an already-known understanding or structuring their involvement can be seen as perhaps most relevant to enabling participation as a means of development (Rogoff, 2003; Wells, 1999). Scaffolding has been identified as a key technique for developing children's thinking in the UK (G. Walsh, et al., 2011), and in a New Zealand *Best evidence synthesis* report (Farquhar, 2003). It is also suggested as a useful approach for supporting working theories in

Peters and K. Davis' (2011) research, with adults moving the child from a puzzling event to related, yet more familiar experiences.

However, my study shows that scaffolding the particular development of a theme is not supportive teacher action, as it tends to simplify the possible scenarios and thereby limit opportunities for working theories. It also tended to lead to patterns of interaction as described by Tayler (2001) in which adults take advantage of their more powerful position, such as ignoring contributions from children perceived by the teacher as irrelevant. K. Davis and Peters (2010a) agree that adults should not attempt to move children's understanding to a specific concept. Instead, being responsive and sensitive to children's meanings is identified as important for enabling quality interactions that extend thinking (Pascal & Bertram, 1999; G. Walsh, et al., 2011). In relation to working theories in particular, Peters and K. Davis (2011) find that sensitivity is required in order to respond effectively to children's working theories, and argue that adults can easily "hijack" the child's idea by responding to only part of the theory.

As further argument against sociocultural conceptions of learning as participation in already established adult practices and ways of thinking, the development of knowledge can be considered to require transformation and growth of practice. My research showed that being open and responsive to children's novel ideas and connections was more supportive of the creation of new knowledge and theory. Jordan's (2004) research makes a similar conclusion, and identifies that teachers should change their focus from the transmission of facts to the study of meanings.

However, this position can be critiqued in subscribing to a laissez-faire, democratic philosophy in which children's own understandings and meanings are respected but not challenged. Poimenidou and Christidou's (2010) research showed that total adherence to a loosely structured, dialogic style resulted in little or no progression in scientific understanding. Alexander too (2000) critiques this approach as not doing enough to support and advance children's thinking through the provision of cognitive structures. It seems, in my research, as well as in the literature, a difficulty in supporting the development of thinking without dominating children's inquiry is recognised. In my study, the pedagogical technique that finds some middle ground in providing cognitive structure for the development of thinking, yet also respecting children's ideas and letting their ideas lead the way, is the technique of making connections. Moreover, the

teaching strategies I identified as 'supporting visibility' and 'extending depth and breadth' might also be considered as techniques that provide support to advance children's thinking.

The technique of making connections is found to be supportive of children's thinking in Jordan's (2004) research which emphasises empowering young children's enquiry, as well as research from the UK on developing children's thinking (G. Walsh, et al., 2011). Moreover, Pontecorvo and Sterponi's (2002) research found teacher's orchestration of children's contributions an important influence in children's development of reasoning while Meade and Cubey (2008) suggested that teacher co-ordination of ideas and concepts is important in schema development. In addition, this strategy links to the search for connections that children seemed to make in my study, and that, in K. Davis and Peters (2010c) research on working theories, led to ideas being seen as islands that gradually grow and connect to become more complex and compelling. Further, making connections between different children's ideas moved my practice towards an understanding of a sociocultural distribution of cognition across activity, resources and people.

Teacher's mental preparation

It seemed that theories and concepts could be carefully structured without dominating the children's activity through the principle of making connections, when I had considered the concepts before the activity with children, and when I was therefore alert to ways in which the children's actions could be meaningfully connected. This principle of being mentally prepared in order to make conceptual connections is supported by complexity research, as B. Davis et al (2000) suggest that sufficient knowledge of the subject supports teachers to be confident to follow children's ideas. Meade and Cubey (2008) also suggest from their research into how teachers support schema development that teachers need to prepare for specific interactions with children to advance their thinking.

My research suggests that mental preparation could lead teachers to dominate if the preparation has been narrowly focused, so although this preparation is important, so is the attitude in the moment with children. Complexity theory also indicates the balance required: being open to surprising events which trigger possibilities, while being attentive to curriculum purposes (B. Davis & Sumara, 2006; B. Davis, et al., 2000).

Preparation which identifies many (too many to actually achieve, equally valued) paths for thinking and theorising is likely to be the most supportive mental preparation.

Supporting visibility

Making children aware of particular actions or qualities, ideas or theories through highlighting them, was found to be linked to children creating working theories, and formed part of the 'focusing in' strategy. Thus my research puts forward the suggestion that describing, focusing attention, repeating, and verbalising theories, in supporting the visibility of ideas, concepts and actions, encourage children to develop or express their theories related them. This section considers the findings around supporting the visibility of ideas as related to the notion of scaffolding. Simmons et al. (2005) identified the use of scaffolding and co-construction as strategies for the complex and sustained learning related to working theory development, but did not define whether the researchers intended to scaffold children from working theories to official, formal theories, or whether scaffolding and co-construction can support children to take the lead in the generation and modification of their theories.

Focusing attention, describing, repeating, verbalising and questions for recall

My findings around supporting the visibility of children's ideas underlines the sociocultural perspective that it is social interaction that supports children to notice and act upon certain details of their actions (Bodrova & Leong, 2007; Inagaki & Hatano, 2002; Rogoff, 2003). Focusing, in particular, supports teachers and children to share attention and develop mutual engagement in activity which is a broad strategy that has been identified in large scale studies of effective pedagogy in early childhood environments, such as Siraj-Blatchford's (2004) study in the UK. My research identified a possibility that focusing on what children are doing and saying through description and repetition may actually slow the teacher down and enable him or her to be more responsive.

This study suggests that focusing on, describing and repeating observations and ideas offers resources for children's theorising. Complexity research too identifies that, because of the complexity of a situation such as teaching and learning, some focusing and highlighting strategies are required to support children to make the discoveries that will extend their learning. "Pointing, telling, highlighting" are important strategies (B. Davis, et al., 2000, p.10) that correspond to my category of 'focusing' teacher actions;

these are also described as part of "focusing phenomena" (p.2) in Lobato et al.'s (2003) research in high school mathematics classrooms.

In my research, the teacher describing, repeating, verbalising, and clarifying theories was found to precede some occurrences of children expanding ideas. Other research has found similar techniques to be effective in relation to thinking in particular, for example "adding a commentary" (G. Walsh, et al., 2011, p.61) is highlighted as an important teacher action in the development of children's thinking in research in the UK, and co-narration of children's contributions is seen as an important strategy in Pontecorvo and Sterponi's (2002) research into how children develop reasoning in preschool and family contexts.

The actions I describe in my research as supporting the visibility of children's ideas are actions which ascribe language to children's actions (describing, focusing, verbalising). Other research confirms the importance of using language to represent ideas, as language is seen to provide the medium of thinking (Arnold, 2003; Bodrova & Leong, 2007; Taggart, et al., 2005; van Wijk, 2008). Meade and Cubey's (2008) research into schema development concluded that the use of language encouraged reflection and cognition on another, more abstract, level.

As in my research, the repetition of children's contributions was found to encourage expansion on that contribution in Pontecorvo and Sterponi's (2002) research, but other research argues that repetition may instead inhibit children's thinking. Rowe (1986) makes the claim (borne out in repeated research) that the act of repetition (mimicry) of students' answers interrupts the thinking time that children require for developing their own thinking. Also, however, my research found, like Hedges' (2007) research, that often children want to test out their ideas and theories with adults, and want the adult to listen and reflect their ideas back to them.

Supporting visibility can also be seen as a strategy used to scaffold children towards particular observations and to, therefore, close down, rather than open up perception. This might explain the fact that the actions of supporting visibility were less strongly linked to theorising in my findings, because they may have narrowed the resources available for connection into theories. It is possible that visibility should be accompanied by the language of uncertainty.

Another issue with the teacher making certain concepts and ideas visible relates to Carr's (2001) findings on social intent, and on the way that identity affects learning (Litowitz, 1993; Wells, 1999; Wenger, 1998). The social situation of the thinking and theorising work may have a powerful impact as demonstrated in other research (Pontecorvo & Sterponi, 2002; Sussman, 1989; Wells, 1999; Wertsch, 1998). If children's social intent is to please or be aligned with the teacher then because the teacher makes what matters to her visible children might adopt it. Alternatively children might deliberately choose a conflicting identity and be limited by their opposition.

6.3.2 'Stretching out'

A context of generating and sharing ideas as well as strategies to extend the depth and breadth of children's thinking also prompted the formation of working theories. These strategies and ideas seem to be more easily related to the notions of dialogic thinking and co-construction, in that they provide children with questions and ideas on which thinking can be built. These strategies are placed within the theme of 'stretching out' ideas, which implies much greater possibility for unique meanings.

Creating a context for sharing ideas

K. Davis and Peter's (2010b) study supports the finding that organising opportunities for children to share ideas is important for the development of working theories. The particular characteristics of this context of sharing ideas were suggested to be 'group work', 'an interested adult' and 'representational activity'.

Group work

Group activity was seen as the principal means for facilitating the sharing of ideas in K. Davis and Peters' (2010b) study. My research suggests further that this is because working with other children may provide prompts and resources for theorising. The wider research on the pedagogical strategy of dialogic teaching has found that this strategy supports the progression of children's thinking (Mercer & Littleton, 2007). Particularly useful was aiming for agreement in order to make progress, which served to extend the debate and thus the children's thinking (Mercer, 2000). Similarly, in my study, aiming to find a mutually agreeable solution, particularly where this was difficult, stimulated many problem-solving ideas and revealed more of the children's working theories.

The presence of other children is almost guaranteed in the social setting of an early childhood centre, and as sociocultural theory suggests, social interaction provides resources with which knowledge is constructed. While dialogic thinking and intersubjectivity is not a guaranteed or automatic consequence of being in a group, my study suggests that it is merely the presence of other children engaged in similar or competing activity that supports and induces theorising, and not a specific quality such as dialogicity.

The group did seem to serve as a location for the shared understandings and memories of past experiences in my study. This is supported by the concept of distributed cognition and knowledge, and the sociocultural notion that meaning can be "deposited in things" (Daniels, 2001, p.23). As others have argued, it appeared that memory and histories of interactions can be re-evoked by material objects and by the environment (A. Edwards, 2001; Lemke, 2002; Wells, 1999).

An interested and respectful adult

My research suggested that my attitude and reactions to children and their contributions to the activity had an influential impact on children's theorising, and put forward a tentative conclusion that interested and respectful attitudes supported children to generate working theories. K. Davis and Peters (2010b) found adults sharing the interest or theory with children was a supportive factor for the creation of working theories. This research also highlights the importance of a culture of "trusting that an individual's theories will be taken seriously" (p.29) and also a culture that encourages and enables children to think differently, while Jordan (2008) also identifies showing trust in children as facilitating children's inquiry.

The importance of teachers' actions in creating a particular learning climate for children is widely agreed in literature drawing on the 'communities of practice' concept (Lave & Wenger, 1991; Claxton, 2002b; Mercer, 2002). Although this theoretical perspective points to the importance of the teacher modelling thinking behaviours, such as questioning, making links, reasoning, imagining, planning and revising (Carr, et al., 2009; Claxton, 2002a), this was not proven to have any concrete influence on children's theorising in my study, which might be because such effects are hard to measure.

The act of asking questions was identified in my study as indicating the teacher's interest, particularly open questions which aimed to encourage children to share ideas.

This point is made strongly in the research literature around working theories: that teachers should focus on children's interests (Simmons, et al., 2005, p.19) and on encouraging ideas, instead of trying to move children's understanding to a particular point (K. Davis & Peters, 2010a). This is also strongly supported by the dialogic teaching research literature, and research literature on questioning which indicates the importance of authentic questions seeking understanding of children's meanings rather than pre-specified outcomes (Hasan, 2002; Jordan, 2004; Pontecorvo & Sterponi, 2002; Wertsch, 1998).

It was noted in my findings that relationships were important, as several children sought intimate interaction or positive affirmation from me in particular. Research such as Carr's et al. (2009) study also showed that children showed interest and engaged in activities because of their relationship with teachers. Whether strong relationships contributed to the quality of thinking (as suggested by Pontecorvo & Sterponi, 2002) or learning (Mercer & Littleton, 2007; Powell & Bingham, 2002) was impossible to determine in this study. However, it seemed clear that children were confident to try out ideas, so perhaps, as in Miller's (2003) study, personal relationships enhance the possibilities of cognitive growth.

Representational activity

My findings showed that representational activity was often linked to children's theorising, but that the relationship between representation and theory generation was complex. It was recognised that the resources offered for representation held other meanings that interacted with (possibly supporting or inhibiting) the construction of theories.

My research thus offers support for the distributed cognition theory that resources contain meanings and tools suggest strategies. I found, like Hedegaard (1998), that objects both support and restrict conceptual understanding, with the example such as Liam's use of the Jenga^{TM} blocks in a particular way (building a tower easily tumbled with the removal of one brick) showing that these blocks both support the generation of (one) theory, but inhibit other possible theories. Further complexity is highlighted by the fact that objects can hold many different meanings, and even relatively stable meanings can be used as resources for new meanings (Wenger, 1998). It was true that certain objects suggested certain paths to children, supporting the suggestion of de

Oliviera and Rossetti-Ferreira (1996) that teachers can use particular materials to reconstruct the particular idea or knowledge that the object is seen to contain.

It thus seems to be possible for teachers to use resources to create learning situations that are relatively bound or relatively open, and thus influence the range and variety of theories created, and the number of connections between knowledge made. My research tends to lend support for the claim of researchers such as Carr et al. (2009) and Wells (1999), that teachers actively need to challenge existing ways and introduce new ways of working with materials, and, I would emphasise in particular, documentation. Therefore it might be better to suggest that while teachers can utilise the particular meanings that support some theories, they might also need to challenge these meanings in order to continue generating further theories.

Extending depth and breadth: Stretching thinking in different directions

The final category of supportive teacher actions for children's working theories are strategies for extending the depth and breadth of children's thinking in order to prompt new theories and more complex theories. My findings suggest that children's thinking could be stretched in several different directions: moving 'forwards' from an idea by considering subsequent consequences or actions, moving 'backwards' in thinking to consider what (ideas, experiences, evidence) led the child to that idea and finally, moving 'sideways' by considering different perspectives and alternative possibilities. Further, simply pausing after each comment was found to lead to children's self-initiated extension of ideas and theories.

My research found that specific questions were more successful in prompting children's thinking and theories. The fact that, in my study, modelling thinking was not related to any instances of thinking or theorising is supported by Walsh et al.'s (2011) report which states that teachers frequently had to move beyond modelling thinking to actually "probe and prompt" (p.39) the children to extend thinking. As well as through questions, my research found that the teacher making a contribution to the discussion could also extend children's thinking, while other research agrees that adult contributions are important (Hedges, 2007; Jordan, 2004; Meade & Cubey, 2008). In my research, it was recognised that inviting many possible answers or solutions was useful. As suggested by Langer's (1997) research, the use of words that imply possibility, rather than certainty, were useful in sustaining thinking, rather than closing

down conversation which often occurred whenever I seemed to indicate the 'right' answer had been achieved. Peters and K. Davis (2011) make a similar conclusion based on their research into working theories, arguing that the presence of uncertainty might benefit the generation of working theories.

Pausing as a strategy to give thinking time seems to be a well-established finding in the literature, which my study would further substantiate. This strategy was consciously trialled as a means of developing my own responsiveness to children's ideas. Wait time has been found in many studies to give children time to think about and elaborate or expand upon what was said, and to give teachers time to formulate a probe or a prompt to delve deeper into children's thinking (J. Walsh & Sattes, 2005). In my study, while pausing encouraged children to expand their thinking, I found for myself that other strategies were required (such as mental preparation before the teaching and learning episode) for me to develop effective responses to children. In my research, a pause of two to three seconds was found to be necessary for children's thoughtful responses, which is supported by other research findings that giving wait time increases the complexity of cognitive processes such as speculative thinking and inference (Rowe, 1986). Likewise, K. Davis and Peters (2010b) found that an important support for working theories was that of "allowing sufficient wait time and spaces for children's ideas to emerge" (p.28).

6.3.3 Problematising my findings: A postmodern perspective

This research is informed by postmodernism and complexity theory, and in this, I argue for great care in the use of its findings. The concepts and metaphors put forward have potential to contribute to early childhood teachers' work, and yet, the postmodern understanding that these ideas emerge from my particular perspective (Gergen, 1999), and the complexity theory framework that suggests that many possible connections will evolve, unpredictably and in a myriad of ways (Mason, 2008b), should arguably diminish their power. Thus my working theory is both value-laden and personal as well as uncertain. Further, it is not my intention to offer a conceptual straitjacket that prevents further development in this field.

Yet we do need some shared vocabulary, shared understandings and shared concepts, to move us forward. As is suggested in relation to children's thinking, too much openness and ambiguity would not support the progression of teacher's thinking or their practice.

However, the emerging concepts require the possibility of movement and modification, important for any working theory, and keeping these ideas open allows for movement. Some of my findings and interpretations show this kind of dynamism. The imagery of ideas connected in complex and expansive ways is one congruent with complexity theory, as complexity thinking aims for an ever-expanding knowledge and ever-expanding possibilities (B. Davis & Sumara, 2006). The rest of this section reports my attempt to further deepen my research findings on teacher role through the early childhood literature relating practice to rhizomatic conceptions of thought.

6.3.4 Returning to rhizomes

The rhizomatic metaphor, which was identified as the most accurate conceptualisation of children's thinking, also has much potential to inform teacher practices. Olsson (2009) argues that Deleuze and Guattari's (1987) rhizomatic conception of thinking requires an early childhood educational practice that accounts for movement and experimentation. Olsson's ideas about movement and experimentation in early childhood activity and curriculum are worth comparing with the ideas that this research has generated. Firstly, in line with complexity theory, Olsson argues that it is impossible to prescribe pedagogical techniques, but that these must evolve and unfold with every situation. Like complexivists, Olsson argues that teaching and learning are living practices, which cannot be systematised or nailed down. And yet, she suggests some principles can be outlined, and these relate to and inform my developing understanding of the teacher's role in this study.

For example, Olsson suggests teachers should challenge children by enlarging number of concepts, hypotheses and theories to augment connections. Rhizomatic thinking creates multiplicities (Deleuze & Guattari, 1987), so Dahlberg and Moss, in their introduction to Olsson's (2009) book, summarise that "we have to search for the '*and'* through augmenting the numbers of connections, or encounters, that provoke something new to be thought" (p. xx). Thus Olsson, alongside Dahlberg and Moss, seems to be advocating a pedagogy that follows and encourages diverse lines of thinking, carried forward by connection after connection, stretched out in all directions. Perhaps my conception of the teaching and learning process is a little more conservative, as I consider a need to hold on to a thread of thinking so that occasionally one can return to firmer ground (the original topic or idea). And yet the image of yo-yo-ing back and forth along strings of ideas would definitely suggest movement!

Olsson's research attempts to "turn the focus on positions and change as moving from one position to another into a focus on movement as something that foregoes positions" (p.48), and, like Deleuze and Guattari, she rejects positions and points. My research, however, suggests that positions or points are important, and the yo-yo metaphor used to describe the process suggested emphasises a starting point, from which thinking begins and can travel in many directions, but remains linked to this focusing point for coherence and meaning. Yet despite this stance against points and positions, Deleuze and Guattari refer to "plateaus" (p.21) within rhizomatic thinking, which might provide time to pause, and take stock, and they compare rhizomes to maps, with multiple routes and entry and exit points. Olsson, too, hints at a sense of focus and even a starting point, as she suggests that it is the identification of an important and specific problem, constructed by the teachers and the children together, that focuses the work.

A new lens for interpreting my findings

Olsson's application of Deleuze and Guattari's concepts to her work in early childhood education offers me a new lens for interpreting my findings, particularly understanding where I had difficulty.

For example, Olsson can explain why I had such difficulty with 'maintaining a theme' and chose instead to reframe my role as 'making connections'. Like others (K. Davis & Peters, 2010a), Olsson would agree that teachers must engage with children's ideas without seeking to reach a particular outcome. If, instead, the teacher has an answer in mind, her questions are worked out on the basis of this answer and actually force children into a position (Dahlberg & Moss, 2009). Movement and experimentation, if tolerated, are "reduced to mediating devices" (Olsson, 2009, p.7). This description seemed appropriate of several observations in my research, where my focus on and towards a particular outcome blinded me to other experiments and other directions that thinking might have taken. While thinking, as a rhizome, is about multiplicities, Deleuze and Guattari (1987) suggest that power can be used to create the illusion of unity. This helps to explain the way I felt I was super-imposing my plan on children's actions and attempting to maintain an illusion that we were following the same plan. I solved the problem of integrating disparate lines of thinking within a theme with a strategy of making connections between the children's ideas and mine. Olsson considers that it is permissible for teachers to try to connect "their own problems and desires with

the children's" (p.50); indeed, I assume that this may open up more spaces for thinking by enlarging the concepts, hypotheses and theories as Dahlberg and Moss suggest.

An area of agreement is that Olsson finds that movement and experimentation are actually aided by the careful preparation of teachers, while a similar conclusion was made in my research. I found that thinking about the numerous possibilities of a topic supported me to 'hear' these different ideas in the words and actions of the children. Further, Olsson's research was in part prompted by an awareness that documentation, although intended to support learning, tended to close down the possibilities of the event, immobilising further thinking. In my study, I noted this effect too, that the use of documentation for recalling specific interpretations of events seemed to close down children's thinking.

There are some important areas of disagreement however, between my study and Olsson's interpretation of Deleuze and Guattari's work for early childhood education. My research finds that actions such as commenting, interpreting and reflecting while engaging with children have some (albeit limited) support for the development of working theories, yet Olsson argues that these actions close down thinking, and Dahlberg and Moss summarise that teachers should be present, experimenting with children, not on the outside, commentating, interpreting, reflecting, representing. However, the fact that commentating, interpreting and reflecting on children's actions are ways of "immobilising them and the event through closing them down within truth claims" (Olsson, 2009, p.106), prompts Olsson to consider the active production of sense, as an alternative to commenting, interpreting and reflecting, and to find and construct what sense, rather than truth, is being produced in teacher's and children's actions. Here sense is one that is a sense under production, like a provisional and developing working theory, judged only in the sense it makes of the knowledge resources to hand. Perhaps commentating, reflecting and interpreting are permissible in a context of searching for sense, and care is just needed to avoid classification and closure.

In summary, Olsson argues "this going in circles, backwards, sideways, forwards, in a mess, draws up the contours of a different kind of learning and a different kind of knowledge" (p.167), and I believe my research too takes these new 'contours'. Olsson's ideas about thinking and learning as "going in all sorts of directions" (p.167) lend

support for the metaphor of a 'yo-yo', where the plastic spool can be reeled off in many different directions, yet should also attempt to return to one spot, a central idea or focus that keeps each different trajectory linked to the others, in the way that rhizomatic roots are linked.

In synthesising my findings with theoretical perspectives, and with other research on pedagogy, I believe a strategy of both focusing in and stretching out is the best development of my working theory I can currently offer. There is a tension between these ideas, and the balance of focusing in and stretching out would need to be carefully considered, yet tensions can be productive. My findings suggest that thinking is a dynamic, social activity that can (and should) traverse multiple directions, but that also it is important to find focus to guide thinking. The children's perspective also seems to suggest a need for coherence, in that they used narrative to story their knowledge into combination and fit concepts together in a meaningful way. The 'yo-yo' metaphor provides a way for teachers to both explore the "as-yet unimagined" (B. Davis & Sumara, 2006, p.135), yet maintain a thread and support coherence so that new possibilities and theories have some value in being capable of addressing a problem or opportunity. This is after all, the assumed purpose of working theory, in finding ways to connect knowledge to make sense of the world and to effectively act upon it and within it.

6.4 Conclusion: In which direction do we head now?

The complex and messy problem of how to support children's working theories perhaps requires an equally complex, messy working theory that refuses to fully tame the problem. This is because the concept of working theories deploys knowledge in an active way, and as activity, it evolves, constantly being re-negotiated and re-defined (Daniels, 2001; Seifert, 2002). Further, working theories are embedded in an early childhood curriculum that embraces relationships and communities, thereby intentionally bringing complexity to the curriculum as a source of learning and of knowledge.

Thus teacher support for children's working theories will involve some or even all of the different actions and ideas I have presented in this research, including group work, an interested and respectful adult and representational activity; starting points and proposals, making connections, mental preparation; focusing attention, describing,

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verbalising, repeating, questioning for recall to support visibility; as well as questioning, and pausing to extend the depth and breadth of thinking in diverse directions.

The more of these supports that are provided, the more complexity will emerge, and in the case of working theories, that complexity is to be desired.

Chapter 7: Conclusion

The conclusions that I have reached in this thesis constitute my present working theory of how teachers can support children to generate and modify working theories. The theorising process thus far has included several detours and misdirections, and a non-linear circling around and between the action with children and theoretical understandings. Yet this journey supported me to reach a complex and rich understanding of the concept of 'working theories' as an outcome for early childhood education, and the implications for the teacher role. It also enabled me to retain some of the complexity and ambiguity of the processes of learning and teaching. A synthesis of the findings from the literature review and the detailed study of four activity episodes in one early childhood centre, enabled me to find some pathways among the theoretical resources and perspectives that may be worth following further.

7.1. A rich literature base

This research involved the careful construction of a definition of working theory, which reflects the spirit of *Te Whāriki* (Ministry of Education, 1996), the curriculum document from which it is taken. Perhaps unsurprisingly, given their recognised emphases in this curriculum document, both constructivism and sociocultural theory proved useful for developing a knowledge base for the concept of working theories. Without a clear positioning of the term in either theory, the review of the literature required the creative connection of a number of concepts, as well as pedagogical techniques, to the term working theory. This work therefore makes a unique contribution to the early childhood literature, and represents one of the first attempts (following K. Davis & Peters, 2010c; and Hedges, in press, November 2011) at delimiting a literature base.

This research explores, and makes some suggestions for alternative theoretical perspectives to inform work in early childhood education. Complexity theory was found to be a theoretical resource that could be connected to working theories in that it too views knowledge as emerging from interactions and connections, with diversity, creativity and ongoing modification as important aspects. Rather than selecting one theory to frame an understanding, it seemed that each framework (constructivist, sociocultural and complexity) offered useful resources, and moreover, could be combined in the working theory offered here. Having 'stretched out' the possible resources in a variety of directions, for ideas and insight, and made connections with

diverse theories, I feel I can return to the 'focus on' working theory, and my role in supporting its development in my teaching, with a deeper and clearer understanding.

7.2 Findings: One working theory of teacher support for working theories

In relation to working theories as a major outcome of *Te Whāriki*, this research aimed to uncover strategies that I as a teacher use to encourage thinking and theorising, and explore their relative success. A specific aim was to develop concepts that articulate supportive practices and roles for the teacher. And finally, recognising that education is not solely about the technical realisation of outcomes, the strategies and practices needed to be congruent with my educational values.

In setting the research questions around identifying supportive actions to encourage children's working theories, I made an implicit hypothesis that there are certain kinds of support that teachers can provide for children to create and develop working theories. However, as early childhood settings are open and messy, complex settings where a multitude of different influences are at work, the possibility of identifying and isolating teacher actions and reliably measuring their impact on children's theorising was impossible. The research identified some associations between particular teacher behaviours and children's theorising, and these were able to be synthesised and simplified to develop a more powerful concept. Thus I present the possibility that teachers who try to support children's thinking both to 'focus in' and 'stretch out' are working in a way that is supportive of both the generation and modification of children's working theories.

The ways in which teachers can 'focus in' on children's ideas are illustrated by my own practice, and are described as 'focusing on an open theme' and 'supporting the visibility of ideas'. Likewise, the actions and roles for 'stretching out' ideas are also listed and illustrated as ways for 'creating a context for sharing ideas' and 'extending depth and breadth'. A way of working that incorporates both stretching out and focusing in on ideas is described as resembling the movement of a yo-yo. I found this a useful way to conceive of my action and it supported me to develop a more active role in interaction with children, rather than the well-established role of facilitation, to which it was easy to succumb. That the suggestions for practice could be integrated within current theoretical frameworks for understanding cognition increases their validity.

Particularly useful are the findings around making connections as a way of ensuring coherence and progression in the development of children's knowledge, thus responding to the criticism of dialogic and discovery approaches (Alexander, 2000; Poimenidou & Christidou, 2010). Making connections also seems to be a way of reducing teacher domination of ideas or pathways, and as a way of improving responsivity and intersubjectivity. This approach offers a way for teaching support to "mesh with children's decision chains" (Meade, 2000, p.22).

On a personal level, the examples of analysis, reflection and adapted strategies in the findings chapter demonstrate that a process of investigating the congruence of my actions with my values has informed and improved my teaching. It was clearly stated that I value expansion of knowledge and multiple perspectives, rather than, for example, supporting children to reach the 'right' answer, and this value is evident in the proposed theory of supportive teacher action. I have also demonstrated that I was working towards democratic ways of sharing power, and towards the view that knowledge is contestable.

While recognising that specific concepts (Hedegaard & Fleer, 2008) and metanarratives (Carr, et al., 2009) have great potential to contribute to a general understanding of teacher support for children's working theories, the concepts of 'focusing in' and 'stretching out', and the practices that they describe are merely provisional and contestable. They are designed to facilitate debate and further exploration, rather than define specific causes which lead to reliable effects. As complexity theory informs us, it is likely that a suitable way to proceed when seeking to engender educational change is to seek to influence as many aspects as possible (Mason, 2008b). The concepts this research identifies, then, may be just some of many supportive constructs that early childhood teachers can deploy, with sensitivity and responsivity to the current context, and their own system of values and beliefs.

7.2.1 Limitations of the research

This research focuses on a small aspect of teaching young children in early childhood settings, related to a specific goal in the current early childhood curriculum in New Zealand. It looks only at one teacher's practice, in a total of just 90 minutes of activity, and as such is a highly constrained study. These limitations mean that it is not possible to generalise the findings across other teachers, groups of children or early childhood

settings. However, the specific and narrow focus of the observation have likely contributed to my ability to offer some detailed findings.

In framing my results with complexity theory, it is easy to recognise that findings that try to determine collocation of teacher action and child response are very simplistic. Pedagogical strategies interact with the multitude of other influences present in the situation, so that where sometimes a strategy works well, on another occasion and in another context it will not. Moreover, the world continues to evolve and change in unpredictable ways. Teaching remains more of an art than a science (Mason, 2008a), so choosing the right pedagogical tool involves teachers' intuition and no tool can guarantee particular outcomes. This research and its findings cannot be used to prescribe practices to teachers.

The subjective interpretations employed in the research might be regarded as both a limitation, and as a factor increasing the validity of the findings, in that I was able to draw on knowledge of previous events to help interpret the observations. However, I was the only observer and only interpreter or coder of the transcripts, which reduces validity. The research is as robust as possible in that I was able to recognise and address my biases (for example, for verbal theories rather than acted ones) and reflexively identify many alternative interpretations. However, further study of the wider contexts that influence my teaching behaviours, including the institutional and societal context, could have been carried out. Moreover certain elements of context were identified as inauthentic and untypical, such as being videoed and being constrained in the timing of activity.

Another limitation is formed through the act of assigning codes to pieces of data, attempting to categorise a complex reality where many interpretations are possible and many times data evade categorisation. The themes and codes that I developed in the research were found to jostle and overlap, in that, for example, one action (such as describing) can be performed for different functions (both 'focusing in': 'supporting visibility' and 'stretching out': 'extending'). Further, the coding categories used are incapable of indicating the quality of the instance of describing or extending. Although both the identification of general patterns and the deconstruction of specific instances were carried out in analysis, a model that can incorporate both teacher actions and a measure of the quality of those actions was not attempted. Further, within this study,

carried out at intervals over only four months, it was difficult to see fully how working theories were modified, improved and built upon.

7.3 Pointing to possible directions: Implications and suggestions

This research goes some way to show that a teacher researching her own practice with an aim to understand and improve it in some way is capable of generating some rich insights that can be made even more meaningful through the lenses of different theoretical perspectives. The practice of self-study, seen as an opportunity to uncover theory from practice, makes it possible to find new ways of conceptualising the teacher role, and this research should encourage other early childhood teachers to undertake a study of their own practice. Complexity theory and living theory perspectives seem to grant licence for situation-specific, local and highly contextualised theories.

This research underlines that self study is much more than a tool for self-legitimisation, but can be combined with other methodologies, particularly grounded theory analysis, to uncover assumptions and widen possibilities. Teachers and children both have working theories that organise their knowledge and guide their action. Although recognising working theories in action was identified as a difficult task, this research demonstrates that self-study and living theories reflective action research may be a tool for teachers to uncover their theories. My working theory was developed and improved through the process of self-study, which, it can be considered, consisted of both focusing in (using specific research questions, observing specific and bounded instances of teaching) and of stretching out (challenging myself to identify alternative interpretations, seeking literature to inform the developing interpretations).

As argued by many researchers in New Zealand, early childhood teachers seem to require significant support to enact the sociocultural perspective of *Te Whāriki* (Fleer & Raban, 2006; Meade, 2000; Nuttall, 2003; Tayler, 2001). If, as my own and other research suggests, taking a facilitative role in activity, rather than engaging children in thinking and theorising, is currently most prevalent because teachers are not sure on how to enact more mediating roles, then this research contributes supportive concepts to guide teacher action. My working theory, that teachers can support children's working theories by both 'focusing in' on and 'stretching out' their ideas, is offered as a provocation for teachers' current practice in the implementation of *Te Whāriki*. It is also a theory developed through practice, which is important because, although it is easy to

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develop rhetoric about good practice, it is hard to imagine the effects of the many competing agendas that early childhood teachers manage on a daily basis. As well as values, my theory of supportive teacher action is supported by a rich theoretical knowledge base. My theory is provisional, and I invite others to critique it, modify it and to generate their own alternative theories. My concepts and ideas provide a starting point, and they may be critiqued and improved, but my intention is that they provoke discussion and reflection.

If one of the aspects of social mediation that early childhood teachers find difficult to enact is that of protecting child-initiation and avoiding teacher-led techniques, then the idea of making connections, which was found to be so powerful both within my research, and on a theoretical level, may be very important. Practically, I found 'making connections' between children's ideas and the theme of our discussion, rather than enforcing a theme, a useful strategy to minimise my power-ful role in the discussion. It also improved responsivity and intersubjectivity, because it forced me to slow down and think about what children were offering, and what connections they might be making. This is a significant contribution to improving practice in early childhood settings, where the qualities of responsivity and intersubjectivity are recognised as important.

The research offers insights into the nature of children's working theories, noting in particular that working theories are strongly related to action as well as to understanding, for guiding representations and for achieving social goals. This is a new contribution that can be backed up with sociocultural theory in which thinking and knowledge is seen as social activity. This research suggests that, as well as finding ways to conceptualise the teacher's role, new ways of conceptualising children's thinking processes might be needed. Children's thinking was constantly in movement and expansion, evidenced by the ways they sought ways to incorporate more materials into a representation, or to lengthen a story by seeking more connections.

Useful tools for this re-conceptualisation include Deleuze and Guattari's (1987) notion of thought as a rhizome. However, this might provide a challenge for *Te Whāriki* in its sociocultural and constructivist underpinnings, because constructivist notions may not be entirely appropriate. Links between concepts may not be entirely logical, and thinking creates itself anew as it moves constantly into new ground (Olsson, 2009). Constructivism cannot really account for the associative and imaginative ways that

children seek to connect knowledge, which are not quite the processes of accommodation or assimilation that Piaget described. Sociocultural theory provides a better understanding of the tools and resources that children have at their disposal for the construction of working theories, but complexity theory, and rhizomatic imagery, might provide a way to better conceptualise the processes of construction.

7.3.1 Future directions

This research raises many questions, about the relationship between resources and theory generation, and between cognitive contexts and theory generation. Perhaps further research on children's working theories is best explored in problem-solving contexts, or in the context of children's representational work. Also the finding that children are motivated to explore theories of self was one interesting finding of the study, and might merit further research.

Within the research, it seemed difficult to reconcile two points: clearly structured and focused exploration that led to focused theorising, and open-ended, child-led determination of topics and interests. I suggested teachers might need to act on behalf of children in implementing activity around their interests, using documentation to come to understand these interests, and further research might investigate ways for teachers to go about this.

In the research, documentation was important in fulfilling several functions: supporting teacher's preparation, introducing children to the topic or proposal as a starting point, as an invitation for participation and as a tool to support the visibility of ideas. This in itself suggests that the use of documentation might be worth further exploration. Moreover, my research agrees with others in finding that resources and documentation are problematic and work in complex ways. Reflection on my practice and the children's perspective showed that power is being enacted in the use of documentation in the teaching and learning process, and that ethical consideration is needed. The possibility of teacher practice that can both utilise and yet overturn and replace the particular meanings contained in teacher documentation and teacher-selected resources is one possible avenue for further research, as is exploration of ways that documentation and resources could be sources for the negotiated development of meaning.

7.4 Drawing it all together: My offering to early childhood theory and practice

I would like to draw my conclusions using complexity theory as a framework, itself a theory that allows me to synthesise ideas from other theories including constructivism and sociocultural theory. While recognising the complexity of the co-determining features of an early childhood environment, this research puts forward one metaphor for teacher support for children's working theories. Integrating the many analyses into a key concept is likely to have more usefulness than merely recognising that many influences are apparent. This research integrates ideas in order to produce a conceptual tool that may be useful to others, and yet does not deny the complexity of situations in which the tool might be deployed, and that all knowledge and theory are living, context-specific and personal, as well as provisional, understandings. Educational research into specific practices that enhance learning still has an important role (Mason, 2008b) in negotiating complexity. Therefore, introducing a new concept and idea into teachers' practice is likely only to enrich practice with a greater capacity for connections and complexity.

'Stretching out' and 'focusing in' are, respectively, perhaps useful ways to increase, and to find ways to manage, complexity. Working theories draw on complexity for multiple and provisional understandings, and yet, too much complexity might actually inhibit creativity of thought. Complexity theory identifies both constraints and divergent thinking to be useful for the continuous evolution of knowledge. These new conceptions may serve as tools to support teachers in early childhood, who might, like me, be searching for guidelines about how to enact teacher behaviours that are in line with the sociocultural emphasis on mediation in the current curriculum document.

As complexity theory offers only a description of the processes involved, complexity understandings of working theories need to be supplemented with teacher's values, themselves a layer of additional elements that interact with other elements in the teaching and learning situation. Further, the complexity of, and interconnections within, our language system (Radford, 2008) means that the terminology I offer ('focusing in' and 'stretching out') is capable of generating many different interpretations and will be always open to re-interpretation. These concepts cannot and should not be strictly defined, as meaning should be open in order for expansion to occur.

It is likely that, whenever a new element is introduced into a complex situation, it will interact with other elements and new, unpredictable connections will be made. Further, no piece of knowledge or understanding stands still for long, but is soon likely to head off in new, maybe multiple, directions. In terms of working theories, we might aim for the theories to connect, combine, and, in doing so, become more complex. This is true not only of children's working theories, but also those of teachers and researchers.

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If you think it would be ok to be in a video with me, please put a mark in the **Yes** box.

If you don't want to be in a video, that is ok. Just put your mark in the **No** box.

If you are not sure, that's ok, put your mark in **Not sure** - perhaps you will make up your mind later.

Yes	**No**	**Not sure**
☐	☐	☐

Your name:

If later you want to change your mind, its ok, you can tell me, or ask your parents to tell me.

Ask your mummy or daddy to put their name in this box if they think that you understood what this letter is about.

Thank you for reading this letter. Please give it back to me so I can read what you think.

Love from Vicki.

AUT UNIVERSITY

TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

PLEASE READ AND COMPLETE WITH YOUR CHILD

A letter from Vicki

I want to do a special project about the work we do on making up our own theories at our centre. I want to record some videos of me playing and working out theories with you and the other children. Then afterwards I can watch the videos and write down what happens.
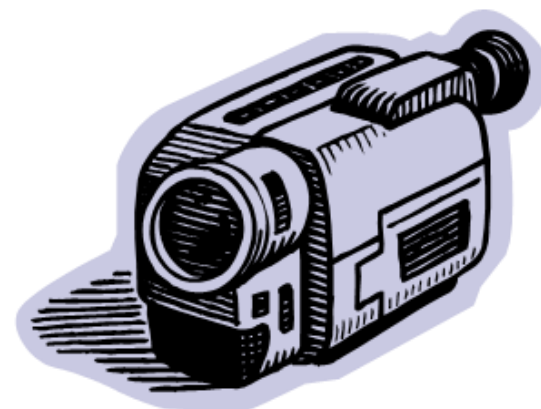
I will show the videos to your Mummy or Daddy. Perhaps you will want to see them too. But because the videos belong to us at our centre, I won't show them to anyone who doesn't belong to our centre.

When I watch the videos, I am interested to see whether I am helping you to think. I do not mind what you do while we are being videoed. The videos might be recorded at any time when we are playing or working and you probably won't know we are being recorded, but don't worry because we don't need to do anything special in the video.

What do you think? How do you feel about being recorded in a video with me?

Mark the face that shows how you feel about the videos.

?????

If you have any questions about the videos and how they are made, please come and ask me.

Ok / happy   Not happy   Not sure

Protocol for the use of the video camera in the research

In order to protect children and their parents from discomfort, embarrassment, and from negative evaluation, this protocol outlines when the video camera should be **immediately turned off.**
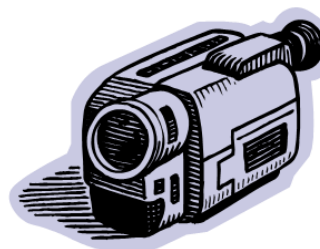
Potential embarrassing / negative situations – **DO NOT VIDEO**:

- **Nappy changing / toileting / showering / changing clothes**
- **Using inappropriate or anti-social behaviour**
- **Tantrums**

Please DO NOT VIDEO:

- Children with special educational needs in situations where this might become apparent
- Children and their parents who have not consented to be videoed. These are:

Name ☐ Name ☐ Name ☐

Any accidental recording of the above must be reported to Vicki, so that she can delete those frames before sharing the video with parents and children. Thanks.

Parent Information Sheet

Date Information Sheet Produced: 29th August 2010

Project Title

Improving support for children's working theories in early childhood:

An action research self-study

Hi there!

I (Vicki) would like to inform you about a research project that I am undertaking at AUT ECC to investigate (my) teaching practice and how it best enables children to develop their own working theories as described in *Te Whāriki* (Ministry of Education, 1996).

I would like to invite you to complete a consent form so that I can collect data about myself teaching your child(ren). As I work with your children everyday, for the children there will be nothing noticeably different when the research is taking place. Your consent is of course voluntary, and you are free to decline without concern. If during the research you wish to withdraw your child, you may do so at any time.

What is the purpose of this research?

I intend to submit the research report as a thesis in partial completion of the requirements of a Masters in Education degree. I also hope to offer the findings of the research to the wider early childhood community in a conference presentation and written article.

How was I identified and why am I being invited to participate in this research?

You have been asked to provide permission for your child to participate because your child attends the centre! I am seeking consent for every child to be included in the research, because at this initial stage, it is difficult to determine which children I will be working with during the research.

What will happen in this research?

The research project will involve making three half-hour videos[1] of myself working with a group of children. The video will be viewed by myself only, in an attempt to describe and analyse what is occurring, and in particular, how my teaching practice affects children's processes of creating working theories. Video provides a unique opportunity for me to be able to view and repeatedly re-view my teaching practice from an outside perspective. I will also include in the research my professional reflection on my teaching which may of course be informed by, and include, episodes of teaching your child(ren).

What are the discomforts and risks? How will these discomforts and risks be alleviated?

You may feel uncomfortable knowing that videos of your child(ren) are to be kept by myself during the duration of the research. I will be conscious of storing the video files securely, on our AUT server (password protected) and my home laptop (password protected). To further secure video files, I will use Winzip to create a compression file which will be password protected. Once the research is complete, this data will be kept for six years, in accordance with the requirements of AUT's Ethics Committee.

You will have an opportunity to view the videos that contain your child. I have designed a protocol for the use of the video camera so that potentially uncomfortable or embarrassing situations will not be caught on video (nappy-changing, toileting, showering, changing clothes, inappropriate behaviour and tantrums). Other parents will of course be invited to view the video if their children are also included. Every parent has the right to edit scenes of their child. The children will also be invited to view the video and asked if they are happy with it, and supported to edit changes if they are not.

Only I will analyse the videos, and no children will be able to be identified in the final report or any presentation of findings. You may wish to provide anonymous feedback leaving your written comment in a marked box for me.

What are the benefits?

I believe teaching practice which supports your child(ren) to develop their own working theories will be interesting and challenging for the children. In addition, the children are likely to feel empowered and develop high self-esteem and a belief in themselves as creative theory-builders. I hope that this research project will support my own professional development which will benefit the children in my care. I also hope that dissemination of the findings will be useful to the wider early childhood community.

How will my children's privacy be protected?

The children will not be identified within the written report of the research. The videos will only be viewed by the children and yourself as parents within the centre shortly after recording to ensure your comfort with the use of these videos and only the written thesis will be read by other people.

What are the costs of participating in this research?

There is no financial cost to yourself as a result of participating in the research. The video recordings will take place during the centre's normal opening hours and during regular child or teacher-led activities.

What opportunity do I have to consider this invitation?

Please provide your consent within two weeks of the date of this letter.

How do I agree to participate in this research?

Please fill in the consent form and return to the office's mailbox in the centre.

Will I receive feedback on the results of this research?

Once the research is complete, I will invite all teachers, managers and families in the centre to a special evening presentation which summarises the research project. You will of course be invited!

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Anne Grey, tel. 921999, ext. 7231, anne.grey@aut.ac.nz.*

Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, *madeline.banda@aut.ac.nz* , 921 9999 ext 8044.

Whom do I contact for further information about this research?

Please if you have any further questions, don't hesitate to contact / chat to me, or Anne Grey (my research supervisor)

Researcher contact details:

Vicki Hargraves

AUT Early Childhood Centre

vicki.hargraves@aut.ac.nz

Project Supervisor contact details:

Anne Grey,

AUT School of Education

Tel. 921999, ext. 7231

anne.grey@aut.ac.nz.

[1]In the event, the third observation was stopped 12 minutes into videoing, and a fourth video-recording was carried out the following week in order to obtain sufficient video data. Overall one hour and 26 minutes of video was collected.

Parent /Guardian Consent Form

Project title: Improving support for children's working theories in early childhood: An action research self-study

Project Supervisor: **Anne Grey**

Researcher: **Vicki Hargraves**

○ I have read and understood the information provided about this research project in the Information Sheet dated 29th August 2010.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that video recordings will be taken of Vicki Hargraves that may also include my child/ children and that they will also be transcribed.

○ I understand I will be invited (alongside other parents whose children are included) to view the videos. Separate consent will be sought if I wish to comment on / interpret the video in any way.

○ I understand that I may withdraw my child/children and any information that we have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○ If I withdraw my child/children, I understand that all relevant information including video recordings and transcripts, or parts thereof, will be destroyed.

○ I permit the researcher to use the videos or photographs that are part of this project, either complete or in part, solely and exclusively for analysis of the teacher's role; and that findings will be reported in the researcher's thesis.

○ I understand that the video recordings will be used for academic purposes only and will not be published in any form outside of this project without my written permission.

○ I agree to my child/children taking part in this research.

○ I wish to receive a copy of the report from the research (please tick one): Yes○   No○

Child/children's name/s :

……………………………………………………………………………

Parent/Guardian's signature: ....……………………………………

Parent/Guardian's name: ....……………………………………

Date:

Approved by the Auckland University of Technology Ethics Committee on 13th December 2010 AUTEC Reference number 10/181.

Note: The Participant should retain a copy of this form.

Dear [parent name]

Your child was recorded in the latest video of my research project. I would like to now give you the opportunity to view the video.

Obviously I am being very careful with this data that contains your child, and so for that reason, all viewing of the videos will take place at the centre. If you choose to see the video, I can provide you with the centre's laptop, the video file and some headphones, as well as a place to sit and watch it.

I can assure you that the video was very sensitively recorded and presents every child in a positive light. However, as you view the video, you are welcome to edit – you can either delete frames yourself, or write down the time of the segment you want deleted, and I will do it on your behalf. Also you might like to leave anonymous written feedback, I will provide a box to collect parents' feedback.

The video is 28 minutes long. Please let me know if you would like to view it.

Thanks again for supporting this research

Vicki

Appendix 6: Example of reflective fieldnotes

Fieldnotes: Video 1   Produced 29th March 4.10pm

Before the observation began, I felt nervous and wondered whether the children would want to come and talk about earthquakes as per my proposal to them. It was planned last night, and yet today I felt was not the right time. The children had lots of exciting things to do outside, and so when I asked B and L ("Oh you're finished", "No we're not we're going back (to the mud)", "oh but would you like to come and do some talking and thinking about earthquakes?") they said no. I asked D (and I know I did not sound confident as I asked: "hey D would you like to come and do some talking and thinking about earthquakes with me? Would you like to build little houses and then make an earthquake come?") Again he said no but I persevered "come on it'll be fun!" and again to B "guess what B? D is going to build little houses and then make an earthquake come!" In the planning I had done in my head I had thought that "would you like to build little houses…?" would be said once we got to the table, and the fact that I had planned this meant I was not being intuitive and not 'tuned' into the children and whether what I said was actually appealing – and I don't think I would normally be like that when I offer a children an activity, because normally I think the time is right and the activity is right, and I offer it in a way that will appeal and does appeal to the children's thinking, mood etc. I was not feeling that today. So I stuck to the plan and actually did not express my own excitement, and did not think about what the children would be appealed by as I spoke. The plan had me not using my intuition!

When we gathered at the table I reminded the children of what we had said about earthquakes in a previous conversation and showed them the piece of paper on which it was written and a picture of D making an earthquake which was his hands crashed down from above. I asked if the children remembered their other theories but I didn't give them enough time to respond. Other children were gathering, attracted by the 'something' that I was showing to the group (the paper) they were curious and didn't want to miss out. So again I invited them to build houses and then make earthquakes. They immediately started to build and then swipe down their buildings. I tried to 'notice' how they did it and used language like "pushed it from the side".

However, I was severely hampered by some organizational issues. There weren't enough blocks, because too many children now had interest, and quickly my time was taken up by pushing for space and arguing over blocks – the small blocks in particular. B and L, children with whom I was intending this to be a follow-on conversation, left! Obviously there are clear lessons about choosing the space carefully (I was limited due to the time of day and the block room being shut) and ensuring that things like resources don't become an issue. Perhaps my forward thinking was lacking here! However, I know with blocks we often don't have enough, or with pens there is an argument over the pink, so this is something to think about. How much do children need skills to manage co-operatively before they engage in these kinds of learning situations? Surely it is concurrent learning?

I realized at the beginning of this activity that actually there were many working theories being enacted about how to get blocks from your friends (steal them, snatch them, cry, shout, ask nicely, refuse) and there might actually be more theories around this then around earthquakes.

Children's responses *code in colour: naming, describing, repeating or recalling; interpreting and representing; concept building, expanding ideas and possibilities, planning, predicting, theorising*

Appendix 7: Example of transcription, first level coding and memos

Seg	Benson	Damien	Sefa	Sarah	Tilly	Izzy	Eloise	Sabrina	Teacher	Interpretation
002	[holding one block level on the hollow block at the right side, and with left hand inserting another block underneath it]	[watching Eloise]			[With paper] that says 'here comes an earthquake?		[holding top] When I do this, look what happens [pulls top over her head]			*Wants to understand the literacy practice in the document*
	[lets go of block and allows it to rest on inserted block]	[watching Eloise]			Why does Damien do					*Responds with a question*
	[adjusts another block which is shorter, tongue out]	[leaning over to look at paper]	[looking at paper]	[looking at paper]	earthquakes? [looking at paper]	[successfully pulling top on]	[walks into frame, stands next to me, looks in]	[walks into frame, stands next to me, looks in]	[Takes paper and] this is what he did he made a building, and then he lifted up his arms [lift my own arms] and he says here comes an earthquake [bring arms down slowly, pause 2 secs] mmm maybe I could read some of the other words here there's some"	D: response to Tilly's question just describes rather than engages with 'why' – here would have been a good opportunity to explain the concept of playing with ideas to understand them D: repeats and rephrases children's ideas D: proposes another action to explore further, models thinking process out loud as if answering the question – where do we go from here? **Describing; Modelling thinking**
					Yeah!	[sucking her thumb]		[enters] Vicki look I am a butterfly [holds arms up to show dress-up butterfly wings]		*Proposal to read more is eagerly accepted- although this may be the interest in literacy noted above Sucking – does this create a thoughtful pause?*
		[sucking a block]							[smiles at Sabrina, turns back to look at paper] we had lots of ideas about earthquakes	D: draws attention to number of ideas **Encouraging many possibilities; Outlining; Valuing groupwork**
				[points at photo] Thats you Damien						*Recognition that another child is part of this (not just the teacher?) Labelling / naming? Why is this important? Belonging?*

Appendix 8: Table of coding categories

Teacher role	
Assuring	Providing reassurance ie. that heard or understand
Being interested	Displaying interest through verbal comment, non-verbal behaviour, or questioning
Clarifying	Questions asked for clarification not for repetition
Dealing with interruptions	Response following an interruption (defined as irrelevant to previous comment)
Describing	Giving an account of an event in words, that hasn't been already formulated in words, in present or past tense
Documentation	Talking about or looking at documentation/video
Enacting power	Ignoring child's agenda / intention to further teacher's own agenda
Extending sideways	Inviting children to change tack, use a different perspective or consider another point of view?
Encouraging many possibilities / different perspectives	Language that shows I expect there to be many answers/solutions
Engaging interest and emotion	Defined by consequent show of emotion (verbal / non-verbal)
Evaluating	Response that evaluates previous comment or action or product
Extending	Going forwards into an answer; considering consequences ie. what happens next?
Focusing	Pointing out a particular action or representation, or a particular quality or characteristic of that action or representation ie. "look"
Holding a theme	Repeating 'key terms' within this observation
Inviting	Making an invitation to participate
Modelling thinking	Using metacognitive language (ie. wonder, think, remember) or rhetorical questions
Organising	Providing resources or pointing children to resources
Outlining	Giving expectations or directions
Pausing	Space consisting of silence
Questioning for recall	Questions designed to elicit children's recall
Questioning to probe	Questions to uncover children's theories or reasoning, such as 'why' questions – going deeper into one answer – going backwards into an answer; also requesting evaluation
Repeating	Saying something that has already been expressed in the same or very similar way; but not including repetition to be heard
Valuing group approaches	Using 'we' or other second person pronouns; co-ordinating individuals;
Valuing behaviour not thinking	Commenting on children's behaviour and providing guidance on, or organisation to manage, children's behaviour
Valuing thinking not behaviour	Commenting on children's thinking and activity while ignoring behaviour
Verbalising theories	Formulating or reformulating a child's theory

Children's thinking	
Describing	Putting into words a phenomenon that is occurring or has just occurred (within the last two turns)
Recalling	Repeating own or others actions or words, with more than one turn inbetween, for purpose of reminder
Repeating	Repeating words or actions of oneself or others, with the aim of trying out ideas for oneself
Representation – generating ideas	Applying a symbolic label to one's actions or construction
Representation – interpreting ideas	Taking a concept and developing a symbolic form to represent it
Working theory	Statements or actions based on statements that make connections between concepts or assertions to predict, explain or infer

Appendix 9: Integrating data using higher-order concepts

A context for sharing ideas:

An interested adult who respects all ideas	Group work children share stories and ideas
Motivation: documentation and resources	Activity – opportunity to represent

Interactions:

Maintaining a theme
- Selecting a theme
- Documentation
- Cognitive contexts for theorising
- Specific invitations and proposals
- Making connections to maintain a theme
- Teacher's mental preparation
- Recognising interesting interruptions

Making Visible
- Describing
- Repeating
- Verbalising / Reformulating
- Clarifying
- Focusing
- Questioning for recall
- Documentation

Extending Depth and Breadth
- Forwards - Extending
- Backwards - Probing
- Sideways – different perspectives and possibilities

V1	Benson	Damien	Sefa	Sarah	Tilly	Izzy	Eloise	Sabrina	Teacher	
003	[looking at paper]	[looking at teacher with camera]	[offscreen]	[offscreen]	[offscreen]	[offscreen]	[offscreen]	[comes round to a space where she can see the paper better]	[quietly] I've got some of them written here [pause 2 secs, then louder voice] Liam said the buildings fall down because they are old [3 secs] mmm	RECALLING CONCEPTUAL KNOWLEDGE
	No they're not	[looks at paper]						[looks at Benson, then away]		*CRITIQUING CONCEPTUAL KNOWLEDGE*
							[has found the camera case, is fiddling with opening the zip]	[looks at paper]	Timothy said Timothy said there's a monster inside the building that shakes it all up [looks at Sabrina and Benson]	RECALLING CONCEPTUAL KNOWLEDGE
	[laughs]								[pause 3 secs]	*Could be CRITIQUING CONCEPTUAL KNOWLEDGE but we don't know what Benson is thinking*
		[looks at Benson and smiles]	[looks at Benson and smiles]					[looking at table, expression hard to read]		
									And Wesley said the earth shakes itself [1 sec]	RECALLING CONCEPTUAL KNOWLEDGE
								[shakes her body]	lots of different ideas there	*INTERPRETS CONCEPTUAL KNOWLEDGE*
	yes								Is this your building?[to Benson] Can we make an earthquake happen?	*CRITIQUING CONCEPTUAL KNOWLEDGE or RECALLING FACTUAL KNOWLEDGE????* EXEMPLIFYING CONCEPTUAL KNOWLEDGE
	[places hands on top and pushes blocks back and forth, gently, hands are holding blocks together so no breakage]	[watching Benson, resting head on hand]	[watching Benson]			[watching Benson]				PRODUCING CONCEPTUAL KNOWLEDGE (MAKE AN EARTHQUAKE)
									[whisper to children on my left – Sarah and Tilly] hes shaking it	SUMMARISING (ABSTRACTING) FACTUAL KNOWLEDGE

Appendix 10: Example of coding with Bloom's revised taxonomy codes (Anderson, et al., 2001)

Context	Focus / theme and development	Visibility	Extension
Groupwork (7) Teacher control may aid participation (ie. reducing number of participants) (8)The thinking of individuals is supported/developed through working with others. Conflict is especially useful for theorising? (9)Children with an individual interest or need tend not to be noticed / supported by the teacher (problems with managing diverse interests is evidence against the idea of groupwork)	(16)Specific invitations generated more thinking and theorising than non-specific invitations. (17) Vague outlining of task led to less theorising and thinking	(27)Focusing on specific qualities or consequences supported theorising	(43) Probing questions ask children to go back and are more difficult for children as consist of unpacking the theory
	(18)Selecting a theme for the children is more successful than asking them to choose their own.	(28)Focusing slowed the teacher down and focused her on what children were saying	(44) Extension questions that ask children to carry on a line of thinking serve to generate new theories
	(19)Refocusing children to maintain a theme, achieved through invitations, focusing, and repetition of key concepts and words, helped maintain a thread through the activity which supported theorising.	(32) Describing and (35) repeating kept the group together as a group	(45) Questions that invite consideration of new perspectives are usually successful
(10)Documentation aided recall (11) Documentation motivated participation	(20)Holding the theme too rigidly makes teachers unresponsive to children's ideas	*(29)* Children expanding their ideas was caused by teacher description, repeating (34), clarifying (36), focusing	(46) Questions that suggest or insist on many possibilities are usually successful
Activity (13)Resources motivated participation (14) Drawing can be deliberate representation, or accidental; the former supports theorising while the latter doesn't (15) In drawing and also construction, children expand theories because they ask 'what else does it need?' *also in construction?*	(21)There is an optimal balance between hearing interruptions and focusing on the theme; interesting interruptions need to be recognised (22)Children's digressions, when thoughtfully pursued, are relevant and supportive of thinking and theorising	(30) Describing, (49) repeating, (52) verbalising, (55) clarifying theories led to children noticing / taking up ideas of others	(38) Pausing leads to thinking and theorising (39) There is an optimum length of pause (2/3 secs) (40) Pauses are not interrupted, accepted as thinking time (41) Pausing enables the teacher to be more responsive
	(23) Rigid plans lead to teacher control and teacher enactment of power (negative case is Video 3 – without any plan for activity seem to be more rigid on behaviour) and rigid plans limit theorising (51)	(31) Describing and repeating offered resources for theorising	
(24)Poor organisation led to more enactment of teacher power (positive and negative effects on theorising) (48) Poor organisation leads to more interruptions (50)Poor organisation hampers thinking	(12)Prepared teachers can respond thoughtfully to children	(33) Verbalising theories served as clarification and sometimes led to modification	
(47) Focusing on behaviour was a barrier to thinking work	(25)A useful strategy for 'letting yourself be interrupted' might be repeating, pausing and thinking during the pause (negative cases where children go off topic or lose interest)	(26) Evaluations closed down conversation	
(42) Modelling thinking had no obvious impact		(53) Children responded best when they felt the teacher was in tune with their thinking	

Appendix 12: Reorganising data: theory and theorising prompts

Prompt	Code	Theory fragment	Segment
TEACHER: Are we ready for another earthquake?	Holding a theme	"No because my teddy bear's hopping in here"	Damien, V1, 011
TEACHER: Ok, how might we make the earthquake this time?	Encouraging many possibilities; holding a theme GENERATING CONCEPTUAL / PROCEDURAL KNOWLEDGE	"you'll have to break it"	Sefa, V1, 011
TEACHER: What about if a monster was inside the house shaking it?	Extending; PRODUCING CONCEPTUAL KNOWLEDGE	"No it lifted up the house and shaked it"	Sabrina, V1, 012
TEACHER: Oh the monster did a jump	Repeating	"did a jump on the house and pulled off the chimney"	Sabrina, V1, 013
TEACHER & CHILD: And what happened [points to buildings] to the buildings when the monster jumps? [Izzy flies block up, bangs it down on table, flies it down to fall on floor] Oo that was a big bang wasn't it? That made the building fall down when there was a big bang	Extending; EXPLAINING CONCEPTUAL KNOWLEDGE Describing; focusing	"an earthshake go bang" ..."All the chickens ran out ah ah ah" [Izzy runs the cockerel toy across the table]	Izzy, V1, 014
CHILD: ?The large bangs made by Izzy?		"my bears going to drive away because he hears an earthquake coming"	Damien, V1, 014
TEACHER: "Do you want to build yours again Sarah?"	Outlining	"Well I don't want to do it. Because I don't know how to do it again"	Eloise, V1, 015
CHILD: "A real earthshake" / "earthquake" / "earthquake" response to "what did that feel like?", repeated "did it feel like a real earthquake did it?"	Questioning as probing; repeating SUMMARISING CONCEPTUAL / PROCEDURAL KNOWLEDGE	"No because earthquakes, no earthquakes are when are when earthquakes are when pipes move wobbly like this"	Damien, V1, 024
CHILD: "No I watched it the earthquake on the news and you won't"		"In Christchurch there is [pause, stands up straight] pipes that wobble and shake [shakes hands] like this and then [stops and stands up straight] buildings crash"	Damien, V1, 031
TEACHER And what happened to the blocks?	Focusing; RECOGNISING FACTUAL KNOWLEDGE	"And mine [building] was all sad"	Izzy, V1, 027
CHILD "No! I don't want mine to break!" & "and mine was all sad"		[pushes a small card from inside the camera case over to Izzy's building] "This says no shaking"	Eloise, V1, 027
CHILD "Guys if you want to do an earthquake guys [pause] don't talk if you want to do an earthquake you have to do it somewhere else Damien wants to don't do an earthquake"		"Do a ground"	Sefa, V1, 029
TEACHER "You really don't like earthquakes do you?"	Describing	"I don't. You'll die"	Tilly, V1, 031
CHILD "I don't You'll die" ("Do you think?")		"No I watched it the earthquake on the news and you won't"	Sabrina, V1, 031

Appendix 13: Quantitative analysis of children's thinking using Bloom's revised taxonomy (Anderson, et al., 2001)

Video 1 (25 min)	FACTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	METACOGNITIVE KNOWLEDGE
1 REMEMBER 1.1 Recognising	XXX	XX		
1.2 Recalling	(X)XXXX	(X)(X)(X)(X)	(X)X	
2 UNDERSTAND 2.1 Interpreting	XXXXXX	XXXXX		
2.2 Exemplifying	(X)	(X)	(X)	
2.3 Classifying	X		X	
2.4 Summarising	X	X	XXX	
2.5 Inferring		XXXXXXX		
2.6 Comparing	XX	XX		
2.7 Explaining	XXXXX	XXXXXXX(X)		
3. APPLY 3.1 Executing		(X)(X)(X)	(X)(X)(X) XXXXX	
3.2 Implementing			XXX	
4. ANALYSE 4.1 Differentiating	X	X		
4.2 Organising	X			
4.3 Attributing				
5. EVALUATE 5.1 Checking				
5.2 Critiquing		XXXX (X)	XX	
6. CREATE 6.1 Generating	X	(X)(X) XXXXXXXXXX	(X)X	
6.2 Planning	X		XXXX	
6.3 Producing	XXXXX	XXXXXX	X	

Video 2 (22 min)	FACTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	METACOGNITIVE KNOWLEDGE
1 REMEMBER 1.1 Recognising	XXXXXXXXXXXX XXXXX	(X)	(X)	X
1.2 Recalling	XXXXXXXXXX			
2 UNDERSTAND 2.1 Interpreting	XXXXXXX	XX	X	
2.2 Exemplifying				
2.3 Classifying	XX			
2.4 Summarising				
2.5 Inferring		X		
2.6 Comparing	X			
2.7 Explaining		X	X	
3. APPLY 3.1 Executing			XXXXXX	X
3.2 Implementing			X	
4. ANALYSE 4.1 Differentiating	XXXXXXXXXX	X		
4.2 Organising				
4.3 Attributing				
5. EVALUATE 5.1 Checking				
5.2 Critiquing				
6. CREATE 6.1 Generating	X	XX	X	
6.2 Planning			X	
6.3 Producing	XXXX	XXXX		

X represents one instance counted; (X) represents an instance also counted as another type

Video 3 (12 min)	FACTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	METACOGNITIVE KNOWLEDGE
1 REMEMBER 1.1 Recognising	XXXXXX(X)			XX
1.2 Recalling	XXX(X)			
2 UNDERSTAND 2.1 Interpreting	XXXX	XX		
2.2 Exemplifying	XX			
2.3 Classifying	XXXXX			
2.4 Summarising				
2.5 Inferring				
2.6 Comparing				
2.7 Explaining				
3. APPLY 3.1 Executing		(X)	XX(X)	
3.2 Implementing				
4. ANALYSE 4.1 Differentiating	X			
4.2 Organising				
4.3 Attributing				
5. EVALUATE 5.1 Checking	X			
5.2 Critiquing	X			
6. CREATE 6.1 Generating				
6.2 Planning			XXXXXX	
6.3 Producing	X			

Video 4 (27 min)	FACTUAL KNOWLEDGE	CONCEPTUAL KNOWLEDGE	PROCEDURAL KNOWLEDGE	METACOGNITIVE KNOWLEDGE
1 REMEMBER 1.1 Recognising	XXXXXXXXX			
1.2 Recalling	XXXXXXXXX		XXXXX	
2 UNDERSTAND 2.1 Interpreting	XXXXX	XXXXX	XX	
2.2 Exemplifying	X	X		
2.3 Classifying		XXXXXXX		
2.4 Summarising	X			
2.5 Inferring	X	XXXXXXXXXXX	XX	
2.6 Comparing				
2.7 Explaining		XXXXXXXX(X)	XXXXXXX	
3. APPLY 3.1 Executing	X		(X)(X)XXX	
3.2 Implementing				
4. ANALYSE 4.1 Differentiating				
4.2 Organising		X		
4.3 Attributing				
5. EVALUATE 5.1 Checking		XXXXXXXXX	X	
5.2 Critiquing		XXXXXX	XX	
6. CREATE 6.1 Generating	X	XXX	XXXXXXXXXX(X)	
6.2 Planning		X	XXXXXXXXXXXX XXXXXXXXXXX	
6.3 Producing	X	(X)(X)XXXXX	X(X)X	

X represents one instance counted; (X) represents an instance also counted as another type

Appendix 14: Quantitative analysis by teacher role

Videos 1-4 combined	Describing	Repeating	Recalling	Representation – generating and interpreting ideas	Theorising level
Assuring					
Being interested					
Clarifying	xxxxxxxxxxxxx	xx		x	xxxxxxxxxxxx
Dealing with interruptions	xx				
Describing	xxxxxxxxxxxx	xxxxx	xxxxxxx	xxx	xxxxxx
Enacting power	xxx				
Encouraging many possibilities					
Extending sideways	xxxx	x	x	xxxx	xx
Engaging interest					
Extending	xxxxxx		x	xxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxxx
Focusing	xxxxxxxxxxx	xx		xxx	xx
Holding a theme	xx	xx			xx
Inviting	xx		x	xxxx	x
Making connections	xx				x
Modelling thinking					
Organising	xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxx	x	x	xxxxxxxxxxx xxxx	xxxxxxxxxxxxx xx
Outlining	xxxxxxxxxx	xxxxxxx	xxx	xxxxxx	xxxxxxxxx
Pausing	xxxxx				x
Questioning for recall			xxxxxx xx		
Probing	xxxxxx	x	x	x	xxxx
Repeating	xxxxxxxxxxxxx	xxxxx	xxx	xxxx	xxxxxxxxxxxx
Sharing documentation	xxxxxxxxxxxx	x	xx	xxx	x
Valuing group approaches					
Valuing thinking not behaviour					
Valuing behaviour	x				x
Verbalising theories		xxxxxx		xx	xx
Not from teacher action	xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxxxxxxxx	xxxxx	xxxxxxx x	xxxxxxxxxxx xxxxxxxxxxx xxxxxxxxxxx xxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxxx xxxxxxx

Focusing brought some words and ideas into prominence, supported visibility, then taken up as a resource for theorising

Preceding comments	Working theory	Subsequent comments
And what happened [points to buildings] to the buildings when the monster jumps?**Extending**	An earthshake go bang All the chickens ran out ah ah ah [runs cockerel across table, across Sabrina's building] (Izzy, V1, 014)	
[Izzy flies block up, bangs it down on table, flies it down to fall on floor]		Determining consequences of representations involves drawing on theories
Oo that was a big bang wasn't it? **Focusing**		
That made the building fall down when there was a big bang **Describing**		
What do you think it feels like to be a poor little chicken **Encouraging many perspectives**	Sad (Sabrina, V1, 014)	(when Izzy's building breaks) And mine was all sad (Izzy, V1, 027)
		Extending also serves to focus on particular ideas so they become prominent in theories
The lack of blocks	...ever has making a chicken home they have to give me one (Eloise, V1, 014)	
What do you think it feels like to be a poor little chicken **Encouraging many perspectives**		Theories are used to serve particular purposes, can be strategic use in connecting knowledge
The large bangs made by Izzy? [Izzy flies block up, bangs it down on table, flies it down to fall on floor]	Now my bear is going to drive away now my bears going to drive away because he hears an earthquake coming brrrrmmm [drives bear through air over to art shelves] (Damien, V1, 014)	No the water is coming (Sefa, V1, 014)
Oo that was a big bang wasn't it? **Focusing**		But look now hes coming without his car psssst [flies bear through air back to table]
That made the building fall down when there was a big bang **Describing**		[hits bear hard on table]
[tapping bear and pencil alternately on building]		
	No the water is coming (Sefa, V1, 014)	and theres some earthquake and there some shark (032)
		No no and we got the water shh shh (032)
		The water goes And some parts got wet
		And they came and they no they no and some thing [pause] rain

Extending in a different direction offered more resources for theorising – broadens the concept

Extending also serves to focus on particular ideas so they become prominent in theories

Focusing brought some words and ideas into prominence, supported visibility, then taken up as a resource for theorising

Ideas naturally expand, get connected to other ideas

Hearing one theory sparks others (through comparison?) Speaking is a kind of representation that other children compare with their theories

	Liam	Tilly	Izzy	Sarah	Eloise	Claire	Darren	Teacher	Interpretation	Critical analysis
010	[goes under table to get Jenga blocks]	[shuffles chair]		[walks behind Eloise, reaches for a chair and pulls it over to the table]	[looks around, then under table and under Tilly's chair]			You two are going to work together there's enough blocks for you to have *some* blocks	D = clarifying sharing of resources **Outlining**	Sarah shows that she intends to spend a focused amount of time working and needs a chair. Both Eloise and Liam are looking for the resources that Tilly moved, indicating they are planning their representations.
				[walking fast round table, diverting around Sarah]	[pushes chair under table]			But there's more on the carpentry	O = anticipating and suggesting solutions to problems (why weren't there any this time? Was it this discussion or just the general calm, non-competitive feeling in the group?)	Or because children had something quite specific and challenging to think about? Or because using glue slows children down and means they use fewer resources overall? Or fewer children? Or fewer choices?
			[reaches into the box and takes wood] I'm gonna glue it		[reaches for wood, takes one piece]			Table eh?	*Izzy describes her plan* generated by the provision of resources - **Organising** *and is proactive in beginning work*	*Is it the creation of a problem that motivates the planning? Or the resources? But problem-solving means using resources available to solve a problem*
		[reaches for wood, inspects short flat piece]	[takes second piece]		[rests hand on edge of box]			[pause 1 sec] You're gonna try gluing	D = repeats Izzy's plan, might generate further elaboration or other plans **Repeating**	Does this repetition inspire other children's plans? Is Tilly planning – what is her criteria for selection?
	[has built an enclosure]	[reaches for two thinner pieces, places flat piece on table, thin pieces either side]		[leans over table watching the girls at the box]	[reaches over Izzy for another piece]			[pause 4 secs]		*Liam is using a familiar building approach. Perhaps the materials suggest it? However, wood and glue is also a familiar strategy, so its not to do with familiarity. why is Liam drawn to this material more when it doesn't solve the problem? Is he not interested in the problem, or hasn't understood key features?*
					Guys remember we need some too [holds 2 pieces up in front of her]				*Eloise extends the theme of some blocks because others need some too?? Response to* **Outlining**	*Or has she not heard me? Or does she remember the issues of a previous activity in this location with these resources and this teacher?*
	[reaches under the table for a handful of blocks]	[discards shorter thin piece back in box]			[stands one piece on table, wobbles it, lays it flat]			[pause 1 sec] Yep	*Tilly's actions suggest that the pieces of wood need to fit together perfectly for her plan, this is an implicit theory? Theorising / planning generated by provision of resources* **Organising**	*Or that they need to have a particular aesthetic? Or is she using the wood pieces as blocks, where the pieces do usually fit together properly?*

Appendix 17: Table of children's working theories

Location	Data fragment	Theoretical assertion (with possible premises)	Function	Bloom's taxonomy analysis
Benson, V1, 003	["Can we make an earthquake happen?"] places hands on top and pushes blocks back and forth	Earthquakes are when buildings shake back and forth	Representation	*PRODUCING CONCEPTUAL KNOWLEDGE*
Sabrina, V1, 007	flays hands about and knocks over her blocks	Earthquakes are when buildings fall down (I can make the building fall down by knocking it)	Representation	*PRODUCING CONCEPTUAL KNOWLEDGE*
Damien, V1, 011	["Are we ready for another earthquake?"] "No because my teddy bear's hopping in here"	We can't have an earthquake because my teddy bear is going inside the building (earthquake will break the building; there can't be earthquakes when there are people inside? Teddy would get hurt?)	Explanative	*EXPLAINING FACTUAL KNOWLEDGE*
Sefa, V1, 011	"you'll have to break it"	To make an earthquake you have to break it (Earthquakes make things get broken; if you want to make an earthquake you will have to break it)	Explanative	*CLASSIFYING PROCEDURAL KNOWLEDGE*
Sabrina, V1, 012	"No it lifted up the house and shaked it"	A monster can make an earthquake happen because he can lift up the house and shake it (earthquakes have shaking; monsters are big and can pick up houses; earthquakes occur because a monster lifts up the house and shake it)	Explanative	*GENERATING CONCEPTUAL KNOWLEDGE*
Sabrina, V1, 013	"did a jump on the house and pulled off the chimney"	A monster can jump on houses and pull off the chimneys (things get broken in earthquakes; jumping on things can break them; pulling things can break them)	Explanative	*GENERATING CONCEPTUAL KNOWLEDGE*
Eloise, V1, 012	"One more can I have one, if you have heaps you need to"	People with more blocks should give some to me (I don't have enough blocks; some people have more blocks; people with lots should give some to people with less)	Persuasive	*GENERATING CONCEPTUAL KNOWLEDGE*
Sefa, V1, 012&13	"Man like this hey [pause 1 sec] you're breaking my house. Like this, wait a minute monster, that not your house. Like this wait a minute thats only my house"	If a monster breaks someone's house, they will complain. (Earthquake monsters break houses; people don't like their houses getting broken; people should tell others when they don't like their behaviour; monsters can break their own houses but not other people's houses)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Sefa, V1, 013	"Breaking the house. Like this kick it. They're like kicking the [...] boom boom boom [kicks with legs]. Do it like this, do a jump. Did a backflip[?]"	Monsters broke the house by kicking, jumping and doing backflips. (Monsters broke the houses; you can break things by kicking them and jumping on them; backflips are a kind of jump)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 013	lifts block up high, makes eye contact with me, brings it down hard on table, and then holding the block, makes it fly up and fall off the edge of the table	Monsters jumping and kicking the house will make the blocks fly up in the air and fall down (kicking things makes htem fly up in the air; the monster is kicking so the building will fly up in the air)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 014	"an earthshake go bang" ..."All the chickens ran out ah ah ah" [Izzy runs the cockerel toy across the table]	Chickens run away from earthquakes (earthquakes make a loud noise; chickens are scared of loud noises, chickens run away from scary things)	Predictive	*SUMMARISING CONCEPTUAL KNOWLEDGE*
Sabrina, V1, 014	["What do you think it feels like to be a poor little chicken?"] "Sad"	The chicken will feel sad because his house broke (the chickens house broke; broken things make people feel sad; the chicken will feel sad)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Damien, V1, 014	"my bears going to drive away because he hears an earthquake coming"	We drive away from earthquakes (earthquakes are bad? we try to get away from bad things?)	Predictive	*EXPLAINING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 014	screams "someone made that noise the	When earthquakes happen / monsters break houses, the chicken feels scared and screams for help (People are	Predictive	*PRODUCING CONCEPTUAL*

	chicken needs help"	scared when their houses break; the chicken's house is breaking; the chicken is scared)		*KNOWLEDGE*
Eloise, V1, 015	"Well I don't want to do it. Because I don't know how to do it again"	I won't be able to build it again so I don't want to shake the table (Shaking the table will break my building; I won't be able to build it again; I don't want to break my building; I don't want the table to be shaken)	Predictive	*EXPLAINING PROCEDURAL KNOWLEDGE*
Sefa, V1, 023	"You just say liar"	I was tricking you, you say "you're a liar" (when someone is tricking you, you say "you're a liar")	Explanative	*EXPLAINING PROCEDURAL KNOWLEDGE*
Damien, V1, 024	"No because earthquakes, no earthquakes are when are when earthquakes are when pipes move wobbly like this"	Earthquakes occur because pipes wobble (saw something on the tv that made him connect earthquakes with pipes wobbling?)	Explanative	*DIFFERENTIATING CONCEPTUAL KNOWLEDGE*
Sabrina, V1, 024	["what do you think will happen to his when we shake [pause] make the"] "Break"	Shaking the table makes the things on it break (this has been the case in my past experience)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Damien, V1, 026	"No! I don't want mine to break"	Don't shake the table because I don't want mine to break (shaking the table makes the things on it break; I don't want mine to break so don't shake the table)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 026	"Mine will break too"	Mine will break if/when you shake the table (shaking the table makes the things break; my building is on the table; mine will break)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Damien, V1, 031	In Christchurch there is [pause, stands up straight] pipes that wobble and shake [shakes hands] like this and then [stops and stands up straight] buildings crash	Earthquakes did occur in Christchuch because there are pipes there that wobble and shake so buildings crash (pipes are under the ground; when pipes wobble they make the ground shake; when the ground shakes buildings crash)	Explanative	*RECALLING /EXPLAINING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 027	"And mine [building] was all sad"	Things are sad when they are broken (people are sad when they are broken; things are sad when they are broken; my building is broken so my building is sad)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Eloise, V1, 027	[pushes a small card from inside the camera case over to Izzy's building] "This says no shaking"	Literacy practices can be used to control other people / events (people don't want shaking because their buildings break; we need to stop the people doing the shaking; signs can tell people to stop)	Persuasive	*PRODUCING PROCEDURAL KNOWLEDGE*
Sefa, V1, 029	"Do a ground"	If you don't want your building to get shaken in this activity, you can build it on the ground (people don't want shaking because their buildings break; we are going to shake the table again; we don't shake the ground so build your building on the ground)	Predictive	*PLANNING PROCEDURAL KNOWLEDGE*
Sabrina, V1, 030	"No its not going to be a real earthquake" in response to "no earthquakes"	We can shake the table because it is not real and therefore ok (earthquakes are forbidden; shaking the table is not a real earthquake; shaking the table is not forbidden)	Explanative	*EXPLAINING PROCEDURAL KNOWLEDGE*
Tilly, V1, 031	"I don't [like earthquakes]. You'll die"	I don't like earthquakes because people die when earthquakes occur (people die in earthquakes; I don't like it when people die; I don't like earthquakes)	Explanative	*EXPLAINING CONCEPTUAL KNOWLEDGE*
Sabrina, V1, 031	"No I watched it. the earthquake on the news and you won't"	People don't die because I saw it on the news (I saw on the news that people don't die; the news is right; people don't die)	Explanative	*CRITIQUING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 031	Building under the table	If I build on the floor my building won't break when the table shakes (shaking the table breaks the things on the table; we are going to shake the table; I will build on the floor; the floor doesn't shake; my building won't break)	Predictive	*PRODUCING CONCEPTUAL KNOWLEDGE*
Sefa, V1, 032	"Yeah and we didn't hide and we died thats why we not die now we safe[looks down] Thats why we go thats why we go rolled the ball like that" [crouches down and moves one arm	If you don't hide, you'll die / If you roll in a ball, you're safe / (if you hide or roll in a ball you will be safe – learnt from leaflet?)	Explanative, predictive	*EXPLAINING CONCEPTUAL KNOWLEDGE*

	forward as if rolling ball]			
Sarah, V1, 032	"How about in your room? You can lie in your cupboard"	You can hide in your cupboard in your bedroom to stay safe (hiding makes you safe; earthquakes happen in houses; there are places to hide at home like in your cupboard in your room)	Predictive	*GENERATING PROCEDURAL KNOWLEDGE*
Sefa, V1, 032	"and then they broke the park. They go like this doosh doosh [punching air]. The monster did."	The monster broke the park by punching it (The park was broken; we break things by punching them; monsters break things; monsters broke the park by punching it)	Explanative	*GENERATING CONCEPTUAL KNOWLEDGE*
Izzy, V1, 034	"No cause it can't break eh So when it very when it moves very faster so very faster it won't break"	Buildings on the floor won't break – even when the table moves very fast (we make an earthquake by shaking the table; shaking the table makes my building break; we don't shake the floor so my building won't break it's on the floor)	Predictive	*EXPLAINING CONCEPTUAL KNOWLEDGE*

Sefa, V2, 001	["That's enough children [for this activity] isn't it?"] "Only me, only me [indicating himself with thumb] and Izzy and Timothy and Benson [pause] And Izzy [pause] And me"	Only the children that were there last time should be here (we are going to watch / look at ourselves doing earthquakes; only me, Izzy, Timothy and Benson did the earthquakes; so only we can watch ourselves)	Explanative	*RECALLING FACTUAL INFORMATION INFERRING CONCEPTUAL INFORMATION*
Sefa, V2, 001	"These two stayed at home"	Darren and Sophie are not in the documentation because they were at home (I don't remember Darren and Sophie being at this activity; they must have not been at the centre; if they were not at the centre, they must have been at home)	Explanative	*INFERRING CONCEPTUAL INFORMATION*
Sarah, V2, 001	"Your house might wobble [shakes body back and forth] and you might feel it"	In an earthquake, your house might wobble and you might feel your house wobble (earthquakes shake/wobble houses; we live inside houses; we can feel things that wobble)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Sarah, V2, 003	"I know the persons might go a[...] on their house and they might bump their head"	In an earthquake, the people might bump their heads because the house is shaking (earthquakes shake/wobble houses; shaking/wobbling means you might bump your head)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Eloise, V2, 008	[reaches pen forward to pass to Darren] He can have black	Darren can have this pen so I can have that pen (Everyone should have a pen; Darren doesn't have a pen and there is one new pen available; I want the new pen; if Darren has the old pen then I will be the one without a pen and I will get the new pen)	Persuasive	*PRODUCING PROCEDURAL KNOWLEDGE*
Eloise, V2, 010	Ok I'll give you the choices blue or green	Children will be more likely to give me the pen I want if I choose them (Choosing is a strategy mum / teacher uses to make me give something I don't want to give; these children don't want to give me the pens; choosing will make them give me the pens)	Persuasive	*IMPLEMENTING PROCEDURAL KNOWLEDGE*
Sarah, V2, 014	["what is your monster doing?] "spinning like that" [circles fist holding pen around on top of paper] "breaking all the houses down"	Houses break down because a monster is spinning (earthquakes break houses down; earthquakes are made by monsters; spinning is an action that can break things; the monster must be spinning)	Explanative	*PRODUCING CONCEPTUAL KNOWLEDGE*
Sarah, V2, 014	"He's got sharp teeth"	Monsters have sharp teeth (monsters are scary? scary things have sharp teeth?)	Representation	*INTERPRETING FACTUAL KNOWLEDGE*
Sarah, V2, 015	"I think. Those are the those are spiky bits" [points in a jerky way to zigzag parts of drawing]	Houses break down because a monster with spiky bits is spinning (as above; but added another premise – spiky things stick out while monster is spinning and break things)	Explanative	*INTERPRETING CONCEPTUAL KNOWLEDGE*
Sefa, V2, 015	["What does this boy think?"] "Naughty"	People think earthquakes are naughty (earthquakes break things; breaking things is naughty; earthquakes are naughty)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Sefa, V2, 015	["What's this going sideways and sideways [excited tone] what's	Earthquakes shake from side to side (we are drawing from side to side; earthquakes shake from side to side; we are drawing an earthquake)	Explanative	*RECOGNISING CONCEPTUAL KNOWLEDGE*

	that?"] "Earthquake"			

Sefa, V3, 002	"I'm making a big house"	I can draw a big house on big paper (this paper is big; houses are big; I can draw a big house on this paper)	Planning	*PLANNING PROCEDURAL KNOWLEDGE*
Izzy, V3, 002	"And [pause] I wanna have a big park too"	I can draw a big park on big paper (Sefa is drawing a big house on the big paper; I want to draw on the big paper; I can draw something else that is big; parks are big? parks are associated with houses?)	Planning	*PLANNING PROCEDURAL KNOWLEDGE*
Wesley, V3, 006	"No [then quietly] you're not allowed to at the shop"	You didn't eat the lollies because people aren't allowed to eat lollies at the shop (people aren't allowed to eat lollies at the shop; you were in the shop; you cannot have eaten the lollies)	Explanative	*CRITIQUING FACTUAL KNOWLEDGE*
Sefa, V3, 008	"Please can I have it?"	If you say please the teacher will give you what you want (I want to cut out that photo; the teacher is not giving out the photos; teachers like children to say please before they give them things)	Persuasive	*EXECUTING PROCEDURAL KNOWLEDGE*
Wesley, V3, 009	"I It was me looking at the one of my lollies [pause] that I have in the picture [pause] that means I have"	If I am in the photo then I should get to keep it (I want the photo; I am in the photo and Sefa is not in the photo; I should get to keep the photo not Sefa)	Persuasive	*GENERATING CONCEPTUAL KNOWLEDGE*
Wesley, V3, 009	"The the ones I like I get the ones the pictures I like the ones I like"	I should get to keep the photos I like (I like the photo; so I want the photo; I should get what I like – because I am a child? Because adults give children what they want?)	Persuasive	*GENERATING CONCEPTUAL KNOWLEDGE*
Sefa, V3, 010	"Yeah and and and paint ball [pause] and paint ball"	The shop that sells balls will sell paint balls (the shop sells soccer and rugby balls; the shop sells all sorts of balls; another sort of ball is paint ball; the shop sells paint balls)	Predictive	*EXEMPLIFYING FACTUAL KNOWLEDGE*
Wesley, V3, 010	"If you don't let me have that picture I'll give you no present at all"	People will give you things if they think / if you tell them that you won't give them a present (The teacher won't give me what I want; people like presents so the teacher will like presents; if I tell the teacher she can't have a present she will give me what I want so I give her a present)	Persuasive	*EXECUTING PROCEDURAL KNOWLEDGE*
Wesley, V3, 010	"Only if its mine"	I can bargain for the photo because the teacher wants me to do writing (The teacher wants me to do writing; I want the photo; when someone wants you to do something for them you can ask them to give you something in return)	Persuasive	*EXECUTING PROCEDURAL KNOWLEDGE*
Wesley, V3, 011	"If you don't let me have that picture I won't you never never ever never ever never ever let you never ever let you have any hot hands [?] of mine ever EVER EVER [shouts]"	People will give you things if you share [toys?] with them (The teacher won't give me what I want; people want to share my [hot hands?]; if I tell the teacher she can't have one she will give me what I want)	Persuasive	*EXECUTING PROCEDURAL KNOWLEDGE*

Tilly, V4, 002	"if you were on the picture then you have to come and watch it"	Children have to come to this activity if they are represented in the documentation (people in the activity had their photo taken; if you had your photo taken you were there; if you were there before you need to be here now? people want to see their picture? people have to come)	Explanative	*GENERATING CONCEPTUAL KNOWLEDGE*
Liam, V4, 002	"That means me can watch eh?"	I can watch because I am in the photos (people who are in the photos are allowed to watch; I am in the photos; I am allowed to watch)	Predictive	*EXECUTING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 002&3	"Someone else can do her cards; Someone actually can do it; If all the other people that were there and don't wanna come [pause] and Sabrina has gone home"	If the children in the documentation don't want to come to this activity or they have gone home, then other children can come (Each person has to do their own card; some people cannot or don't want to so there aren't enough people; other children can come if the others don't want to)	Explanative	*PLANNING PROCEDURAL KNOWLEDGE*
Tilly, V4, 006	"[like the gingerbread men] Even when people's inside there"	People can be inside houses when there's an earthquake (earthquakes shake houses and houses fall down; people get hurt if they are inside; on the news people were hurt?	Explanative	*SUMMARISING FACTUAL KNOWLEDGE*

	[pause 1 sec] there can be an earthquake"	people must have been inside to get hurt?)		
Sarah, V4, 008	["How would you make a house that doesn't fall down?"] "A really really strong one"	A really strong house won't fall down in an earthquake (earthquakes break things down; really strong things don't get broken down)	Predictive	*INTERPRETING CONCEPTUAL KNOWLEDGE*
Eloise, V4, 008	"And wood"	Wood is strong so we should use wood to make a house that doesn't break down (earthquakes break things down; strong things don't get broken down; wood is strong)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 008	"And nails"	Nails are strong so we should use nails to make a house that doesn't break down (earthquakes break things down; strong things don't get broken down; nails are strong)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Eloise, V4, 009	"And I went [..] like this with the glue"	Glue is strong so we should use glue to make a house that doesn't break down (earthquakes break things down; strong things don't get broken down; glue is strong)	Predictive	*GENERATING CONCEPTUAL KNOWLEDGE*
Izzy, V4, 009	["Do you think glue would make it strong so it doesn't break from the earthquake?"] "Yeah I made a dinosaur [pause] and look at my dinosaur" [points]	Glue makes things strong because my dinosaur is strong (strong things don't get broken down; I made a dinosaur with glue and he is not broken; my dinosaur is strong)	Predictive, explanative	*RECALLING FACTUAL KNOWLEDGE*
Izzy, V4, 009	"No he don't need a house cause he's cause he's a dragon he burned it down"	Dragons don't need houses because if they have houses they will burn them down (dragons burn things down; if a dragon had a house he would burn it down)	Explanative	*EXPLAINING CONCEPTUAL KNOWLEDGE*
Izzy, V4, 009	["That looks very strong"] "Can't fall down eh?"	This can't fall down because it is strong (Strong things can't fall down; this is strong; this can't fall down)	Explanative	*EXPLAINING CONCEPTUAL KNOWLEDGE*
Izzy, V4, 009	["what about if the earth was shaking, would it fall down then?"] "No [pause 1 sec] Its got lots of glue on it [pause] here"	This house won't fall down if the earth is shaking because it has got lots of glue on it (strong things don't get broken down; glue makes things strong; my dragon has glue on it; my dragon is strong)	Predictive	*EXPLAINING CONCEPTUAL KNOWLEDGE*
Eloise, V4, 010	"Guys remember we need some too"	Infers rules about sharing: You need to remind people if you need blocks, otherwise they might use them all (Everyone is taking blocks; blocks should be shared for all who want them; I need to remind people that we want some too)	Persuasive	*INTERPRETING PROCEDURAL KNOWLEDGE*
Izzy, V4, 011	holds flat piece upright and holds second flat piece at the top at right angles to the first, pressing them together	You have to stick things at right angles because each part needs to touch	Procedural	*PLANNING PROCEDURAL KNOWLEDGE*
Eloise, V4, 013	"See look what happens if I do this" [holds arm up parallel to building	My building will fall when I knock my building (people like to see buildings fall down; my building will fall down spectacularly so you will want to see; my building will fall down very quickly so you need to look now)	Predictive	*CHECKING PROCEDURAL KNOWLEDGE, INFERRING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 013	"Fall down"	If you shake the table it will fall down (when you shake the table, buildings fall down; if you shake the table it will fall down)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Eloise, V4, 013	That was reallll [bends slightly so blocks slide onto table] ly [pause] naughty Eloise!	Breaking things is naughty? (Breaking things is a negative outcome; behaviour that leads to negative outcomes is naughty?)	Moral	*CRITIQUING PRCEDURAL KNOWLEDGE*
Izzy, V4, 014	"That's what I need but you got all of them so you can't"	You can't have all of something (I need some; if you have them all I can't have some; you can't have them all)	Persuasive	*EXPLAINING PROCEDURAL KNOWLEDGE*
Izzy, V4, 014	[touches the join, pulls it] "Can't break"	It won't break in the earthquake because it won't break when I pull it (strong things don't break in earthquakes; and strong things don't break when they are pulled)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Izzy, V4, 014	"No it traps him"	He can't fit so he is trapped (Things that are trapped get stuck; my dragon can't fit; my dragon gets stuck; the house traps the dragon)	Explanative	*INTERPRETING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 014	["what can Eloise t-do to make sure hers	It won't break if we don't shake the table (shaking breaks buildings; if we don't want it to break we mustn't shake	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*

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	doesn't break she doesn't want it to break"] "So don't shake the table"	the table)		
Sarah, V4, 014	"Put Eloise's on the ground with your hands"	It won't break if it's on the ground (things break when they shake; we shake the table but we don't shake the ground)	Predictive	*RECALLING PROCEDURAL KNOWLEDGE GENERATING PROCEDURAL KNOWLEDGE*
Izzy, V4, 014	"Make it a little bit just break it a little bit"	It's ok if it only breaks a little bit so shake it a little bit(a little shake will make it break a little bit; breaking it a little bit would be ok)	Predictive	*GENERATING PROCEDURAL KNOWLEDGE*
Liam, V4, 014	"Take a photo"	If you take a photo of it, it doesn't matter if it breaks (photos make the buildings permanent, if the building can be permanently recorded then it doesn't matter if you break it)	Persuasive	*GENERATING PROCEDURAL KNOWLEDGE*
Eloise, V4, 014	"Just break [leans across table, holds arm up next to Liam's building] break his like this"	Only break the buildings of people who want theirs broken (some people want their buildings broken; we can target specific buildings if we push them over)	Predictive	*GENERATING PROCEDURAL KNOWLEDGE*
Eloise, V4, 014	["could you make yours stay together even when the table is shaking is there a way?"] "glue"	Glue will hold the building together even if the table is shaking (we are going to shake the table; shaking will make this building come apart; things that are glued don't come apart)	Predictive	*GENERATING PROCEDURAL KNOWLEDGE*
Tilly, V4, 014	"I'm going to take this one home but I'm using glue gun"	This will stay together because I used the glue gun so I'm going to take it home [things that are gluegunned stay together; if I want to keep it it will need to be glue gunned)	Explanative	*EXPLAINING PROCEDURAL KNOWLEDGE*
Eloise, V4, 015	"But I [stand up and flaps arms]want some people to help me glue"	This will take a long time so I want people to help me (I need to move each block; I need to glue each block; there are a lot of blocks; it will take a long time; if other people help me it will be quicker)	Predictive	*INFERRING PROCEDURAL KNOWLEDGE; PLANNING PROCEDURAL KNOWLEDGE*
Sarah, V4, 016	"Sellllllotape" / "Lots of sellotape"	Lots of sellotape will make it really strong? (Sellotape makes things stick together; to be more strong it needs to be stuck together more; lots of sellotape will make it really strong)	Predictive	*INTERPRETING PROCEDURAL KNOWLEDGE*
Liam, V4, 016	takes another block off the side and building collapses, looks up at Vicki and smiles	I can take blocks out and the building will fall down (Eloise doesn't want to shake the table; I want my building to fall down; if I take out some blocks it will fall down)	Predictive	*EXECUTING / GENERATING PROCEDURAL KNOWLEDGE*
Tilly, V4, 019	["How can you find out if it is strong can I have a look?"] Tilly holds plane in hands and shakes it vigorously up and down	It is strong if it doesn't break when I shake it (things that aren't strong break when you shake them)	Predictive	*CHECKING CONCEPTUAL KNOWLEDGE*
Izzy, V4, 020	["whats gonna [places hand on cheek] happen to Izzy's[points] one when we shake the table?"] "No cause I will glue it"	Mine won't break because it is going to be glued (Things with glue on don't break; mine is going to be glued; mine won't break)	Predictive	*INFERRING / EXPLAINING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 020	"It will break"	If you shake the table it will break (when you shake the table, buildings break; if you shake the table it will break)	Predictive	*INFERRING CONCEPTUAL KNOWLEDGE*
Tilly, V4, 022	"yeah [pause] take all the yucky bits off"	The gluey bits are yucky so take them off (gluey bits are yucky; I don't want my aeroplane to be yucky; take the yucky bits off)	Explanative	*PLANNING PROCEDURAL KNOWLEDGE*
Tilly, V4, 023	"How long you want it to fly you press that"	Aeroplanes have buttons that can time how long the aeroplane flies for (aeroplanes are on timers; timers have buttons; you press the button to time the duration of the flight)	Explanative	*PRODUCES CONCEPTUAL KNOWLEDGE*
Izzy, V4, 023	["Do you want us to wait for you?" OR "Why are you putting so much glue on Izzy?"] "Cause I um I need to [lifts up apex	More glue will make this thing stick (glue makes things stick, if its not sticking it needs more glue? I need you to wait because I need to stick something?)	Explanative	*EXPLAINING PROCEDURAL KNOWLEDGE*

	house]stuck that thing"			
Tilly, V4, 023	["Izzy's worried that if she doesn't put glue on then it might break when the earthquake comes"] "And me too thats why I glued on it"	I glued it because I am worried that if I don't it will break when the earthquake comes (agreeing with theory: things without glue break in earthquakes; things with glue don't break so make one with glue)	Explanative	*EXPLAINING PROCEDURAL KNOWLEDGE*
Darren, V4, 147	"Lock a gate"	Our buildings will be safe from earthquakes / rockets if they have locked gates (rockets/earthquakes break our buildings; we need to keep the rocket / earthquake out; gates keep things out)	Predictive	*GENERATING PROCEDURAL KNOWLEDGE*
Liam, V4, 148	"Vicki you did it too fast"	I didn't record the video because the earthquake was too fast (you have to press the button to record the video; you have to press the button at the right time;the earthquake happened very fast; I didn't press the button at the right time so I didn't record the video)	Explanative	*INFERRING PROCEDURAL KNOWLEDGE*
Tilly, V4, 149	[laughs] "that is that is because I glue gunned it"	My building didn't break because I glue gunned it (shaking usually breaks buildings; my building didn't break; my building was glued with the glue gun)	Explanative	*EXPLAINING / PRODUCING CONCEPTUAL KNOWLEDGE*