A culture for science in early childhood education: where cultures meet culture

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Abstract

In recent years there has been an increase in literature advocating for and describing early childhood science education; however, little attention has been given to the complex interplay of cultural communities of practice that influence science learning and teaching in a play-based curriculum. This study examined where and how science learning could be privileged when many cultural practices were being enacted at the same time.

This study investigated how science learning and teaching was enacted within a play-based curriculum in three kindergartens in Aotearoa/New Zealand. The investigation also explored the influences of professional learning for teachers on their definition of the culture of science and explored aspects of how children learn science. The field work took place over a period of seven months. Data was collected through weekly sessional observations, interviews with teachers, children and parents, as well as the documentation teachers made of children's learning. The professional learning sessions with the teachers were conducted halfway through the data collection so that the second half of the data collection could take into account the influences from the professional learning sessions. Three conceptual reference points from sociocultural theory framed the data analysis. The reference points were multiple cultural communities of practice, semiotics within and across communities of practice and teacher influence on children learning science.

The thesis argues, and provides evidence for, four science-education-related communities of practice that interact to create opportunities for teaching and learning science with young children. The four communities are the everyday, early childhood education (in this case in Aotearoa/New Zealand), science, and science education. The interaction of the four communities has been defined as a "quadruple move", indicating that all four communities are involved when science learning takes place. The concept of hybridity was used to illustrate that some practices were used in a similar way by all four communities and this was seen to support children learning science. The research highlighted that children were using a combination of semiotic artefacts within their science learning. This was analysed through the concept of intertextuality. Intertextuality also identified that each child might interpret the same artefact differently. The implication is that teacher awareness of the quadruple move and the interplay of semiotic artefacts in and across the four communities will enrich children's science learning in a play-based curriculum setting.

Teacher influence on children learning science was identified through the teachers' affordance of science learning in their kindergarten's physical and social environment and teacher affordance to children learning science content knowledge and practices. Also of influence was teachers' attunement to children's interest in the physical environment that had the potential to connect to a science community. Examples from the study illustrated that involving children in exploring the physical environment using scientific practices was a way to sustain and enrich their learning. The findings identified teachers' interactions were enriched by a broader understanding of science knowledge and practice when they recognised the connections to their kindergarten contexts and their children's interests.

The implication is that teachers' awareness of the quadruple move and the interplay of semiotic artefacts in and across the four cultural communities will enrich children's science learning in a play-based curriculum setting.

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1 The Introduction

"Early childhood is the most important period for math, science and technology education but only if we adapt such instruction to the unique needs, interests and abilities of young children." (Elkind, 1998, p. 15)

1.1 The study explored

The study explored how early childhood science education was enacted within a play-based curriculum in Aotearoa/New Zealand. As the Elkind (1998) quote above suggests, science education for young children has a place within early childhood education but needs to be enacted within a pedagogy that acknowledges the unique characteristics of how young children learn. The researcher's interest in science education for young children, as implied by the title of the thesis, was to explore how and where science education was and could be privileged within an integrated, play-based curriculum programme. In this way the thesis seeks to investigate the relationships between early childhood pedagogy and science learning and teaching. It included both children's engagement in science learning and the ways teachers facilitated children's science learning. The influence of teacher professional learning about science and how children learn about science is included within this study.

The argument that underpins the research is that science is an important cultural community within society today and therefore deserves a place in the early childhood curriculum. There is a substantial body of international literature that asserts the importance of science education for young children (Alward, Nourot, Scales, & Van Hoorn, 2014; Campbell & Jobling, 2012; Elkind, 1998; Eschach, 2006; Fleer & Robbins, 2003; Johnston, 2005; Lind, 2000). The study proposed to build descriptive knowledge about the science learning and teaching promoted for young children within the context of the New Zealand curriculum document, which is *Te Whāriki: He Whāriki Mātauranga mō ngā Mokapuna a Aoteatoa: Early childhood curriculum* (Ministry of Education, 1996) . This will be referred to as *Te Whāriki* within the thesis.

The study describes how teachers from three kindergartens identified what could be seen as science education. It then creates a framework that describes science learning and teaching within the dynamic child interest-based, holistic, play pedagogy that is promoted by *Te Whāriki*. The analysis of the data presents a descriptive account of what children are already engaged in that can be identified as developing understandings related to science. The professional learning stage of the research involved the teachers from the three kindergartens in professional learning. The professional learning stage contributed to evidence-based arguments about how enhancing the lenses of science and science education for teachers could enrich the learning of science for children in early childhood play-based settings. It adds to a trend in research where the researcher and the teachers work together in negotiated professional learning, giving the teachers a greater say in the direction of the research in terms of the teachers' learning (Hedges, 2007; Timperley, 2004). It is the hope of this researcher that the research will contribute to empowering early childhood teachers to act on the potential for science learning and teaching within the early childhood curriculum.

The two main questions that frame the study are:

1. How is science learning and teaching being enacted in three kindergartens?
2. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children in these three settings? If so, then how does this occur?

Early childhood science education literature includes comments that science is everywhere (Taylor, 1993). However, the researcher understands that the potential for science learning is everywhere within the physical environment but only becomes science when the learner engages in the perspectives of the physical environment held by a community of scientists. For this reason the terms *science-specific* when the science learning is evident from the learner's perspective and *science-related* when learning about the physical environment will be used in this thesis. These could later be connected to science communities' ways of viewing the physical environment. The term science learning in this thesis is relative to young children's level of ability.

1.2 Why research science education in early childhood?

The motivation for this study is the researcher's own curiosity about young children learning science. The curiosity grew from her love of science during her school years, experience as a kindergarten teacher in the late 1970–1980s, hosting science education workshops for other teachers from 1980 through to 2000, and lecturing student teachers on early childhood science education 1990–2014.

Three curiosities have concerned the researcher's thinking. The first is, as play is valued within the early childhood curriculum as a medium for learning, how can we integrate science learning and play? The second curiosity is in considering how sociocultural framing impacts on how science learning is and could be enacted. In 2004 the Ministry of Education published *Kei Tua o te Pae; Assessment for learning: Early childhood exemplars.* In the introduction to this publication there is a statement acknowledging that the principles in *Te Whāriki* reflect a sociocultural approach to learning. This announcement that the New Zealand early childhood curriculum is influenced by sociocultural ideas prompted the researcher to think what this could mean for science education. The final curiosity is how to describe the dynamic interactions between teachers and children that create moments of science learning based on children's spontaneous interest in an aspect of the physical environment. It is expected that investigating the researcher's three curiosities would add to the knowledge on early childhood science education within a play-based curriculum.

1.3 Theoretical framework to the research

There is ample literature that acknowledges the sociocultural approach to teaching and learning in early childhood educational settings in New Zealand (Carr, 2001a; Lee, Carr, Soutar & Mitchell, 2013; Ministry of Education, 2004; Nuttall, 2013). The study asked: When a sociocultural approach to early childhood curriculum is promoted, then what does this mean for science education? Does the idea of a sociocultural perspective on science education begin to address Elkind's (1998) identification of young children's unique needs, interests and abilities?

Sociocultural theory positions teaching and learning as a social act (Siry, 2013). Learning is seen to happen within cultural communities of practice (Lave & Wenger, 1991; Rogoff, 2003; Wadham, Pudney, & Boyd, 2007). Therefore, the question to be asked is: What cultural communities of practice contribute to early childhood science education — where cultures meet cultures? Social participation within cultural communities is how people learn about a community. In the literature social participation is often identified by the artefacts or tools within a culture's practice (Lave & Wenger, 1991; Robbins, 2007; Wells & Claxton, 2002). A sociocultural perspective also acknowledges that learning takes place within a specific context (Wells & Claxton, 2002; Fleer & Richardson, 2004; Rogoff, 1990). In this study the context is three kindergartens working within *Te Whāriki* to enact a play-based curriculum that acknowledges a place for science within their curriculum

A second positioning from sociocultural theory that this thesis investigated was the notion of children's meaning-making about science communities associated with the social semiotics they perceive of the artefacts they engage with in their learning. Social semiotic as a concept identifies how people respond to make meaning from, or interpret signs and signal within their community of practice (Hervey, 1982; Lemke, 1998; Stables, 2005). These artefacts include words, images, symbols and actions that denote and embody meaning-making practices within a community (Lemke, 1998). Most research specifically related to social semiotic in science education is focussed on secondary education (Bussi, Corni, Mariana & Falcade, 2012; Jaipal, 2010; Lemke, 1998). Their use in early childhood science education has begun to be explored (Fleer, 1991; Fleer & Robbins, 2003; Robbins, 2005; Siry, 2013), although early childhood education research has mainly focussed on the importance of oral language as a social semiotic. This thesis engages the concept of social semiotics in order to investigate the range of artefacts young children are engaging with in their science education within a play-based curriculum. Exploring how young children engage with a range of artefacts within a play-based curriculum may well give answers to how to take into account children's unique needs, interests and abilities within science education.

1.4 Early childhood in Aotearoa/New Zealand

Early childhood education in New Zealand focusses on children from birth to five years of age. Legally, children are required to enrol in primary school education by the age of six years. However, children are able to start school at age five years. Most children start school on their fifth birthday.

Early childhood education in New Zealand has a diverse range of services. The diversity of services includes kindergartens, education and care centres, home-based education and care, correspondence school, te kōhunga reo, playcentres (parent co-operative), play groups, nga puna kohungahunga and Pacific Island playgroups (Ministry of Education, 2015a). This study took place in kindergartens within the Auckland region. The Auckland Kindergarten Association (AKA) has been involved in early childhood education since 1908 (Duncan, 2008). Today the AKA has 107 kindergartens, mainly catering for three- and four-year-old children. The three kindergartens where the study took place were sessional kindergartens. Sessional means they have a session in the morning for three hours with one group of children and a second session in the afternoon for two and a half hours with another group of children. The study involved children from the morning sessions of the three identified kindergartens.

All teacher-led early childhood services in New Zealand are required to use *Te Whāriki.* The Ministry of Education Early Childhood website begins with the following quote:

> *Te Whāriki* is the Ministry of Education's early childhood curriculum policy statement. It is a framework for providing tamariki (children's) early learning and development within a sociocultural context. It emphasises the learning partnership between kaiako (teachers), parents, and whānau/families. Kaiako (teachers) weave a holistic curriculum in response to tamariki (children's) learning and development in the early childhood setting and the wider context of the child's world. (Ministry of Education, 2015b)

Te Whāriki was developed through rigorous consultation with the early childhood sector during the 1990s (Mitchell, Carr & May, 1993). From the outset the document was required to create curriculum guidelines for a diverse range of early childhood education services (Mitchell et al., 1993; Carr & May, 1993). *Te Whāriki* was implemented in 1996. The document is organised through the interconnection of four principles and five strands. The four principles are family and community, holistic learning, empowerment, and relationships. The five strands are well-being, belonging, contribution, communication, and exploration. The strands are further developed into a collection of aims, goals and learning outcomes. Within the document play is promoted as a way that children learn.

Science education is evident throughout *Te Whāriki* (Backshall, 2000a). In exploration goal four, all the science domains of knowledge are mentioned using the names given by the Ministry of Education school aged curriculum documents (Ministry of Education 1993a & b; 2007). The domains are living world (biology), physical world (physics), material world (chemistry), and the planet earth and beyond (geology and astronomy). One example of how science education is integrated through the document is in the communication strand where there is mention of "an expectation that words and books can amuse, delight, comfort, illuminate, inform, and excite" (Ministry of Education, 1996, p. 78). This learning outcome can be related to science through books that illuminate, inform and excite children about science ideas in their physical environment. Another example is in exploration goal three, where there are a number of goals related to general processes of inquiry, such as problem solving, classifying, predicting and observing (Ministry of Education, 1996, p. 88). The processes of inquiry mentioned can all be related to science processes of inquiry. This thesis is interested in how teachers are interpreting the strategies for science learning and teaching from *Te Whāriki.*

1.5 The research context

The research takes place in three kindergartens in the wider Auckland region. The three kindergartens are in distinctly different suburbs in Auckland.

- Kina Kindergarten is in a low-socio-economic suburb
- Jandals Kindergarten is in a mid to low socio-economic area
- Pohutukawa Kindergarten is in a high socio-economic area

Each kindergarten has a roll of 45 children with three qualified early childhood teachers in attendance. The dominant early childhood curriculum is play-based. This means the children can choose how and where they play within the kindergarten environments for most of their session time.

The morning routine at the kindergartens include:

- Teachers arrive about an hour before the children and set the physical environment
- Children and parents arrive, then children choose where they want to play. In all three kindergartens children can choose between inside or outside activities
- Children choose when they have morning tea in two of the kindergartens. At Pohutukawa Kindergarten the children have morning tea together at about ten-thirty. Morning tea, after a short group-time, is usually about 20 minutes long
- Children choose where they play until the end of the session
- At the end of the session the children at all three kindergarten have a 15–20 minute large group time before they are collected by their families

The play areas available to the children in all three kindergartens include:
Indoors:

- Book area
- Play dough table
- Block area
- Painting on easels
- Family corner
- Art activities
- Literacy table
- Music, dance and drama area
- Puzzle area

Outdoors:

- Sand area
- Water play

- Climbing equipment including swings and slide
- Grass space
- Dramatic play area
- Gardens
- Trolleys, bikes and balls

In all three kindergartens, assessments are documented in a narrative form and are called learning stories. Each child has a portfolio of learning stories and other evidence of their learning. The Ministry of Education website (2015) introduces the *Assessment for Learning: Early childhood Exemplars* with the following statement: "Narrated stories document children's engagement in learning experiences. Subsequent assessment of the learning informs ongoing learning. The stories and assessments are presented in children's portfolios for children, families and teachers to read and re-read." The learning stories construct an identity for each child as a learner (Carr & Lee, 2012).

1.6 Overview of the thesis

The next chapter will give an overview of sociocultural theories and their connections in the literature on science education for young children. Chapter Three will describe the research methodology and design of the study. The following three chapters (four–six) present the data analysis. Chapter Four considers the science processes of inquiry through data from one case study. Chapter Five is an analysis of how children are engaged in science learning using the study of semiotics and the concept of intertextuality. Chapter Six specifically analyses the teachers' influence on children's science learning using data from all three case studies. Chapter Seven connects science education literature and the findings from this study. Conclusions presented in Chapter Eight provide implications from the study as well as directions for future research.

2 Sociocultural theory linking to early childhood science education in Aotearoa/New Zealand

"Grounded in a sociocultural theoretical perspective (e.g. Sewell, 1999), I position teaching and learning as a social act. The notion of "science learning" through such a framework is considered as cultural enactment, with the "culture" that we perform being everything that we do" (Siry, 2013, p. 2408).

2.1 Introduction

As stated in Chapter One, sociocultural theory has a strong influence in curriculum documents and teacher practice in early childhood education in Aotearoa/New Zealand (Carr, 2001a; Fleer, 2013; Carr & Lee, 2013; Ministry of Education, 1996; 2004; Nuttall, 2013). Scholars acknowledge that a variety of educational theories seem to underpin *Te Whāriki* (Duhn, 2006; Fleer, 2013; Hedges, 2010; Nuttall, 2013; White, 2011). However, there is a general consensus that the major perspective that underpins *Te Whāriki* is sociocultural (Cullen, 2001; Hedges, 2010; Lee et al, 2013; Nuttall, 2013). For example, *Te Whāriki* (1996, p. 19) asserts the importance of exchanges between the child, the environment and communities that children belong to in the learning process. In *Kei tua o te pae: Assessment for learning: Early years exemplars,* a support resource for early childhood assessment in ECE New Zealand, Book Two explicitly emphasises sociocultural assessment (Ministry of Education, 2004). Looking more broadly, as evidenced in the introductory quote from Siry (2013), there is a move to view early childhood science education from a sociocultural perspective (Inan, Trundle, & Kantor, 2010; Fleer, 1991; Fleer, 2006; Robbins, 2005; Siry, 2013; Siry, Ziegler & Max, 2012).

For the purpose of this study, three main ideas have been identified from sociocultural literature related to learning and teaching. The three ideas have been informed by the works of Hervey (1982), Lave and Wenger (1991), Lemke (1992, 1998), Rogoff (2003) and Slattery (1995). These are the ideas of (i) learning happens across multiple cultural communities of practice, (ii) semiotics within and across cultural communities support students' learning, and (iii) teachers are a key influence on children learning science. In this chapter the three ideas are discussed as the *conceptual reference points* forming the thesis argument. They are explored through the examination of the literature in terms of how they relate to early childhood science education.

2.2 Multiple cultural communities of practice

The first of the three conceptual reference points to be discussed is that of multiple cultural communities of practice. Culture from a sociocultural perspective is defined not purely from ethnic identity but from the identities people develop through belonging to multiple and diverse groups or "communities" within society (Claxton, 2002; Lave & Wenger, 1991; Rogoff, 2003; Wadham et al, 2007; Wenger 1998). Cultural communities can be identified when a number of characteristics (or practices) are consistently present within a group of people. These practices include the use of specific symbols, signs, language, values and meanings, beliefs, norms, rituals, and material objects (Wells & Claxton, 2002; Lemke, 2001; Wadham et al., 2007).

Children and adults are involved in multiple cultural communities over the course of their everyday lives. Examples acknowledged in the education literature are school, sports clubs (Wadham et al., 2007), family, religion, and ethnicity (Rogoff, 2003) and science education (Lemke, 2001; Tobin & Roth, 2007). The importance of this is that the cultural communities that children and adults belong to provide the meanings and reference points that they use to make sense of themselves, of the world around them and how they fit into the world (Claxton, 2002; Wadham et al., 2007). The cultural communities of which people are members provide the places where learning occurs. Seen this way teaching and learning are viewed as social acts which occur for the learner within the cultural communities they have or are given access to (Siry, 2013).

In today's world young children belong and gain their identity from the practices within multiple communities (Carr, 2001b; Claxton, 2002; Wadham et al., 2007; Wenger, 1998). The four cultural communities of interest in this study are those of the local everyday community within which children and their families engage with, the early childhood education community in New Zealand (ECE), the science community and science education communities. The idea of children learning through engagement with their local everyday community and their early childhood centre has been established in New Zealand policy and literature (Ministry of Education, 2004; Carr & Lee, 2012). The science community and science education communities are of particular interest for this study given the focus is on how young children are learning science. The diagram below depicts these four communities of interest and implies that there are relationships between the communities. The suggestion underpinning this thesis is that all four communities have the potential to influence science learning for children in early childhood education. The next sections address the question: What are the current understandings of the four communities?

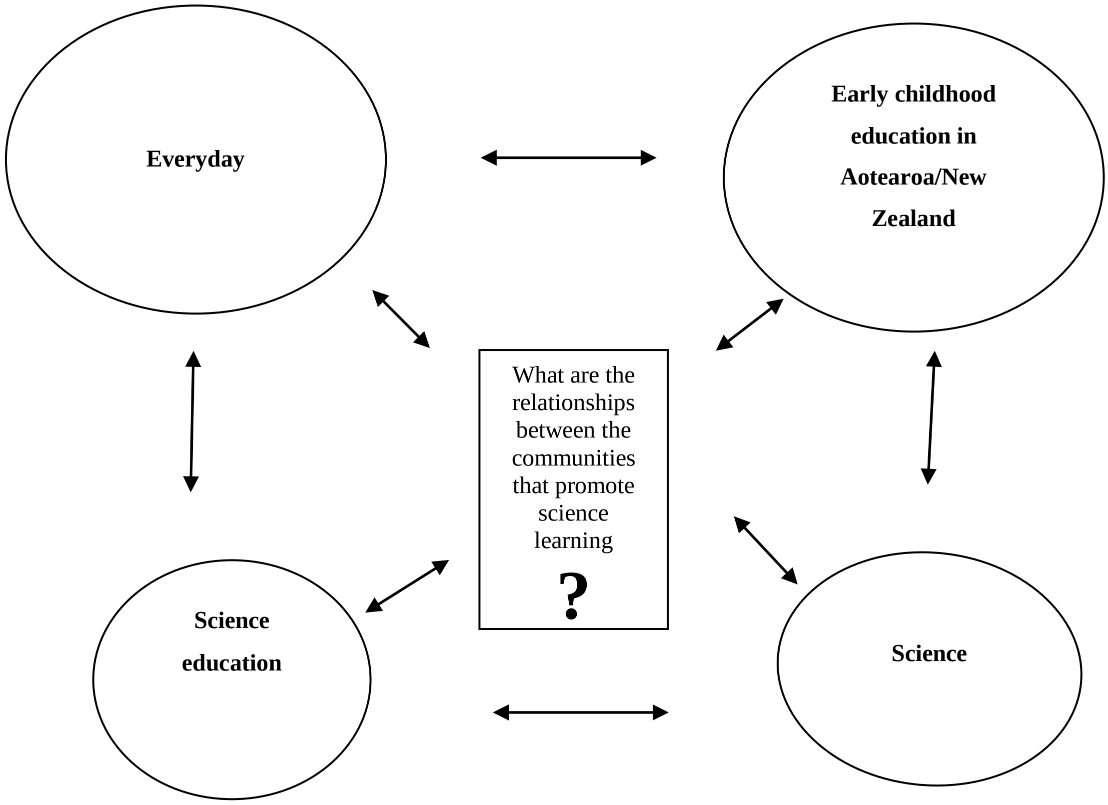


Figure 2.1. *The four cultural communities relevant to the research project. What are the relationships between them that influence science learning and teaching in the threekindergartens?*

2.3 Everyday cultural community

Children's everyday cultural community was one of the cultural communities this study was interested in investigating. The everyday cultural community of interest is the families and other groups within a local geographic area that serve as a community of learning for children (Hedegaard & Chaiklin, 2005; Lave & Wenger, 1991; Rogoff, 2003; Vygotsky, 1987). Everyday cultural communities of practice can be differentiated from academic, school or early childhood centres' cultural communities of practice (Fleer, 2010; McLachlan, Fleer & Edwards, 2010; Vygotsky, 1987). The inclusion of this community recognises that everyday experiences in and of themselves create ways of knowing and practising (Gonzalez, Moll, & Amanti, 2005; Lave & Wenger, 1991). The everyday practices that children develop are defined as those that are happening in the children's homes and those in their immediate surrounds. Academic communities of practice are those that relate to school subjects (Vygotsky, 1987). Examples of academic cultural communities are history, mathematics and science.

Within early childhood science education, there are those who advocate that everyday experiences are valuable for supporting children's science learning in the future within more formal schooling settings. Vygotsky (1987) also argues that everyday experiences can lay the foundation for school-based academic learning. Carr (1994), for example, discusses how the processes of inquiry children learn in everyday life can support the further development of science ways of inquiry into their future. Johnston (2005) discusses the importance of young children's exploration of everyday objects in supporting their future development of science conceptual knowledge. In Fleer's (2009a) research on rich play environments, she noted that teachers believed children would pick up science related ideas in a "roundabout way" as they explored and played with the materials provided to them.

It is evident from the discussion above that not only do we need to acknowledge that children belong to and learn through their everyday community experiences, they also have the potential to influence children's academic/science learning. However, when viewed from a sociocultural perspective, it is questionable whether children's experiences with and in everyday communities of practice are sufficient to induct children into the science community's practices (Fleer, 2009a).

2.4 ECE cultural community

The ECE cultural community is the second community relevant to this study. It is made up of the people who influence and participate in early childhood education. In New Zealand this community is bound together by the early childhood curriculum document, *Te Whāriki* (Ministry of Education, 1996) and the Ministry of Education ECE regulations (Ministry of Education, 2008). The dominant cultural practices emphasised in both documents are that the curriculum needs to be holistic, child interest-based and one that values children learning through play (Ministry of Education, 1996, 2008).

i) Holistic curriculum

Holistic development is one of the principles within *Te Whāriki*. The definition of holistic curriculum includes the notion that curriculum experiences are integrated to take into account the child's whole context. An integrated approach to children's learning happens through holistic experiences rather than discrete activities designed to help learn specific academic competencies or knowledge. Taking into account the child's whole context within the curriculum includes awareness of the physical, social, cultural and an emotional influence on a child's learning (Ministry of Education, 1996, *p. 41*).

The integrated nature of learning promoted in *Te Whāriki* is further evidenced in the way the document describes links to the school curriculum. Unlike the school curriculum that highlights particular knowledge, competencies and attitudes specific to a learning area, *Te Whāriki* places the learning of school subjects within the wider context of the child's everyday and early childhood centre cultural community experiences. All the learning areas and associated competencies that are identified in the school curriculum are integrated within the strands of *Te Whāriki*. In this way *Te Whāriki* asserts continuity of learning for the child through a holistic early childhood education pedagogy that aims to develop confident learners to go forward into schooling (Ministry of Education, 1996). Although the school curriculum has changed since *Te Whāriki* was published, the connections that can be made between the documents in terms of school subjects are still relevant.

Within *Te Whāriki* there is evidence that aspects of science can occur in any of the five strands of the document (Backshall, 2000a). This illustrates the potential for holistic science learning experiences in New Zealand early childhood centres.

ii) Interest based curriculum

Te Whāriki's main focus on curriculum content (including potential science learning) is generated by the children's own interest (Carr & May, 1993; Ministry of Education, 1996). This has also been referred to as emergent or child-initiated curriculum, or more recently "interest-based curriculum" (Hedges, 2007). At the beginning of *Te Whāriki*, the document states that it is a curriculum guideline, leaving the detail of the curriculum to each early childhood centre. It is the teachers who have the most influence on the enacted curriculum (Slattery, 1995) and it is their responsibility and their interpretation of their children's interests that shape the enacted curriculum (Cullen, 2003). The *Te Whāriki* emphasis is on the need for a child interest-based curriculum as well as clear links with possible science learning across all five strands of the document.

iii) Learning through play

Learning through play is affirmed in *Te Whāriki* as an important approach for learning for young children (Carr & May, 1993; Ministry of Education, 1996). Traditionally, in early childhood education, the areas of play (e.g. water, sand, art, blocks and carpentry) are seen as very appropriate contexts for children to learn aspects related to science (Alward et al., 2014; Sprung, 1996). However, the literature on play is extensive, with many varying definitions of play (Fleer, 2013; Isenberg & Quisenberry, 2002). Therefore, it is important to describe the aspects of play relevant to this study.

Te Whāriki asserts the value of play as meaningful learning and describes three aspects of play as characterising the play-based curriculum in New Zealand. The first aspect is children's free choice in what they participate in and their spontaneity within play (Ministry of Education, 1982, 1984, 1996). Children's free choice and spontaneity within play infers a child-interest and open exploration focussed curriculum. The second aspect of play is that children's exploration and curiosity are valued as important ways of learning (Ministry of Education, 1984, 1996). Children's play as exploration infers exploration is a process they use to investigate, inquire and discover. Children's exploration supports their formulation of conceptual understandings about aspects of the physical environment they are exploring (Fleer, 2009a, 2009b; Johnston, 2005). The third aspect of play is articulated as follows:

"Increasing confidence and a repertoire for symbolic, pretend and dramatic play" (Ministry of Education, 1996, p. 84).

The use of dramatic play is seen as a strategy for reinforcing or extending children's scientific ideas (Lind, 1991; Segal & Cosgrove, 1992).

A parallel consideration with the three aspects of play described in *Te Whāriki* is the pedagogical continuum of child-independent through to teacher-directed play. Woods (2014) describes three modes of play in regard to teacher involvement. The three modes of play are child-initiated (free choice), adult-guided play (an emergent response to child-initiated play), and technicist play (play expected to promote learning related to specific learning outcomes). As is to be expected the order of the three modes of play given above align with the progression from child-initiated through to teacher-directed. It has been suggested that all three modes of play pedagogy are present within *Te Whāriki* (Carr, 2014).

The emphasis within the ECE cultural community in New Zealand on a holistic, child-interest and play-based curriculum has implications for how science learning and teaching is enacted within the kindergartens in this study. This study will investigate how teachers are engaging in the pedagogy of holistic, interest-based, play curriculum in ways that promote children's learning of science.

2.4.1 Science cultural community

The third cultural community of practice is science. Science has long been acknowledged as a cultural community of practice in its own right (Dahlberg, Moss, & Pence, 1999; De Albla, Gonzalez-Gaudiano, Lankshear, & Peters 2000; Pickering, 1992). From a sociocultural perspective, science knowledge and practices are seen as the social product of the science community. Science can be seen to be defined by its cultural artefacts (Lemke, 2001), which are the scientific equipment and ways of thinking or processes of inquiry that are used by scientists to investigate, understand and explain the physical aspects of planet earth and the wider universe (Prain & Waldrap, 2010).

Having a definition of the cultural community of science is crucial for this study as it is the significant community informing what kinds of learning are desirable. How the participant teachers in this research project perceive science is expected to have a direct influence on the science learning opportunities they facilitate for children (Johnston, 1996). The definition of science for this research project is taken from the New Zealand Curriculum Framework for schools (Ministry of Education, 2007a) where it states, "Science is a way of investigating, understanding, and explaining our natural, physical world and the wider universe" (p. 28).

Implicit within this quote is the idea that science is both a body of established knowledge and a process for furthering or applying knowledge about the planet earth and the wider universe in relation to their physical attributes. Both elements are essential to the science community as progress or application of science cannot happen without an understanding of these two elements (Duschl, Schweingruber, & Stouse, 2007).

In line with current thinking (Niaz, 2012), the importance of the nature of science is also recognised in ministry documents (Ministry of Education, 2007). The main aspects of the nature of science as discussed in the *New Zealand Curriculum* document's element statement are:

- Skills, attitudes and values important to the community of scientists
- The durability of scientific knowledge but also how the knowledge is consistently reviewed when new evidence emerges
- How science is a socially valued knowledge system
- How science ideas are communicated and linked between scientific knowledge and every day decisions and actions (Ministry of Education, 2007a, p. 28).

This list elaborates on the definition of science, giving specific links to elements of how science is carried out, the changing nature of science knowledge and how science relates to society and individuals in their everyday lives. How and when these aspects of science relate to young children's learning will be explored in this research project.

Also important in this thesis is the understanding that science can be considered a cultural community of practice that supports distinctive communities within its cultural borders. The well-known communities are biology, chemistry, physics, geology and astronomy. Within the New Zealand curriculum documents for early childhood and the school sectors these well-known communities are identified as the living world (biology), material world (chemistry), physical world (physics) and the planet earth (geology) and beyond (astronomy) (Ministry of Education, 1993b, 1996, 2007).

In summary, this section makes three statements about the science community of practice. The first is that the science community exists as a community in its own right. The second is the importance of a definition/understanding of the science community of practice for the facilitation of learning about the community. The third is the diversity of science communities within the larger cultural community of science. The next section discusses the cultural community of science education as "culturally enacted", in line with the quote at the beginning of this chapter (Siry, 2013).

2.5 Science education cultural community

Science education is the fourth community of interest to this study. Science education is a specific community within the education community. Its existence is evidenced by the wealth and breadth of its body of research literature (Bell, 2005; De Boer, 1991; Hodson, 2009).

In recent years there has been a growth in research focussed on science learning in the early years (Campbell & Jobling, 2012; Eshach & Fried, 2005; Eshach, 2006;

Gelman & Brenneman, 2004; Worth, 2010). The rationales purposed for the importance of science learning for young children are many. They include evidence that

- Young children are capable of abstract and some complex thinking (Gelman & Brenneman, 2004; Siry & Lang, 2010).
- Young children's natural curiosity provides a motivational reason for children to be involved in science learning (Backshall, 2000b; French, 2004; Holt, 1989; Johnston, 2005; Siry, 2013; Alward et al., 2014; Worth, 2010)
- Young children doing science benefits their general physical, social and emotional learning (Holt, 1989; Eschach & Fried, 2005; French, 2004; Worth, 2010)
- Science learning has benefits for language learning and building conceptual understanding of aspects of the physical environment (Burton & Thornton, 2010; Campbell, 2012; French, 2004; Siry, 2013)
- The early experience of science can develop the children's positive attitudes towards science (Eschach, 2006; Holt, 1989)
- Early experience of science phenomena leads to better understanding of science concepts in more formal settings later in life (Eschach, 2006)

The early childhood science education research relevant to this project relates to how children can be inducted into aspects of the science community within the ECE community. Play has been identified as an important way children learn and explore the physical world related to children beginning to be inducted into science learning (Johnston, 2005; Alward et al., 2014). Research has also identified how children engage in learning about the physical environment and science through dialogue (Campbell, 2012; Fleer & Raban, 2006; Robbins, 2005; Siry et al., 2012). Another thread of research has investigated children's interests in the physical environment and how this can be a catalyst to their science learning (Inan et al., 2010). This study aims to add to the understandings of how young children are inducted into aspects of the science cultural community.

As part of my earlier work, I identified 14 science processes of inquiry that were then evident in the early childhood science education literature (Backshall, 2000a). The table from my dissertation is presented here.

Table 2.1 Identification of Process Skills from Literature

Process Skills	**J**	**H**	**F&A**	**La**	**Li**	**Ho**	**H & R**	**O**	**Total**
Observation	#	#	#	#	#	#	#	#	**8**
Questions	#	#	#	#	-	-	#	-	**5**
Classification	#	-	#	-	#	#	-	#	**5**
Hypothesis	#	-	#	-	#	#	-	#	**5**
Communication explanation	#	-	#		#	-	#	#	**5**
Prediction	#	-	-#	#	-#	#	-#	-#	**7**
Investigation	#	--	--	--	-	#	#	-	**3**
Interpretation of data	#	#	-	#	-	#	#	-	**5**
Description	-	#	-	-	-	-	-	-	**1**
Comparison	-	#	-	-	#	#	-	-	**3**
Problem solving	-	#	-	#	-	-	-	-	**2**
Record information	-	#	-	-	-	-	-	-	**1**
Measurement	-	-	-	-	#	-	#	-	**2**

Key to the eight references:

. # represents the process skill being mentioned in the science education text.

J: Johnston, J. (1996)

H: Van Hoorn, J., Nourot, P. Scales, B. & Alward, K. (1999)

F&A: Fleer, M. & Atkinson, S. (1995)

La: Lally, M. (1991)

Li: Lind, K. (1991)

Ho: Holt, B. (1989)

H&R: Harlan, H. & Rivkin, M. (2000)

O: Owen, C. (1999)

Table 2.1 indicates that there has long been evidence that young children engage in a range of science inquiry skills and that they are capable of complex thinking about science ideas (Gelman & Brennenman; 2004). Eschach and Dor-Ziderman (2011) highlights this and asserts that if we do not work to develop these skills we are missing an important opportunity: “Moreover, it may be that by ignoring the development of inquiry skills and reasoning at this age we are missing an important window of opportunity for expanding young children’s scientific thinking” (p. 435).

Zeitler (1972), Kirkwood (1991) and Johnston (2009) illustrate this point in depth. Zeitler (1972) investigated whether three-year-old children can be taught scientific observation skills. Zeitler’s research concluded that some observational techniques can be taught to three-year-old children. Kirkwood (1991) found that a University of Waikato interactive science model developed from research with older children could be applied to New Zealand kindergarten (three- to five-year old children) with some success. Johnston’s (2009) investigation illustrated how young children’s observation skills developed with age in the strategies they employed to examine different toys.

The Preschool Pathways to Science project (PrePS) emphasises the importance of facilitating children into ways of thinking, doing and understanding science (Gelman, Brenneman, Macdonald & Roman, 2010). The PrePS study provided evidence that teacher directed activities could facilitate the learning of science-specific processes of inquiry.

Inan et al., (2010) investigated how the natural sciences were part of a Reggio Emilia inspired laboratory school. These researchers developed a taxonomy of ways children engaged with science. Included in the taxonomy were the uses of science process skills, along with using books and the internet as research tools for science learning (Inan et al., 2010). In their study the teachers’ approach was to work from children’s inquiries and questions and to encourage finding answers by searching. Examples from the research were children using a small fan to explore the characteristics of the wind as well as observing weather episodes and representing their ideas and theories through drawing, painting, dancing and dialogue. This study builds on this work to investigate children’s involvement in science processes of inquiry. To this point the discussion on the four cultural communities has focussed on their separate identities, but as noted earlier the communities interact with each other in children's lived experiences. The notion of hybridity is used to describe the interactions children and teachers have across the four identified cultural communities.

2.6 Hybridity of practice across all four cultural communities

The interest in the concept of hybridity for this study is in how teachers and children might perceive and use cultural community practices from each of the four identified communities to engage in science teaching and learning. Hybridity is defined as the use of a community practice across a number of cultural communities (Gonzalez et al., 2005; Wadham et al., 2007). As people join and come to belong to a number of communities, they incorporate some of the practices from a particular community into the other communities of which they are members. In this way some practices are found in more than one cultural community (Gonzalez et al., 2005; Rogoff, 2003; Wadham et al., 2007). For example, practices associated with information communication technologies are used by a number of cultural communities. However, these practices may not be used in exactly the same way, as in the case of taking photos. For the everyday community, the practice of taking photos of people could be about maintaining interest and relationships between people. On the other hand, the practice of taking photos for a biologist might be about recording changes of the growth of a living organism.

At the same time, some practices are distinctive and specialised within a particular community (Eberach & Crowley, 2009). For example, in the community practice of biology, a distinctive practice would be genetic engineering. It is the interrelationships between the four cultural communities that is of interest in this study, specifically the potential for both shared and distinctive practices to be used and to influence children's learning. The many possible relationships between the four communities are represented in the following diagram. The overlapping sections of the diagram represent possible hybrid or sharing of practices between different combinations of the four communities. This study investigates which of these many interrelationships play a role in children's learning of science.

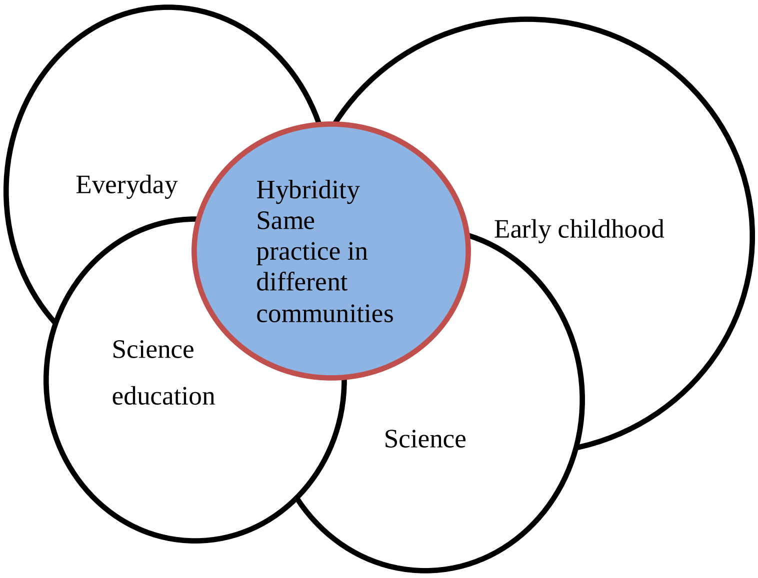


Figure 2.2. *The hybridity of practice across the four identified communities.*

To reiterate, the diagram illustrates that, given the ideas discussed above, there will be times when the four cultural communities are using the same or similar practices and times when the communities will be using practices that are specific to that community. In this study the researcher aims to explore these relationships to illuminate how they may be influencing science teaching and learning for young children.

2.7 Semiotics within and across cultural communities of practice

Semiotics within and across cultural communities of practice is the second of the three conceptual reference points that were outlined in the introduction to this chapter and that underpin this study. This section sets out the definition of semiotics used in this thesis. Then the literature on intertextuality is used to discuss how several texts as semiotic artefacts can be used to gain enhanced understanding of an aspect of a community's practice and how there may be varied interpretations for any one artefact.

2.7.1 Semiotics

Semiotics involves the study of how people respond to, make meaning from, and/or interpret signs and signals within their communities of practice (Hervey, 1982, Lemke, 1998; Stables, 2005). Lemke (1998) asserts that the signs and symbols that are interpreted and used for meaning-making include artefacts such as words, images, symbols, equipment and actions. These semiotic artefacts are what denote meaning and support meaning-making within a cultural community. Put another way, semiotic artefacts are the physical items and mental processes communities use as part of their practices (Lave & Wenger, 1991; Claxton & Wells, 2002). The artefacts that a cultural community uses are the tools young children need to learn about and learn to use to participate in that community (Hervey, 1982, Lemke, 1997; Wadham et al., 2007). Examples of physical artefacts in common use in the everyday communities of which children are members include the microwave, the iPad and the digital camera. Children learn how to use physical artefacts like these by watching others use them (Rogoff, 2003). Mental artefacts include the cognitive meaning-making strategies used within a cultural community of practice (Claxton & Wells, 2002; Lave & Wenger, 1991; Rogoff, 2003; Wadham et al., 2007). Examples of mental artefacts are language, artistic representations and scientific procedures (Wells & Claxton, 2002; Lave & Wenger, 1991; Rogoff, 2003; Wadham et al., 2007). Children learn to use these artefacts by interacting with others in a community and by participating in the community's practices (Rogoff, 2003). To reiterate, semiotics involves the study and interpretation of physical and mental artefacts. Semiotics provides a useful framework for this research project because the project aims to investigate how children engage with and give meaning to the various physical and mental artefacts to be found in the four communities identified in the previous section. The use of semiotics as a conceptual framework is congruent with a sociocultural orientation to learning through its emphasis that children learn science through engagement with science-specific semiotics including language, visual representation, mathematics and actions (Eschach, 2006; Lemke, 1998; Sawyer, 2006; Siry, 2013).

2.7.2 Intertextuality

Intertextuality as a concept supports considerations of how texts can be and are interrelated by an individual to gain understandings. From its origins intertextuality was derived to describe the process of passage (how people make connections between) from one signal or sign system to another (Kristeva, 1984, pp. 59–60). The significance of intertextuality is in its intention to and description of how different texts are related to each other and the learner within the learning process (Kristeva, 1984; Wolfreys, 2004). Research in science education illuminates that meaning-making often occurs through the connections of many texts within a cultural community (Lemke, 1992; Varelas, Pappas, & Rife, 2006). From this premise a text in itself is considered a semiotic artefact in that the text contains a sign-system or understanding for the individual (Hervey, 1982; Jesson, MacNaughton & Parr, 2011; Lemke, 1992).

The intertextuality of artefacts for meaning-making can be explored in two ways. The first is through the intertextual links across the various texts or semiotic artefacts that children engage with as part of their meaning-making about a particular idea or phenomena. The second way is how <u>different</u> children might interpret <u>one particular text</u> or artefact differently (Lemke, 1992). The importance of these ideas to this research is in understanding how teachers perceive children making connections to and between a variety of texts to create science-related or science-specific meaning. Also of importance is the different ways children are interpreting the same text within the same physical environment. These two types of intertextuality are discussed next.

Research illuminates that meaning-making can occur through the learner making and expressing meaning through a combination of a number of texts that are connected in the learners' thinking (Lemke, 1992; Varelas et al., 2006). Lemke (1992) has researched the multiple texts students used to learn science at a tertiary institution. His work describes explicitly the interlinking of semiotic artefacts by older students in their making and expressing meaning in science. Lemke shadowed a successful tertiary student and found that the student used diagrams, articles, laboratory work and lectures to formulate his science understandings. Varelas et al. (2006) have investigated how children engage with a variety of texts as part of their developing conceptual understandings of evaporation. They found that children and teachers employ and connect a variety of texts to create science-related or science-specific meaning.

The second way intertextuality can be explored is through the varied interpretations different people have of a single artefact because their particular past and present experiences inform their meaning-making about that artefact (Lemke, 1998; Wolfreys, 2004). The idea being driven by this branch of intertextuality studies is that the identification of perceptions people have of a text or semiotic artefact is derived from the communities to which they belong (Wolfreys, 2004). Intertextuality as an analysis tool is useful in describing how semiotic artefacts (as texts) may be interpreted by children and teachers within the science teaching and learning process.

Both types of intertextuality are pertinent to this study in offering a way to understand young children's meaning–making related to science. Studying how children use a variety of texts as semiotic artefacts allows a focus on how the learner and/or the teacher employs and connects a variety of semiotic artefacts to create science-related and science-specific meaning. The study aims to address the gap in the research related to intertextuality to science learning for young children. From the readings on intertextuality, the text seems to belong mainly to one community. For example Jesson et al. (2011) have investigated the domain of English literacy and Varelas et al. (2006) have investigated concepts within the cultural community of science. As well as the intertextuality of semiotic artefacts within communities, this research project will investigate the hybridity of practice across communities. The concept of intertextuality is useful for this study as it supports an analysis of how children are interpreting texts or semiotic artefacts and the relationships between texts. The concept of hybridity is useful to this study as it will illuminate how practices used in more than one of the four cultural communities influences the teaching and learning of science for young children.

2.8 Teacher influence on children learning science

The third of the three conceptual reference points identified in the introduction of this chapter is that of teacher influence on children learning science. Teachers are the key adults of influence in the early childhood learning environment as they are the hosts of these educational settings. They dominate, to a large extent, the ethos as well as the physical environment available to children (Anning & Edwards, 2006; Slattery, 1995). Fleer (2009a) makes this point clearly when she states, "What children pay attention to is determined both by what is in the environment that can be explored and what adults or significant others around them, point out" (p. 282). In making this statement, Fleer indicates she takes the environment to include the space, the resources, people and experiences that learners and teachers are involved in with each of these aspects recognised as influencing children's learning (see also Carr, 2001b; Claxton, 2002; Slattery, 1995). This study explores teacher influence on both the physical and social environment in relation to how it might support children learning science.

The notion of affordance as proposed by Gibson (1979) is useful in thinking about and understanding the role of the environment as an influence on and context for learning. The essence of affordance is that the affordance is perceived and owned by the *individual* and not the object or environment being considered (Gibson, 1979; Norman, 1988; Scarantino, 2003). Gibson used the term affordance to describe the potential uses or "action possibilities" of innate objects in the physical environment. Affordance can be explored in terms of an environment's physical characteristics, its potential uses as a tool to be used towards achieving a goal, and/or its threats to achieving a goal as perceived by different individuals.

Gibson (1979) also acknowledges the importance of social affordance through his discussion of what people can afford for each other. Social affordance is linked to and involves the interactions and communication that takes place between people (Kono, 2009). In the literature social affordance is discussed as affordances for learning arising from other people (Rietveld & Kiverstein, 2014). It is linked to the idea that people learn through social interaction and participation in cultural practices (Rogoff, 2003), and hence it is congruent with a sociocultural view of learning. In this study the main interactions and communications to be investigated are those that occur between teachers and children and that promote science education. The notion of attunement (Kirch, 2007) is also used in this study to consider the influence of teachers' awareness of the various science communities and their awareness of children's interests and ideas about the physical world around them.

2.8.1 The physical context and its affordances

Recognition of the importance of the physical environment as a teaching and learning resource is not new in early childhood education (Fraser, 2006; Greenman, 2005; Mawson, 2010). There is also research on how a teacher might perceive and understand the physical environment as affording science learning within an integrated curriculum framework (Fleer, 2009a; Inan et al., 2010). This section provides an overview of what the literature identifies about the physical environment in regard to young children's science-related and science-specific learning.

The first point to note is that the affordance to science learning within an early childhood integrated learning environment needs to be recognised by the teachers. This affordance cannot be taken for granted and will vary from person to person. A study by Alward et al. (2014), for example, demonstrated that scientists from different disciplinary backgrounds perceived different affordances for science in the same play environment. These authors brought scientists from different science communities into an early childhood centre to observe children engaged in play. The chemist linked children's sand play to the beginnings of investigating properties of wet sand, while the biologist noticed children observing snails on the wooden edge of the sandpit. The biologist linked children's observations to children learning about snail behaviour. This research project investigates what teachers note within the physical environment as being able to afford children's science learning.

Fleer (2009a) has researched how the physical environment affords to four- and five-year-old children's experiences of a material rich play-based curriculum. Her findings indicated that unless teachers mediate children into learning science concepts as the children play with resources, their play simply involves children in everyday conceptual development and not science-related conceptual development. This finding is congruent with the sociocultural view that people/ children need to be inducted into science communities of practice. Research by Inan et al. (2010) contributes to an understanding that teachers need to identify the places where science learning can take place within a free-play Reggio-inspired curriculum. These authors identified that science learning within the early childhood setting can happen in almost every area. However, for science learning to happen there needed to be interaction between teachers and children around the children's interest in a physical phenomenon. On the other hand, Campbell and Jobling (2012) discussed the need for a rich variety of materials for children to explore. These authors noted that teachers can acquire or build physical resources with a particular affordance to children's science learning in mind; for example, the inclusion of a ramp to support children's learning about inclines and gravity.

This thesis investigates two aspects of teacher affordance influencing children's science learning. The first is teacher affordance of the physical environment to foster science learning. The second is teacher social affordance linked to their understanding of the five communities of science (biology, physics, chemistry, geology and astronomy) and how teachers afford appopruntities for learning in the environment through their interaction and communication with children for children to learn about these five communities.

2.8.2 The social context and its affordances

As noted earlier, the phrase social affordance is used in this thesis to refer to interactions and communication between teachers and children. Social affordance also refers to the situations teachers set up that provide children with opportunities to interact and communicate with each other. The early childhood science education literature identifies that children's interactions with their teachers are a major influence on children's learning science (Eschach & Dor-Ziderman, 2011; Fleer, 2009b; French, 2004; Johnston, 1996; Siry & Lang, 2010). Indeed, responsibility for inducting children into science community practices rests largely with teachers (Eschach, 2006; Robbins, 2005). These teacher-child interactions can be spontaneous and contingent and/or they can be part of situations teachers set up to support children to interact and communicate with each other. This section considers the idea of social affordance with emphasis on the role of teacher dialogue.

Duschl (2008) acknowledges the importance of children's engagement in science dialogue by referring to America's National Research Council's identification of four dialogical knowledge-building processes:

- Know, use and interpret scientific explanations of the natural world;
- Generate and evaluate scientific evidence and explanations;
- Understand the nature and development of scientific knowledge;
- Participate productively in scientific practices and discourse. (National Research Council, 2007).

These four dialogic-building processes are identified for school age children but dialogue as a specific type of interaction has gained some prominence in research in early childhood science education (Campbell, 2012; Fleer & Raban, 2006; Siry, 2013; Siry et al., 2012; Siry & Lang, 2010).

Early childhood research has identified ongoing critical dialogue between teachers and children and between children themselves with three distinct functions in the science teaching and learning process. First, it supports *children's developing thinking processes* in ways that move these towards those used by scientists (Siry, 2013; Siry et al., 2012). Second, it can support *children's construction of knowledge;* that is children's introduction to and opportunities to use science language in ways that promote and provide a richer way of looking at and understanding the world (Campbell, 2012; Eshach & Dor-Ziderman, 2011; Gelman & Brennenman; 2004). The third function of dialogue is that it gives *teachers opportunities for insight* into each child or group of children's ways of knowing and developing interpretations of the practice of science (Siry & Lang, 2010).

Siry and colleagues provide a number of examples of dialogue supporting children to think more like scientists. Siry et al., (2012) worked with a group of four- to six-year-old children who were given the opportunity to explore water through open-ended activities. One of the examples they detail is of two boys who played with water using two bowls. The boys' explanations of the physical phenomena emerged through their action and dialogue in a manner similar to that of a scientist. In another example, Siry and Lang (2010) followed a group of second grade students (five to six-year-olds) who were discussing the decomposition of a pumpkin. One of the children described his learning about pumpkins as having seeds. The role of teacher interactions in these open-ended science investigations is to facilitate children to think further about the physical phenomena (Siry, 2013). For example, when in the group, exploring the concept of floating and sinking one of the children took an eraser and placed it on a piece of wood, the student teacher asked, "Why does it float? This led to a discussion between the teacher and the child about which variables contributed to the eraser floating (Siry, 2013). Across these articles Siry and colleagues explained that by listening to children's group interactions the teachers could assess what science processes the children were using. The value in terms of the teaching of science was that the teacher could facilitate further learning based on the science concepts and processes the children were interested in and discussed.

2.8.3 Teachers being attuned to children's interests related to science

This section has a somewhat different focus from the previous one. It directs attention to teacher characteristics and actions that enable them to activate the physical and social affordances of the environment. For the purpose of this study, the characteristics and actions are considered through the notion of attunement. Kirch (2007) states, "Attunement can be thought of as an interpretation or specific perception of what is happening in any given situation" (p. 790).

The importance of Kirch's statement is that attunement can be used to identify the influence of teachers' interpretations on the children's potential science learning. Integral to the interpretations teachers make is their understanding of the practices of the cultures involved (Kirch, 2007). As set out earlier, for this study the cultures of interest are everyday, ECE, science and science education.

Kirch (2007) notes that attunement for science learning depends on a teacher's body of knowledge in science as well as their attunement to children's interests and ideas about the physical world around them. Teachers linking access to science learning through children's everyday community experiences has been discussed as meaningful/relevant connections when working with older learners (Aikenhead, 2006). Teachers thinking and acting to make these connections can be thought of as them being attuned to the opportunity to make links between children's everyday and science ideas and practices. They need to be attuned to opportunities for meaningful science learning within children's play in order to notice and respond in ways that provide meaningful contexts for children learning science (Fleer, 2009a, 2009b; Siry, 2013; Worth, 2010).

Also relevant but not mentioned in terms of attunement specifically is teachers' attunement to ideas from science education — how children learn and can be assisted to learn science (Fleer, 2009a). Research on teachers' understanding of children's likely science-related ideas and ways to move these towards ways of scientists has illustrated the need for teachers' professional learning about science and early childhood science education pedagogy (Watters, Diezmann, Grieshaber & Davis, 2001; Fleer, 2009b). Important to this study is that teachers pedagogical and pedagogical content knowledge includes how to facilitate science learning within an integrated curriculum. The complexity of this pedagogical challenge arises from the need for teachers to make connections across subject content (in this case science) and the everyday communities that children engage with through their children learning experiences and play (Hedegaard, 2002; Fleer, 2009b). While science education researchers do not always use the word attunement, the essence of its meaning can be seen to be implied within early childhood science education research that endorses the value of dialogue for learning (Siry, 2013; Siry et al., 2012; Siry & Lang, 2010)

Being attuned to a learner and a learning situation involves entering into a responsive, dynamic and flexible state where interpretations change as learners and teachers interact as learning occurs (Roth, 2005). Put another way, a teacher's attunement can be thought of as their responsiveness to the needs, interests and ideas of the children they are teaching, which often takes place as part of dialogue while children are engaged in play.

To conclude, Section 2.4.3 has directed attention to the influence teachers have on children's science learning through their management of the physical and social contexts. Within teacher interaction the physical and social contexts can come together to support rich science learning for children (Eschach & Dor-Ziderman, 2011; Fleer, 2009b; Siry & Lang, 2010). The concept of affordance was introduced to explain that the potential for learning is not inherent in the physical or social environments. Rather children's science learning relies in a large part on how teachers perceive the physical environment and children's interactions with it as having potential for science-related or science-specific meaning-making. Teachers' attunement to and response to children's ideas about the physical environment and the social supports teachers provide is what activates the affordances for children.

The concepts of affordance and attunement have only recently begun to be explored in early childhood science education. This study investigates their potential in understanding science teaching and learning in the context of a play-based curriculum. The hypothesis this researcher is putting forward is that when teachers take account of or engineer affordances for science learning in the physical and social environment and they are attuned to children's interests and ideas, they are better able to scaffold children's science thinking and interests through their interactions with children and this then creates opportunities for rich science learning.

2.9 Conclusion to chapter two

This chapter identifies and describes the three conceptual reference points that are used to frame this research project. The three conceptual reference points are multiple cultural communities of practice, semiotics within and across cultural communities, and teacher influence on children learning science. Together they point to a gap in the literature this thesis will address.

2.9.1 Identifying the research gaps

i. Multiple cultural communities of practice

This study aims to identify and analyse any links between the four cultural communities identified earlier in this chapter which are thought to influence children's science learning. While there is research on the links between everyday and science communities of practice (Fleer, 2009a; Hedegaard & Chaiklin, 2005; Siry, 2013), this research project investigates the inclusion and roles of two further communities — ECE and science education. This focus leads to the question of how the four identified cultural communities of practice influence science learning for the children within an integrated play-based curriculum. Answering this question will extend the understandings on the dynamic interplay between the everyday, ECE, science and science education cultural communities in relation to how young children learn science.

ii. Semiotics within and across cultural communities

Researchers have begun to explore the types of resources useful for children's science learning (Campbell & Jobling, 2012; Fleer, 2009a, 2009b; Johnston, 2005; Alward et al., 2014; Worth, 2010). This thesis aims to extend this work by using semiotics and intertextuality as frameworks to analyse the artefacts children engage with in and for their science learning. The proposition is that the lens of semiotic artefacts and their interrelationship as part of children's learning will add richness to the description and understanding of early childhood science pedagogy. Eschach, Dor-Ziderman and Arbel (2011) acknowledge that the pedagogy of how young children learn science is still unclear. Investigating how science is enacted through semiotics and intertextuality will expand the understanding of the pedagogy of science learning for young children.

iii) Teachers' influence on children learning science

Most of the research regarding teachers' support for science learning has either been carried out on children five to eight years of age or outside the context of an early childhood centre play-based curriculum. Three studies have explored how teachers might afford children learning science within an integrated play-based learning environment (Fleer, 2009a, 2009b; Inan et al., 2010; Watters et al., 2001). Further research is needed on how teachers' might afford science processes of inquiry in and through the physical environment. There is also a need for further research on teachers' attunement to science learning within the physical environment and teachers' interactions with children, as these shape children's science learning.

The next chapter will describe the methodology and research design used in this research project

.

3 Research Methods and Design

"What does it mean to take a sociocultural perspective on science education? Most basically it means viewing science, science education, and research on science education as human social activities conducted within institutions and cultural frameworks" (Lemke, 2001, p. 296).

3.1 Introduction

This study aims to enhance the understanding of how science education takes place in early childhood play-based curriculum settings. In recent times research has begun to explore science learning and teaching within the parameters of a play-based curriculum (Fleer, 2009a, 2009b; Hedges, 2003; Inan et al., 2010). This research project aims to add to the knowledge on how science learning and teaching is happening in play-based early childhood curriculum settings. This study orientation is not underpinned by a push down curriculum approach (from primary science education) but rather is pursuing a proactive stance towards the promotion of science learning within early childhood education play-based settings.

Two main questions frame this study:

1. How is science learning and teaching being enacted in three kindergartens?
2. Does enhancing teachers' knowledge of science and early childhood science education enhance learning of science for young children in these three settings? If so, then how does this occur?

The openness of question one is deliberate. It aimed to gain an overview of how and when science learning and teaching was happening. The purpose of the second question is to illuminate teacher influences on children's science learning within a play-based curriculum. Inherent within the idea of teacher influence is the need to attend to their understandings of the science communities' knowledge and practices as well as science education, ECE pedagogy and children's everyday lives.

3.2 Research framework

All research is informed by a number of related assumptions. Therefore, a research theoretical framework includes assumptions made about ontology, epistemology and the research methodology (Sarantakos, 2005; Waring, 2012). As indicated by the focus in Chapter Two, the methodology is underpinned by sociocultural theory. Sociocultural perspectives have already been established within research on early childhood science education (Fleer, 1991; Fleer & Robbins, 2003; Robbins, 2005; Siry, 2013). The general advantage of a sociocultural perspective in research is that it not only takes into account the interactions of individuals and their peers, but also how cultural tools (semiotic artefacts) influence learning (Lemke, 2001; O'Loughlin, 1992). The next sections identify the ontology, epistemology and methodology assumptions that have framed this study as sociocultural.

3.2.1 Ontological position

Ontology is concerned with the perception of the nature of reality. There are two broad contrasting positions related to ontology. The first position views reality objectively, emphasising that a singular reality exists independent of the person's perception of it. The second position views reality as subjective, emphasising that people construct their realities. This second position, often referred to as constructivism, sees reality as neither singular nor objective (Waring, 2012). Constructivism views the social world as being made up of a multitude of realities created by each individual (Waring, 2012). A constructivist view of reality allowed for the analysis of how children think about their engagement with the physical environment relative to the science communities. Constructivism also allowed for the analysis of teachers' perceptions of science and how children learn science.

A sociocultural perception on the reality of learning aligned with the constructivist idea that individuals create realities for themselves. These individual constructs of reality are influenced by the communities where they belong (Sarantokos, 2005). A sociocultural perspective acknowledges groups of people construct a reality based on common goals, customs, values and beliefs (Wadham et al, 2007; Wenger, 1998). Different group realities can be referred to as cultural communities of practice (Lave & Wenger, 1991). In educational research where teachers' and children's realities are important for understanding the learning and teaching process, a sociocultural approach to reality is a good fit for purpose. The reality of science learning and teaching in the three kindergartens is found in the complex integration of the 'realities' perceived by individual children and teachers. In this science education research project, the researcher's perceptions of the science learning that took place also became part of the integration of realities, as the researcher was a participant observer. The reality of science education in the researched contexts is also influenced by the teachers' perceptions of the four identified communities of practice. This thesis asserts that by accepting the rich complex understandings of both individual and cultural communities' realities, an enhanced understanding of science learning and teaching within play-based curriculum contexts can be gained.

3.2.2 Epistemological position

Epistemology is concerned with how people know what they know (Waring, 2012). In other words, "What is the way in which reality is known to us?" (Sarantakos, 2005, p. 30). Knowledge like reality can be framed in a variety of ways. The binary that tends to be explored within the notion of epistemology is that of positivist and interpretivist views of how knowledge is perceived (Waring, 2012). Positivism is a view that knowledge exists externally to the learner and is in the world to be observed and understood. Interpretivism positions knowledge as an interpretation of the world, meaning it can be different for different individuals and for different cultural communities (Waring, 2012). Sociocultural theory promotes knowledge as being constructed by communities of practice rather than being out in the world waiting to be discovered. Learners make meaning through social interaction with others in a community and come to understand the values and practices (Lave & Wenger, 1991; Sarantakos, 2005).

Saranakos (2005) explains, “Here the construction of meaning is based on culturally defined and historical situated interpretations and personal experience” (p. 39).

This quote by Saranakos fits with the sociocultural focus of this study and accepts that children learn in the early childhood environment from their peers and teachers, as well as from the communities to which they belong (Carr, 2001b; Claxton, 2002; Wadham et al., 2007; Wenger, 1998). Children’s learning is embedded within the contexts they experience. Therefore, meaning-making is derived through transactions between people and objects (Lemke, 2001). In the words of *Te Whāriki*, children learn through their participation with people, places and things (Ministry of Education, 1996, p. 43).

3.2.3 Interpretive, ethnographic study

A qualitative interpretivist research design was employed within this research project. The focus was on capturing an authentic narrative from the three kindergarten early childhood education settings (Hughes, 2001). The research interpretive focus was on understanding teachers’ perceptions of children’s thoughts and actions that could count as science-related or science-specific learning. It included children’s interpretations of their meaning-making about the physical environment, specifically relative to their engagement with practice linked to science community of practice. This research explored these interpretations within three kindergartens to make sense of science-related or science-specific learning and teaching.

There are a number of different approaches to interpretive methodology (Cohen, Manion & Morrison, 2000). The approach used in this study is ethnomethodology. Ethnomethodology explores a wide range of social activity, seeking to understand how people make sense of their world (Cohen at el., 2000). Ethnomethodology is based on three assumptions as set out by Wood (1979; cited in Cohen, et al, 2000). The first assumption is that people act towards objects and experiences based on the meaning they have for them and their meaning-making is influenced by two different worlds. One world is the physical environment and another world is the social environment. The social world is derived of symbols that enable people to attribute meaning to objects and events. Ethnomethodology provides a research platform for considering the meaning given to artefacts by children and teachers in their meaning-making in relation to science learning and teaching.

The second assumption of ethnomethodology is that "attributing of meaning to objects through symbols is a continuous process" (Cohen, et al, 2000, p. 25).

This recognises that people individually construct, modify and negotiate meaning throughout their lives. There is a strong parallel here between this individual process of change of understanding over time with how communities of practice can also evolve and change over time (Lave & Wenger, 1991; Wadham et al., 2007). The interconnection between individual's placing meaning on objects and communities' meanings for objects was considered in this study through the notion of semiotics.

The third assumption of ethnomethodology is that the process of modification of meaning takes place through social contexts. Social contexts for learning happen within the cultural communities where people reside (Claxton, 2002; Lave & Wenger, 1991; Rogoff, 2003; Wadham et al., 2007; Wenger 1998). This study investigated the modification of meaning children and teachers made as they learnt more about the science community's knowledge and practice. Ethnomethodology as a methodology supports this research project in contextualising a sociocultural perspective within the research as a whole. Within this methodology a case study approach was adopted to study the complex phenomena of science learning within three play-based curriculum settings (Baxter & Jack, 2008, p. 544).

3.2.4 Case study approach

Case study is well established in educational research (Yin, 2014). A case study approach allows for the capture of data from real people in real situations and provides an in-depth perspective of what is happening within the setting being studied (Cohen et al., 2000; Flick, 2006; Merriam, 1998; Yin, 2014).

There are three conditions within a research investigation that indicate a case study approach is warranted. The three conditions are: “(a) the type of research question posed, (b) the extent of control a researcher has over actual events, and (c) the degree of focus on contemporary as opposed to entirely historic events” (Yin, 2014, p. 781). This research investigation meets all three of these conditions. The questions posed focus on how learning and teaching happens or could happen within the culture of early childhood education in New Zealand. Research information was wanted about how science learning and teaching occurs in a ‘natural’ setting, as experimental controls would not yield the required information. Finally, the research was set within the present rather than the past in terms of data collection. Hence, a focus on each kindergarten as a case was a good fit for this study.

3.3 Research design

The research project used purposive sampling to identify the three kindergartens (Tracy, 2013). The purposive selection process was based on all the teachers at each kindergarten being committed to the ideas of the research project and consenting to be involved. The Auckland Kindergarten Association agreed to be involved. The Auckland Kindergarten Association sent a message to all their kindergartens seeking kindergartens who were interested in participating in the research. Three kindergartens responded and so were selected to participate in the research project. The research then proceeded through the six stages detailed next.

3.3.1 Six stages of the research programme

There were six stages to this research project. Once informed consent was gained, the researcher spent one morning a week in each of the kindergartens for the duration of the data gathering stages of the research project. The attended session (4.5 hours) at each kindergarten occurred on the same morning each week for the duration of the data gathering. The researcher arrived with the teaching staff in the morning and left once all the children had departed at the end of the session. Each stage of the research is described below.

Stage one: The researcher shared information about the research project and gained consent from the Kindergarten Association and all teaching staff of each of the three kindergartens.

Stage two**:** *First three weeks in the kindergartens.* This was the time for the researcher to familiarise herself with the three kindergartens and begin to build relationships with the teachers, children and parents by participation in sessions. Giving time for the researcher to become familiar with the contexts and build relationships with the children, teachers and parents in the kindergartens supported access to quality data (Anning & Edwards, 1999; Robbins, 2007). This was also the time when, with the teachers' advice on process, a random sample of six children and one of their parents/guardians from each kindergarten was selected as the participant children/parent group. This was also the time for the researcher to collect descriptive observations of the overall contexts of the three kindergartens. The researcher collected information on demographics, physical environments and the overall assessment and planning procedures, and teachers' general views on the curriculum they presented to the children.

Stage three: *The following seven weeks.* During this time there was focussed participant observations of the participant children's (six from each kindergarten) engaged interest in experiences offered in the kindergarten, including their interactions with teachers and other children. The observations included photos of what the participant children were involved in during sessions. During this time the researcher viewed and made a copy of any general planning and learning documentation of the morning sessions and collected copies of any learning stories of the participant children. At the same time the researcher made general observations of the artefacts in the environment, and the activities any of the children or teachers and children were engaged in within the morning sessions. Towards the end of the seven weeks the researcher carried out individual interviews with each of the participant children from each kindergarten. The duration of the interview was approximately 20 minutes (see Appendix B for questions). The interview process included photos of the child engaged in learning experiences at the kindergarten as a trigger for discussion about the learning that took place from the child's perspective. The interviews investigated what learning the children thought was taking place in chosen incidents during the researcher's observations of the participant children. The chosen incidents reflected the researcher's assessment of the possible science leaning taking place and sought to gain a view of learning in those incidents from the children's perspective. There were also individual interviews with one of the parent/caregivers of each of the 18 sample children (see Appendix B for indicative question). This interview was to support the sociocultural emphasis of this research by gaining a wider view of how the learning incidents at the kindergartens were linked to the child's home or community interests and visa versa.

Stage four: *Professional learning stage: Teachers' negotiated professional learning.*

The researcher continued to visit the three kindergartens one morning session a week, observing the participant children's engaged interest in experiences offered in the kindergarten settings and teachers' interactions with the participant sample children. The researcher also continued with the general observations of the kindergarten sessions. During this time the researcher facilitated two, two hour sessions of professional development with all the teachers involved in the research. The professional learning focus enhanced teachers' knowledge of science and science education. The content was negotiated between the researcher and the participant teachers. The negotiation with the teachers occurred through discussions, researcher observations of the children's interests in the physical environment and teachers' answers to the interview question: What aspects of helping children learn science would you like to know more about?

Stage five: *The following seven weeks.*

This stage was a repeat of the naturalistic data gathering in stage three. This was also time for the teachers to ask questions about the science education relevant to the professional learning and their particular kindergarten environment. Appendix

B outlines the changes in the guiding questions for the interviews with parents, children and groups of teachers.

Stage six: The data were **analysed** and the thesis was written

3.3.2 The study involved participants in the following ways.

i) The teachers

- There were two group interviews of approximately two hours duration with the other teachers from each of the kindergartens. The interviews were audio taped and then transcribed. The interviewee had an opportunity to review their transcript and provide any correction to the meaning of the answered questions.
- Informal professional discussions with the researcher during the one morning a week she observed in the kindergarten session (from stage four onwards). These were recorded and used as data.
- Observations of teachers interacting with participant sample of children and photographed working with these children.
- Involved in collaborative/negotiated professional development with all the teachers involved in the research. There were two, two hour sessions.
- Their teaching documentation related to the participant children (assessment and planning documentation for the sample children) was read and copies made by the researcher.
- Teachers' general teaching documentation that was displayed in the kindergarten read and noted by the researcher.

ii) The children (participant sample only)

- Interviewed individually twice for approximately 20 minutes. The interviews were audio taped and then transcribed on the same page as the photos of the children engaged in the kindergarten experiences. Children interviewed were given an opportunity to review the summary of their interview with the researcher reading the transcription to them and giving them an opportunity to comment.

- Observed and photographed as they engaged in learning in the kindergarten sessions.
- Their learning stories and any other written documentation on their learning was read and a copy made by the researcher.
- Note: Other children who engaged in activities with the participant children were observed and notes were made of their activities. Notes were only taken to allow the actions of the participant children to be fully described and understood.

iii) Parents/guardians (participant sample only)

- Interviewed in their homes or at the kindergarten about their child's interests and how these interests were reflected between the kindergarten and the home. The specific focus of these interviews was to consider any learning relevant to the children learning related to science. The interviews took place during stage three and five of the data collection. The interviews were audio taped and transcribed. Those interviewed were an opportunity to view their transcript and to provide comment on the accuracy of the transcript.

3.4 Data gathering instruments

The data gathered from the three kindergartens was multi-layered, both in terms of the variety of participants and the variety of data gathering methods. Geertz (1973) refers to the multi layers as "thick description", meaning that the different layers of data gathered allowed for a fuller account of the learning and teaching of science happening in the kindergartens. A case study approach relies on multiple sources of data (Eisenhardt, 2002; Yin, 2014). This study engaged the research instruments of observations, interviews and documentation analysis from the three kindergartens. This section outlines how each of the research instruments was used in the data gathering process.

3.4.1 Observations

The researcher was a participant-observer within each of the three kindergartens. A participant-observer is known to the participants as the "researcher" but has the opportunity to interact with the participants within the research context

(Cohen et al., 2000; Merriam, 1998; Yin, 2014). A participant observer observes from within a setting and documents what is happening (Cohen et al., 2000; Yin, 2014). This approach provides the researcher with the opportunity to observe first-hand what is happening within a physical and social environment (Cohen et al., 2000). As a participant-observer the researcher spent time with the children, teachers and others who were participating in the kindergarten (Cohen et al., 2000; Merriam, 1998). Along with the benefits of participant observations, there are two dilemmas the researcher needs to keep in mind. The most obvious dilemma involves consideration of how the researcher's presence is affecting the research participants (Merriam, 1998). For this study this influence seemed to be more prominent for the teachers, than for the children and parents. For the teachers it appeared to illuminate their awareness of possible science learning and teaching. This was seen as an advantage for the research project, as it meant teachers' awareness to interact and create science experiences for children was heightened. For the participant children it was important to discuss with each of them what the researcher was doing and to gain permission from them to observe their play during the sessional observation. It is interesting to note that one of the participant children actioned his right to not be observed on a particular day. When Ben arrived at Pohutukawa Kindergarten, he came to the researcher and asked, "Please don't watch me today." The researcher honoured Ben's right to decline being observed. The next week when Ben arrived for the kindergarten session the researcher asked if it was all right to observe him today, he replied, "Yes, that's fine." What this example illustrates is that young children assenting or declining needs to be checked for each observation. They are just as able as adults to exercise their right and their views on whether they participate within the research. For the study, the three week introduction time was crucial to building the trust to allow the researcher to observe and interview the participant children with their willingness to assent.

The second dilemma for participant-observers using case studies is the decision of what and when to observe (Merriam, 1998; Yin, 2014). In this study it was impossible to observe a whole kindergarten physical setting and children for the duration of a 4.5 hour sessions. For this reason two types of observations were employed. The first was time sampling of 5–10 minutes of each of the participant children, two or if possible three times each session. The time sampling gave an indication of the types of engagements the participant children were having with the kindergarten sessions. The second type of observation was a general impression of the kindergarten sessions, recording the activities presented to the children each day, any changes in teaching staff, the weather and general assessment and teaching documentation.

Recording and interpreting the field notes is an important aspect of observation as a data gathering skill (Merriam, 1998; Yin, 2014). The researcher designated two field observation note books for each kindergarten. One field note book was used to write her general impressions of each session and the other notebook was specifically for writing the time-sampled observations of the participant children. Photographs of the general environments and the participant children's engagement in the kindergarten sessions augmented the field notes. The main reason for using photographs as a visual recording strategy was that it was a commonly-used practice in kindergartens already and so was not seen as invasive by the children (Hedges, 2007). While children can take photographs (Einarsdóttir, 2007), in this research project, the researcher took the photographs. The reason for the researcher taking the photographs was the need to identify and document children's engagement in the physical environment to do with science-related or science-specific learning. The children were not aware of what these engagements might be. One of the principles related to participant-observer is the importance of the observer having a sound understanding of the issues being studied (Yin, 2014). The researcher as an early childhood science educator was able to identify potential and actual science learning. Confirmations that what was in the photographs related to children's engagement in potential or actual science happened through asking the children what they were thinking when the photo was taken.

3.4.2 Interviews

Interviewing is one of the most common data gathering instruments (Sarantakos, 2005). Interviews are a powerful way of understanding other people's constructions of reality (Punch, 2005). All the interviews in this research project were semi-structured by nature. Semi-structured interviews include the use of some questions to focus the interview, but the interviewer can be flexible in order to respond to and gather view-points that had not been considered before the interview.

The interviews with the teachers were group interviews. Each group interview comprised of all the teaching staff from a kindergarten. This meant there were three separate groups that were interviewed. Appendix B outlines the focus questions for the interviews. Interviewing the teachers together gave an opportunity for teachers to check their ideas with each other and provided the teaching teams' perspectives on the questions. In the group interview that was semi-structured, the researcher was able to act more as a facilitator of a discussion (Punch, 2005).

The children and parent interviews were individual interviews in order to gain information on individual children's ideas of what they were thinking about when engaged with the physical environment. The research literature attests that interviews with children are different from interviewing adults (Einarsdóttir, 2007), with the difference identified as the lack of social experience with the interview and children's conceptual understanding of what an interview is. For this reason it is advised that young children's interviews are best facilitated as conversations (Gollop, 2000). Conversations support gaining in-depth understandings of young children's thinking. Researchers have found that conversations within the interview process with young children are sustained through the use of props, pictures or photos (Brooks, 2001). In this research project, photos of the children's engagement in the physical environment were used to support the interview process. During the early stage of interviewing the children, the researcher asked each child, "Can you tell me what was happening in this photo?" This often brought about a general discussion so the researcher changed her opening question in the interview to, "Can you tell me what you were thinking?" The change in the opening question for each photograph brought about clearer insight into the children's thinking. Interestingly, the replies about their thinking did not alter when the researcher verified with the children in a second interview about the answers the children had already given.

The parent interviews were an important triangulation of information about the participant children. The family is one of the significant influences on development and learning (Bronfenbrenner, 1979). The social context for learning in the early years incorporates the family and the wider community as part of the science education community (Cumming, 2003; Fleer, 1996). The early childhood educational community has asserted the importance of "parents as partners" in the sense of parents and teachers working in partnership for the educational well-being of children (Stonehouse, & Gonzalez, 2004). Fleer (1996) affirms this possibility within the domain of science by carrying out research that demonstrated how connections between home and a childcare centre can jointly support young children's scientific learning. Acknowledging the significance of the family influence on learning, the research project included data collected from the parent interview. The parent interviews verified that some of the connections with children's science-related interests were happening at home as well as at the kindergarten and vice versa.

3.4.3 Documentation

Included in the data gathering instruments was the collection of documents generated or facilitated by the teachers before or during the data gathering stage of the research. It is common practice for qualitative researchers to supplement participant observations and/or interviewing with analysing documents that are produced during the everyday events being studied (Marshall & Rossman, 2011). Documentation from a setting can be a rich source of information for detecting and confirming participants' values and beliefs (and understandings) in the settings that were studied (Marshall & Rossman, 2011). In this study the documents that were collected were from the participant children's portfolios and teachers' documentation on their assessment of children's learning that was available on the walls. In one case study, the teachers' planning book was available for parents to read was also collected.

3.4.4 Professional development

The second research question explored the benefit of science and science education professional learning for the participant teachers. To this end the researcher facilitated learning on both the communities of science and early childhood science education. Within research literature on teachers' professional learning there is a validation for researchers participating actively in the research (Hedges, 2007; Timberely, 2004). The philosophical stance is research "with" rather than research "on" teachers. In this study the professional learning sessions took into consideration both what was happening in the kindergartens for children and what the teachers indicated they would like to know about science learning and teaching.

As stated earlier in this chapter, there were two professional learning sessions involving all the teachers from all three kindergartens. Below is a description of the content that was covered in the two sessions.

Session One: The first professional learning session

The following content was covered:

1. A Power-Point photograph presentation by the researcher on the participant children's engagement in the physical environment and her perspective on how this linked to potential and actual science learning. The Power-Point did not work on the computer in the university room she had booked and so the following week she took time to show the presentation to the three groups of kindergarten teachers in their own kindergartens. All teachers got to see the other kindergarten's photographs

Handouts on the day were: (see Appendix G)

i. Alward, K., Nourot, P., Scales, B., & Van Hoorn, J (1999). *Play at the center of the curriculum.* (2nd ed.). Upper Saddle River, New Jersey: Prentice Hall

ii. Ministry of Education, (2004). Sociocultural Assessment: He aromatawai ahurea pāpori. (Book 13) in *Kei tua o te pae, Assessment for learning: early childhood exemplar.* Wellington, New Zealand: Learning Media

iii. Ministry of Education, (2007b). *The New Zealand Curriculum.* Wellington, New Zealand: Learning Media.

2. Discussed the links between the *New Zealand Curriculum Framework* and *Te Whāriki* goal three and four.
   The cultural knowing in science includes:

   The nature of science including science processes of inquiry, the living world, the material world, the physical world and the planet earth and beyond.

Session Two: Second professional learning session

The following content was covered:

1. The inclusion of what teachers had revealed in terms of what they would like to know more about (as evidenced in their answer to question 8 in the teachers first group interview, Appendix B)
2. An important aspect of the "culture of science" in the three kindergartens that the research was beginning to identify was how teachers discovered when the learning related to science was happening. The definition of science and science education was taken from Science in the New Zealand Curriculum Framework (2007a) and the other handouts from session one.
3. The researcher showed more photographs and talked about the movement experiences children were involved with. Pohutukawa Kindergarten had specifically asked for some professional learning about science aspects of movement.

4. Forces were identified by the researcher as a science content area the teachers wanted to know more about and how children had the potential of exploring this through experiences at kindergarten.
5. Discussion on Newton's three laws. Handout sheet from session in Appendix G
6. The teachers were invited to make "things" that moved with Duplo and string, balloons, cardboard and the wooden dowel that was supplied. The researcher and the teachers then had a discussion about what forces were involved with the movements they created and how the forces related to Newton's three laws on movement.
7. Seed germination – what are the science ideas? The teachers and the researcher reviewed a handout that described the germination process from a science perspective. This content was generated by the amount of seed germination experiences the children were engaged in at both Jandals and Pohutukawa kindergartens.

After session two the researcher also shared the reading *Everyday to scientific observation: How children learn to observe the biologists world* by Eberbach and K Crowley (2009). The article was discussed with the teachers at the teachers' second group interview.

3.5 Analysis of the data

The method of analysis for this study was data driven, which means the category system for analysis was constructed from the evidence collected (Edwards, 2001). Although the analysis was data driven, the constructs for the category system of analysis were informed by the literature on sociocultural theory as described in Chapter Two. Identifying these constructs in advance of the data gathering stage supported the analysis stage of the research; otherwise useful qualitative interpretations may be lost because of the time laps between data collection and analysis (Eisenhardt, 2002). The rich descriptive observations and researcher's impression as the data was collected was recorded in the field notes.

The analysis included descriptive and pattern coding related to the science learning and teaching of the participant children and general learning environment at each kindergarten as it became evident within the data collected (Punch, 2005). “Memoing” was used whereby the researcher wrote reflectively on the ideas being formulated through the coding, making sense of them in terms of possible theorising about how science education was occurring (Punch, 2005).

For the purposes of understanding the science learning happening in each kindergarten, each kindergarten was studied as a separate case over the seven months of data gathering. The analysis of each case involved identifying science-related and science- specific learning and teaching instances.In this way each kindergarten was seen as a distinctive learning community. This approach is consistent with a sociocultural perspective where context is important. It was appropriate given the exploratory nature of the study where no clear single set of outcomes to the research questions were available when the data was collected (Yin, 2014).

From this initial analysis the decision was made to use the extended investigation of snails in Jandals Kindergarten to illuminate the kind of science dialogue and inquiry that did and could take place in a play-based environment. The Jandals Kindergarten observations generated rich data on children and teacher involvement in inquiring about snails. The snail learning and teaching inquiries became chapter four of this thesis. Chapter five and six were developed through analysis that spanned all three case studies/ kindergartens. Chapter five presents a cross kindergarten case analysis that illuminates the semiotic artefacts children used to learn about and express their science ideas. Chapter six presents the range of teacher influences on children’s science learning; it focuses in on their affordances of the physical and social environment for science learning.

3.6 Ethics

An ethical principle that is integral to research involving people is their human right to respect and autonomy of choice of involvement (Coady, 2001; Punch, 2005). To this end, informed consent was gained from all adult participants before the research began. This included the Kindergarten Association, the teachers and parent participants. Special consideration was given to gaining *assent* from all participating children (Coady, 2001; Cohen et al., 2000). This is in keeping with the United Nations Convention on the rights of children (Coady, 2001). Informed consent/assent meant all participants received a written information sheet and consent/assent form to sign. In addition, the researcher read the children's information sheet to them and asked if they had any questions. The written information clearly described the research project and outlined the expectations of participants in terms of their individual involvement (Coady, 2001). The researcher made herself available to discuss the research with all of the participants. Following standard practice in research consent/assent, all participants were informed of their right to withdraw and withdraw unprocessed data from the research project at any time (Coady, 2001).

An interesting incident happened during an explanation of the research time with one of the participant children at Pohutukawa Kindergarten. As part of the agreement to participate, the children drew a picture or wrote their name in a box on the form the researcher read to them. This particular child nodded and showed interest while the researcher explained what her participation in the research would be. At the end of the discussion the researcher asked if the child was happy to be involved. The answer was "um hum" with a nod (meaning yes) and then added "but I'm not ready to sign yet." The researcher, after checking that the child did not want to ask any further questions about the research, respected this decision. A week later the child approached the researcher and said, "I'm ready to sign now." For the researcher this demonstrated that children as young as four years of age are able to consider and make these decisions. If the child had replied that they did not want to be part of the research, that answer would also have been respected.

Participants' confidentiality was respected. The Kindergarten Association was informed of the three kindergartens that consented to involvement in the research but information on the participant sample of children and parents from the kindergartens was confidential to each kindergarten concerned. The teachers in each kindergarten knew about each other's participation but did not have access to who the participating children and their parents/guardians were in the other kindergartens. The children and parents/guardians at each kindergarten were known to each other but the information remained confidential to that kindergarten. Participants were assured that confidentiality would be maintained. All data collected was coded and the codes kept separately from the data. Both the data and the codes for the data were kept in locked storage. Only the researcher and her two supervisors from The University of Waikato had access to the data. The researcher diligently ensured that the thesis, any articles published or papers presented at conferences would not contain identifying material. Further permission, towards the end of the research, was gained from parents and teachers to use their children's or the teachers' images in any published journal articles or lectures on science education for young children.

Three specific aspects of potential harm have been considered. The first was the participants' vulnerability to being perceived in a judgemental or deficit way. The assurance was that the focus of the research was to inform rather than to judge and so would be set in a positive discourse for all involved. The case study emphasis is based on reciprocal relationships (Yin, 2014). In this study it was between the researcher and the participants in terms of gaining an understanding of the science learning taking place. The second aspect was children's vulnerability to being used without considering the influence of the research on their well-being. During the data gathering time, parents/guardians of participant children, teachers and the researcher monitored the effect the research had on each individual child. If any of the parents had concerns about the effects of the research on a child, then that child would not be required to participate further. If children showed signs of or verbalised they did not want to participate their request was respected, as was expressed in Section 3.4.1 when the child asked not to be observed for that particular session. The third concern was the possibility of bringing change or disruption to the continuity of the kindergarten programme for all children attending the session. All possible care was taken to fit into rather than change the kindergarten's environment. The researcher was there to learn and focus on the cultures that existed in each kindergarten. Any changes that took place in any of the kindergartens after the teachers' professional development sessions were instigated by the teachers or at the teachers' request, not by the researcher. The aim of the professional development was to enhance practice by illuminating aspects of science and science education.

An information letter was sent to all parents at each kindergarten explaining the research and the researcher's presence in the kindergarten for the duration of the data collection stage.

3.7 Trustworthiness

Trustworthiness of data is an important part of any research. For this research project it was considered in three ways. Firstly, trustworthiness was considered through having a variety of data collection approaches. Here the trustworthiness was ascertained through the different data collection approaches identifying similar narratives or explanations for differing narratives (Edwards, 2001; Yin, 2014). The second aspect of trustworthiness related to interpretivist research and had to do with the authenticity in its representation of the participants' voices (Hughes, 2001). Trustworthiness was gained by giving the participants the opportunity to consider how the researcher was interpreting their understandings. In particular this happened through the adult participants having an opportunity to view the transcripts of their interviews and an opportunity to provide any corrections to any inaccuracies. For the participant children the trustworthiness of the interviews was confirmed through reading their comments back to them. The researcher wrote on the photographs of the children's engagement with the physical environment in a similar way to the learning stories teachers wrote with the children. Using the photographs and the children's voice about the photographs emulated the assessment of learning that was already happening in the three kindergartens. During the data analysis stage, identifying emergent concepts and theories were compared to existing research. This enhanced the trustworthiness of the analysis and was seen as important as the concepts and theories were constructed from a small sample of cases (Eisenhardt, 2002).

3.8 Conclusion and introduction of the next chapter

The variety of data gathered and the analysis of the data supports a rigorous analysis of how science learning and teaching was happening in the three kindergartens. The next chapter is the first of the analysis chapters and illuminates ideas about children participating in science dialogue and other processes of inquiry.

4 Children and teachers supported in the process of science dialogue and inquiry

"Children learn deeper knowledge when they are engaged in activities that are similar to the everyday activities of the professionals who work in the discipline" (Sawyer, 2006, p. 4).

4.1 Introduction

This chapter outlines an example of children and teachers being supported in moving from everyday processes of inquiry towards more scientific processes of inquiry, inclusive of dialoguing. The teachers and children at Jandals Kindergarten moved from mainly everyday ways of observing small animals towards more science-specific ways of observing snails. The catalyst for the change was the professional learning sessions the teachers attended and the direct advice from the researcher in terms of ways snails could be investigated.

Analysis of the children's science-related ways of observing the snails identified other science processes of inquiry being practised. The analysis incorporated America's National Research Council's (2007; cited in Duschl, 2008) dialogic knowledge-building processes of science. The four dialogical knowledge-building processes were identified as:

- "Know, use and interpret scientific explanations of the natural world;
- Generate and evaluate scientific evidence and explanations;
- Understand the nature and development of scientific knowledge;
- Participate productively in scientific practices and discourse" (National Research Council, 2007).

The four dialogic-knowledge building processes mentioned in Duschl (2008) are identified for school-aged science learning. What this analysis demonstrated was the beginnings of engagement in the four dialogic-knowledge building processes with children as young as three and four years of age.

Moving from everyday ways of observing small animals towards ways biologists would observe snails provided an opportunity to explore Sawyer's (2006) quote above in relation to children engaging in practices closest to the community of biologists.

4.2 Everyday observations

Findings from sessional observations at Jandals Kindergarten included many instances of children's natural fascination with small animals. Below are four vignettes that demonstrate the children's everyday observational interests in small animals.

4.2.1 Vignettes of children's natural fascination

i) Example one: Participant children's observation diary

Claire walked along the concrete path near the sandpit. She stopped in front of a big tree and felt the bark of the tree with her hands, while she looked closely at the trunk of the tree. "Ohhh ants," she said, and she intently watched the ants for two minutes, crouched at the trunk of the tree. Then she stood and walked on down the path to meet with some of her friends.

Figure 4.1. *Claire observing ants.*

ii) Example two: Sessional observation diary

Three boys were playing in the climbing boxes in the outdoor area when they found a cricket. “Cricket, cricket — catch it, quick catch it,” called one of the boys. The three boys spent three minutes trying to catch the cricket. “Ooh it jumped!” one of the boys exclaimed as the cricket jumped out of reach. They did not manage to catch the cricket and moved on to play with the boxes.

iii) Example three: Sessional observation diary

A group of four children were in the outdoor garden looking at the ladybirds on the pumpkin leaves. They let them climb on their hands and then watched them fly off their hands back onto the pumpkin plant. The conversation was about finding the ladybirds and watching them crawl on their hands. While looking for another ladybird, one of the children noticed a leaf had a hole in it and said to one of the other children, “A caterpillar ate that hole. Let’s look for caterpillars.” The group of four changed their focus to look for caterpillars and worms and started digging around in the soil. After they had been digging in the garden for nearly three minutes, without finding any small animals, the children left the garden to play on other equipment in the outdoor area.

iv) Example four: Sessional observation diary

A child noticed sparrows on the concrete area outside near the morning tea table. She said, “Look at the birds.” She stood watching two sparrows hopping along the concrete looking and finding small crumbs of food for 30–40 seconds and moved on to get her morning tea from her bag.

The everyday vignettes illustrate the children’s natural fascination and curiosity of small animals. The vignettes also illustrate children’s typical everyday observations of small animals in the immediate environment. The main characteristics of the children’s everyday observations included:

- Noticing small animals that they are familiar with, within the environment
- Fascination at looking at small animals
- Identification of animals through the use of their everyday names
- Desire to look for small animals which brought with it a beginning understanding of animals living in specific places/environmental conditions/habitat
- Children observed for small periods of time (between 40 seconds – 3 minutes) and seemed not to repeat the interest over the ensuing days or weeks that followed.

Recognising child-initiated everyday observations of small animals illustrated that these children had been mediated into the observation of their physical environment. Further examples from the full set of field notes and centre documentation identified the children were able to identify a worm, cricket, ants, snails, ladybirds and spiders (Appendix D). Children had learnt the names of these small animals from people in the communities where they lived. The adults involved could have been teachers, family members or people from the wider community.

The idea of looking for animals did not come to the children without adults first modelling looking for small animals. At Jandals Kindergarten the teachers instigated looking for small animals in the vegetable garden in two distinct ways. The first way was by pointing out small animals when the teachers themselves noticed them while gardening with children. Secondly, by suggesting and supporting children to look for a specific small animal that lived on a leaf e.g. ladybird, or lived in the earth e.g. a worm.

The value of these everyday observations of small animals was the interest they engendered in the living world and the general knowledge children began to build. In many instances the everyday observations contained a link to an aspect of some science conceptual knowledge. Examples of links to science conceptual knowledge from the vignettes of children's everyday observations include:

- Identification of small animals (e.g. worms, ants, sparrow, spider, snails, ladybirds)
- Beginning understanding of animals living in specific places/environmental conditions that link to the concept of habitat (e.g. ants in the tree, ladybird on the pumpkin leaf, worms in the ground)
- Different animals have different food preferences (e.g. caterpillar ate the leaf)

4.2.2 Teachers' facilitation of everyday observation of small animals

This next set of vignettes identifies instances where a teacher brought small animals to the attention of the children. Here, again, everyday observations were the predominant way of observing.

i) Example one: Sessional observation diary:

As Avril (teacher) was setting up the outdoor area she noticed a slug and a beetle in the bottom of the water trough. She decided to leave the small animals in the trough for the children to notice. Later when the children arrived, the researcher observed Avril asking two boys if they would like to see what was in the water trough. The boys came over and looked at the beetle and the slug. Avril told the boys that the small animals were a beetle and a slug and that they were in the water trough when she arrived at the kindergarten this morning. The boys looked at the small animals for 30 seconds and then moved off.

ii) Example two: Participant children observations

A small group of children and a teacher were looking at a small animal on the leaf of a plant. The teacher (Mary) commented that the small insect was called an aphid. The children looked at the aphid for a few minutes and then moved on to other activities.

iii) Example three: Sessional observation diary:

As the children came into the morning session many of them noticed the chrysalis on the swan plant. Jane (teacher) alerted interested children to the “just hatched” butterfly that was beside the plant. Children looked at the butterfly for between two to five seconds and moved on to other activities. Later that morning Jane brought the monarch butterfly that had hatched outside. A group of seven children gathered and Jane told the children how the butterfly had hatched in the weekend. Jane talked about the patterns on the wings and how the butterfly needed to dry his wings so he could fly. She then put the butterfly on a hanging basket and said, “When he is ready he will fly off.” Most of the children moved away when Jane went back inside. Two of the children stayed and watched the butterfly for five more seconds and then moved on to other activities.

The vignettes illustrate how the teachers introduced children to novice ways of observing small animals. Characteristically the novice ways of observing were the use of everyday language to:

- Identify small animals (slug, beetle and aphids)
- Observe the external morphological features (patterns on the wings of the butterfly)
- Discussion on the life stage of the animal (“hatched”)

Significantly, the teachers’ facilitation of small animal observation was very similar to the observations the children were making on their own. This supported the idea that the children had been mediated into everyday ways of observing small animals by the adults around them, namely the teachers.

4.3 Supporting teachers’ understanding of science processes of inquiry

Science processes of inquiry were part of the teachers’ professional learning sessions included in this research project. The professional learning content on science processes of inquiry included a discussion on the following literature:

- *Alward etal. (1999): Chapter 7: Science in a play centred curriculum.* This chapter advocates that processes are the science communities' way children use to seek answers about the physical environment they live in. The particular processes emphasised in this reference are observing, describing, comparing, questioning, problem solving, thinking about data, recording information and interpreting results. (Since this time the researcher has become aware of more recent editions of Van Hoorn et al., 1999 and has used the 2014 text further on in this thesis)

- *Ministry of Education. (2007b) Kei tua o te pai Book 13.* The discussion this booklet focusses on is the importance of children questioning as well as learning from their mistakes. The focus of doing science incorporates discovering new facts, new patterns and new relationships between things; the importance of working theories and how these are dynamic and serve a useful purpose; seeing knowledge as knowing where the emphasis is on knowing as a process, as a verb; and, again, articulating the need for involving doing and acting on things, on building relationships and connecting between things.

- *Te Whāriki, exploration goal three (Ministry of Education, 1996b. p.88).* The researcher and teachers discussed the ideas related to scientific processes of inquiry through the Exploration Strand, Goal Three. The main links made were observing, predicting, looking for patterns, classifying things for a purpose, guessing, using trial and error, thinking logically, making comparisons, asking questions, explaining to others, participating in reflective discussion, ability to identify and use information, perception of themselves (children) as explorers, as well as the confidence to choose and experiment with materials. All these processes were considered in terms of children making sense of the physical environment they live in.

4.3.1 Change in teachers' understanding of children doing science

The first interview with the teachers (Appendix B) provided data on their understanding of children involved in science processes of inquiry before the research intervention of professional learning took place. The main emphasis drawn from the interview was that the teachers thought that children learnt best by doing, by exploring the world around them with their senses. Children asking questions and using magnifying glasses to look more closely at things were two specific strategies mentioned by the teachers. The teachers valued what the deposition of curiosity could bring to science learning. For example, a teacher stated, "Children's natural curiosity is always part of science." The importance of trial and error, especially in terms of what would or wouldn't grow, was seen by the teachers as a valuable learning strategy for science. The teachers' comments illustrated a level of understanding about how the processes of inquiry supported children's learning in science.

Also notable were the answers to interview question three: "What science learning do you see happening at the moment?" The teachers' answers fell into two categories. The first category was science concepts. For example, they talked about insects, life cycle and gravity. The second category was contexts for learning science; for example, planting the garden, twirling the swing and ramps. The teachers' answers did not include the processes of inquiry, even though the process of inquiry was the main emphasis in the answers to the question, "Can you tell me what you know about how children learn science?"

In summary, the teachers' answers in the first interview indicated that science ideas rather than science processes of inquiry, inclusive of specific science strategies and dialogic knowledge building processes, were not at the forefront of the teachers' thinking about science learning for children. Validation of this is evident in the vignettes earlier in this chapter. The teachers seemed unaware of the science communities' specific processes of inquiry.

The second teacher interview took place after the professional learning sessions. The teachers' answers illustrated some shifts in their thinking about children being engaged in science processes of inquiry. Two specific comments from the interview illustrated the teachers' change in understanding.

"We've given children more opportunities to experiment themselves and have documented it. Whereas before we might not have done that…"

"Well we know about these words now that we always did know but are coming more into our documentation you know like investigating, comparing, experimenting."

In the second interview with the teachers there was a direct question related to Eberbach and Cowley's (2009) differences between everyday and science observations. The teachers' thinking about the reading was summed up by the comment: "To me the crux of it is was the quality of the observer, the observer's knowledge and how that impacted on how they observed and what they saw as valuable and relevant in their observations."

The quote above further indicated growth of awareness of the attributes for doing science that was not present before the professional learning sessions.

A further aspect mentioned by the teachers was the importance of scaffolding and how they had an active role in the scaffolding. When the teachers were reminded and/or became more aware of the science processes of inquiry, they also became more aware of the need to scaffold children into science processes of inquiry. The other significant change was that the teachers talked about starting to include language related to science processes of inquiry in the documentation of the children learning.

Below are three examples that illustrate a change in teacher language to include aspects of doing science related to children using science-related processes of inquiry.

Example One: Rhja's experiment. This example is a learning story written by a teacher on how Rhja thought the pea seeds in the outdoor garden and in an indoor pot were growing well. He wonders if the seeds would grow as well without soil. So the teacher helps him set up some seeds on a wet paper towel. Two weeks later the seeds are starting to sprout. First Rhja notices the roots and then the green shoots. He was able to perceive that seeds can grow without soil. The science-related process of inquiry is the setting up of an investigation and the systematic daily observations of any changes to the seeds and the formation of ideas about seed germination that come from the investigation.

Example Two: In terms of children being involved in processes of inquiry, below we have a prediction drawing of how the seeds would grow over time. The prediction drawing was made at the time the seeds were planted. The seeds were planted outside in the winter at the request of one of the children. The drawing was made at the suggestion of the teacher. The prediction drawing served two purposes. One purpose was for the child to be aware of her thinking about plant growth. Another was to remind the child of what she had predicted. Recording predictions and outcomes can be seen as a science-related process of inquiry.

.Figure 4.2 *Child predicting how the seeds would grow by drawing their prediction.*

Example Three: In this example one of the teachers talked to the researcher about how she set up cars and ramps running from the water-trough to the ground. This example was a good example of integration of learning science-related processes of inquiry through a play experience. When the children were playing, one of them poured water down one of the ramps and excitedly commented that it made the cars go faster. The teacher, in her conversation with this child, highlighted the comparison between the wet and dry surface of the ramps. (The conversation was not recorded, so the detail of the conversation cannot be given.) The teacher set up the cars, ramps and water as an extension of the children's interests in cars moving down slopes. In this example the teacher set up the investigation but it was the children's *thinking* that directed the learning from that point. It was the children's interpretation of the physical environment that prompted the teacher to talk with the children about friction and include the word friction in her discussion with the children.

What these three examples illustrate is the way that science processes of inquiry can be present in both the actions of the children and the dialogue about their actions with children as they explore the physical environment. The strategies that were relevant to science processes of inquiry in the three examples were: The strategy of thinking through an experiment — with scaffolding from the teacher with Rhja's pea seeds, the action of predicting how the seeds would grow in example two, and the strategy of using the different frictional surfaces for the cars to move on in example three. Two further pertinent ideas come from the three examples above. The first is how science processes of inquiry can be facilitated within a play-based curriculum informally while children's play is occurring. This is best identified through the third example of the comparison of ramps. The child instigated the physical action and out of the natural play came the idea of comparison. The teacher giving attention to the child's comparison gave privilege to the link with science processes of inquiry.

The second idea, that comes from the three examples above, is how these and similar instances can be recorded as learning stories to be revisited by the children involved. In the three examples above, there were two forms of recording. The first was the recording through a learning story. The second was a recording of the child's prediction of how the bean would grow. The recording of the science process of inquiry within the children's play in itself relates to processes of inquiry that are similar to what scientists use. The relationship is to the science process of recording ideas. What it allowed for was the revisiting of the process of inquiry aspect of science learning in a context that was relevance to the child. The next section analyses children making the change from everyday community to more science communities related ways of exploring garden snails.

4.4 Making the change to biological ways of observing

During the initial observation period, the children demonstrated an occasional short term interest in snails. They would hunt for snails, watch them for a few minutes and then move on to play with other things. The types of observations the children made were similar to the examples in Section 4.2. The teachers talked about the children's interest in snails occurring from time to time during the year especially during the seasons when snails were more active. The teachers mentioned that snail interest was emphasised at times by some children.

4.4.1 Change towards biological ways of observing

The change in intensity of learning about the garden snail happened when one of the children found a snail on an outside plant and brought the snail to the attention of one of the teachers. Four children gathered to observe and talk about the snail. Two of the children went and found another two snails and brought them back for others to observe. A further three children joined the group. Children came and went as they took time to observe the snails.

Figure 4.3. *Left: Looking at the snail with a magnifying glass.*

Figure 4.4. *Right: Boy watching the snails foot work as it moves on the clear plastic awning.*

When the snails had fully extended from their shells, the teacher noticed the children’s interest in their tentacles. The teacher said, “The snail smells with those tentacles on his head.” She then asked the children, “What do you think the snail eats?” Simone replied, “Eat slugs, eat leaves.” The children noticed the snail had moved some distance. The teacher responded, “He is really fast, they aren’t slow.” One of the children went inside and brought back a magnifying glass and was looking intently at the snail. He asked the researcher, “Can he talk?” The researcher replied, “I don’t think they make sounds.” The boy responded, “How do they reach up?” The conversation of the group moved on and the boy’s question was left unanswered.

The teacher facilitated the children’s interest in learning about the snails further over the following two weeks. The facilitation included exploration of the anatomy of snails, the comparison between the kindergarten apple-snail and the garden snail, what the snails preferred to eat, and verbal reports children gave on what they had been learning. The vignettes below are of more focussed, more science-related processes of observation and investigations.

i) Anatomy of the snail

The children were encouraged to observe the snails and compare the snails they were observing with the anatomy diagram the teacher had obtained from the Internet. The children would put snails onto a tray with lettuce or leaves and watch them move about, discussing with the teacher what they saw and how it related to the anatomy diagram.

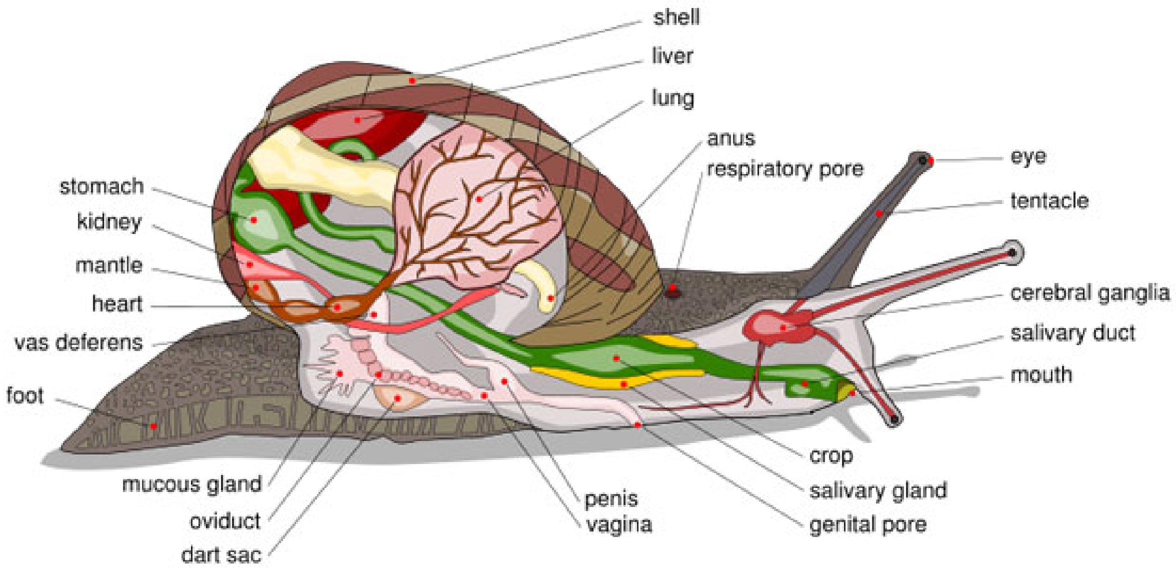


Figure 4.5. *This image was the one the teacher downloaded for the children to look at.*

Retrieved 28 July 2014 from http://www.snail-world.com/snail-anatomy/

ii) What the snail would prefer to eat

The researcher suggested that the teacher set up an investigation that the children could contribute their ideas to. This meant asking the children about what food the snail might prefer to eat and having that food included in the food offered to the snails. The researcher also suggested including bran and cheese as she knew the garden snail seemed to like those foods. When the snail ate bran it was easy to observe the movement of the snail's mouth.

Figure 4.6. *What do snails prefer to eat? The children investigated whether the snails would prefer bran, apple, lettuce, cheese or grass.*

iii) Comparison between two types of snails

The kindergarten had a pet apple-snail that could live for several hours out of water. The teacher put the apple-snail and the garden snails on a tray for children to observe however they wished.

Figure 4.7. *Children comparing the apple snail with the garden snail.*

iv) Reporting on the children's learning

Children reporting on their learning about the snails happened in two specific ways. The first was through discussions at the large group time. As part of the culture of the learning environment at the kindergarten, the children all gathered together for 10–15 minutes at the end of the kindergarten session. The revisiting of the children's learning was often included in the group time. Below is a photo of the teacher's recordings of some of the ideas the children identified as their learning about the snail.

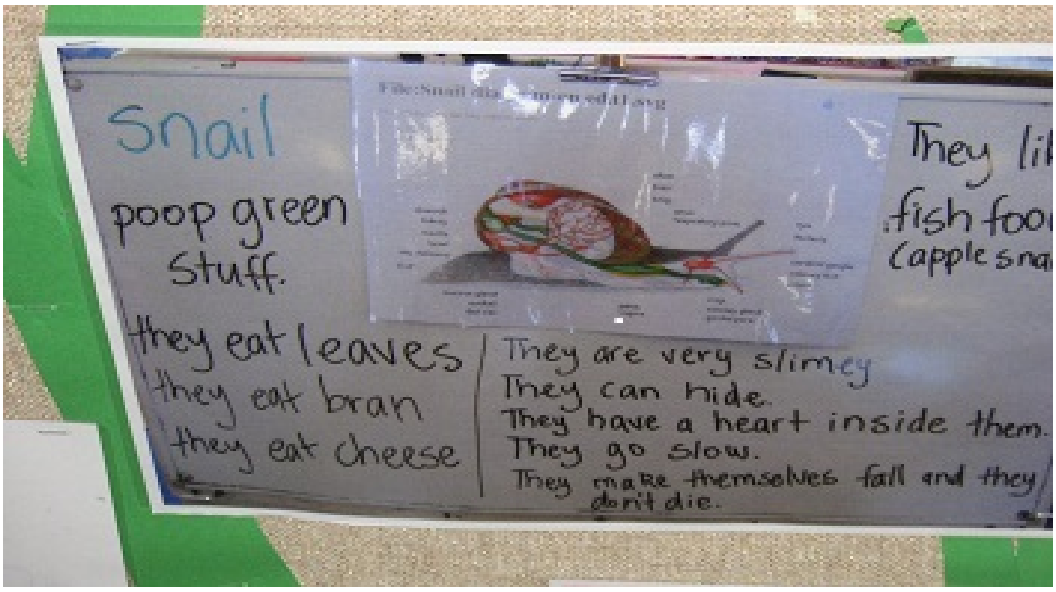


Figure 4.8. *Children's identified ideas of what they had learnt about the snails.*

Two further comments were captured by the researcher in a group time discussion. The first comment was: "Don't give the lettuce to, to the giraffe, give it to the snail." The second comment was made by another child: "I know what, I know what, I've got a heart and the snail's got a heart!"

The second way of reporting children's learning was through their voices in the learning stories. Part of the kindergarten learning culture was to ask children what they want to write as a learning story or documentation of photos the teacher had taken about their learning. Below are three examples of the documentation teachers recorded from the children.

i) Child one said, “They have hearts. I was looking at the apple snail and it had a hard foot.”

ii) Child two said, “The apple snails had a hard foot but not the ones outside. They like the bran and the leaves. They eat the cheese. They didn’t like the apple. The little snail climbed over the big snail. It thought it was a hill. They make slimy trails from their food. It tickles on my hands. The snail thought the plant was food. The shell helps the snail to hide.”

iii) Child three said, “It’s a snail. The snail was going over the other snail because it was tired. They are eating leaves, green leaves. The snail is climbing on the tree plant, they crawl very slow.”

All the examples in Section 4.4.1 illustrated some change in children’s processes of inquiry from everyday ways of observing the snails to ways more like biological scientists would observe. The transition from everyday to more biological ways of observing would not have happened without the teacher scaffolding the children into the biology ways of observing. Through the teacher’s facilitation of children into biological ways of observing, the children gained a richer knowledge about the snails. Another important finding was that once the children engaged in more science-related processes of inquiry, the interest in snails was sustained over a longer period of time. The children’s interest in observing snails at the beginning of the data collection period lasted for a short time (Section 4.2). The children’s interest post the professional learning and support for teachers lasted for a period of three weeks (Section 4.4.2). This finding suggests that scaffolding children into science processes of inquiry enhances not only the richness of the learning but can sustain their interest for a longer period of time. The types of changes from everyday towards biology ways of observing the snails are summarised in the table below. The table is adapted from Eberbach and Crowely (2009).

Table 4.1 Snail Observations Moving from Everyday to More Related-Science Observational Skills:

Everyday Observations	Transitional Observations	Scientific Observation
Noticing: Notice that the snail is different from other animals Comparing snail to everyday life experience – mummy daddy and baby snails, the snail is hungry or tired	**Noticing:** Starting to notice and discuss physical features of the snail. Touch the shell, notice the antennae but not sure what to call it	**Noticing:** Greater awareness of anatomy of a snail. E.g. the snail has a heart. Using anatomy diagram to identify physical features
Expectation: Vague idea of what to observe. Seems to be what catches their attention	**Expectation:** Focussing on finding specific answers to questions What does the snail eat? What are the parts of the snail's body? Starting to think about the functions of the parts of the body	**Expectation:** To answer specific questions about the snail
Productive Disposition: Short interest span in their interaction with the snails Curiosity about snails in general finding them and looking at them for short periods of time	**Productive Disposition:** Sustained interest through focussed observations of interest. Curiosity more focussed but still not sure what to do with the questions	**Productive Disposition:** Curiosity heightened by investigation related to the child's question of interest that sustains the interest and knowledge building about the snail

Table adapted from Eberbeck & Crowley 2009.

4.4.2 Other science processes of inquiry

The teacher's scaffolding of children into biology related observations led to the children being engaged with other science processes of inquiry. Below is a summary of how the children's actions and thinking related to the processes of inquiry mentioned in section 4.3 in terms of the processes of inquiry identified during the teachers' professional learning session.

Table 4.2 *Summary of the Types of Processes of Inquiry Children Were Involved With While Exploring Snails*

Process Skills	Examples from the data
Describing	Children describing what the snail preferred to eat. Describing the snail's poo is green. Describing anatomy and behaviours of the snails.
Predicting	What the snail might eat.
Looking for patterns	Child observing the pattern of snail behaviour that led him to articulate in his own words how the snail seemingly purposefully fell off one step and crawled to the next to get down stairs quickly.
Classification	Different snails (apple and garden).
Comparing	The two different snails. The anatomy diagram with the living snail. The apple snail had a hard foot and the garden snail had a soft foot.
Asking questions	How does the snail reach up? Can he talk?
Thinking about data	I have a heart and the snail has a heart. Don't give the lettuce to the giraffe give it to the snail.
Recording information	This was done for the children in the large group time and in the teacher facilitating the individual children's ideas for their learning stories. It was the children's ideas recorded for them by the teacher.
Interpreting results	Interpreting why one snail crawled over another. Interpreting how the snail purposely dropped off one step at a time to get to a place quicker than crawling all the way.

Tables 4.1 and 4.2 illustrate that children as young as three and four years of age were engaged in a range of science-related processes of inquiry. The engagement in the processes of inquiry happened when the teacher facilitated more science-related ways of children being involved in hands-on science practices relevant to an interest the children had instigated. The focus and motivation for the children's engagement were teachers' awareness and attention to science processes of inquiry related to the children's thinking.

4.4.3 The four dialogic-knowledge building processes

As noted in Chapter Two, there has been an increase in research interest in children's ability to dialogue like a scientist and to examine what this means for children's learning (Duschl, 2008; Siry et al., 2001; Siry & Lang, 2010). This section analyses how children were engaged in the four dialogic-knowledge building processes mentioned in Duschl (2008).

1. Knowledge use and interpreting science explanations of the natural world

This was identified by the children's engagement in interpreting the snail diagram retrieved from the Internet that illustrated the anatomy of a snail.

The children's discussions were explicit in identifying that the snail had a heart. The science explanation of the living world (biology) was embedded in the Internet diagram of the snail.

2. Generate and evaluate scientific evidence and explanations

By engaging in an investigation about what the snails would prefer to eat, one of the children exclaimed, "Don't give the lettuce to the giraffe give it to the snails." The explanation was the child's way of evaluating and explaining his growth in understanding that snails eat lettuce. A further example was the elaborate explanation explicit in the child's comments: "They make themselves fall and they don't die." The comment came after the child's sustained observations of a snail's behaviour (seen as child appropriate generation of scientific evidence).

What the child observed and then described was how the snail fell off a step on purpose to travel faster down steps. The teacher verified that this was what the child was referencing. Inferred in the child's comment above was his explanation of a snail's behaviour.

3. Understanding of the nature and development of science knowledge

Both the exploration of the diagram and the investigation of what snails eat gave an opportunity for children to experience the nature of how science knowledge is developed. The nature and development of science knowledge was also identified in the teacher's documentation of what the children had learnt. The teacher's documentation illuminated for the children what they were learning from the physical evidence in their environment, emulating how biology scientists develop knowledge from observing physical events.

4. Participating productively in science practices and discourse

The children were participating in science practices when they engaged in the investigation of what food the snails preferred to eat. The children were also engaged in science practices as they compared the real snail to the diagram of the snail. Both experiences engaged the children in practices in a similar way to biologists. The investigation productively provided insight into what the garden snail and the apple snail would prefer to eat, providing data that the children could discuss. The use of the diagram had a direct link with how biologists record the anatomy of animals. The practice was productive for the children in that it enhanced their understandings about some of the anatomy (body parts) of the snail.

It was after the children had experienced looking at the diagram of the snail and investigated what food the snails preferred to eat that they began to talk more about the snails in ways that biologists would discuss small animals. For example, the comparative comments about the snail and the child both as having a heart.

The information above illustrated how three- and four-year-old children can be engaged in the four dialogic knowledge building processes. The engagement emphasised children having more control over the direction of the investigations and discussions to the point where the experiences were not specifically structured activities. Children being more in control of the science-related processes of inquiry created a dynamic interaction between the teacher responding to the children's science-related interest and scaffolding the children into further science processes of inquiry to support their science learning. Children's ownership of the investigations and discussions directed where the exploration would go. For example, with the anatomy of the snail it was the child that focussed on the identification of the heart.

4.5 Conclusion

The analysis in this chapter provides evidence that children as young as three and four years of age can be engaged with doing science. The chapter also illustrates that children in the study learnt deeper knowledge when they were engaged in practices similar to those of scientists (Sawyer, 2006).

Seven findings summarise the findings within this chapter. The first finding is that children as young as three and four years of age can be mediated into learning science processes of inquiry. The chapter gives examples of children being mediated by teachers in science-related ways. The children observed, predicted and explained their theories on the living world, investigating and recording information.

The second finding relates to children being mediated into science processes of inquiry and that this brought about richer learning. Without teacher mediation children would not have gained the experience of the different processes of inquiry and the depth of science knowledge gained.

The third finding is that the children's engagement in the investigations and interest in reading the snail diagram brought about a more sustained interest in the science learning about the snail. One of the early research findings was that the interest in small animals often diminished quickly because the children seemingly do not know how to sustain their own interest. What the teacher mediation into some biology community practices demonstrated was that children could sustain a science-related interest when they were mediated into how to use the community's practices.

The fourth finding is that the children's interest is the starting point for entry into the biology community's ways of exploring and knowing about small animals. Children's disposition of curiosity was an important motivation for the learning.

The fifth finding is the importance of empowering the teachers to know and be confident about biology community practices to facilitate children's use of the practices. While most research on teachers' confidence in science focusses on science knowledge, the findings in this study demonstrated the need to consider professional learning about the nature and processes of inquiry practices of science. The assertion is that science processes of inquiry are an important pedagogical element to young children gaining access to science communities' ways of knowing.

The sixth finding is how engaging children in science-related processes of inquiry also engaged them in science-related dialogue. The analysis specifically focused on America's National Research Council's four dialogic knowledge building processes of science for school age children. It is useful to note that the teachers were not specifically aware of the dialogic knowledge building processes, so were not focussed on seeing the processes happening within their facilitation of science learning about snails. The children's conversations were a direct result of their engagement in more science-related processes of inquiry.

The seventh finding is themanner by which young children explored the living world around them was dependant on how they were culturally mediated into perceiving and investigating animals in their physical environment. What became clear was the mediation into biological processes of exploring living animals was a way for children to have access to the rich perceptions biology brings to understanding the living world.

The next chapter analyses the ways children are engaged in a variety of everyday, ECE and science-specific semiotic artefacts in their learning about science.

5 Science learning through social semiotics and intertextuality

"*Continued reflection is needed on the place of cultural tools within learning*" (Robbins, 2007, p. 61)

5.1 Introduction

This chapter illustrates how children at the three kindergartens were engaged with science-related or science-specific learning using a variety of semiotic artefacts. The study of semiotics, as discussed in Chapter Two, refers to people's interpretation of artefacts such as words, images, symbols and the actions of a culture that denote meaning and support meaning-making (Lemke, 1998). The analysis focusses first on how everyday and ECE semiotic artefacts in the kindergartens support children to learn science. The analysis then illustrates how more specific-science semiotic artefacts provided children with deeper insights into processes and knowledge within the science communities. Evidence is presented that demonstrates the importance of teacher understandings of scientific semiotic artefacts and how they influence the depth of children's learning in science cultural communities of practices.

Intertextuality as a concept is then used to illustrate children's varied perceptions and the children use of a variety of different semiotic artefacts they engaged with to develop understandings about the physical environment around them. In this way intertextuality identifies the ways children engaged with a variety of semiotic artefacts in their science learning.

5.2 Children's science-related interest in the physical environment

This section illustrates that children can be mediated into science communities ways of knowing related to their interests within the physical environment. From the onset of the research observations there was clear evidence of children being engaged in experiences relevant to the science ideas of movement. In all three kindergartens, children were observed playing with balls, water wheels and rolling objects down slopes. Observations of these and other experiences also indicated that the children's interactions were most often a spontaneous response to the environment available for them to explore.

At Kina Kindergarten a wooden labyrinth was of particular fascination to a group of children. Children came and went during the sessions to roll the balls down the labyrinth track. One of the participant children, Joy, spent 10 minutes at a time exploring what happened when two balls were released down the labyrinth at the same time, observing what happened when the two balls bumped into each other. Her exploration was evident over a three week period, demonstrating sustained interest (Appendix 10.4 (1)).

Figure 5.1. *Joy and her friend exploring the wooden labyrinth.*

When the researcher asked Joy about what she was doing, she replied, “Fell into the yellow one, then the red one.” Joy’s comment verified that her focus was on the wooden balls as they bumped into each other. A further question from the researcher was: What made the balls fall? Joy’s answered, “The rollercoaster — no it’s not a rollercoaster it’s a ramp.” This implied that Joy was also engaged in thinking about the movement of the balls. Joy implied it was the ramp (incline) that made the balls move.

Another movement example was Joy’s fascination with rolling a large metal truck down the different hilly slopes and the concrete path in the outdoor area (Appendix 10.4. (2)). She repeated the metal truck/slope experience over a two week period and was overjoyed when she saw the researcher had taken photos of the truck movement. She reacted by talking excitedly about taking the truck up the hill and how she had held onto the truck then let it go (Appendix 10.2.4. Kina: second interview Joy Mother with Joy present for part of the interview). Her comments verified the deliberate nature of Joy’s explorations of the movement of the truck.

Figure 5.2. *Joy with the metal truck at the top of the grass slope.*

At Jandals Kindergarten a group of children started bringing small toy cars to kindergarten and racing them down the sloping concrete path (Appendix 2.2.2 Second teacher interview Jandals teachers). This kept happening over a period of four weeks, indicating a sustained interest in the movement of the cars. Another example of children's interest in movement was when a group of girls decided to wind the swing up by twisting it around many times. They then let it go and watched it spin with excited exclamations. They repeated the exercise with a doll in the swing and repeated it again with a child in the swing (Appendix 10.4 (3)). There was intense interest from the children in watching the swing twirl and understanding that the swing could only "twirl" after it had been "twisted".

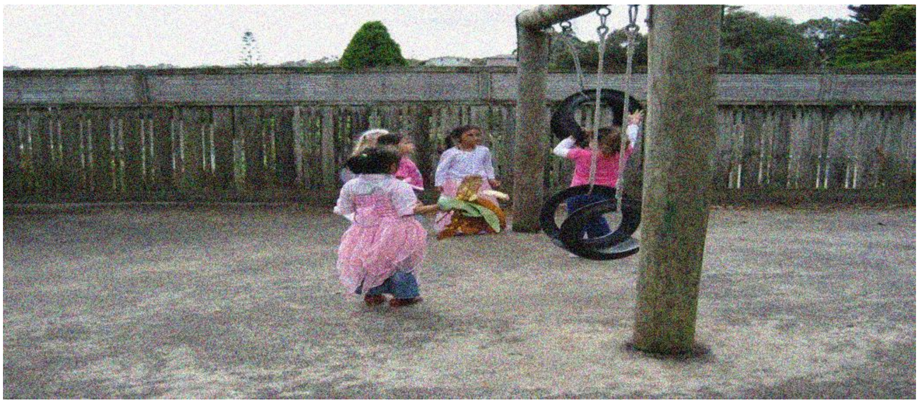


Figure 5.3. *Group of girls deliberately twirling the swing and observing what happened.*

An example from Pohutukawa Kindergarten was when Sonia spent 30 minutes of a morning session getting small plastic boats to move down PVC guttering at the water trough. She did this by pouring jugs of water onto the PVC guttering behind a plastic boat until the boat was pushed down the guttering and into the water trough. This achievement was accompanied by exclamations of delight. She would then choose another plastic boat and repeated the process seven times (Appendix 10.4. (4)). When the researcher showed her a photo of this experience Sonia said, "The boats were sliding down and I was putting water in it." When Sonia was asked what made the boats move, she replied, "Water." (10.2.3: Sonia's first interview with photo). Her comments verified her understanding that the movement of the boats was due to the movement (force -gravity) from the water.

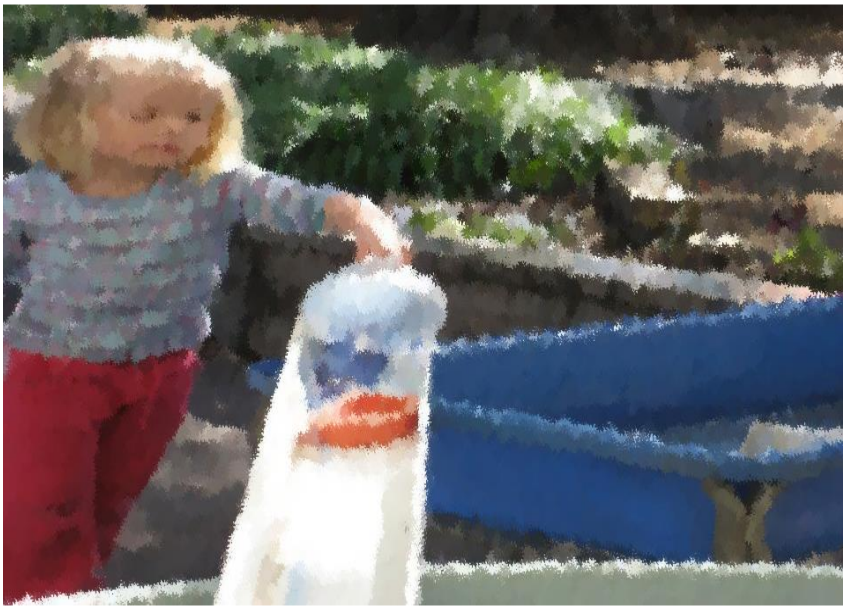


Figure 5.4. *Sonia using water to push boat down the guttering.*

A second example from Pohutukawa Kindergarten was when Michael was playing outside with a large plastic cylinder, large enough for a child to sit in. The piece of equipment was usually used for a child to sit in and manoeuvre about controlling both direction and speed of their movements. This particular day Michael decided, with a group of his friends, to put a ball in the cylinder and roll it around. One of the teachers noted this interest and followed through the next day by bringing the large plastic cylinder inside and making marbles available for the children to spin in the cylinder. The children extended this experience by adding ping-pong balls and larger plastic balls to the variety of balls being spun in the cylinder. The teacher stayed and joined in the movement experience, adding the word momentum and asking the children questions about the experience. The teacher included the word momentum in context, introducing the children to a science way of thinking about the movement (Appendix 10.4., 5). Although the teacher used the word momentum in discussions about the cylinder and ball experience, later she talked to the researcher about not being sure of how to extend the experience into science learning and being unsure if momentum was the right word to use.

Figure 5.5. *Pohutukawa Kindergarten movement of balls in the cylinder.*

All the examples above provided evidence of children's sustained interest in movement within many different contexts. They demonstrate the broad interest that the children in the three kindergartens had within the idea of movement. The language and ways of exploring movement evidenced in the examples above were mostly characteristic of everyday semiotics in both action and spoken language. Action was a semiotic artefact for everyday meaning-making as the children manipulated (acted upon) the physical resources and observed the corresponding actions/reactions. The semiotic of spoken language was used when, at times, the children or the teachers described the actions the children were noticing. The descriptions of the actions the children were involved in tended to use everyday language and the everyday vocabulary the children had learned from within the communities they belonged. For example, when the group of girls at Jandals Kindergarten were twisting the swing they used the words "turn, turn, turn" as they twisted the swing. When Joy spent time rolling the wooden balls down the labyrinth at Kina Kindergarten, she talked excitedly about the balls "banging" into each other.

Although in all three case studies an interest in movement was apparent, this does not necessarily signal that science learning was occurring. What makes experience science learning? More pertinent, how can children's interest in movement be developed into opportunities to introduce them to science ways of knowing and thinking about movement within these described contexts? The next section illustrates how the professional learning of the teachers meant that the teachers were able to mediate children into science-specific semiotics.

5.2.1 Teachers being supported to enhance children's journey in science learning

How the children's interest in movement can be related to science learning became one of the foci for the second professional learning session with the teachers. In terms of negotiated professional learning, the researcher linked the children's interests and involvement in movement with the teachers' desire to enhance their understanding of how to facilitate children's learning about science ideas and concepts. This was done by introducing the teachers to Newton's Three Laws of Motion. The laws describe the influences of forces acting on an object and the motion of the object; put simply in the hand-out given to the teachers these are:

Law One: Objects do not move or remain moving in a straight line at a constant speed unless acted upon by a force

Law Two: Objects move in the same direction as the applied force

Law Three: Objects push back against the force that pushes them (Ross, 2001).

The laws were discussed as a way to allow the children opportunities to both explore movement and to be introduced to science ways of knowing about movement. A practical session followed where the teachers were required to build "things" with Duplo that "moved". Once the teachers had built a number of "things that moved", the researcher facilitated a discussion on the source of the movement for each of the creations that groups of teachers had made. The teachers were asked to consider where the push or pull came from and how a force acted upon the things that they had made. The discussions were then related back to Newton's Three Laws.

5.2.2 Children's journeys into the semiotics of science language about movement

The professional learning with the teachers gave the teachers insight into how valuable children's interest in movement can be for potential science learning. What followed in the three kindergartens was that the teachers increased the variety of movement experiences available for children to explore. The teachers also purposely used science terminology related to movement with the children. The teachers themselves in the second interview talked about having gained more confidence in noticing children's engagement in exploring movement as well as discussing movement from a science perspective.

One example of this was at Jandals Kindergarten where there was an increased number of experiences for children to explore related to ramps and the movement of small cars. This resulted in an increased interest and involvement by more of the children. A further result was that the ramp play was sustained for significantly longer periods of time than before the professional learning session with the teachers (Appendix 10.4. (6)). One of the teachers at Jandals Kindergarten talked with the researcher about using the word friction with children. This happened when the children noticed the different speed of cars going down dry ramps as opposed to those going down ramps wet with water. (Appendix 10.4. (7)). The teacher's use of the word friction denoted a focus on a science description of the influence of surface texture on movement through the use of science vocabulary.

Another example was at Kina Kindergarten where children were given more experiences with movement, including themselves moving down the sloping concrete path on scooter boards. There was an increase in science terminology related to movement being used with children and, in particular, in the documentation being written about the children's interests in movement. The children were introduced to science words such as friction, incline and speed more readily by teachers through conversation.

Figure 5.6. *New scooter boards at Kina Kindergarten. This is an example of a child using action as a semiotic tool for learning about movement.*

Documentation of children’s experiences with the scooter illustrated evidence of the use of more science language within the documentation of the children’s movement experiences at Kina Kindergarten. An example of the documentation was written up in the daily documentation book:

> “The children discovered they can have better control if they lay on their stomachs.
>
> XXX said, “You can stop it easier if you are on your tummy.”
>
> The new scooters promote:
>
> - Exploring concepts such as velocity, speed, gravity, friction
> - Supporting children to develop control over their body
> - Peer tutoring and support
> - Negotiation and turn-taking skills.”

The movement narratives in Section 5.2 gave examples of where children’s curiosity and interests had the potential to be contexts that could lead to their introduction to science ways of knowing and thinking. The following sections of this chapter explored, in more breadth, the ways children in the three kindergartens were being introduced to science ways of knowing and thinking through using a variety of everyday and science-specific semiotics.

5.3 Everyday and ECE semiotic artefacts supported children learning about science

An analysis was made of all the everyday and ECE semiotic artefacts used in the kindergarten communities, in terms of artefacts children engaged with that supported their science learning. The semiotic artefacts are discussed under the headings of dialogue, visual, fiction books/children's portfolios and actions.

5.3.1 Evidence of children using dialogue as a semiotic artefact to support science learning

It is well documented in the literature that dialogue is the most widely used of the semiotic artefacts (Lemke, 1998). Table 5.1 below provides a summary of examples of the types of dialogue that promoted science learning evidenced in the three kindergartens. Four categories of dialogue were identified for the purpose of the discussion below. The four categories from Table 5.1 are child/teacher, teacher/child, child/family and child/child.

Table 5.1 Examples of Everyday and ECE Dialogue as Semiotic Artefacts for Science Learning

Examples of dialogue as a semiotic artefact	**How they related to science learning**
ECE Language Artefacts	
Child instigated conversations with a teacher Child asked the teacher why we can't see the shadow anymore.	Building on the concept of shadows and how they are formed.
Child instigated a conversation with a teacher about the sky being very dark.	Child verbalising what the weather characteristic might mean by interpreting observed data.
Discussion about what is a plant.	Ideas on the definition of a plant
Teacher instigated conversation 1. Teacher at the large group time talked about the life cycle of a butterfly.	Life cycle of a butterfly.
2. The teacher discussed with children how the blossom will turn into fruit – peach over time.	How a flower turns into a fruit.
Everyday Language Artefacts	
Conversations at home	

1. Many of the participant children in all three case studies discussed the life cycle of a butterfly with parents and siblings. 2. Participant children at two of the kindergartens asked their parents if they could freeze water as they had done at kindergarten.	Life cycle of a butterfly. Freezing and melting water.
3. Some of the participant children at two different kindergartens asked their parents if they could freeze water with objects in the water as they had done at their kindergarten.	Freezing and melting.
<u>Child to child conversations</u> 1. Child played at the water trough picks up a plastic animal from the table next to the water trough and squeezes it. He then said, "You can hear the air coming out of this!" to another child	Verbalising about hearing air pressure (though may not as yet be aware of the word pressure used in this way).
Two children discussing how the different angles of the slopes affects the speed of the marbles.	How slopes/gradients affects speed and movement of marbles.

i) *<u>Child /teacher dialogue</u>*

Child instigated conversations about science ideas allowed the children to think about the phenomena and articulate their ideas. Dialogue served as a semiotic artefact for meaning-making about the idea being explored. An example of this was when the children were discussing shadows with the teacher. The discussion began with a child asking the teacher why they couldn't see the shadow any more. A conversation that developed included the teacher's ideas about the sunlight being needed to make shadows and how when the sunlight was blocked by something then the shadow did not form. (Appendix 10.4. (8)).The dialogue between the child and the teacher gave opportunity for the child to be introduced to a science way of thinking about the phenomena of interest.

ii) *<u>Teacher/child dialogue</u>*

Children also focussed on science when teachers highlighted science ideas within the contexts a child or group of children were interested in. If the children showed interest then the teacher would continue the conversation about the science ways of knowing. In this way ideas that the children may not be aware of could be introduced to them. An example of this was when one of the teachers at Kina Kindergarten took a small group of children for a walk and the children pointed out a tree in blossom. The teacher explained how the blossoms would turn into peaches. The children showed both surprise and interest at the thought of the blossom changing into a peach. The teacher then talked about returning to see how the change occurred. What the dialogue allowed was for science knowledge about flowers developing into fruit to be introduced to the children. The dialogue was semiotic in terms of giving children insight into the growth changes from a flower to a fruit.

iii) *Whānau (family) member/child dialogue*

The analysis of whānau and child dialogue illustrated that children's interests initiated by the experiences in the kindergarten influenced the way the children engaged with the physical environment and conversations with others outside the kindergarten. There are benefits for children's learning for teachers to be encouraging these links, where possible, in terms of flow of information in children's learning from the kindergarten to home and visa versa.

There was evidence of children having conversations at home about science-related learning that had happened at the kindergartens. The two significant subjects of discussion noted through the parent interviews were the life cycle of the monarch butterfly, and freezing and melting water. The examples related to the life cycle of the monarch butterfly included siblings retelling their experiences with learning about the life cycle. There was evidence of parents providing swan plants with the eggs and caterpillars and continuing the experiences and discussions on the life cycle at home. These discussions support children's understandings of science and can signify the importance of acknowledging that dialogue as a semiotic artefact go beyond interactions at the kindergarten to include those the children have in their communities.

In terms of the ice exploration, at Pohutukawa Kindergarten, three of the six participant children took an interest in "making ice" and observing how it melted the ice exploration was instigated at the kindergarten. These three children then asked parents if they could repeat the experience at home. Fredrick’s mother told the researcher about how he made ice, adding food colouring and leaves to the water before it was frozen at home as an extension to the ice-making at kindergarten. He then took it back to kindergarten to show everyone (Appendix: 10.2.3). Jane’s mother talked to the researcher about how Jane had insisted on making ice at home. This had directly stemmed from the ice-making at the kindergarten. In the ice examples there was evidence of dialogue as well as action (see Section 5.3.4) as a social semiotic artefact that introduced children to the concepts of freeze and melt. An example of this was when a parent commented in the second set of interviews, “Oh, OK because she has been really interested in us freezing our ice cubes and putting different colours in the ice cubes and mixing the colours and making other colours … I think that’s come from that kindy exercise because, you know, once again we hadn’t directed her towards it but she asked to freeze it …” The parent’s comment signified the dialogue between the child and parent at home that complemented the ice conversations that happened at the kindergarten.

iv) *Child/child dialogue*

The last category of dialogue types was child to child conversation. In free play settings many child to child discussions happen on a daily basis. What was interesting within the data captured on child to child conversations was how a number of the conversations were about discoveries the children were making about natural phenomena. What this data illustrated was that children do discuss natural phenomena with each other. Two examples were given in Table 5. 1. The first example was when John talked with another boy about how the air was coming out of the animal when he squeezed it. The second example was a discussion between two children about the movement of the marbles in a labyrinth. Here the discussion focussed on each other’s ideas about the gradients and how they affect the movement of the marbles through the labyrinth. What this illustrated was a level of developing intersubjectivity around a science-related idea (slopes and marble movement) between the two children involved. In both these examples the assertion is that dialogue acted as a semiotic artefact for meaning-making about the science related ideas the children were exploring. In both these examples the children's actions were semiotic as they played an important part in the meaning-making process they were engaged in.

Figure 5.7. *Children discussing the movement of marbles in a plastic labyrinth.*

5.3.2 Evidence of everyday and ECE visual semiotic artefacts supporting children learning science.

The children in this study related well to everyday and ECE visual semiotic artefacts used in the kindergarten settings. As they have yet to master reading and writing, it is not surprising that visual artefacts were prominent in children's meaning-making.

Four categories of visual semiotic artefacts were identified for the purpose of the discussion below. The four categories are photos/pictures/drawings, television, plastic animals and information posters.

Table 5.2 Examples of Visual Everyday & ECE Semiotic Artefacts Supporting Science Learning

Examples of visual artefacts	**How they related to science learning**
ECE visual artefacts	
Photos /Pictures/Drawings A picture of the outdoor garden being planted with seedlings by the children.	The picture of the planting of the seedlings became a visual comparison for how the plant grew beyond the seedling stage.
Pictures of the sun and a cloud raining.	Reminder that a plant needs sun and water to grow.
Child drawing the germination of seed.	Careful observations of the parts of the germinated seed – anatomy.
Plastic animals Sets of anatomically correct small animals.	Anatomy, species identification (classification), behaviours children associated with the different animals. Noticing external morphological features of different animals.
Information Posters Big poster of insects found in NZ.	Species identification and recognition that there are lots of different species.
Big poster of animals and plants of the seashore.	Again species recognition and also habitat. (what lives on the seashore)
Everyday visual artefact	
Television – At home Watching animal documentaries.	Species, animal behaviours, animal anatomy, habitat.

i) Photos/pictures and drawings

As children are yet to learn to read, visual semiotic artefacts are a useful way of making the connections for children to learn about the science communities. The science communities use photos, pictures and drawings to convey their meaning about the physical environment they study.

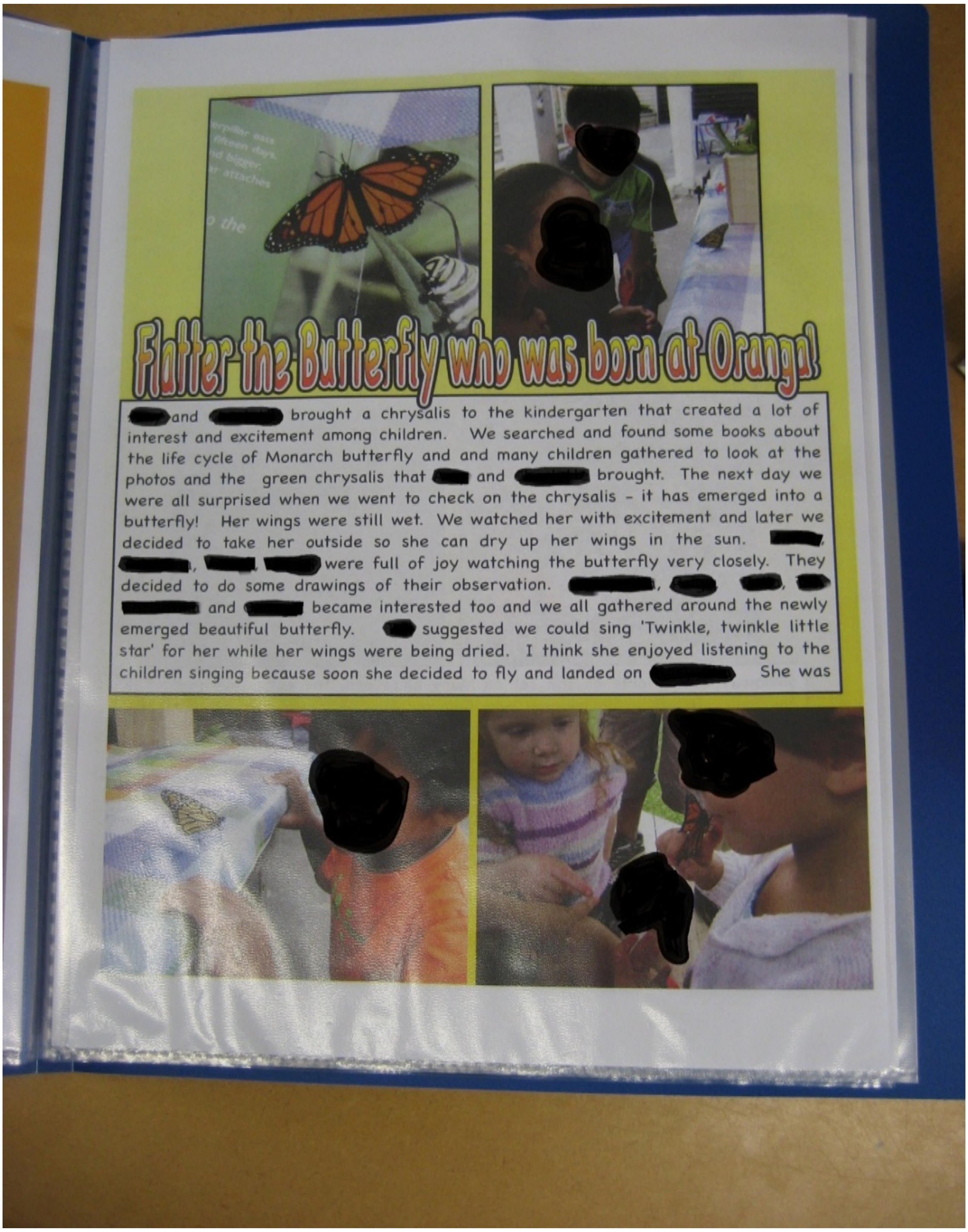
One example was the picture of the sun and the rain in terms of what plants need to grow, and the photo of original seedlings planted in the outdoor garden for the children to compare the growth of plants over time. A participant child spontaneously spoke to the researcher some weeks after the hands-on planting sessions in the gardens about what the photos meant to them. Joy said as she pointed to the pictures on the fence behind the garden, “See the plant needs sun and rain to grow” (Appendix 10.4. (9)). Minnie (Joy’s friend) said, “Look how the plants have grown”, comparing the pictures of the seedlings to the plants in the garden (Appendix 10.4. (9)). The two examples demonstrated that the photos supported the children’s revisiting of the events, and in the case of the plant growth gave Minnie a platform to support her judgement of how much the plants had (changed) grown. The two examples above also demonstrated that photos can be a semiotic artefact for children regarding their understanding of plants. The point here is that whereas older children might refer back to written material to remember information, younger children can refer back to photographic images to support the memory of information within a context that supports science learning. It also affords children the opportunity to consider physical data over time to inform their meaning-making, introducing children to an important way that photographic data is used within the science communities.

Figure 5.8. *Newly planted garden at Kina Kindergarten.*

The pictures on the left side of the fence are of the sun and rain showing that plants need both to grow. The photos on the right are of the children planting the garden.

The photos and the pictures were semiotic as they were symbolic of the experiences and supported children's learning about the plants in the garden.

On two occasions the researcher observed children drawing a physical phenomenon of interest. The first occasion was a group of children sitting around a table, with a teacher present, watching four monarch butterfly caterpillars that one of the children had brought to kindergarten. On the table there were felt tip pens, paper and a branch off a swan plant with large monarch butterfly caterpillars on it. On the swan plant branch there was also a newly hatched butterfly drying and stretching its wings. The children talked with the teacher about what they had noticed and two of the children had chosen to draw pictures of what they were observing. This was written up later as a learning story that included a statement about the children expressing their understanding and observations through a number of media including clay work, painting, dance and drama about the life cycle of the butterfly (Figure 5.9).



Flatter the Butterfly who was born at Oranga!

[redacted] and [redacted] brought a chrysalis to the kindergarten that created a lot of interest and excitement among children. We searched and found some books about the life cycle of Monarch butterfly and and many children gathered to look at the photos and the green chrysalis that [redacted] and [redacted] brought. The next day we were all surprised when we went to check on the chrysalis - it has emerged into a butterfly! Her wings were still wet. We watched her with excitement and later we decided to take her outside so she can dry up her wings in the sun. [redacted], [redacted], [redacted], [redacted] were full of joy watching the butterfly very closely. They decided to do some drawings of their observation. [redacted], [redacted] [redacted], [redacted] [redacted] and [redacted] became interested too and we all gathered around the newly emerged beautiful butterfly. [redacted] suggested we could sing 'Twinkle, twinkle little star' for her while her wings were being dried. I think she enjoyed listening to the children singing because soon she decided to fly and landed on [redacted]. She was

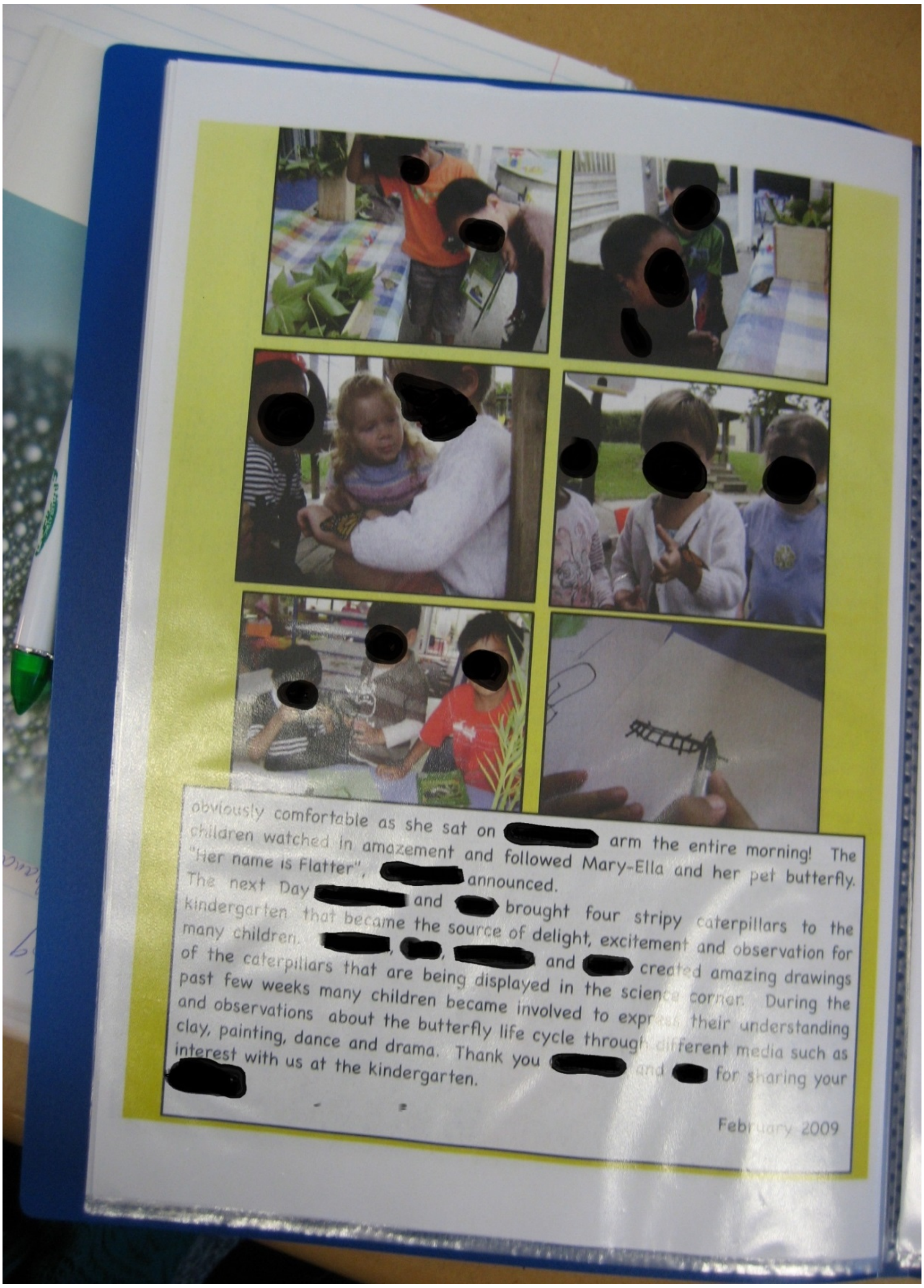


Figure 5.9. *Document of chrysalis and caterpillar at Kina Kindergarten, including children's drawing of the caterpillar.*

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The second occasion was a table set up with the germinated bean seeds, magnifying glasses, pencils and paper. One of the participant children at Pohutukawa Kindergarten (Jane) approached the table and at first observed the germinated seeds with the magnifying glass. Jane then asked one of the teachers to make a photocopy of the bean seed (common practice at this kindergarten to photocopy objects of interest for the children at their request) which she then looked at again with the magnifying glass and began to draw. Several times she stopped drawing and looked carefully at the photocopied seed before she continued drawing (Appendix 10.4. (10)).

Figure 5.10. *The beans set out for children to observe.*

Figure 5.11. *Jane drawing the germinated beans from the photocopied copy of the beans.*

The drawing of the bean seed and the caterpillars could be interpreted as the beginnings of science semiotics as drawing species and specimen has been an important part of observation within the observational processes, in biology in particular. The examples of drawing and the reference in the learning story to other visual media demonstrated how useful these visual expressions were as semiotic artefacts to enable children to think about the external morphological features of small animals and plants. Giving children the opportunity to engage in using drawing as a semiotic artefact led to closer observation and thought about the external physical features of the living organisms of interest. This was evident in how detailed the drawings were in both the examples mentioned above. It was also interesting to note that the timing of when children chose to draw the physical phenomena occurred when the real object was in sight rather than from pictures in books. This is illustrated well as when the children did draw the phenomena (caterpillar and germinated seeds), it was when the phenomena were present. Another time, when the children at Jandals had shown interest over a number of days in ants, the teachers provided pictures from a book and an opportunity to draw an ant, but the children seemed not to be interested (Jandals teachers' second Section 10.2.2).

ii) Television

Table 5.2 illustrated there was evidence that children were gaining science ideas through television programmes (a predominantly visual semiotic artefact for young children). The television, in particular, was a common part of the home environment and at times was a semiotic artefact as children were introduced to aspects of the natural world and afforded the television capable of informing on aspects of science knowledge. This was evidenced as children used information gained at home to inform their dramatic play with plastic animals in the kindergartens. One example of this was when Joy dramatised being a mother dinosaur watching over her eggs. Through the parent interview with Joy's mother it became apparent that Joy frequently watched children's documentaries on dinosaurs at home. The television being the initiator of the dramatic play related to an animal, reinforcing the science ideas about dinosaurs laying eggs.

iii) *Animal posters*

There were two significant observations of children's interests in animal posters within the data collection. The first was when children showed an interest in identifying oversized plastic insects with an insect identification poster. The insect poster provided children with the opportunity to visually identify a range of insects. Two of the children spent five minutes matching the plastic animals to the poster.

Figure 5.12. *Insect poster and small plastic animals, including insects.*

The second observation was of Joy when she walked up to a poster of large animals and said, "Oooh*"* and stroked her hand over them saying the names of the different animals (Appendix 10.4. (11)).

What is of interest from a semiotic point of view is that in both observations the children used the poster for very basic animal identification. The posters were visual semiotic in that they enriched meaning-making related to basic everyday animal identification. Everyday language was used but with strong links into the idea of external morphological aspects of animal classification (what makes a bee a bee, visually; species of animals have different names). The posters were a good example of the hybridity between everyday knowledge and science social semiotics. Both everyday and science communities use posters to convey information. Posters are used specifically in science education and by some scientists, usually for identification of species using science names (binomial nomenclature), but here we have two posters physically showing the animals but the language being the everyday names of the animals.

5.3.3 Fiction picture books as semiotic artefact for science knowledge learning

What became evident from the observation of the kindergartens' sessions was there were times when a fiction book stimulated interest in science ideas. Fictional picture books are used in both everyday and ECE cultural communities.

Table 5.3 Examples of Fiction Books as Everyday and ECE Semiotic Artefacts for Science Learning

Examples of fiction books	**How they related to science learning**
Rainbow in the fiction story book.	This led to a discussion about how the children thought rainbows were formed.
Story about a crocodile wanting to have the river to himself.	Gave information about how a range of animals inhabit the river environment.
Big book "I like the rain".	Introduced the different forms of precipitation.

Examples of fictional picture books that stimulated children's thinking about science ideas included a rainbow in a story that led to a discussion about how a rainbow is formed (Appendix: 10.4. (12)), a book that told a fictional story about a crocodile wanting to have the river to himself but told of the range of inhabitant animals that use the river (Appendix: 10.4.(13)) and the book that talked about liking rain and included a wide range of precipitation that weather can bring (Appendix: 10.4.(14)). As fictional picture books often include the physical environment in some way as part of the story, there was evidence that they motivated children's interests in science knowledge related to the content within the stories. This makes fictional picture books potentially a valuable social semiotic artefact as a motivator for children's thinking about science ideas or physical phenomenon sometimes presented within fiction picture books.

5.3.4 Children's portfolios as an ECE semiotic artefact for science knowledge learning

Learning stories were part of the culture in all three kindergartens. In this chapter the interest in learning stories is in how the children engaged with the stories as a meaning-making artefact related to their science learning. This enabled the researcher to reflect on how the learning stories themselves were at times a semiotic tool for children to think about science knowledge or inquiry.

Table 5.4 Children's Portfolios as ECE Semiotics for Science Learning

Examples of learning stories as social semiotic artefacts from the data	**How they related to science learning**
Child's love of small animals and his ability to identify them and learn about them. Described him as being an entomologist.	Introducing the science word "entomologist".
Story about the apple snail and how it has laid orange eggs in the aquarium.	The idea that snails lay eggs.
"Making ice" or freezing water and then watching it melt.	Concepts of melting and freezing.
The life cycle of the butterfly.	Life cycle

The participant children's interviews formed the base information for considering learning stories as a semiotic artefact. The researcher analysed the science-related comments the children made. Several of the children remembered the life cycle of the butterfly and information on other small animals. The children used the photos as visual clues into what the stories in the portfolio were about and the types of learning they could articulate. In terms of the living world, the children were able to articulate about the identification of small animals and the life cycle of the butterfly. It is interesting that not all children talked about the egg stage of the life cycle, in that the egg stage of the life cycle was visually missing from the photos accompanying the learning stories. The children's responses in not remembering the egg stage of the life cycle of the monarch butterfly raises questions about what details are shown in the photos that accompany learning stories and their effects as visual social semiotic prompts for science learning.

Previous research literature has shown in general that the sharing of information through learning story documentation has led to richer learning opportunities (Buldu, 2010; Carr, 2001). Both the monarch butterfly and the ice experiences were well documented in the learning stories in all three kindergartens. These learning stories were revisited by the children who were able to express understandings, making the learning stories a semiotic artefact in meaning-making about the science ideas involved.

5.3.5 Actions as a semiotic artefact

Children's actions within the physical environment and material artefacts within the environment at times functioned as semiotic artefacts. Lemke (1998) discusses the science laboratory work as **actions** (specific semiotics to the science community) that support science community meaning-making for secondary school and adult students. In a similar vein the researcher asserts that the physical environment in the three kindergartens provided meaning-making opportunities where children's actions (as everyday semiotics) supported their thinking process related to science learning.

Two types of children's actions presented themselves within the data analysis. The first was the children's inter**actions** with the physical environment itself being a semiotic artefact. The second was that children's **actions** within their dramatic play were at times a semiotic artefact towards consolidating science-related ideas.

Table 5.5 Action as Semiotic Artefacts for Science Learning

Examples of action as a social semiotic tool	**How they are related to science learning**
Children interacting with the physical environment Labyrinth at Pohutukawa pp. 25–27	 Inclines, pull of gravity

Examples of action as a social semiotic tool	How they are related to science learning
Children swinging on the swing	Children thinking about what made the swing move.
Mixing different coloured paints.	Substances can be mixed and some substances change by being mixed.
Dramatic play Joy was dramatising with plastic animals.	Animal identification and behavior.
Building a home for the meerkat.	Habitat
Pretending to make a stream.	A stream as a geological phenomenon.
Song/drama of a seed germinating.	Germination
Butterfly song that children dramatised the stages in the life cycle of a butterfly.	Life cycle of a butterfly

The physical actions examples in Table 5.5 illustrate how the children's action in and to the environment brought about children's thinking about a physical phenomenon at hand. The children's actions were part of semiotics of everyday explorations and it is this exploration that contributes to the understandings of the science ideas related to the physical artefacts the children encounter in their environment.

For example, when the children at Pohutukawa Kindergarten observed the movement of the marbles in the plastic labyrinth, they noticed and talked about the effects of the variation of the slopes made by the way they put the labyrinth together. Another example was the children's everyday use of the swings in the kindergartens. As part of the researcher's interview with two of the children at Kina Kindergarten she asked them, "What made the swing move?" Kushla answered, "My legs." Ruth answered, "That thing up there," indicating in the picture the shackle that allowed the swing to move smoothly back and forth. This example illustrated that the children were thinking about the physical environment they were engaged with. It could be said that the first child learnt it was her legs that moved the swing because of conversations about how to make the swing move. After talking with Ruth's mother it became evident that Ruth had developed the idea of the shackle moving the swing by itself. These two examples illustrated that the children's interactions with the environment provided an opportunity to use the environment as a tool for learning. From the perspective of seeing the environment as an artefact for learning it can then be purported that the environment itself is a semiotic artefact.

Figure 5.13. *The two children with the different ideas on what made the swing move.*

A further example of physical action was at Pohutukawa Kindergarten when the children mixed different coloured paint together deliberately looking and talking about the colour changes that were occurring. This was an experience the children instigated and carried out for themselves.

The following examples were times when the children's **dramatic play as action** was a form of expressing the science ideas the children were thinking about. At

Kina Kindergarten Joy dramatised the actions and behaviours of a number of plastic animals (Appendix D: 10.4. (15)). At Pohutukwa Kindergarten a group of four boys spent 30 minutes building a home for a meerkat. One of the boys commented to the researcher, “We’re building a meerkat cage. They don’t mind a little rain but they do like some shelter.” When the cage was completed, two of the boys crawled into the cage to try it out. When the boys crawled into the cage they dramatised about the habitat of meerkats. At Jandals Kindergarten Rhja filled a large container with water from the water trough and poured it on the path. He ran back to get more water. As he poured the second lot of water on the concrete he says to the researcher, “I’m planning a stream.” He stepped back and watched the movement of the water. Then Rhja repeated pouring water onto the path four more times before moving on to play elsewhere (Appendix D; 10.4. (16)). The stream play example gave aspects of both action within drama and interaction with the environment being present as semiotics allowed Rhja to think about the concept of a stream.

A further form of dramatic play action as a semiotic was action songs. The examples in Table 5.5 are of songs and actions about germination and the life cycle of the butterfly. The teachers led the children into the drama that was also accompanied by words and music or a song. The strategy was for children themselves to act out being the seed or the butterfly egg and moving through the life cycle changes. As the children chose their own movements it can be inferred that the ideas of how the life cycles changed belonged to the way each child thought about and interpreted the stages through their actions. The premise being developed about everyday dramatic play, both action in the physical environment and dramatisation, is that it is through this play that children can synthesise science ideas and therefore use the actions as a social semiotic for making meaning about the science ideas they are exploring.

What the analysis in Section 5.3 has demonstrated is that the community’s everyday social semiotic practices in the three kindergartens support science learning for the children. Within the analysis above, there is clear evidence of dialogue, visual representations, fiction books, learning stories and actions being social semiotic tools children engage in to learn or revisit science ideas. The next section focusses on specific science semiotic artefacts and how the children were engaging in science community "artefacts" and ways of using artefacts that supported more in-depth learning about the science ideas they were interested in.

5.4 Introduction to the science communities' semiotic artefacts

The analysis of science specific semiotic artefacts was considered within four category headings taken from Lemke's (1998) description of science semiotic artefacts. These are science language, science visual expressions, mathematical expressions and actions. The specific focus of this part of the analysis was concerned with what science-specific semiotic artefacts children found helpful to engage with that enhanced their access to learning about science.

5.4.1 Science language

Through the data analysis two aspects of science language were identified as pertinent semiotic artefacts for children's science learning. The first was the actual specialised science words used in the science communities. The second was the specific ways language is used in the science community (Reeves, 2005).

Table 5.6 Science Language as Social Semiotic Artefacts

Science language	**Evidence from the data**
Specific words	Momentum, germination, dissection
Specific dialogue	Factual discussions on science ideas • Discussion on what a plant is • Describing the result of an experiment • Children's thoughts on what the word dissection meant
Non-fiction books	• The life cycle of a butterfly • Ladybirds and ants • Shells from the sea • Animals from the Amazon forest. Habitat and behaviour of animals

Science language	Evidence from the data
Information from the Internet	• Jandals Kindergarten only. Read information from the Internet to children related to the specific ladybird on their pumpkin plant

i) Science words as semiotic artefacts

The data illustrated evidence of children being introduced to science words within the context of some of the conceptual ideas they explored. Examples of this were the:

- use of the word momentum within the context of exploring the movement of balls in a large cylinder as mentioned in Section 5.2
- use of the word dissection when examining a bird's nest
- use of the word germination when children observed the root and shoot emerging from the bean seed

What was important to the children's conceptual learning was the use of the science words in context to their interest and hands-on experience with the physical environment. In each of the examples given, children heard the science words spoken in context which can be inferenced as the beginning level of conceptual understanding of the science words.

Of considerable influence on the children's introduction to use of science language was the reticence of the teachers in terms of their confidence and knowledge about when it was useful to the children's learning to use science specific words. The teacher interviews revealed a desire to gain insight into when to introduce children to scientific words. The main concerns raised by the teachers at their interviews were how much the children could understand ("take in"), how far they should extend children in science learning, how to achieve this and when to do this. "How much does a four year old know or absorb?" (Appendix: 10.2.1)

Through the participant children's interviews, it became apparent that through some of the science-related ideas they were exploring they did not have science words to describe their interest in the physical phenomena they had encountered in the environment. The lack of science language led to children not being able to articulate the ideas they were exploring. One example of this was when Joy noticed the reflective light from her lunchbox. All she could say was, “Look, look, look” as she moved her lunch box to show the reflected light changed position and then pointed at the sun (Appendix: 10.4. (17)). She had an idea of what was happening, evidenced by her gestures, but no words to describe it. Another example was Sonia’s interest in movement and force through a number of experiences in the kindergarten environment. When the researcher showed her a photo of her letting go of large foam blocks at the top of the slide and sliding down the slide after them (which she repeated many time for over 30 minutes) and asked her about what was happening, Sonia replied, “Going down, down, down” and gestured with her hand the path the foam blocks travelled in (Appendix 10. 2.3 Pohutukawa). The two examples above illustrated further evidence of the need to consider how science terminology can inform the children’s science interests and support developing their science ways of knowing about physical phenomena in the environment they are interested in. The examples also demonstrated what Reeves (2005) asserts about students’ growing experience of “realities” being restrained by the limits of their known language. The two examples above illustrated that science language can give an enhanced understanding of what realities exist within an idea of interest to a child. The significance within a holistic curriculum is that science terminology/words can enrich some of the learning taking place.

ii) Science ways of using language as semiotic artefacts

The discourse of science is important to consider for a number of reasons. The discourse itself has a specific way of reasoning, discussing, evaluating and contesting working theories about the physical world we live in (Duschl, 2008; Reeves, 2005). This section of the analysis had significant connections with the dialogical knowledge building processes mentioned in Chapter Four. Below are three examples of children using language in a similar ways to scientists.

What is a plant discussion? This was a discussion that was facilitated by a teacher with a group of six children. The importance was not so much the actual ideas, but that the discussion itself was science discourse in practice. It was science discourse in that the children were articulating their thoughts on what a plant is. The teacher captured their ideas in the photo presented below.

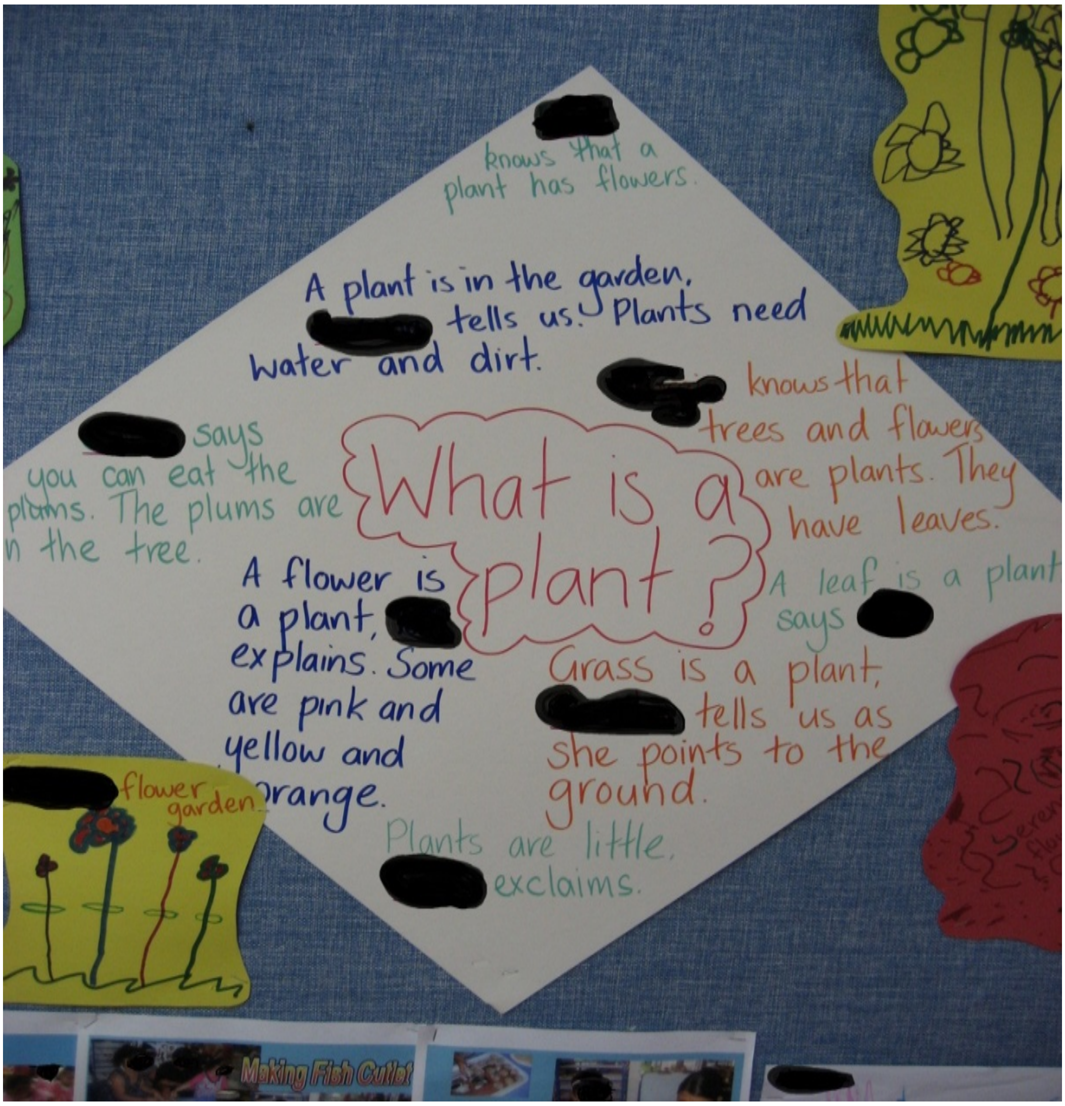

Figure 5.14. *Recorded discussion with children on what they thought a plant was.*

Will the branch grow? Rhja discovered a branch from a tree on the ground and decided to plant it in the ground. He talked with one of the teachers about how he thought it would grow. He gave his explanation that the branch needed to be in soil and be watered to grow. A week later the branch was starting to die. Rhja than changed his thinking and said that the branch was dying because it did not have roots. The importance of the language here was that Rhja was using and interpreting explanations of his physical environment at the level he could comprehend (Appendix: 10.4. (18)).

Dissection: At Pohutukawa Kindergarten a teacher and a group of children discovered a nest on the ground after a stormy night. A discussion about how the nest was made ensued. The teacher suggested that they dissect the nest with the children. Afterwards the teacher discussed with a small group of children what the word dissection meant. Within the bird nest experience there were a variety of opportunities for children to be engaged in science ways of discussing the phenomena. Within the documentation on the children's thoughts below, there are examples of creating explanations, investigating their ideas, as well as generating and evaluating evidence. All these experiences gave the children the opportunity to use language in a way similar to scientists. It also gave children an experience of how scientists understand and develop scientific knowledge. (Appendix: 10.4.(19) & Appendix 10.2.2 Pohutukawa).

Figure 5.15. *Harry dissecting the bird's nest with one of the teachers.*

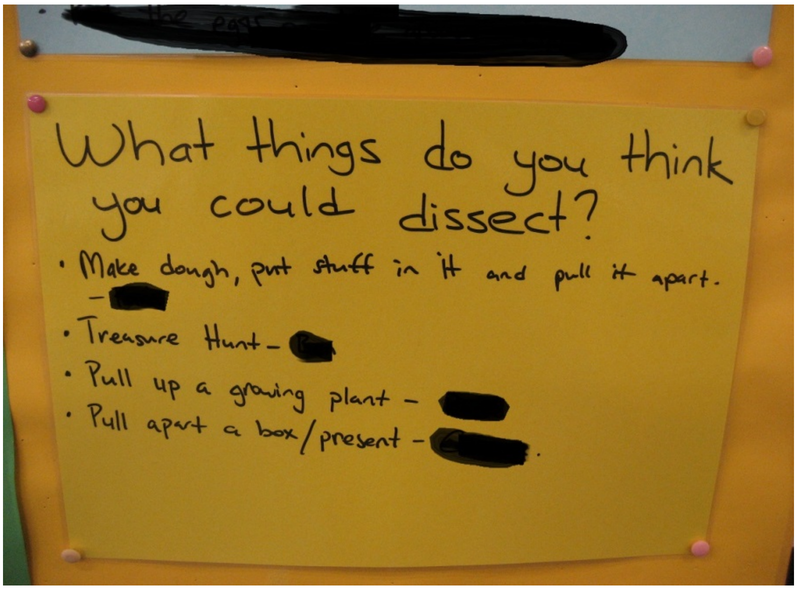

Figure 5.16. *Recorded ideas from children about what the word dissection means.*

5.4.2 Science visual expressions as semiotic artefacts

The purpose of visual semiotic artefacts in science is to advance science knowledge and to enrich the process of discovery (Trumbo, 2006). For science education this is also extended into learning what the science communities have already established. The data was analysed in terms of how visual semiotic tools scientists used were used by the children to enhance their science knowledge.

Table 5.7 *Science Visual Expressions as Semiotic Artefacts*

Examples from data	**How they related to science learning**
Diagrams Anatomy of a snail from the Internet	Supported the learning of anatomy.
Poster: 1. Poster of the insects 2. Poster of the animals	Both posters supported children identifying different species of animals.
Evidential photos 1. Plant growth over time	Supported children remembering

Examples from data	**How they related to science learning**
	how plants grow over time.
Graphical representations 1. Children's visual drawings of their predictions of growth of a pea seed in winter.	Supported revisiting children's ideas on how the pea would grow.
DVD recording Recording of a human embryo inside its mother. One of the teachers brought in a DVD of her scan.	Learning about scans and images inside of people.
Physical environment 1. Children noticing and identifying small animals in their environment.	Physically identifying animals in the environment.
2. Children noticing the movement of the marbles down the labyrinth.	Physically noticing the phenomenon of movement.

The findings evidenced that children were engaging in the science communities' ways of using visual expression to make sense of the science ideas they were exploring. The children used diagrams, posters, photos, graphs, recorded information and the physical environment itself as visual semiotic artefacts in exploring and communicating science-related ideas. Table 5.7 gives evidence of children being engaged in science semiotics to enrich their science learning.

5.4.3 Mathematical semiotic artefacts

Mathematics is an integral semiotic artefact in the strategies scientists use to create and confirm aspects of quantitative relational science understandings within their learning theories (Lemke, 1998). The most significant use of mathematic tools used by the children were comparisons, measurement and classification.

Table 5.8 Mathematics as Semiotics for Science Learning

Mathematical artefacts	**Examples from data**
Comparison	• Photos of seedlings when first planted for children to revisit to compare the changes over time • Weight of buckets depending on how much sand is in the bucket. Sand has weight • Land snail and a sea snail
Measuring	• If you go faster you are more likely to fall off. Truck at Jandals Kindergarten • Some beans germinate faster than others – I wonder why? • Changes in the shadow over time and coming up with explanations of why the shadow changed
Classification	• Identifying of small animals. Beginning to differentiate animals by appearance • Properties of matter through exploration of variety of materials

The children's engagement went beyond being aware of or exploring the mathematical concepts of measuring, comparing and classification. The use of mathematics became an artefact for science learning when the children engaged in mathematics in order to enrich or confirm a science-related idea. What this evidence affirmed was that it is possible for children three and four years of age to be introduced to using science ways of using mathematical artefacts as semiotics to support their science learning.

5.4.4 Scientific action

There was evidence that the children were capable of engaging in actions similar to scientists in the three specific ways outlined in the table below. By action Lemke (1998) describes the actions scientists use in laboratories to gain and verify science knowledge. The analysis for this aspect of social semiotics considered how children were using actions that scientists used but within the kindergarten environment.

Table 5.9 Scientific Action as Social Semiotic Artefacts

Action	**Examples from data**
Using a magnifier	• Magnifying the birds nest for detail of what it was made of • Magnifying the snails to see more external morphological detail
Investigations	• What would the snail prefer to eat? • What happens when I let go of the truck at the top of two different hills?

What the analysis identified was that there was clear evidence of actions scientists use being present in both children's spontaneous play as well as being facilitated by teachers. What was also apparent was that without adult facilitation, children would not gain the same depth of experiences of acting like scientists in exploring their world.

All the semiotic artefacts mentioned so far in this chapter were used for either conceptual or epistemic learning about science ways of knowing. Conceptual in terms of mediation into the conceptual knowledge the science community has already established, epistemic in terms of children using science ways of building theories purposely to enrich their understandings of the physical environment.

5.5 Intertextuality: Enriching children's science-related ideas

Children were making links to several different semiotic artefacts as signals for meaning-making were happening all the time. The value of using intertextuality as a coding system for analysis is that it enables the researcher to analyse in more depth the complexity of the interrelationships of the semiotic artefacts being used by children to gain understanding about a specific science ideas. Chapter Two introduced Lemke's (1992) idea of science not being captured by a single semiotic but by the interlinking of a variety of semiotic artefacts. Lemke's research explored the multiple semiotic artefacts students' use to learn science in a tertiary institution. The intertextuality analysis in this research considers, in a similar way, how children children's used a variety of semiotic artefacts to continue on the journey of developing their understandings of science ideas. It also illustrated the interlinking in children's experiences between everyday, ECE and science-specific semiotics.

5.5.1 The variety of semiotic artefacts children used

The first set of examples below identified the many semiotic "texts" (artefacts) children were engaging with to develop their science ideas:

Example one: Understanding about *Snails* – the semiotic texts included hands-on experiences of observing snails, science diagram of the anatomy, investigation into what snails like to eat, observing with a magnifying glass, discussions at large group time and learning stories.

Example two: What is a *Bird's Nest* made of– the semiotic texts included hands-on exploration of a nest, photos to revisit the dissection of the nest, dissection, discussion, documentation on the wall and learning stories.

Example three: Movement of balls in a large cylinder – the semiotics texts included hands-on experience of moving the balls in the cylinder, discussions with peers, discussions with teachers, considering the questions the teacher posed about the movement of the balls and documentation of the experience.

What was notable about the interlinking of the semiotic artefacts was the way the different semiotic artefacts were drawn together by the teacher for the children's engagement in learning science. The important connection was the children's interests. For instance, with the snails it was as the teacher noticed the children talking about the features of the snail that she introduced the diagram from the internet to support their interest. For the bird's nest it was as the children started to talk about what the nest was made of that the suggestion was made to dissect the bird's nest. The children agreed to dissect the nest. With the movement of the balls it was because of the children's interest in the movement that the teacher suggested adding different balls to the experience. Rather than a random selection of interesting semiotic artefacts/texts, the teachers were introducing semiotics they noticed would support the children's science interest.

5.5.2 The different perceptions children had of the same semiotic artefacts

The second set of examples identified that children were interpreting the same text in different ways.

Example One: What the word dissection means to children. From looking at the documentation in 5.4, section ii) it was apparent that the children had differing ideas about what dissection was. For example on of the children thought dissection was like a treasure hunt, while another child thought dissection was like "pulling a box apart with a present inside."

Example Two: Interpreting what happened physically to make the swing move. When two of the participant children were interviewed about what made the swing move one of the children said that it was their legs. The other child said it was the thing up there (meaning the swivel fitting) that made the swing move.

Example Three: What is a plant? In the documentation in 5.4, section ii, example three, the children gave their ideas about what a plant was. For an adult their answers seem interconnected, as they all described aspects of a simple definition of a plant. For the children there were differences within their descriptions.

The second set of examples above identified how children interpreted the same artefacts in different ways. The differences in children's ideas can be related to their facilitation into everyday and possibly science communities of knowledge to date. What is important for the teacher is to be aware of the different ways the learner interprets a semiotic so as to engage in the learning process from the place of the child's understanding.

5.6 Conclusion

The study of semiotics as an analysis instrument highlighted how the resources in the kindergarten environments were used by children, sometimes in interaction with teachers, to support their science-related and science-specific learning.

Whenever children explored the physical environment there was the potential for science learning, with this being most evident in terms of the physical world science (physics) as set out in the first section of 5.2. Across the three settings physics was the science that related most closely to children's everyday experiences and explorations within a play-based curriculum. Section 5.2 also illustrated how teachers' awareness and knowledge of how science (physics) explains movement influences the nature of their interactions with children. Teachers' awareness and knowledge of science was a factor in children's engagement both in how teachers created opportunities for children's movement exploration and how they introduced science ideas/ terms for children to consider when explaining what was happening.

A range of everyday and ECE semiotic artefacts were identified as supporting children's engagement in science-related learning. These artefacts included dialogue, visual representations, fictional picture books, children's portfolios and children's actions. Two types of action in particular were identified in the findings. These were children's actions within the physical environment as with their experimenting with the balls in the cylinder (Table 5.5) and their dramatic play to do with how seeds grow (Table 5.5). These everyday and ECE semiotic artefacts influenced children's science learning through the way they initiated children's interest in science and through their use by children and teachers to revisit the science they had been learning.

While everyday and ECE semiotics were valuable for children's engagement in science-related learning, there was evidence that engaging children in science-specific semiotic artefacts created richer science learning opportunities. One outcome was that this enhanced the depth of science knowledge being learnt, as in the case of children learning that a snail has a heart while using a science anatomy diagram of a snail. The specific-science semiotics identified from the three kindergartens was language, visual expressions, mathematical ideas as part of science learning, and action. Science language included science terminology such as the use of the word momentum by the teacher when the children were exploring how the balls moved in the cylinder (Section 5.2.). Science language use also included science dialogues such as the discussion a teacher had with a group of children about defining a plant (Section 5.4.1). The visual expressions related to science were identified in section 5.4.2. These included diagrams, posters, photographs, graphs, and records of information. The physical environment itself acted as a visual semiotic artefact in stimulating children's exploration. An example was when children noticed and commented on the movement of wooden balls down a labyrinth (Section 5.2).

Mathematical semiotic artefacts became science–specific semiotic artefacts when they were used to assist children to learn more about an aspect of the physical environment that was of interest to the children. An example was when the teachers recorded the changes in a shadow on the wall over time. The recording of the shadow over time illustrated to the children that shadows change within the day and motivated their curiosity to know why (Table 5.8.). Scientific actions were identified as actions that scientists would use to inquire about the physical world. Two examples from this chapter were the children using magnifying glasses and the children being actively involved in science-like investigations, as was the case when the children in Chapter Four investigated what the snails would prefer to eat.

Hybridity, meaning the use of same practice across different communities (see Section 2.6), was evidenced within dialogue, some visual semiotics and actions. The benefit to the children of this was that because they had experience with a practice in ECE and/or everyday contexts they more readily adopted and understood this practice when developing their science and or science-related understandings. One example of this was when the teacher took photographs to track plant growth – taking photographs to track learning was common place in the three kindergartens and scientists use photographs to track change.

Consideration of intertextuality between texts highlighted that children do not glean their understanding of a science idea from one semiotic artefact alone, but from their engagement with a variety of different semiotic artefacts. When teachers noticed a specific aspect of a child's science-related interest they often used a number of artefacts to support the child's interest and engagement. An example from section 5.5.1 was the different ways the teacher facilitated children's learning about the bird nest. What was illuminated in this example was the value of teachers knowing, and being able to use, a range of semiotic artefacts to support children's learning about a specific science- related interest.

Across the three settings there was also evidence that children will interpret the same semiotic artefact differently from each other. This aspect of intertextuality is valuable in reminding teachers to be aware of children's individual meaning-making related to learning science. An example was the children's different interpretations on a definition of what a plant is (Section 5.5.2).

The next chapter analyses more specifically how the teachers influenced children's science learning.

6 Teachers influences on science learning

6.1 Introduction

This chapter analyses how the teachers influence children's engagement in science learning using data from the three kindergartens. There were three main foci of analysis of the teachers' influences. The first is teacher awareness of science learning affordances to the physical environment. The second is the teacher influence on the social environment that supports science learning. The third focus is on how the teachers' knowledge of science and science education influenced children's learning.

6.2 The physical environment

This section begins by analysing how the children are engaging in the physical environment that the teachers have created for them. By investigating the children's engagement, a perspective of how teachers influence children's science learning through the environment they create can be gained. The analysis also identifies where potential and actual science learning was being privileged in the physical environment within the integrated curriculum.

6.2.1 Children engaged in the physical environment: Implication for teaching science

A coding system was established to analyse *participant children's engagement* with the kindergarten's physical environments to investigate how teachers influenced science learning through the physical environment. Most of what is in the physical environments is controlled in some way by the teachers. In this way teachers have influence over the physical learning environments provided. The coding was applied to the observation data of participant children's free play. Three categories were identified and the data analysed for instances of the categories (Appendix F). The three categories were:

- (CPE) **Children's** engagement with science-related learning through their **interactions** with the **physical environment** created by the teachers with no teacher interaction in developing children's engagement in the learning at that time.

- (THPE) Teacher highlighted - where a **teacher**'s interactions **highlighted** an aspect of science learning within the **physical environment** with the child responding with interest
- (NEPE) **Natural events** in the **physical environment –** events, such as weather, which were beyond the physical environment that the teachers deliberately provided acted as a catalyst to children's interest in the physical environment around them.

Table 6.1 Summary of the Number of Instances of CPE, THPE and NEPE (From participant children observations of free play experiences)

	Kina Kindergarten	Pohutukawa Kindergarten	Jandals Kindergarten	Total
CPE instances	28 = 80%	28 = 88%	18 = 75%	74
THPE instances	03= 9%	03 = 9%	04 = 17%	10
NEPE instances	04 = 11%	01 = 3%	02 = 8%	7

Analysis of the participant children's engagement in the physical environments revealed that in all three kindergartens, 75% or more of the exploration that could have been related to science occurred while the children were spontaneously exploring the environment, mainly by themselves and on some occasions with their peers.

Examples of children's interactions in CPE contexts included children's independent exploration of the gardens and general plant life in the outdoor environments, the water trough, the swings, the sand area, the blocks, the messy play area (e.g. finger paint, corn flour and starch), trolleys, scooters, pedal cars and play dough.

Children's interests in science-related thinking were instigated and/or engaged in by the children's exploration of the environments created by the teachers (see Appendix F for the full list of examples). The science-related engagements in these often solo explorations of the environment were verified by the researcher's interviews with the participant children. These interviews illustrated that the children were engaged in thinking about physical phenomena in a way that could be related to the thinking within science communities of practice.

One example was when Paul spent some time riding one of the kindergarten scooters down the sloping concrete area. At the beginning of his ride he used one of his feet to push against the ground and make the scooter move. Towards the end of the concrete area he used his feet to slow down the scooter. When the researcher showed Paul a photo of him on the scooter and asked him what made the scooter move his reply was, “Your feet slow you down when you put your feet down or you can use fast feet, then the wheels.” What the scooter example illustrated was that Paul was gaining information about what made the scooter move which, it can be inferred, supported his developing theories that linked to the science idea of movement and force.

A second example was when the researcher showed Claire a picture of her using the glue gun and asked her what she was thinking at the time the picture was taken. She responded by saying, “Stick, very hot when sloppy and it is not hot when it dries.” This illustrated that Claire was gaining information through her glue gun experience about some physical properties of the glue stick.

The children’s independent exploration of the physical environment was where a substantial amount of children’s exploration of potential science-related ideas occurred. The predominance of this independent exploration suggested the importance of teachers’ awareness of what they provided within the physical environment for children’s exploration. The influence was that the physical environment the teachers created had a direct impact on the types of science-related exploration the children could be involved in. Also to be noted was the variation on how the children explored a similar aspect of the physical environment as noted below. This variation is discussed next.

i) Variation in children's responses to similar aspects of the physical environment.

The physical contexts were similar in the three kindergartens but the children's identified science-related interests and learning was often different in each of the kindergartens. For example, all three kindergartens had gardens and plants in the outdoor areas. When children played in these areas without the teachers, some children focussed on the plants and other children focussed on the animals. The children's different foci presumably related to their particular interests at the time. The instance, from Chapter Four, of Claire's interest in the ants on the tree was an obvious example of a child focussed on observing animals by herself. Another example of children focussed on exploring animals was when a group of children were looking at ladybirds in the vegetable garden. They let the ladybirds climb on their hands and then watched them fly off their hands and back onto the pumpkin plant (Section 4.2.1).

An example of children's exploration being more focussed on plants than animals was when Ruth was picking leaves from different plants to "put on a stick and cook on a fire". Ruth felt one of the leaves deliberately with her finger and then indicated to the researcher she would like the researcher to feel the leaf. Ruth seemed surprised at the feel and commented, "It's soft." Ruth then called out to one of her friends, "Joy, you want to feel this!" Joy came over to Ruth and felt the leaf. Joy commented, "It's soft," sounding surprised. Through her exploration Ruth's actions suggested that she had found a leaf that felt very different from the others she had experienced. She had noted this difference to such an extent that she wanted to share this information with her friend as well as an adult, in this case the researcher. The point is that children's interests had a significant effect on the types of exploration they gave focus to relate to science in the physical environment. Ruth's example was of specific interest as it demonstrated a child discovering first-hand a characteristic of plant life (differences in the texture of the leaves).

The differences in the science learning the children were engaged in seemed to relate to the cultural communities the children belonged to. Revisiting Claire's interest in the ants, when the researcher analysed the interview with Claire's mother it became apparent that Claire's interest in small animals was fostered at home. When the researcher asked what Claire's main interests were, her mother stated, "Her animals and taking care of things, animals more than dolls, loves mice. Claire has two gold fish and the neighbour's cat that is here most of the time." During the second interview, towards the end of the data gathering time, Claire's mother talked of Claire having received a magnifier with a pot on the bottom of it, so you could put small animals into it. Claire and her mother had been catching spiders and putting them into the pot at the base of the magnifier so Claire could look more closely at the spiders. The comments from the interview with Claire's mother demonstrated clear evidence of Claire's interest in small animals being supported at home. It can be assumed that Claire's interest at home has influenced her interest in a similar focus on small animals in the kindergarten's physical environment.

Similarly with the children's interest in ladybirds and who ate the hole in the leaf, their interest seemed to have been influenced by one of the teachers. This teacher had a particular interest in small animals herself and encouraged the children to look for small animals and observe characteristics of the animals. The teacher was observed by the researcher pointing out small animals to children as she gardened with them at an earlier time than the boys' exploration mentioned above. It can be inferred that the boys' exploration with the ladybird was an example of a science-related interest resulting from a teacher modelling her interest in small animals.

Further evidence of an experience that demonstrated the idea of children being informed by the cultural communities they engage with was when the researcher showed Joy a photo of another child playing with the magnetic train set that she liked to play with. During the discussion Joy mentioned that the trains stick together. The researcher asked Joy, "What makes the trains stick together?" Joy's reply was, "The glue!" said in a way that implied that the researcher should have known that answer. Seemingly Joy knew that glue stuck objects together — so glue (as an idea) was what stuck the magnetic train carriages together. It can be assumed that the idea of glue (kindergarten and home communities) had come from her experience within the communities she belongs to and formed her current idea of what "sticks things" together.

6.2.2 Teachers highlighted science in the physical environment

Although less prevalent, teachers highlighting science related ideas and actions in the physical environment (THPE) was observed as an effective way of capturing and stimulating children's interest in engaging in science learning. In some instances this led to the participant children being able to describe their ideas about the highlighted physical phenomenon. Usually the teachers' highlighting actions occurred during a learning experience where a science learning possibility became visible to the teacher.

An example of this happened during a visual art experience where the teacher had provided lit candles. The children were letting the melted wax from the candle drip onto cardboard and then they painted over the cooled wax with different coloured food dye. As this experience was happening, the children looked intently at the melted wax dripping from the candle onto the cardboard. The teacher highlighted the physical change that was happening to the wax. The teacher talked with the children about how the wax melted because of the heat of the flame from the candle. She also talked with the children about how the wax hardened on the cardboard once it had cooled down. One of the children discussed what she called, "cooling hard" physical changes with the teacher, illustrating her engagement in thinking about the properties of the wax. At one point Vasanti felt the wax on the cardboard and the teacher asked her, "What does it feel like?" and Vasanti replied, "Warm." The teacher nodded in acceptance of Vasanti's description. The teacher's question to Vasanti about how the wax felt, demonstrated one way of drawing Vasanti's attention to the properties of the wax she was focussed on.

A second example was the conversation a teacher had about a blossom tree and how the blossom would turn into a fruit (Chapter 5, Section 5.3.1). The teacher had taken a small group of children for a walk to a local shop and on the way the teacher noticed a peach tree in blossom. The teacher highlighted the blossom and talked about how the blossom would over some time turn into a peach. The blossom example is important in this chapter as it drew attention to a science phenomenon that, because of the length of time between the flower stage and the fruit stage, may not have been noticed by the children.

If the teacher did not highlight the science-related learning in these two examples above, and similar situations, then the potential science learning opportunity would be lost. A key feature of occasions when teachers highlighted potential science learning seemed to be when a teacher noticed, through a child's body or verbal language, the interest the child had in a physical phenomenon (e.g. the wax melting). Teachers also highlighted aspects related to science within an experience the children were engaged in. The teacher then noticed if the highlighted phenomenon was of interest to the children involved (e.g. the flower to fruit stage of the life cycle of a tree).

6.2.3 Natural events were a catalyst for children's interest in science

There were times when the teachers were aware that the natural environment and natural events beyond what they had purposely provided, gave opportunities for children's science learning (NEPE). One example of this was when a cold overnight temperature produced ice at the bottom of the slide at one of the kindergartens. A group of children excitedly brought a piece of the ice over to show one of the teachers. The teacher talked with the children about watching it melt. The small group of children also showed the ice to the researcher. The researcher talked with the children about how the cold night had made the water freeze and that the ground had got so cold the water on the ground turned into ice. The children's interest in the natural event of ice forming on a cold night led to discussions about the characteristics of ice.

Figure 6.1. *The ice discovered at the bottom of the slide.*

Another example of NEPE was when a child commented to one of the teachers that the sky was really dark. The teacher asked, “So what do you think that means?” The child responded, “Storm.” The teacher said, “Yeah.” The child noticing the dark clouds can be related to observing the physical phenomena of clouds and making predictions of what the observations could mean in terms of the weather. The natural physical characteristics of the cloud brought about the opportunity for this exchange and although it only lasted a few seconds it was a meaningful exchange for the child in that it gave the child an opportunity to comment on her thinking about what dark clouds could mean.

The two examples above illustrated the science learning opportunities that seasons and other naturally occurring physical events can instigate. In the examples given above, the teachers were able to facilitate science communities’ ways of looking and thinking about the natural phenomena being considered. For instance, the opportunity to think more specifically about some of the properties of ice and with the weather a prediction made from the appearance of the clouds. In the incident with the ice and the dark clouds the children were encouraged to articulate not just their interests but their current thinking on the natural phenomenon.

6.3 The social environment

This section analyses how teachers’ interactions with children influence children’s science learning. Teachers’ interactions included informal, formal interactions and teachers use of semiotic artefacts (6.4.3).

The data in Table 6.2 for Jandals Kindergarten was significantly different from the other two kindergartens. A major contributor to the difference seems to be that one of the teachers at Jandals Kindergarten was very passionate about the living world. Her interactions with the children on living world ideas contributed to more of the children seeking to look and observe small animals within their own exploration without teacher involvement. This aspect of the data from Jandals Kindergarten illustrated how teacher interaction with the children within the provided physical settings introduced children to science-related ways of exploring the physical environment. The science that was privileged within the teachers' actions and interactions with the children was the science ideas and behaviours the children were more likely to emulate.

Teachers interact with children in two significant ways. The first was informally with children as they interacted with the physical environment. In other words, the spontaneous interaction within the learning experiences that related to science learning. The second type of teacher interaction was formally planned in advance by the teachers to enhance the children's science learning. The table below sets out examples of both types of teacher interaction.

Table 6.2 Examples of Teachers' Informal and Formal Interactions to Support Children's Science Learning. (The examples were taken from researcher's general field notes of kindergarten sessions)

Kindergarten	**Kina**	**Pohutukawa**	**Jandals**
Informal Teacher Interactions	Two children found a snail on a swing and took it to a teacher. Teacher said, "Let's find where it belongs." (habitat) Ten minutes later the snail was in an egg carton and the teacher asked the children what else they (snail) would like in their house. At large group time the teacher read a randomly chosen story about a dinosaur and asked the children what the dinosaur was eating; they replied "Leaves." The teacher responded, "Yes it is a herbivore." Child comes inside calling the teacher's name carrying a piece of ice. The teacher asked, "Where does the ice comes from?" Child replies, "From the water." The teacher	Child sitting at the magnets with the teacher asked, "Why can't we see the shadow anymore?" Another child replied, "Because there is no sun!" Researcher coulnd't quite hear the actual sentence, as the teacher talked about the shadow they saw yesterday on the wall and how it changed because of the position of the sun changed during the day. It was a foggy morning and one of the teachers talked with a small group of children about the fog and how it was made of water. She asked if they had noticed the fog that morning. The teacher had begun a seed germination investigation with bean seeds. This particular	Noticing the children's interest in ladybirds and ants in the outdoors the teacher brought out books on ladybirds and ants and looked at them with the children. In one of the books it talked about an experiment where you put sugar near the ants and watched what happened. The teacher asked the children if they would like to do this. They said yes. The teacher got some sugar and put it near the ants. The children watched the ants pick up the sugar and carry it away. Teacher noticed a slug and beetle in the water trough and left them there for the children to discover. As the children arrived the teacher had a discussion about what the slug and beetle

	asked, "What is happening to the ice in your hand?" Child: "It's melting." Teacher added, "How will it turn back to water?" Child replied, "Put more water on it." The teacher was reading a story to a small group of children. During the story one of the children noticed the rainbow in the illustrations and mentioned it was a rainbow. The teacher asked the children, "What makes a rainbow?" One child says it's rain clouds that make rainbows. The other child thinks the rainbow is inside the cloud and has a house inside the cloud. Teacher cooking potato cakes with the children. When the mixture was made they put several spoonfuls in a frying pan. Teacher asked, "What is going to happen?" No reply so the teacher said, "Can you see the bubbles?" Child replied, "I can see the bubbles popping." Teacher talked about the mixture changing – liquid , soft and changes to solid Blowing up balloons with children using a pump. The teacher asked the children, "What is going into the balloon?" One of the children replied, "Wind."	morning she asked if two girls would like to water them. The children and teacher talked about how they were growing and the teacher commented "Oh yes – look at those ones – I'll bring one over so we can compare them," and then asked why some were growing better than others. Child: "That one's had more water." And watered the seed that had gone dry. Teacher outside points out the moss growing on the large climbing box. Two children look closely. The teacher adds, "Real moss growing between the fake grass – it (moss) likes the wet." The two children listened and then moved on to play elsewhere Teacher talked with a child about the bird nest they found and dissected to find out what it was made of. Teacher commented that some birds had mud inside their nests which made it all smooth. Teacher had been watching the children in the sandpit make a waterfall. Later she came back and asked, "What has happened to your waterfall, it's all flattened out." Child response: "The hole has grown; it has got bigger and bigger!"	might eat. The children decided silverbeet and brought some to the water trough but the slug and beetle didn't eat it. Teacher brought monarch butterfly outside that had just hatched. Seven children came and watched. The teacher talked about the patterns on its wings and that the butterfly needed to fly when his wings were dry. She put the butterfly on a hanging basket and said, "When he is ready he will fly off." Teacher noticed the children playing with the plastic levers. She talked with them about how far the small soft toys go when the children jump on the end of the lever. The harder you jumped the further the soft toy went.

Formal Teacher Interactions	Introduced still art drawing of the monarch caterpillar and butterfly – small group Planting a sprouted kumara with a group of children- small group At large group time: Teacher talked about the weather that day. How there had been rain and sunshine At large group time children watch a DVD of the teacher's baby growing inside her.	Teacher had set out magnets and things the magnets would pick up. Two girls came to the table to have a look. The teacher said, "These are called magnets – they have special metal inside covered in plastic." The children explored what the magnets would pick up and then the teacher showed one of the girls how the magnets could push away from each other and asked the girl, "Can you feel that?" The girl nodded and smiled. At large group time the teacher talked about the cylinder the children had been rolling balls and marbles in and demonstrated to the whole group. She asked, "What do you notice about marbles?" One child said, "Faster at first and then slower." The teacher also asked, "What ball will get to the top first?" At large group time the teacher asked the children, "What is the name of our planet?" Children replied, "Earth." The teacher talked about the Earth spinning and reminded them about the shadow investigation they did yesterday. Then the teacher asked the children, "What does our Earth spin around?" the children replied, "The sun!" Another child responded by saying, "The sun is really, really big!"	There was a planned trip to a Butterfly Farm and so at the large group time the teacher talked about the stages of the life cycle of the butterfly with the children. Another day another teacher played the butterfly song and the children acted out being the various stages of the life cycle of the butterfly as the song played. At large group time a teacher showed children an autumn coloured leaf and a green leaf. She asked the children if they thought the brown/ orange leaf was on the tree. Children say no. then she showed them the green leaf and asked the same question. The children say no again – so she explained how she got the brown/orange leaf off the ground and the green one she had picked off a tree. Large group time: Teacher shows a picture of snow on the front cover of the newspaper and talked about it being winter time and in some places it had snowed. A teacher read to a small group of children a children's book about a man going to the moon. She told the children that it was 40 years today that the first man walked on the moon. At large group time a teacher read the large

		Another day at large group time the teacher said, "Let's look at the amazing bean. What have we noticed about them? They have all grown at different rates, why?" One child said, "'cause they haven't had much water!" Another child said, "I could give it to a giant." They go on to talk about a story of a giant. Then they return to looking at the beans. The teacher asked, "Have you noticed how those beans are getting black on the top?" Meaning the shoot. One of the children replied, "They haven't had any sun." Another child responded, "I don't know where the sun is." Another child said, "It's outside." The teacher then talked about what they would do with the beans next – plant them in the soil outside.	book "I like the rain". The book is about different forms of precipitation At the large group time a teacher asked what the children knew about snails (after having investigated the small animal for two weeks). The children talked about the snail having a heart, they pooped green stuff, they ate leaves, bran and cheese, they could hide and they go slow.

6.3.1 Teachers' informal interactions with children supported science learning

What was notable about the teachers' informal interactions that promoted science learning was the way opportune moments were identified by the teachers. These opportune moments privileged science ideas or science ways of inquiring into the physical environment in a context of interest to the children, within a specific moment of time. There were four specific ways science was brought to the fore through teachers' informal interactions with children. The first was teachers adding to a conversation by adding science terminology to the conversation. Examples of science terminology being added to the conversation from Table 6.2 above were introducing the words herbivore, momentum and friction.

A second way science communities of practice were brought to the fore was when teachers highlighted science ideas within the physical environment children were commenting on or experienced through action. One example of science ideas being highlighted was when teachers considered with the children the idea of what birds' nests can be made of. A second example was when the teacher highlighted the idea that the harder the child jumped on the lever, the further the lever would push the soft toy (examples from Table 6.2).

The third way science was brought to the fore was when a teacher highlighted a process of inquiry that indicated some connection with the nature of science. One example of teachers' highlighting the nature of science was when the teacher suggested bringing the second sample of bean seeds closer so that the children could compare the germination process. A further example of the nature of science was when the teacher discussed what the slug and the beetle might eat, motivating the children to think about an answer and trialled giving the small animals some silverbeet (Table 6.2).

The fourth identified way teachers informally interacted with children to support science learning was through questions. One example from the above table was when the teacher talked to the children in the sand area and asked them what they thought had happened to the waterfall. Another example was when the teacher asked what was happening to the ice in the child's hand. One further example was when the teacher asked what was going inside the balloon. In all three examples the question gave the children an opportunity to reflect on what was physically happening. It also gave the teacher an opportunity to observe the children's thinking about the physical environment being considered (Table 6.2).

6.3.2 Teachers' formal interactions with children supported science learning

With the interactions where teachers had planned the experiences ahead of time there was still room for spontaneous conversation. The difference in the category of teachers' formal interactions was that science ideas were at the forefront of the teachers' thinking and had a deliberate pre-thought-out science learning focus.

Four purposes of formal interactions that support science learning for children were identified.

The first purpose was to provide learning connections to the children's current ideas that had been noticed by a teacher. An example of teachers working from children's current interests/ideas in Table 6.4 was the cylinder experience at group time at Pohutukawa Kindergarten. Rolling objects in the large cylinder had been something a small group of children had instigated for themselves (as described in Chapter Five). The teacher took the children's idea about rolling balls in the large cylinder and introduced more balls and more children to the experience. The enhancement of children's science knowledge was about investigating, comparing, predicting and describing what happened to the different balls as they moved inside the cylinder. The teacher's interaction encouraged children in a science way to consider the variables involved.

A second purpose of the teachers' formal interactions seemed to be to highlight physical phenomena within the immediate environment. An example of this from Table 6.4 was when the teacher discussed the type of weather they had had in the kindergarten session that day: there had been rain and sunshine. A second example was when a teacher discussed with the children the autumn leaves from a deciduous tree.

The third purpose of the teachers' formal interactions seemed to be adding a new experience that related to science knowledge. Two of the examples from Table 6.2 were providing and discussing what magnets were with a group of children, and the children watching a DVD of a baby scan

The fourth purpose was to facilitate children revisiting what they had been exploring over time.
An example of this from Table 6.2 was a teacher at Jandals Kindergarten asking the children what they had learnt about snails. A further example was at Pohutukawa Kindergarten when the teacher encouraged the children to consider what they had learnt about the amazing bean.

6.3.3 Teachers' perceptions of how semiotic artefacts promoted science learning

Congruent with children's engagement in semiotic artefacts in the previous chapter is teachers' understandings of semiotic artefacts and their influence on learning had a significant impact on children's learning. Of particular interest from the teacher interviews were the comments the teachers made about the ways children learnt about science. There was a direct correlation between what the teachers' expectations were for how the different semiotic tools could support science learning and the actual artefacts teachers used in each of the three kindergartens. Pohutukawa Kindergarten staff mentioned language, books and songs as important semiotic artefacts for children's science learning. There was evidence of the Pohutukawa teachers using science words deliberately, providing songs about seed germination and the life cycle of a butterfly as well as reading books with science information in them related to the science ideas being explored by children. At Jandals Kindergarten teachers mentioned literature (for them this meant books) and the Internet as contexts for children learning science. The data from Jandals Kindergarten demonstrated that when the children showed an interest in a science idea that the teachers would then augment this interest with either a children's non-fiction book or by researching information for the children on the Internet. At Kina Kindergarten the teacher mentioned children's exploration, trial and error, the ability to guess, hypothesise, to make predications and to try out and test their own theories as the main semiotics useful for children learning science. They also mentioned it was important to develop a sense of awe and wonder, opportunities for children to discuss their theories and to respect children that want to be "onlookers." In practice the researcher noted that children's exploration of the environment was valued within the learning environment by the teachers.

The teachers in all three kindergartens promoted the idea of children exploring the environment (children's actions) as an important part of the science learning process. This can be linked to the idea of actions as a semiotic artefact used for learning as discussed in Chapter Five. Children's actions, children's exploration and free play were seen by all the teachers as an important ways children learnt about their world, including science learning.

What the analysis of the teachers' affordances to semiotic artefacts illustrated was that their understanding of the use of the artefacts for science learning affected how they interacted with the artefacts to promote science learning for the children.

6.4 What science communities were privileged by teachers

A second coding theme was used to explore the relationship between the environment provided and the participant children's engagement in science learning related to the five worlds/disciplines within the science learning section of *Te Whāriki*, in Exploration goal four (Ministry of Education, 1996). Using the same instances as Table 6.1, the data was re-coded and analysed for what world or worlds each instance related to.

Table 6.3 Instances Related to the Different Science Knowledge Worlds in Participants' Free Play.

	Kina Kindergarten	Pohutukawa Kindergarten	Jandals Kindergarten
Physical World	24 = 62%	24 = 62%	10 = 40%
Material World	03 = 26%	04 = 10%	05 = 20%
Living World	10 = 8%	09 = 23%	07 = 28%
Planet Earth & Beyond	02 = 5%	02 = 5%	03 = 12%

Note: Some instances related to more than one world. For this reason, the total of instances will be different from Table 6.1.

In all three kindergartens the physical world was the world most explored by the participant children contributing between 45 – 66% of all instances. The types of physical world science ideas explored were related to movement, forces, shadows, reflections and magnetism. Theoretically it is interesting to note that Bronfenbrenner's (1979) micro and macro influences on a child or groups of children gave a sound explanation of why this is the case. The physical world can be seen to be closest to a child's micro world, most accessible for the children to explore. The science ideas being explored were often about their physical bodies and relationships related to forces associated with movement. Examples included how to balance their own bodies and the force required to move objects; these are all aspects that young children are aware of in their everyday lives. A more detailed example was when Claire balanced on the log wall and discussed with the researcher how she was balancing by using her arms. She commented to the researcher, “This is balancing; you need to use your arms.” In making this comment, Claire demonstrated that she was aware that what she had done was to balance and what could physically help her balance. She showed an interest with this learning experience by continuing to balance on the logs for a further five minutes by herself after the discussion with the researcher.

Figure 6.2. *Claire demonstrating balancing for the camera.*

Figure 6.3. *Vasnati learning throwing and hitting.*

Another example, involving the movement of things, was when two girls spent ten minutes hitting a ball that was tied to a rope hanging from a large branch of a tree. When the researcher asked, “What were you thinking?” Vasanti replied, “Learning throwing and hitting, hitting shows moving fast. When we cut it, it’s going down.” Vasanti’s statement suggested that her thinking while engaged in the hitting game was focussed on how hitting changed the speed (“shows moving fast”) and direction (“when we cut it, it’s going down”) of the ball. This can be interpreted as Vasanti exploring the physical world concepts of force. The examples above, as well as the many examples in Chapter Five, are evidence of a considerable amount of physical world exploration that was happening in all three kindergartens.

The analysis of the other three science communities' strands identified more variability of instances of engagement between the three kindergartens, as seen from Table 6.3. A question of interest was what influenced what and when which of the science worlds were privileged. The answer to this question seemed to be threefold. One of the significant influences was the physical environments that were created for the children to explore. The physical environment available linked with the idea of accessibility of the types of physical environment directly influenced what children could explore. The second influence was the teachers' interaction with the children. The idea of teachers' interactions linked to the notion that social interactions gave children access to science learning. The third influence was the communities of practice the children belonged to outside kindergarten. The communities of practice outside the kindergartens would include both the physical environments children encounter and the social interactions with the people in the communities they belong. The next section considers events where the teachers deliberately included science-related experiences in the kindergarten environments.

6.4.1 Teacher provision in the physical environment for the communities of science

The data analysed for this section of the chapter was taken from the general field notes and observations of the morning sessions in all three kindergartens. Evidence that the physical environment influenced potential science learning was seen through what physical provisions the teachers introduced to the kindergarten environment. One such example was the monarch butterfly being introduced to children at all three kindergartens. A further example was the kindergartens that provided experiences with magnets. Many of the children did not seem to have experience with magnets or monarch butterflies within their home or community. Therefore it can be said that providing these semiotic artefacts widened the types of potential science-related and science-specific learning to which children were being exposed.

When and how did the physical environment support science-related learning congruent to the physical, material, living worlds and the planet earth and beyond? It was only as the child's mind was engaged in the thinking related to science communities of practice that the researcher evidenced that science education had the potential to occur. Examples of science-related learning from the physical environment teacher are provided related to the:

Physical World

Children ran their toy cars brought from home down the sloping path and discussed the movement of the cars with each other. The teachers allowed the children to use their toy cars on the path.

- A child twirled the ladder swing and watched it un-twirl and repeated this several times. Although the ladder swing was usually for physical movement with children on the ladder, the teacher allowed the child to explore the movement of the swing when twisted.

Material World

Children mixed different coloured paints together to purposely see what new colour was created. The teacher provided palate trays and cotton buds for the children to continue their investigations.

- Claire, while using the glue gun, talked about how hot makes the glue runny. Teachers provided the opportunity as they allowed the children to use the glue gun by themselves.

Living World

A child noticed leaves falling from the oak tree and showed surprise and wonder as it happened. The teachers provided the tree as they allowed the tree to remain part of the outdoor environment.

- A child told a teacher about the pea sprouts and that they had gone black (planted in the winter to see what would happen). A teacher provided the opportunity as she gave the children who wanted to plant pea seeds in the winter an opportunity to see what would happen.

Planet Earth and Beyond

A child talked about how the ground was cracking. The teachers provided a dirt area for children to play in. In the warmer, dry weather the dirt area dried out and cracks appeared in the ground.

- Rhja talked about making a stream while he was pouring water down the concrete path. He poured the water down the path several times. The teacher provided water and a bucket for children to play with. The teacher also allowed the child to use the water outside the set areas of play; this gave the opportunity for Rhja to explore the flow of the wateras he observed it travelling down the contrete path.

What all the examples above illustrated was the importance of deliberately having a wide range of physical components in the environment for the children to explore. It also illustrated the importance of teachers noticing how the children were engaged with exploring the materials. It was the teachers' noticing that brought about the children investigating how the seeds would grow in the winter. The teachers allowed the child to explore "making" a stream by putting the water on the path. Of importance was not just the setting up of a varied physical environment but teachers responded to how the children wanted to use the physical environment to explore their developing ideas that related to science. The following section examines the changing ideas of the teachers on affording potential science learning within the physical environment.

6.4.2 Changing the balance: Teachers' understandings of the science communities of practice

The title of this section refers to the change in balance in terms of what teachers afforded potential science learning to within the physical environment. From the premise that science is made up of a number of science communities, it can be argued that young children would benefit from the opportunity of gaining experiences related to all five science communities. However, this required teachers to be aware of knowledge and practices within each of the science communities. One of the professional development components of this research project identified the different science communities. The analysis in 6.3.1

examined the changes in teachers' awareness of potential physics learning after the professional development session, suggesting that the teachers' awareness could be enhanced for the other four science communities.

6.4.3 Teachers' awareness of science worlds enhanced

One of the changes noted by the teachers after the professional learning component of the research project was that they had a greater understanding of the science worlds. This was most evidenced when one of the teachers commented that "it's not just the living world!" Unbeknown to the researcher, this teacher had looked up the definition of science in the Oxford dictionary at the beginning of the research project. The teacher read this to the other teachers present in her kindergarten teachers' second interview session with the researcher:

" … the intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment: the world of science and technology …" (Oxford Dictionary online, retrieved 2 July, 2012).

It was a real revelation to this teacher that the definition in the dictionary related to more than just the living world. The realisation by the end of the professional learning sessions was that her interpretation of the science communities of practice had been significantly broadened to include the domains of the material world and physical world — science in particular.

The teacher's perspective on the science communities illustrated the importance of teachers' interpretations of what the main science communities of practice are. A further significance was the teachers' understandings of what the physical, material, living worlds, and the planet earth and beyond language in *Te Whāriki* meant for the curriculum they provided for children's learning.

It was clear from the first set of teacher interviews that the teachers had more understanding of their kindergarten environment's connections with the living world than the other three main communities of science mentioned earlier in this chapter. This find was reiterated by all three kindergartens' first teacher interviews. The teachers unanimously described the living world as the most important science learning within the kindergarten setting. "Care for nature", "the care of the world" and "the natural world" were the words the teachers used to describe the most important science learning that could take place in their early childhood centres.

The first set of teacher interviews also gave insight into the teachers' general notions about the science communities of practice. The strongest evidence was presented in the teachers' answers on identifying what the living, material, physical worlds and the planet earth and beyond represented from a science perspective. The teachers' answers revealed that they were not that aware of the science communities of practice in terms of the language used in the curriculum framework document or goal four of *Te Whāriki*. The types of answers referenced more to possible everyday understandings of the words physical, material, living worlds, or planet earth and beyond. Table 6.3 below sets out the teachers' answers related to the science communities of practice within the first questionnaire. There was a distinct correlation, from all the teachers' answers, with the teacher who looked into the dictionary for the definition of the physical world and related that definition to the living world.

Table 6.4 Answers From Teachers' First Interviews on Science Communities of Practice

Kindergartens	Kina	Jandals	Pohutukawa
Living world	People, places, things Children's own perceptions Their environment What is in the physical world And properties of matter – what things are made of	Insect thing Life cycle	Relationships with the natural environment Bugs and things social
Material world	Man-made side of it The computers Things of a non-natural base	Chemistry like mixing Chemical reactions	Types of things we are using – like magnifying glasses and all that type of thing Bugs and things Natural material Material and what they do with it Materials are the things they can handle

Physical world	About living and non-living environment Differences between man-made and natural Knowledge of the environment	Tangible things you can see, touch , feel – like sand and water The physical world and how it impacts on us Difference between hot/cold Their place in the world Recycling Sustainability Taking care of the world How to look after nature Twirling the swing – that's physics	Nature Planet earth and beyond Their own place within the world Working theories about the living world and how to care for it
Planet earth and beyond	Planet earth and space	No comment made	Not asked directly in this interview
Processes of inquiry scientists' use	Learning dispositions Questions Working theories is hypothesising Research Exploration	Children using magnifying glasses Exploring the physical world – the trees, the grass, the insects Questions Modelling researching through computer Inquiry Children's natural curiosity	Representing their (children's) discoveries Looking at patterns Classification Asking questions Explorers Exploring the environment Making sense in their own way

A consequence of the professional learning sessions was the change in the teachers' perception of the potential affordance for science learning available within the range of physical environment experiences they already offered for children. More specifically, for example, were the increased affordances of the outdoor resources like the trolleys, scooters and balls to potential physical world science learning as described in Chapter Five. The outdoor environment in general was no longer just seen as supporting physical development and social learning but, more inclusively, was valued for the potential science learning as well. The teachers' enhanced ideas of the science communities added another dimension of richness to the holistic nature of the learning environment.

Further evidence of teachers' change in focus towards potential science learning was when two of the case study kindergartens decided to significantly reduce the science areas they had set up in their environments after the professional learning. Their reasoning being that the potential for science learning was as prevalent in the holistic everyday environment so did not need a significant focus on a specific place for science learning to occur.

6.4.4 Teachers foregrounded science learning

The researcher became aware of how the teachers thoughtfully set some equipment up in the environment with science learning in mind. Examples of teachers foregrounding science were:

- Magnets placed on a table for children to explore
- Anatomically correct plastic insects placed on a low shelf for children to explore
- Bringing in a swan plant in a pot with a chrysalis attached to one of the branches
- Non-fiction books or posters relevant to a science interest placed strategically in the environment

In the examples described above, science was at the forefront of the teachers' thinking on the provided physical environment. The artefacts afforded science learning in the minds of the teachers.

Foregrounding science by placing specific science-related artefacts in the environment gave the children opportunities to interact with that environment in different ways and often when this happened science learning was brought to the fore. The science foregrounding in the physical environment that the teachers provided gave opportunities for children to learn science that may not otherwise have been available to them.

6.4.5 Science learning at the background of a learning experience

There were also other instances (mentioned in point 6.3: CPE & NEPE) where children became interested in an aspect of science in the physical environment incidentally without the teachers intentionally setting the physical environment for the purpose of science learning. Examples of science learnin**g being at the background of the experience were**:

- Children explored with mixing the different coloured paints to create new colours and discussed with each other what they had discovered. The experience had been set up as an art experience.
- A participant child immersed in water play who could describe her interest in how the water pushed plastic boats down the guttering.
- Children making a river in the sandpit discussed how the water flows downward.
- Two separate instances where children explain how the glue from the glue gun gets sticky when it heats up.

In these instances, science learning was in the background as possible affordances to learning from the experiences set up in the environment by the teachers. It was the children's interests that gave rise to the contexts supporting opportunities for children to learn science ideas. Teachers' awareness of children's interests that related to science learning was an important skill in providing science learning within a holistic curriculum.

One of the rich and complex aspects of the three kindergartens was how dynamic and, at times, unpredictable the children's interactions with the environment were. For example, some aspects of the environment were seen by teachers to highlight science learning at times when children would gain learning related to other disciplines. An example of this was when one of the kindergartens focussed on the monarch butterfly and its life cycle. Sarah, one of the participant children, was far more interested in the artistic beauty of the butterfly wings than looking at the butterfly as a living organism. When asked by the researcher what she was thinking when she saw the monarch butterfly Sarah replied, "Oh I was just thinking how beautiful those wings are." The implication was that children put different interpretations on the same artefact/experience signalling the importance of teachers' attunement to what perceptions each child was focussed on. The teachers' attunement to children's different perceptions to the artefacts in the physical environment was an example of the importance of one of the ideas of intertextuality mentioned in Chapter Five. The intertextuality idea here was of the same text (i.e. the same physical artefact) being perceived in different ways by different children. Within a holistic curriculum framework it was important to acknowledge and be fluid enough to notice, recognise and respond to the children's affordances that they gave to the physical environment available. This was the general intent of the teachers in all three kindergartens but was more evident in terms of potential science learning after the professional learning sessions.

The ethos of the possibilities of foregrounding and back-grounding science learning experiences was important as it provided a basis for the following discussion on the relationships between the physical environment set up for holistic learning and the acknowledgement of potential science learning within. More specifically it illustrated the theoretical concept of teachers' affordances given to the physical environment and how this applied to science learning.

6.4.6 Professional learning increased teachers' affordances and attunement to science learning

An outcome from the professional learning sessions was that all the teachers evidenced in the teachers' second round of interviews (Appendix B) became more aware of the affordance for potential science learning within the holistic play-based curriculum. One teacher referred to this as "incidental moments have become more evident as pertaining to science". Another teacher talked about how looking through the lens of science she now felt she was able to recognise the potential science learning and respond to it, but that in the past she would not have necessarily seen them under the lens of science. A third teacher commented that she had gained in understanding of "looking out for different opportunities to extend those sorts (science-related) of concepts ..." While another teacher commented that she was "more focussed on listening to the children's thoughts and how they work things out". This last statement added another dimension to affordance: that the increased awareness of the teacher afforded children the ability to theorise about the physical environment. The teachers' comments above have revealed two aspects of influence that teachers can have that promote science learning. The first aspect is teachers' affordances of the actual physical environment for the potential for children's science learning. The second aspect is teacher's attunement to the interpretations the children themselves attributed to physical artefacts in the environment that could be related to an aspect of science.

6.5 Conclusion

This chapter has considered three foci of teachers' influence on children learning science. The first was teacher awareness of science learning affordances in the physical environment. The second was the teacher influence on the social environment that supported science learning. The third focus was on how the teachers' knowledge of science and science education influenced children's learning. These influences are discussed separately but are acknowledged as being intrinsically linked in practice.

The physical environment teachers created for children had a direct influence on the potential for children to explore and learn about the five science worlds. The findings in section 6.2 illustrated that children's engagement with science-related learning was mainly happening through their interactions with the physical environment created by the teachers with no teacher interaction in developing children's engagement in the learning at that time. This finding illustrated the role and importance of the physical environment in own its right given science is about interpreting physical phenomenon. It also highlights the role teachers have in ensuring there are a variety of physical resources available for children to explore.

Influential within the social environment was teachers' social support for learning, specifically the teachers' attunement to children's interests and their interpretations of how these related or could be related to science. All three kindergartens were pursuing a child interest-based curriculum and teachers' attunement to children's interests that were science-related influenced the extent and depth of science learning that could take place. The teachers' attunement to children's interests was evident within the physical environment teachers sought to create, their interactions with children and their responses to the natural physical phenomenon happening in the environment as these were encountered by children

Across the three kindergartens teachers interacted with children in three different ways, broadly speaking. The first was informally within the free play curriculum. These informal interactions between teachers and children included teachers using science language and teachers highlighting science ideas within the contexts children were exploring. Other informal interactions of teachers was them highlighting science processes of inquiry and science ways of knowing as children explored the physical environment. The second way teachers interacted with children was more deliberate based on them having planned for science-related experiences linked to children's interests. Three purposes for teachers' deliberate planning for science related experiences were identified: (i) connecting science learning with children's interests in the physical environment; (ii) highlighting a physical phenomenon within the children's immediate environment, and (iii) supporting children to revisit what they had explored/learnt that related to science ways of knowing.

One of the findings from this study is that teachers and children can and do interact within the physical environment around science-related ideas. Teachers guided children to think about their experiences within the physical environment in science-like way. However, it was the children who needed to engage in science-like thinking about an idea or physical phenomena for their science learning to occur. This challenges the notion that 'science is everywhere', as is often claimed. The findings verified that teachers' knowledge and understanding of the science and science education communities influenced children's science learning. Teacher knowledge of science and the nature of science influenced the affordances to science learning they aimed to provide through their organisation of the physical environment. Their knowledge influenced what they attended to in the physical environment and the extent and ways they were attuned to children's interests in the physical environment as these might relate to science. The professional learning sessions demonstrated that it was possible for these teachers to develop a deeper understanding of some of the ideas within the science community, in this case the physics community, and then to share their new understandings with children. There was evidence that gaining an understanding of physics led to the teachers to perceiving more clearly affordances for physics learning within the physical environment and within children's free play.

Crucial to teacher influence on science learning was the understandings they had of the science communities mentioned in Exploration Goal Four of *Te Whāriki*. Which worlds were privileged was influenced by the worlds the teachers perceived as important. The living world was seen by the teachers in the three kindergartens as the most important. So it is no surprise the living world (biology) was the most privileged world within the integrated curriculum, both in physical provision and in teacher dialogue. However, as the teachers' awareness and understanding of the physical world science practices increased through professional learning, so the physical world experiences were more privileged within the holistic curriculum presented to the children. What this demonstrated was that as teachers gained more understanding about the different science communities of practice, they became more attuned to children's interests in science knowledge and practices within those worlds.

The next chapter discusses the main finding from Chapters Four, Five and Six in relation to the literature.

7 Factors contributing to how science was enacted

“What children pay attention to is determined by what is in the environment that they can explore and what adults or significant other around them, point out” (Fleer, 2009b, p. 282).

7.1 Introduction

The three conceptual reference points identified in Chapter Two provide a framework for this chapter to describe the factors that contributed to science learning and teaching. These conceptual reference points are multiple cultural communities of practice, semiotics within and across cultural communities and teacher influence on children learning science.

The researcher’s interest in how the dynamic interactions between the four communities influence science learning in early childhood play-based settings provided the overarching framework for this study. This interest provided an impetus for the two main research questions in this thesis:

1. How is science learning and teaching being enacted in three kindergartens?
2. Does the enhancing teachers’ knowledge of science and early childhood science education enhance the learning of science for young children in these three settings? If so, then how does this occur?

This chapter identifies the main findings of the study and discusses them alongside existing literature. Specifically, the findings indicate the four cultural communities of practice that were proposed in Chapter Two are involved in children’s science learning. The findings also identify the supportive role of semiotics within and across the cultural communities and the influence teachers have in creating science learning opportunities for children. The relationship between the three conceptual reference points is represented in the diagram below.

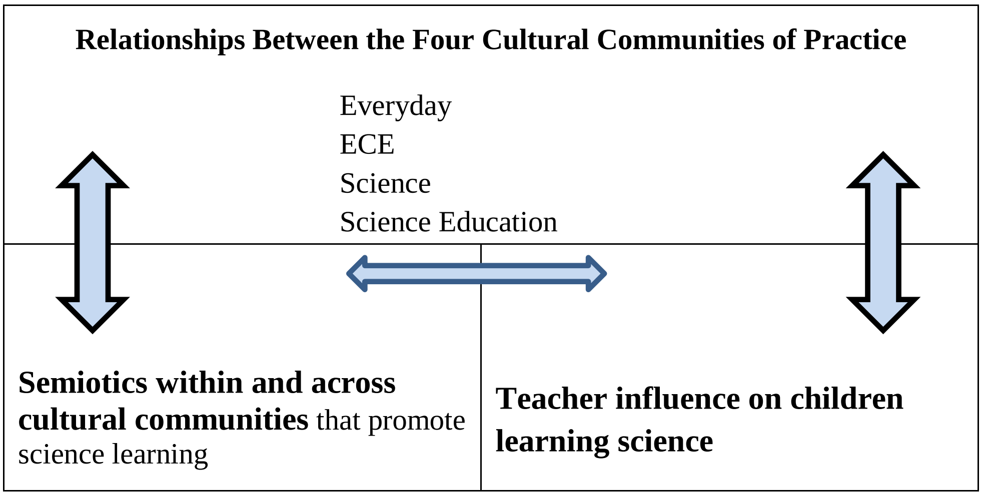

Figure 7.1. *Diagram identifying the three conceptual reference points that framed the study.*

The chapter begins by discussing the relationship between the four cultural communities of practice

7.2 Relationships between the four cultural communities of practice

The findings illustrated that the intersection between everyday, ECE, science and science education communities created the space where science learning and teaching happened. Teacher understandings of the four communities and their engagement in the possible relationships between them were a dominant influence on children's science learning.

The notion of a "quadruple move" is introduced as a way of describing the dynamic interplay between the four identified communities that resulted in children learning aspects of science at the three kindergartens. This section then presents findings on how the teachers' understandings of the four communities and the relationship between them influenced children's science learning. Using the concept of hybridity, the final part of the section identifies the benefits to children's science learning when practices are synthesised across the four communities.

7.2.1 Science learning happening between the four cultural communities

The facilitation of science learning and teaching in this thesis is perceived as a dynamic interaction between the four identified cultural communities of practice. The catalyst to learning is viewed as the interaction between children's everyday interests and practices in the physical environment and teachers' understandings of how children's interests can relate to those of the science community. Teachers then facilitate learning through their understandings of the ECE and science education communities. The researcher has named the interactive process whereby the four communities meet and where science learning occurs, a *quadruple move*. Within the quadruple move, teacher engagement with the four communities takes place during children's spontaneous play and, at times, through planned possibilities aimed at mediating young children into science community knowledge and/or practices. Below are two examples of the quadruple move that demonstrated the interplay between the four communities when science learning was happening.

i) First example of the quadruple move

The first example, described in Chapter Five, was when the teachers engaged with the children's interest in movement. The *everyday community* connection was with and through children's everyday interest in the movement of objects as documented in Section 5.2. An example of this interest was when Joy explored movement by experimenting with a metal truck moving down the different grass slopes at the kindergarten. The *science community* connection was made through the teachers linking movement experiences to science concepts of force, friction, velocity and speed (Section 5.2.2, Kina Kindergarten). Within the Jandals Kindergarten example, there was also a science connection through processes of inquiry related to variations in slopes and friction and what effects this had on the movement of small cars (Section 5.2.2, Jandals Kindergarten). The researcher's first professional learning session supported teachers' awareness of the link between the everyday community (children's interest in movement) and science. After the professional learning session the teachers were more aware of the science related to children's interests in movement and provided further experiences for them to explore. At Kina Kindergarten this was done by the teachers buying new board-scooters for the children to use on the sloping concrete path. At Jandals kindergarten this was done by the teachers providing children with experiences to move toy cars down various slopes made with drain pipes (Section 5.2.2). The *ECE community* connection was made through the teachers documenting the children's science related learning to movement through learning stories (Section 5.2.2). The *science education community* connection was through the teachers mediating children into science terminology related to movement and through them considering ways children might engage with understanding the physics concepts mentioned above.

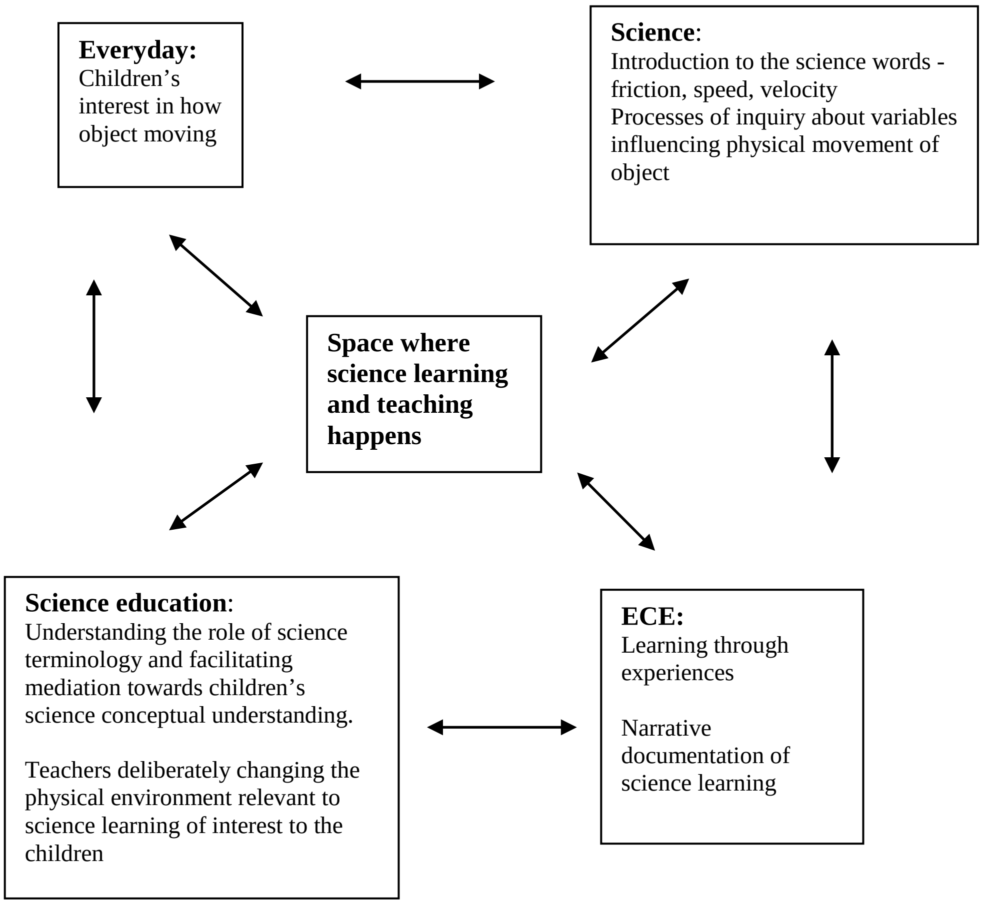

Figure 7.2. *Representation of the dynamic of the quadruple move: Teacher facilitation of science learning related to how objects move.*

ii) Second example of the quadruple move

The second example of the quadruple move, described in Chapter Four, was when the teachers, with the support of the researcher, engaged with the children's interest in snails. The snails were part of the *everyday community* and the children were demonstrating a curiosity to learn about them. *The science community* connection was through biology knowledge about snails and some understanding of how scientists investigate small animals. The *science education community* connection was through the introduction of the snail anatomy poster, engaging children in science related investigation and facilitating dialogue about the snails. Science processes of inquiry were further illuminated for the teachers by the researcher when she suggested to teachers to include an investigation about what snails might prefer to eat but with the children choosing some of the foods and being active in the investigation. The *ECE community* connection was through the teachers' facilitation of hands-on exploration of the snails and the narrative documentation of the children's learning.

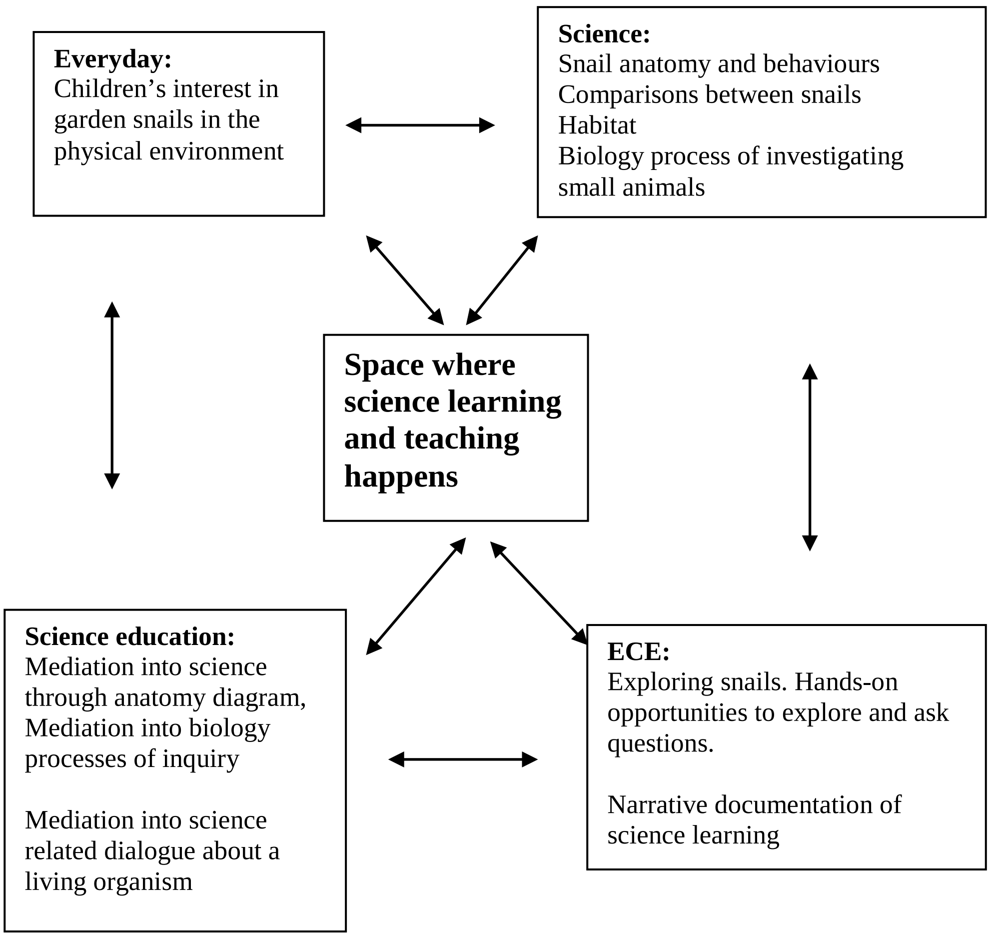

Figure 7.3. *Representation of the dynamic of the quadruple move: Teacher facilitation of science learning related to how object moves.*

In the literature the idea of connections between everyday and academic communities is well established. For instance, Vygotky (1987) refers to the connection between children's everyday and academic communities as an important connection for their learning. Hedegaard has described a model of teaching and learning relationships between subject knowledge and everyday conceptual ideas for school age children (sited in Hedegaard & Chaiklin, 2005). The model is referred to as the "Double Move". The main principle of the model is that teachers keep in mind the child's everyday tacit concepts and consider how these concepts link to subject matter they want to teach. In this way the teacher places the subject matter learning within an everyday idea familiar to the learner. Fleer (2010) uses Hedegaards's double move to describe the connections between everyday and science conceptual knowledge within an early childhood, integrated curriculum setting. Fleer states that within a play-based early childhood curriculum, a conceptual (science) and contextual (everyday) intersubjectivity is needed between both the children and the teachers (Fleer, 2010. p. 12).

The research findings described in Chapters Three to Five encompass this double move. However, reflecting on the four identified communities brought a deeper understanding of the complex dynamic of science learning situations in a play-based curriculum setting. In this research project, the pedagogical communities of ECE and science education were identified as communities involved in teachers making connections between science and everyday communities. The inclusion of these communities is consistent with Fleer's (2009a) findings, that teachers are often unsure of how to make the connection between science and how young children can learn about them within a play-based curriculum. The discovery of the teachers' limited confidence in both science education and science practices in relation to children's learning in an early childhood play-based curriculum led to an appreciation of how the *four* identified communities were involved in teachers' facilitation of children learning science. The dynamic interplay between the four cultural communities was needed to describe science learning within the play-based curriculum in the three early childhood settings in this study. The quadruple rather than the double move more aptly identifies the cultural communities of practice involved in children learning science within a play-based curriculum, from a teacher's point of view.

7.2.2 Teacher understanding of the cultural communities

Teacher understandings of the four cultural communities and the possible relationships between them influenced children's access to science learning. This section considers teacher understandings of each community and their engagement across the communities that had influence on science learning. The teachers' documentation, the researcher's observations and the group interviews with teachers inform this section of the discussion.

i) Teacher understandings of the different communities of science

All teachers in the study had a limited understanding of the different science communities' knowledge and practice. The evidence for this came from the *teachers' group interviews at each of the three kindergartens. As reported in* Section 6.3.1, the teachers in all three kindergartens had a greater understanding of the living world than the other four main communities of science mentioned in *the New Zealand curriculum documents. Similar to Sackes (2012), the findings in* this study affirm that teachers are more likely to focus on the life sciences than other science communities of practice. This was evident in the teacher interviews when the teachers discussed the importance of children learning about the living world (biology) as it linked to the sustainability issues facing our world. The findings also indicate that teachers seemed to have little affinity to the science knowledge related to chemistry, physics, geology and astronomy (Section 6.4.3). Other research literature on early childhood teachers' science knowledge has also reported that early childhood teachers have limited knowledge of the breadth of science communities (Fleer, 2006; Garbett, 2003; Watters et al., 2001).

The findings have revealed that, like science knowledge, teachers could benefit from a greater understanding of science processes of inquiry. In the first set of interviews with teachers their answers were also limited in terms of understandings of science processes of inquiry (Section 6.4.3). The prevalent ideas related to science inquiry were about the importance of children having the opportunity to learn through trial and error and the children using magnifying glasses to examine the physical environment. There is a substantial body of literature on the benefits of young children being engaged in *science processes of inquiry* (Eschach& Dor-Ziderman, 2011; Gelman et al., 2010; Johnston, 2009; Siry, 2013; Alward et al., 2014). However, there is little research on how young children engage with learning science processes of inquiry (Siry, 2013). Research on elementary school teachers' understandings of science processes of inquiry has revealed a similar finding (Haefner, 2004; Ireland, Watter, & Brownlee, 2014). Eberbach and Crowley (2009) raise an important science education point when they argue for an emphasis on each science discipline communities' ways of inquiry for primary aged children. The findings have illuminated that there would be benefits in early childhood teachers knowing aspects of how each of the five communities of science practice their processes of inquiry (Section 6.4.3).

The findings indicate that teachers' understandings of science processes of inquiry and how to engage young children in these practices are important in recognising and acting to facilitate science learning for young children. One example from Chapter Four was the teachers' facilitation of children's science investigations about snails. At first the teachers worked with children observing the snails and looking at and discussing an anatomy diagram from the Internet. The researcher suggested developing an investigation with the children about what the snails might prefer to eat. When the children participated in the *investigation*, their learning was enriched, and their interest was sustained over a longer period of time. Research has talked about young children's involvement in science processes of inquiry as enriching their science learning (Gelman & Brenneman, 2004; Siry, 2013). The finding in this study affirms that such involvement can also sustain children's interest for longer periods of time than otherwise happens in a free play environment, providing an opportunity for deeper engagement in science learning (Section 4.5, third finding).

ii) Teacher understandings of the early childhood community in New Zealand

The findings demonstrate that the early childhood education community in New Zealand was the community in which the teachers felt most confident. The curriculum at each of the participant kindergartens promoted free play for most of the three hour session each day. The documentation about the programmes at each kindergarten was characterised by the idea of learning being led by children's interests, the value of holistic learning experiences, and that children learn through play.

The findings identified that children's independent exploration and adult guided play were the most common types of play where science-related and science-specific learning took place (Table 6.1). These were the two types of play teachers acknowledged as the mediums for children to learn science.

The researcher's interview questions included a focus on the Exploration Strand of *Te Whāriki*, goals three and four. The focus on goal three aimed to illuminate the teachers' ideas on the everyday and science-specific processes of inquiry. The teachers' comments in the first interviews mainly focussed on everyday processes of inquiry (Section 4.3.1). The emphasis on goal four aimed to illuminate the teachers' thoughts on the five communities of science, identifying them as the living, material and physical worlds and the planet earth and beyond. The findings indicated that the teachers had minimal understanding of the reference made to the science worlds in exploration goal four (Section 6.4.3). A relevant point, as discussed in the last section is that the teachers were not confident or skilled in perceiving the science curriculum possibilities within *Te Whāriki.* The professional learning sessions empowered the teachers to comprehend further possibilities for science learning and teaching within the play-based curriculum.

iii) Teacher understandings of the everyday community

Everyday community as it is understood in this study refers to the families within a local geographic area being a community of practice (Hedegaard & Chaiklin, 2005; Lave & Wenger, 1991; Rogoff, 2003; Vygotsky, 1987). The findings affirmed that the everyday communities were represented in the curriculum at the three kindergartens and at times connected to science learning. An example was when the monarch butterfly was a curriculum interest (Table 5.1) this butterfly is very common in the summer months in the region. Another example was that the teachers in the three kindergartens all set up experiences for children to turn water to ice and then watch it melt (Table 5.1.). In this example the everyday community artefact was the water; the science was the children beginning to talk about the science idea of changes to the state of water.

iv) Teacher understandings of the science education community

Although teachers were confident about how children learn in general, the teacher interviews revealed that they were less confident about how they might be supported to learn science. That is, about the ideas and practices of the science education community. All three teacher interview groups commented about not being sure how to teach science. One such reply was, "Kind of extending them on the basics. You know like when you do the ice balloons — watch them melting and you're talking to them about what it feels like — is that it? Like what can we do to go beyond that?" (Kina Kindergarten teachers' first interview). Another reply was, "Yeah, really understanding how much they can take in. How far you can really go with, um, explanations or tailoring explanations to their understanding 'cause that's something I really don't know how far I can go." (Jandals Kindergarten teachers' first interview). What these comments illustrated was the gap teachers had in being able to connect more intentionally the science communities' ways of knowing and practising and the science education and ECE communities' practices needed to facilitate children's science learning.

Nevertheless, there was some evidence that the teachers used strategies recommended within early childhood science education during learning moments with children at each of the three kindergartens. One example from Jandals Kindergarten was the way the teachers connected the science learning of interest to children through information on the Internet (the snail diagram: Section 4.4.2).

v) Teacher understandings of the connections between the cultural communities

The findings in Chapters Four, Five and Six reveal that the interactions between children and teachers drew on the four communities to create science learning and teaching opportunities and experiences. For example (Section 7.2.1) the children's learning about science ideas related to movement and children's investigations about snails. The findings also revealed the teachers' realised the value of the connections between children's everyday interests in physical environment and science ideas. The last two sentences above would seem to be in conflict with each other. However, what is pertinent is that the teachers would benefit from knowing and using the meeting places between the four communities (the quadruple move) more *intentionally* in their work with children.

vi) Summary

To empower teacher understandings of the science learning opportunities that exists within a play-based early childhood curriculum this thesis asserts that teachers need to be cognisant of the four identified cultural communities and how they can be related to create science learning spaces for children via the quadruple move. The findings illustrated that, at times, teachers were confident in perceiving the learning potential within the everyday and early childhood education communities of practices. The findings also indicated that teachers had some understanding about the science and science education communities but could benefit from enhancing their knowledge of these communities. The teachers' awareness of the possible relationship between the four identified communities is the potential meeting place for science learning to happen. It is beneficial to consider, how through the similarities and differences between the four communities, teachers can be empowered to perceive more clearly further possibilities for children's science learning.

7.2.3 Hybridity between communities of practice

The discussion to this point in this chapter has considered the cultural communities practices as discrete units. In real life many of the cultural communities use the same practices (Wadham et al., 2007). A consideration within learning environments is the interlinking of practices across communities (Gonzalez, Moll & Amanti, 2005; Wadham et al., 2007). Gonzalez et al. (2005) refers to the interlinking across cultural communities of practice as hybridity, meaning that some practices are used by more than one community. The interest in the concept of hybridity in relation to this thesis is its effects on children's engagement in science learning. The findings identified hybridity occurred within three separate types of community practices across the four cultural communities. They were processes of inquiry, visual representation and dialogue. The findings on the hybridity of these three types of practices are now discussed.

The finding on processes of inquiry as a community practice is that children learn science-related processes of inquiry and use these processes in their everyday play practice. An example from Chapter Four was teachers modelling searching for specimens (small animals) and observing their behaviours (Section 4.2). The children were then observed independently carrying out searches for small animals within their free play. The other example was children using the magnifying glasses independently to observe objects and living organisms more closely (Section 5.4.4). Again teachers had modelled the use of the magnifiers in the first instance. These examples illustrate teachers introducing children to science-related ways of inquiry and the children then using these practices in their everyday play. Carr (1994), on the other hand, comments that young children learning general *everyday processes of inquiry* will lead to future potential for learning science processes of inquiry. Both aspects of hybridity within the learning environment are useful but serve a different purpose. Carr's argument is for future science learning being enhanced by children's practice in general everyday processes of inquiry. However, the findings in this research project argue for enhancing science processes of inquiry during children's early childhood education.

Two visual cultural community practices were identified as being used by more than one of the four communities. The first of these was the use of photos. In children's everyday practice they saw photos being used to capture family moments, as demonstrated in some of their kindergarten portfolios where information about their families had been recorded. Within early childhood education community practice, photos are an emphasised medium in documenting children's learning (Ministry of Education, 2004). As children have yet to learn to read, photos, as well as other visual representations, are helpful community practices for children to use in their meaning-making about the physical environment. Photos are a familiar community practice for children for thinking about the world they live in; it is a medium they are likely to respond to for science learning. The research confirmed this. In science communities, photos are used as a practice to record specific data for identification and also to demonstrate change over time. Using photos in a similar way to scientists was demonstrated in Chapter Five with the photos recording the size of the seedlings when they were planted at Kina Kindergarten (Table 5.2).

The second visual community practice was posters (Table 5.2). At Pohutukawa Kindergarten there were posters identifying different insects found in New Zealand and others illustrating small animals, e.g. a spider, insects and snails. At Kina Kindergarten there was a poster identifying different mammals and at Jandals Kindergarten there was a poster of plants and animals of the seashore (Table 5. 2). While the posters were science-based in relation to the visual accuracy of the plants and animals represented, the language used in the posters was everyday language. What this provided for children was a link across the science, science education and everyday communities. The posters related to the science community in terms of the accurate representation of a specimen. The posters related to the science education community as the poster provided a transitional link across everyday and science communities about insects, mammals or habitat from the seashore. The link to the everyday community was that the poster used everyday language to describe the specimen. Often the engagement was in identifying the animals. One example was Joy who brought a plastic animal up to the animal poster and said. “Same” with surprise (Section 5.3.2 iii). The identification related to everyday aspects of the animals with potential links to later science learning of the earliest classification systems for animals

Dialogue is one of the main thinking community practices people use to learn (Vygotsky, 1999). Remembering here that this discussion is only on the hybridity of dialogue, it was clear that children were using dialogue to support their meaning-making about the physical environment. An example of the use of dialogue across the communities was the discussion a child had with a teacher about shadows (Table 5.1). The child asked the teacher why he couldn’t see the shadow at the present moment, and a conversation ensued in which the teacher added science conceptual ideas on how shadows are formed into the conversation. Often the hybridity within this dialogue was a mix of everyday and science dialogue.

The diagram below depicts how each of the four cultural communities uses processes of inquiry, visual representation and dialogue. At times the practice is learnt within one of the communities and this makes it easier to use in one of the other communities.

Process of Inquiry
Everyday
Noticing small animals at home and in the communities they live. Parents providing swan plant and monarch butterfly experiences at home
Science
Specifically honed to search out answers about the small animals in the environment
Science Education
Introducing children to science ways of investigating small animals
ECE
Natural exploration of the environment was encouraged; at times the children find small animals

Visuals
Everyday
Family photos
Science:
Data collection & at times illustrating change over time
Science Education
Used to bring attributes of the physical environment to the attention of children. As a semiotic artefact for children to revisit science learning
ECE
Documentation of children's learning

Dialogue
Everyday
Children dialoguing with others about what they are noticing in the physical environments around them
Science
Scientist dialogue to better understand the physical environment
Science Education
Between teachers and children to mediate children into science communities ways of thinking and talking about the physical environment
ECE
Dialogue is a way for children to think through their meaning making

Figure 7.4. Hybridity: Use of community practice by more than one cultural community.

In summary, hybridity between the four identified cultural communities of practice was happening and was potentially beneficial to children's science learning. The benefits of hybridity are twofold. Firstly hybridity promotes the use of everyday practices that children are familiar with being part of their science learning. The second benefit is children learning to use science practices that they could then use in their everyday play.

7.3 Semiotics within and across cultural communities of practice

Semiotics within and across cultural communities of practice is the second conceptual reference point of interest in this thesis. As discussed in Section 2.3.1, through using a community's semiotic artefacts children have access to learning about the practices in that community (Paradise & Rogoff, 2009; Rogoff, 1990). The study of semiotics includes both the physical and mental community practices as described in Section 2.3.1 (Rogoff, 1990; Lave & Wenger, 1991). Exploring the practices within the four cultural communities through the study of semiotics allows for a deeper investigation into the communities' practices. The focus is on identifying the benefits of children's engagement with science-related or science meaning-making through everyday, ECE and science-specific communities' semiotic artefacts. In this section intertextuality is also discussed in terms of children's interpretation of physical phenomena through a combination of different semiotic artefacts and also how children interpret a single semiotic artefact differently (Lemke, 1998). The diagram below serves as a reminder of the relationship of semiotics within and across cultural communities to the other two conceptual reference points.

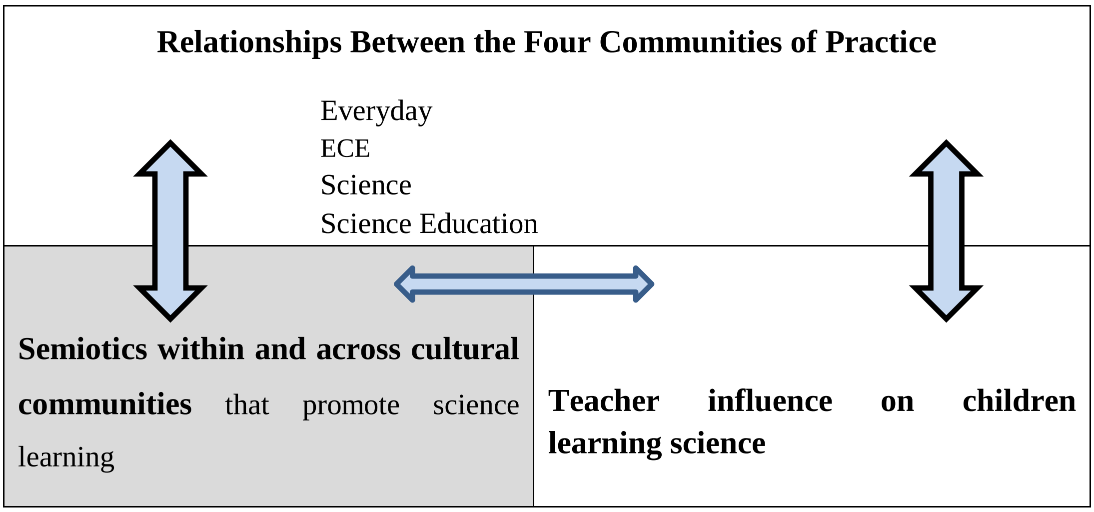

Figure 7.5. *The three conceptual reference points that framed the study.*

7.3.1 Everyday/early childhood education (ECE) semiotic artefacts influence on science learning

This section explores the benefits of everyday and ECE semiotics in children learning about the science cultural community. The findings demonstrated that children were learning aspects of science through everyday and ECE semiotic artefacts. Central to the idea of semiotic artefacts is that the artefact is representative of a sign that holds meaning for the individual and for particular communities of practice (Hervey, 1982; Lemke, 1998; Stables, 2005). The link between the semiotic artefacts and the child is therefore associated with *children's thinking* rather than teachers' thinking about the different semiotic artefacts. For children, everyday semiotic artefacts connect to familiar communities of practice within their local geographic location (Hedegaard & Chaiklin, 2005; Lave & Wenger, 1991; Rogoff, 2003; Vygotsky, 1987). ECE semiotic artefacts are the specific semiotic artefacts that children encounter in the kindergarten environments and are a category constructed for this study. The categories of *everyday semiotic artefacts* identified in Chapter Five were dialogue, fictional story books and visual representation. The categories of *ECE semiotic artefacts* identified in Chapter Five were dialogue, visual representation, children's portfolios and children's actions within the ECE environment.

Two findings in Chapter Five demonstrate the influences everyday and ECE semiotic artefacts had on children's science learning. The first influence is that the semiotic artefacts stimulate children's interest in science learning. For instance, in Section 5.3.3 an example given is fictional story books being a starting point for science-related learning. In one of the examples a story talked about a rainbow. The idea of a rainbow stimulated a spontaneous discussion between a teacher and two children about how they thought rainbows were formed. This example illustrates how a fictional story that has elements of the physical environment within the story can instigate children's curiosity to know more about that phenomenon. Further examples in Section 5.3.5 were children's actions within the ECE environment as semiotic artefacts that stimulated interest in science-related ideas. For example, the plastic labyrinth that could be pulled apart and reassembled. The labyrinth stimulated a discussion between children about how the variance of the gradient of the slope could affect the speed of the ball. This example illustrates how exploration of physical objects in the environment can be a catalyst for science-related learning.

The second influence was how everyday and ECE semiotic artefacts supported children to revisit their science learning. In Section 5.3.2 everyday or ECE visual representational artefacts were often a reminder to the children of science-related learning. For example, the use of pictures showing what a plant needs to grow placed on the fence behind the outdoor garden. The pictures reminded the children that plants need sunlight and water in order to grow. In Section 5.3.4 the example given is from the children's portfolios. Learning stories were used for them to revisit their learning about science. One example was a learning story about the life cycle of the butterfly. A further example was the learning stories children narrated on their learning about the snails in Chapter Four. In the learning stories what was important was how the science related learning was represented both in the photos and the written narrative. The visual photo was important as it was the semiotic artefact children were able to interpret to make sense of the learning story. Otherwise the children needed someone more capable at reading to read the learning story to them. This makes what is represented in the photos in terms of the children's science learning important.

This next section discusses everyday dialogue as one of the main everyday semiotic artefacts children used to gain access to the science communities of practice. Of particular interest from Chapter Five was the importance of everyday dialogue as an everyday semiotic artefact that supported children learning about science-related ideas. Others have identified dialogue as the most widely used semiotic artefacts (Lemke, 1998; Vygosky, 1999). In Chapter Five four types of engagement in everyday dialogue were identified as connecting with children's science-related learning. The types of dialogue were a) child instigated conversations with teachers, b) teacher initiated discussions with children, c) conversations at home, and d) conversation child to child. Chapter Five gives examples of children initiating a discussion with a teacher about a physical phenomenon and being able to articulate their ideas about the phenomenon

(Section 5.3.1.). One example was a child's discussion about some dark clouds she had noticed. The child wanted to bring the phenomenon she was interested in to the teachers' attention. The child gave the teacher an opportunity to see what aspects of the physical environment held her interest. The teacher was then able to make some links to science-related ways of thinking about clouds. In this way dialogue became a semiotic artefact for the child's thinking as well as an artefact for the teacher to mediate the child into science related to her interest in the physical environment. Children also focussed on science-related ideas when teachers highlighted physical phenomenon within the everyday context they were experiencing. The examples from Chapter Five were the teacher talking about the life cycle of a butterfly and how over time a flower on a peach tree turns into a peach (Section 5.3.1). The teachers mainly used everyday language but at the same time illuminated physical processes important to biology. The importance of teachers illuminating science aspects of the physical environment was that it opened children's thinking to new ideas about the environment that they might otherwise not have access to. The dialogue was a semiotic artefact in terms of giving children insight into growth changes of living organisms.

From the interviews with parents, it was apparent that some of the everyday discussions at the kindergartens were also happening in the home. The two prominent examples were the life cycle of a butterfly and the freezing of water (Section 5.3.1). What this indicated was that conversations about the physical environment that were instigated at the kindergartens were often continued in the home. Cumming's (2003) research found rich science talk between parents and children was occurring. What this thesis adds is instances of how such dialogue is happening between home and the kindergarten. The dialogue at home was a semiotic artefact to revisit ideas related to science between home and the kindergarten.

The findings illuminated dialogue between children as a useful semiotic artefact for children to develop their science related ideas. An example from Chapter Five was when one child talked excitedly about hearing the air as he squeezed a soft plastic animal. He wanted to explain to another child the physical phenomenon he had discovered (Table 5.1). Another example from Table 5.1 was when two children discussed how the angles of the slopes affected the speed of the marbles down the plastic labyrinths they had made. In both examples above, dialogue was a semiotic artefact used between children to discuss a physical phenomenon they were observing. Although the children talking between themselves is not science but everyday dialogue and thinking, the conversations the children had could be seen as a precursor to science learning about the effects of gravity on inclines. The evidence of peer interaction is similar to other research that illustrates children's everyday dialogue and exploration supporting children's science-related learning about the physical environment (Siry, 2013).

This thesis is arguing that combining action and the concept of embodiment as a semiotic artefact within the literature equates to identifying how children's actions support science-related and, at times, science-specific meaning-making. Children's actions as an everyday or ECE semiotic artefact supporting science learning was an identified finding in Chapter Five. There were two identified categories of actions that were seen as meaning-making symbols for science learning in Section 5.3.5. The first was children's exploration of the physical environment and the second was children's actions through their dramatic play. Action as a semiotic artefact in science learning has been articulated for tertiary and secondary school learning situations (Lemke, 1998). Action as a learning artefact for young children in general is also represented in literature. The early childhood literature often refers to children's actions as learning through body knowledge or embodiment (Dewey, 1916; Eschach, 2006).

Two examples of children's physical action related to the early childhood education environment that supported their science-related learning were the children on the swings and the children building a labyrinth. The children on the swings was identified as an action connected with science related learning when two children articulated what it was they thought made the swing move (Table 5.5). The researcher asked the children individually what made the swing move.

One of the children said, “My legs” and the other child said, “…that thing up there”, pointing to the shackle on the picture of her swinging on the swing. The point being made is that the action of using the swing facilitated children’s making-meaning about what made the swing move. The children building the labyrinth were able to articulate the effects of different slopes and the sizes of the marbles and how they flowed through the labyrinths. The point being made is that the action of making a labyrinth and trying it out made children aware of some of the variables related to movement that can later be linked to science ideas about the force of gravity (Section 5.3.5). Both examples of children’s actions provided opportunities for children to explore physical phenomenon. The findings verify that the children were making meaning about the physical phenomenon related to movement via their actions.

The second type of early childhood education community action was children’s dramatic play. Action through drama, related to science learning, was represented in the children’s play in two distinct ways. The first way was through the children spontaneously dramatising experiences. An example given was when the children made a meerkat cage out of the large plastic blocks and then tried the “cage out” (Section 5.3.5). The children talked about what the cage needed to include and tried out the cage to see if it was all right. One of the children commented to the teacher, “We’re building a meerkat cage. They don’t mind a little rain but they do like some shelter.” The making of the cage was an opportunity for the children to revisit the experience of seeing the meerkats at the zoo and to think about a meerkat’s habitat. The second way children’s actions within their dramatic play was evident was when the children acted out a prescribed song about a science idea about life cycles (Table 5.5). There were two examples of this happening. One was when children acted out a song about the different stages of the life cycle of a butterfly. The other example was when children acted out to music how a seed germinates and grows. When children were engaged with action as a social semiotic artefact within an everyday experience related to science, the purpose for the children seemed to be to revisit learning. When children’s actions were about an interaction with the physical environment, it seemed to be within moments when children made connections to science-related aspects of the physical environment. Robbins (2007) makes a general link between cultural artefacts and signs with children's meaning-making about the physical environment and science learning. In her research the main artefact investigated is speech. What the findings in Chapter Five add to previous research is the identification of a wider range of children's engagement with social semiotic artefacts from everyday or ECE communities being employed for science learning in a play-based learning environment.

The analysis on everyday and ECE semiotics and science learning illuminates the potential use of the connections across social semiotic artefacts in the four communities. For the connections between the communities to be meaningful for the children they need to be connected to *their thinking* about a physical phenomenon and artefacts at hand.

There are two ideas within literature that explain the findings about children's dominant engagement with the potential science learning in the physical environment. One connection is through the idea of body knowledge or embodiment (Dewey; 1959; Eschach, 2006). Body knowledge refers to children learning knowledge as they physically interact with the environment. An example from the findings was the boy who noticed and commented with surprise that it was air that came out of the plastic animal when you squeezed it (Section 5.3). The other connection is to Bronfenbrenner's idea of the communities of influence on children's learning (1979). What is of interest here is how the teachers assessed the *children thinking* about the physical environments they had created for the children's learning. For instance, at Jandals Kindergarten when Deborah was interviewed about what she was thinking about the monarch butterfly, her answer was, "I was thinking how beautiful the wings were, the patterns on the wings." Whereas other children talked about the life cycle of the butterfly, Deborah's focus was on the artistic beauty of the wings. Being attuned to Deborah's interest in the physical environment would mean the focus would be on the patterns of the butterfly wings. A further example was the time the teachers set the water play up for integrated learning without having science learning as a focus. However, Sonia spent time exploring how the water pushed boats down the guttering as described in Section 5.2. Sonia's experience could be afforded the potential opportunity to learn about the aspect of the science ideas on force. How teachers are attuned to notice, recognise and respond to learners thinking about science-related learning influences what science learning can be actuated (Cowie, 2000).

7.3.2 Science-specific semiotics

There is the potential for engaging children within a play-based curriculum in science-specific semiotics. Four types of science-specific semiotic artefacts were identified in the findings in Chapter Five. They were science language, visual representation, mathematics and action. The literature considered a wider variety of science-specific semiotics (Lemke, 1998). However, from the findings only four types of science-specific semiotic artefacts were identified. The literature that links science and semiotic artefacts is related mainly to secondary school and tertiary science education (Bussi et al., 2012; Jaipal, 2009; Lemke, 1998; Lemke, 2008). However, Robbins' (2005, 2007) research investigated artefacts as cultural thinking artefacts within the early childhood physical environment. This thesis describes cultural communities' practices through semiotic artefacts in a way that illustrates children's participation in science learning within a play-based curriculum.

One of the identified categories of science-specific semiotic artefacts is language. The findings demonstrate two aspects of science-specific language were active in the three kindergartens. One aspect was science dialogue, the ways that scientists discuss the physical environment (Reeves, 2005). The findings in Chapter Four demonstrated that children as young as three and four years were engaged in science-related dialogue initiated through their interest in the physical environment. One example was children and teachers discussing the anatomy diagram of the snail and learning about internal morphological features. A second example was children and a teacher discussing how a snail can purposefully fall off a step to travel faster (Section 4.4). The findings illuminated that the stronger the focus on science practices, the greater the potential for science-specific dialogue. The findings also demonstrated that when the children were involved in observing and investigating the snails they engaged in the four dialogic-knowledge building processes as described by the American Council of Research (2007 cited in Duschl, 2008). The four dialogic-knowledge building processes are;

- *Know, use and interpret scientific explanations of the natural world;*
- *Generate and evaluate scientific evidence and explanations;*
- *Understand the nature and development of scientific knowledge;*
- *Participate productively in scientific practices and discourse. (National Research Council, 2007).*

Science dialogue is reflected in the literature for school age children (Duschl, 2008). Research on four- to eight-year-old children's use of dialogue in teacher set but open-ended investigations has demonstrated positive connections with children's science learning through their use of dialogue (Siry, 2012, 2013). What this study demonstrates is that open-ended science investigations related to children's interests in the physical environment are a way of engaging children in science dialogue relevant to their level of understanding.

The second aspect of science language is science terminology. Science has developed words with specific meaning to the science communities (Reeves, 2005). The findings illustrate that there were times when science words used in conversation with children brought about a richer understanding of the physical environment for children. One example was a teacher using the word germination with the children (Table 5.6). Another example was the word entomologist used in a child's learning story at Kina Kindergarten for a child who loved observing small animals (Section 5. 3.4). Literature has affirmed the importance of young children being introduced to science terminology in learning contexts (Campbell, 2012; Gelman & Brenneman, 2004). However, it was interesting to note that the teachers in this study were unsure at times whether to use science terminology, evidenced in their comments in the first set of teacher interviews. This finding indicates there is still a need to encourage teachers to use science terminology in context with young children.

The second identified science-specific semiotic artefact was visual representation. Science specific visual representation seems to be established thinking in two of the kindergartens. The examples were photos of seedlings so children could compare the growth over time, and pictures of the sun and the rain to remind children that the plants needed sun and rain in order to grow (Section 5.3.2). The teachers' use of the photos was modelling how scientists capture physical data to be referred to at a later date. Although the teachers did not discuss with children the connection to science, children were gaining a tacit awareness they could take with them for future science learning.

The third identified science-specific social semiotic artefact was mathematics. The connection between science and mathematics is well established within the communities of science (Lemke, 1998). Mathematics as a process of inquiry is often used by all disciplines of science to investigate and/or verify understandings about the physical environment. Within the findings the aspects of mathematics used were comparison, measurement, classification and representational graphs (Table 5.8). Within the examples in Table 5.8 it was clear that the children were using mathematics as a semiotic artefact for understanding an aspect of the physical world in a similar way to a science community. One example was when the teacher suggested measuring the shadow to see if it changed over time. The evidence of the shadow changing was the point of interest for the children that stimulated their curiosity to know why the shadow changed (Section 5.3.1). Another example was children's estimation using graphs of how they predicted the pea seeds would grow, which sustained the interest in the pea growth as well as provided a visual stimulation to remind the children of their prediction. In each instance the focus for the children went beyond the mathematics to *inform their understanding of the physical phenomena* and that is what makes mathematics a science semiotic artefact.

The fourth identified science-specific semiotic artefact is action. Lemke (1998) refers to action as one of the languages of science and affirms action as the practical “actions” within the science community. The findings from Chapter Five (Section 5.4.4) identified two types of actions that can be related to science communities of practice. One type of action was the children’s use of magnifying glasses to observe aspects of the physical environment. Examples of children using a magnifying glass in a similar way to scientists were when they observed the bird’s nest (Section 5. 4.1) and snails in more detail (Section 4.4.4). What was interesting, within these particular research observations, was how children themselves *instigated* the use of the magnifying glass signifying that the children had gained a meaning for the use of the magnifying glass. The meaning for the magnifying glasses was related to observing objects more closely to gain further information about the object; magnification devices have that function in some of the science communities. The second type of science semiotic action was the children doing science related investigations inclusive of observations of aspects of the physical environment. One example was the investigation of what the snails preferred to eat, another was of Joy investigating what happened when you let a truck go at the top of two different grass slopes (Table 5.9). In terms of children’s science learning, both investigations, mentioned above, acted as a semiotic action that gave meaning to the investigations for gaining further information about an aspect of the physical environment.

7.3.3 Intertextuality

The introduction of 7.3 identified two types of intertextuality. Type one is how a child interprets a variety of texts to gain understanding of an idea, and type two is how several children can interpret a single text in a variety of ways. The crucial component is how the texts or set of artefacts are perceived by the learner in their meaning-making (Hervey, 1982; Jesson et al., 2011; Kristeva, 1980; Lemke, 1992; Lemke, 2002). In this section intertextuality is explored in relation to how children engage with intertextuality of social semiotic artefacts to learn science and science-related ideas.

The findings in Chapter Five demonstrated that children were making connections between semiotic artefacts for the purpose of making-meaning related to science community knowledge and practices. One example was the different semiotic artefacts children engaged with to answer their question about the construction of the bird's nest. The semiotic artefacts were the process of inquiry through dissection, photos of the dissection process, children and teachers dialogue while dissecting the nest and teacher documentation of the bird's nest experiences displayed on the kindergarten wall. What was important was that the semiotic artefacts were linked to the children's interests in the science idea being explored. For this set of semiotic artefacts described in Section 5.5 the children's interest in what the bird's nest was made of also informed children's interest about the meaning of the word dissection. The birds nest example illustrates that the ideas the teacher followed were the ones of most interest to the children engaged in the learning. A second example from Section 5.2 was the science learning from the children's interest in the movement of balls in a large cylinder. In this example the social semiotic artefacts were the experiences with the cylinder and ball, discussions with peers and teachers, photos and documentation about the experience, and teachers' questions at group time about the experience. The findings add to the discussion on intertextuality by describing how intertextuality was occurring in science education for young children within a play-based curriculum.

There were also examples of the second type of intertextuality where children responded to the same single semiotic artefact in the environment in different ways. The examples given in Section 5.5 were the children's different interpretations on the word *dissection* and how two children interpreted what made the swing move in two different ways. The examples are a reminder that children can view a semiotic artefact differently from each other, depending on their participation with the artefact and the links the semiotic artefacts have with their experience within different cultural communities.

Both types of intertextuality were evident in the findings and have relevance to how children learn science. Intertextuality as *multiple semiotic artefact* indicates the relevance of a variety of experiences within the play environment that children can make meaning from related to science cultural practices of interest. The focus here was on how the children made learning connections through a variety of semiotic artefacts. Intertextuality can also be seen as a way of introducing children to some of the multiple science-specific semiotic artefacts used by the science communities (Lemke, 1998). What multiple semiotic artefacts indicated was greater opportunity for the child to explore and make meaning related to science community practice. The relevance of knowing *children may interpret the same semiotic artefact in different ways* (the second type of intertextuality) reminds the teacher of the need to assess what each of the children are thinking in terms of the experience related to science learning.

Everyday and ECE Semiotic Artefacts:

Dialogue
Fiction picture books
Visual representation
Children's portfolios
Children's actions within everyday and ECE communities of practice

Science Education Purpose

- Develop a child's interest in an aspect of the physical environment
- Children revisiting their science learning
- Experiences in the physical environment that support science learning in the future

Science-Specific Social Semiotic Artefacts:

Language: dialogue and science terminology
Visual representation
Mathematics
Action

Science Education Purpose

- Deeper learning about the science communities
- Sustains interest in children's learning about the science idea of interest

Figure 7.6. *Summary of individual semiotic artefact categories and their relevance to children learning science.*

In summary, everyday, ECE, science and science education semiotic artefacts have a place in early childhood science education. However, their purposes in science education are different. Everyday and ECE semiotic artefacts provided three types of potential science learning. The first was to provide an interest as a starting point of learning something related to science, and the second was the everyday semiotic and ECE offered opportunities to revisit science learning. The third was in gaining experience with the physical environment that would support later science learning. Science-specific semiotic artefacts provided ways for children to learn richer and deeper ideas about the science communities' practices.

7.4 Teacher influence on children's science learning

The conceptual reference point of teacher influence on children's science learning is the third conceptual reference point mentioned in the introduction to this chapter. The diagram below serves to remind the reader of the relationship between the three conceptual reference points.

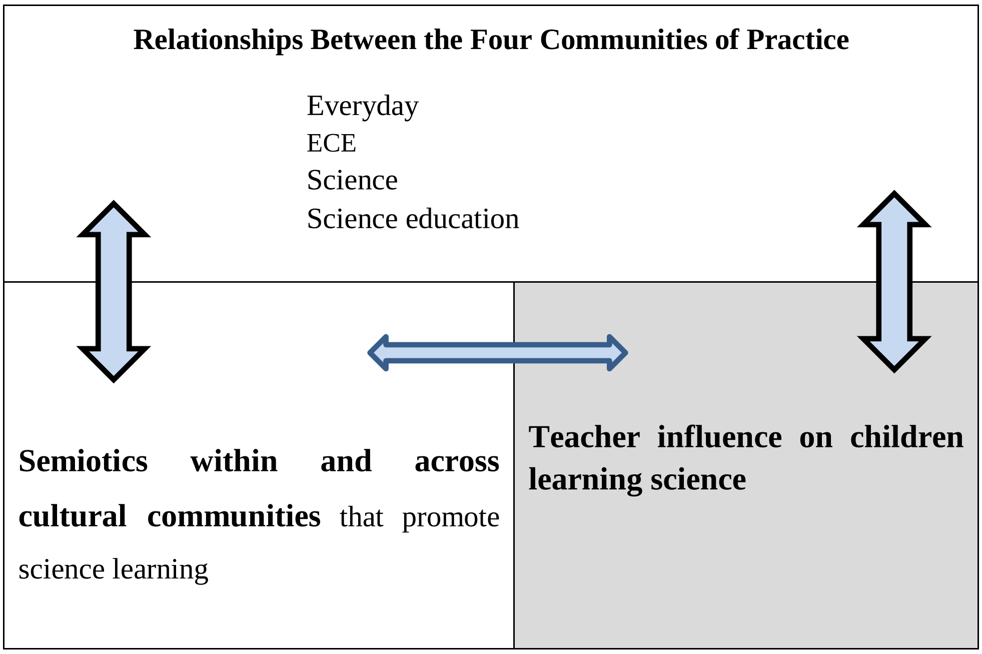

Figure 7.7. *The three conceptual reference points that framed the study.*

The importance of including the third conceptual reference point is to identify the influence teachers had on the contexts for science learning within the three kindergartens. One of the most influential aspects of the early childhood learning environment are the teachers as they are the hosts of the education settings and, as such, dominate the ethos and the physical environment available to children (Anning and Edwards, 2006; McGee, 1997; Slattery, 1995, 1996). The findings indicated that teachers influenced science learning in four main ways. The first way was how the teachers afforded potential science learning to the physical environments at the three kindergartens. The second way was how teachers afforded science learning within the social environments. The third way was how teachers gave affordance to the *different science communities of practice* and the opportunities for children to learn about them. The fourth way was how teachers were attuned to children's interests and ideas within the physical environment that had the potential affordance to science learning.

Integral to teachers being aware of the potential for science learning in play-based curriculum was their understanding of how the physical environment had the potential to afford science and science-related learning. Affordance as described in Section 2.2.4 examines how teachers perceive the qualities of the physical environment related to children's potential science learning. Although the early childhood science literature does not mention the word affordance, it does contain ideas that are representative of the conceptual idea of affordance. For example, Alward et al. (2014) consider affordance to science learning when they comment on the observation a range of different scientists make on potential science learning through children's actions in an early childhood centre environment. Another example is Lundib and Jakodsen (2014) when they consider affordance to science learning through drawing and dialogue. The drawing and dialogue afforded children the opportunity for meaning-making about the human body. The next section discusses how teachers' awareness of affordances to science learning within the physical environment influenced what science learning was privileged.

7.4.1 Teacher affordance to potential science learning in the physical environment

The findings identified two ways teacher affordance influenced potential science learning within the physical environments at the three kindergartens. The first influence was through the variety of physical resources teachers created for children to explore. The affordance in this case is how teachers afforded the potential for children's science-related learning through children's independent exploration of the physical environment. The second influence was teacher affordance in creating specific physical resource experiences with children's science learning at the forefront of teachers' minds.

The findings in Chapter Six identified the influence of teacher awareness of potential science-related learning affordances within the physical environment. Teachers' main influence on the physical resources within a play-based environment is in the variety of types of physical resources they create for children to independently explore (Backshall, 2000b; Campbell, 2012). One insight from the findings was that 75% of children's play that was related to science learning in the physical environment occurred within children's explorative play, independent of teacher interaction (Table 6.1). The prominence of children's independent exploration is no surprise as independent play was an emphasised feature of the play-based curriculum at the three kindergartens. As children's independent play is prominent, then what the children have to play with in the physical environments is a major influence in the types of science-related learning that can occur.

Although this thesis argues that children need to be mediated into science communities' practices, there is also an understanding that children do gain *science-related* understandings from their independent exploration. The justification for the importance of independent exploration from literature is that children develop their understandings of attributes of the physical environment through their experiences with it (Johnston, 2005; Pugh 1997; Siraj-Blatchford & MacLeod-Brudenell, 1999). Early childhood science education literature acknowledges the importance of children exploring physical materials (Campbell, 2012; Eschach, 2006; Johnston, 2005; Lind, 2005; Harlan & Rivkin, 2008). Two examples from the findings were the children's curiosity for the different textures of leaves and Nova's interest in how the temperature of the glue gun changed the state of the glue from solid to sloppy (Section 6.2.1). Understandings about the science communities' ideas on function of morphological features of leaves and how heat melts some solids would be difficult without some prior physical experience of the phenomena first hand. The benefit of the children's exploration is their beginning curiosity and understandings of the physical environment.

The professional learning sessions within the study enhanced teachers' awareness of the affordance to potential science-related learning through children's exploration of the physical environment. Two examples from the findings illustrate the teachers' enhanced awareness of the science-related affordances in the physical environment. The first example was demonstrated through the teachers' actions after the researcher had shared (through photos and children's interviews) children's science-related exploration within the kindergarten environments. After the professional learning sessions within the study, two of the kindergartens decided to remove their science-specific area in their kindergarten environment and focus on potential science learning from the children's exploration within the physical environment in general. The reason for the change was that the teachers became more aware of the potential for science learning within children's emerging interests in the physical environment at the kindergartens. Another example was once the professional learning had taken place, the teachers at all three kindergartens were much more appreciative of the opportunities the physical environment afforded for the children to learn about physical world science (physics). Affordance of the potential science learning from children's interests brought about teachers perceiving the benefits of a wider range of physical resources in mediating children into science communities of practice. The researcher's observations and interviews with the children illuminated their interest in movement. The children's interest in movement afforded the opportunity to make links with the physics science community

(Section 5.2). This in turn made teachers aware that rather than the living world, the physical world was the world that children were more interested in exploring.

The findings illustrated that, at times, teachers would foreground potential science learning within experiences they created for children to explore. The foregrounding of potential science learning happened in two ways. The first was the way teachers associated a physical context with potential science learning and, for that reason, made the physical provision in the environment; for example, when a teacher put out magnets for children to explore (Section 6.3.2). When teachers put material out in this manner their approach to teaching can be described as the discovery approach (Campbell, 2012; Fleer, Jane, & Hardy, 2007). The discover approach is characterised by teachers purposefully creating physical environments with children's science learning in mind, but then allowing the children to explore and discover aspects related to science for themselves. *However, there were times when teachers then interacted with the children,* mediating children into science community ideas as they explored the physical phenomenon. An example was when the teachers provided the children with anatomically correct plastic insects to play with. At times the children played with the insects by themselves and at other times the teachers interacted with the children, foregrounding the science names for the parts of the insects as discussed in Section 6.3.2. When this happened the discovery approach became a guided play approach, the guided play approach is characterised as an emergent response to children's independent play (Wood, 2014). At times the guided play then turned into teachers scaffolding children into open-ended science investigations related to their emergent interests, as was the case with the snail investigations in Chapter Four. Open-ended science investigations have been recognised as an effective strategy for young children learning science (Siry, 2012, Siry et al 2012).

In some instances the choice of physical context did not come from children's interest but from a desire from teachers to introduce children to the potential science involved. For example, all three groups of teachers thought the context of an outdoor garden was an important link to science ideas related to sustainability and life cycles of plants and animals (first group interviews). However, once the physical experience was made available to children, the teachers responded and mediated learning based on children's interests in the resource. So with the magnets, the aspect of most interest seemed to be the attraction of the magnets to each other, and with the gardens, the ideas explored varied between children's interest in either animals or plants that lived in the garden.

The second way teachers foregrounded science in the physical environment was through the purposeful use of artefacts to support children's science interests. The findings from Chapter Five demonstrated that the teacher purposefully added artefacts as learning contexts to support children's interests and enrich their understandings of a particular aspect of science. For example, when the children were interested in the germination of bean seeds at Pohutukawa Kindergarten, one of the teachers used an ECE action semiotic by encouraging the children to act out being the seed germinating. The children were also encouraged to use the science-specific social semiotic of using the magnifying glasses to observe more closely the changes that were happening to the seed.

7.4.2 Teacher affordance to potential science learning through the social environment

The social environment within this study refers to the interactions teachers have with children to support their science-related or science-specific learning. This section explores the types of teacher interactions evidenced in this study.

i) Teacher interactions

The findings in Chapter Six identify teacher interaction as the main support for children learning science. There were two categories of teacher interactions related to children's potential science learning identified in the findings. The first category was teachers highlighting science aspects within the physical environment to children (THPE; Section 6.2). THPE was often a brief but poignant moment that teachers used to make the connection between the everyday and science communities for children. For example, the brief interaction the teacher had with Vasanti about the effect of heat on wax, and the discussion teachers had about how the peach blossom would turn into a peach (Section 6.2.2). The second category of teacher interaction was teachers planned mediation of children into some aspect of science communities' of practice. The distinction between the two categories is that THPE occurred spontaneously within the moment whereas the planned mediation took further planning on the teacher's part to implement. An example of teachers' planned mediation was when a teacher discussed with the children the variable of wet and dry slopes once the children had noticed these for themselves (Section 5.2.2). The interactions occurred as children played at the water trough with the ramps and cars. The experience was planned and set up as a response to children running their toy cars down a concrete slope some days earlier.

ii) Introducing children to science inquiry

Children's engagement in scientific inquiry about aspects of the physical environment is considered an important part of science education for school aged children (Duschl, 2007: National Research Council, 2007; Ministry of Education, 2007a). This study affirms that children participating in "*scientific–like*" inquiry is an important part of science education for three- to five-year-old children in a play-based curriculum. The examples in this section are taken mainly from the findings from Chapter Four. The findings indicate that children were engaged in rich science learning when they participated in science-related processes of inquiry.

The research findings illustrate that children's interests in the play environment can lead to a teacher mediating their engagement in science processes of inquiry. One example was Rhja's interest in a branch from a tree he found on the ground at Jandals Kindergarten. He discussed with one of the teachers how he thought that if he planted it, it would grow. The teacher gave Rhja the opportunity to plant the branch in the kindergarten garden to see if the branch would grow (Section 5.4.1). In this example Rhja had an opportunity to test his hypothesis that the branch only needed water and soil to grow. The investigation of planting the branch and observing what happened changed Rhja's ideas about what the branch would need in order to grow. After the branch died Rajah suggested that the branch died because it did not have roots. This incident illustrated how Rhja had the opportunity to engage in aspects of science inquiry in a similar way to scientists but in pursuit of an investigation linked to his hypothesis and his level of understanding.

Research literature discusses young children being engaged in science processes of inquiry but mainly through teacher instigated and dominated activities (Duschl, 2008; Eschach, 2006; Fleer & Raban, 2006; Gelman & Brennan, 2004; Johnston, 2009; Zeitler, 1972). The literature also affirms science inquiry processes as a way of children finding answers to science-related questions they were interested in answering (Fleer & Cahill, 2001; Kirkwood, 1991). Recent research has promoted young children being directly involved in the direction of a science investigation and the importance of a playful context within science lessons (Siry, 2013). The findings in this study make connections to children's curiosity and interest in the physical environment as a way for teachers to facilitate children's access to learning about science processes of inquiry. In order for children to gain this access, teachers need to be attuned to the possibilities for children to engage in science processes of inquiry and alert to actual opportunities when they arise.

Teachers modelling science related inquiry processes and gradually encouraging children to engage in the practices themselves was generally how children were mediated into science inquiry practices. The children's engagement in biology processes of inquiry happened in four ways: a) teachers modelling science practices, b) children participating in interpreting a science diagram, c) children participating in developing, and d) carrying out investigations and children participating in science related dialogue.

a) *An example of teachers modelling a science practice* was when they modelled searching for small animals in the kindergarten garden. After the teachers had modelled this practice, the children confidently instigated searches for small animals by themselves (Section 4.2).

b) *An example of children and teachers interpreting a science diagram* was when they explored the anatomy diagram of the snail together. The children's participation in discussions about the anatomy diagram of the snail led to them making comparisons between themselves and the snails. For example a boy who commented that he had a heart and the snail had a heart (Section 4.4.2.iv). What this example illustrates is that children doing science through dialogue and diagram interpretation brings them to a deeper level of understanding about not only the anatomy of a snail but that different animals have some common features e.g. a heart.

c) *An example of children and teacher participating in developing and carrying out an investigation* was the investigation in Chapter Four about what the snail would prefer to eat. A second investigation was to make a comparison between the garden snail and the apple-snail (Section 4.4.2.iii). Through teachers facilitating the investigations, children were involved with predicting, analysing what they were observing and explaining to each other what they interpreted from the observations.

d) *Examples of children and teachers participating in science related dialogue* was described in Section 4.4. The teacher led discussion about what snails prefer to eat brought about an understanding for one child that giraffes and snails both like to eat lettuce. Another discussion brought about excited conversations about how a snail can purposely fall off a concrete step to travel faster to its destination (Section 4.4.2). Section 4.4.2 illustrates children beginning to use the identified dialogic knowledge building processes as they engaged in using science related processes of inquiry (Duschl, 2008).

In summary, the discussion in this section illustrates the importance of teachers affording social interactions with children that promote science learning as a deliberate strategy. This section began by identifying situations where teachers interacted intentionally in spontaneous learning situations and through pre-planned interactive situations to promote science learning.

The benefit of teacher interactions that encourages children's engagement with science processes of inquiry was that children gained ability and confidence to then use the learned practices themselves. The children were able then to gain further knowledge about the physical environment within their exploration and play. The importance of enhancing children's practice and ability in science processes of inquiry in this thesis also linked to teachers responding to aspects of the physical environment young children were interested in learning about.

The benefit of teachers scaffolding children into scientific practices was also included in a study by Eschach and Ziderman (2011), who emphasised teacher directed strategies for engaging children in science processes of inquiry. Teachers of young children using scaffolding strategies related to children's participation in investigations makes science more accessible to children (Eschach & Dor-Ziderman, 2011). The difference between Eschach and Ziderman (2011) and this study was that this study had more of a child directed focus for science-related investigations. Similar to Siry (2013), this study evidenced teachers giving children power in the decision making within investigations and this brought about greater participation from the children. What this study also evidenced was that in play-based curriculum children have the opportunities to independently continue investigating the practices they have learned within the physical resources available.

7.4.3 Teacher affordance to the different science communities of practice

Teacher affording learning opportunities to the different science communities was investigated through the teacher group interviews. This thesis argues for the benefits of teachers being able to afford practices and knowledge within all five communities of science as mentioned in the New Zealand curriculum framework document (Ministry of Education, 2007).

As discussed earlier, teachers were more aware of the living world than the other four worlds identified in *Te Whāriki* (Section 7.2.2.i). The impact of teachers being aware of the living world (biology) meant that the living world opportunities were more prevalent within the curriculum offered to children. For instance, all three kindergartens created an outdoor garden as a context for children to explore plants and small animal life. The teachers' limited understandings of the other science communities meant that they were less likely to perceive and therefore privilege the other science communities in their affordances of the physical environment or within their interactions with children. However, what the evidence in Table 6.2 brings is juxtaposition between the teachers' intent to teach the children about the living world (biology) and the children's main interests in the physical environment being more closely aligned with the physical world (physics). Through the professional learning sessions within the research project, teachers became more aware of some of the practices related to the physical world (physics) science community. What was beneficial for the teachers, within the professional learning sessions, was having examples of children's interest in the physical environment from their own centres.

7.4.4 Teacher attunement to children's interest in the physical environment

The findings identified that teachers' understandings of science community practices influenced their ability to be attuned to possible connections between potential science learning and children's interest in the physical environment. The use of the word attunement here is in parallel with the meaning derived in psychology related to mothers being attuned to their babies. In this section the teachers' attunement is to children's interests in the physical environment and how the interests may relate to science learning (Kirch, 2007). An example of a teacher being attuned to children's interests that had the potential for science learning was when a teacher responded to the children's interest in the shadow on the wall. The teachers' attunement to the children's interest led to her suggesting that they track the shadow on the wall over time to see what happens, and also to a discussion with a boy about how shadows are formed when the sun is the source of light (Section 5.3.1). An example of teachers not being attuned to children's interest in the physical environment that potentially connected to science learning was the children's general interest in how objects moved (Section 5.2). Until the researcher, through one of the professional learning sessions, identified the connection between the children's interest in movement and physics, the teachers were not aware of the potential science learning. Teachers' attunement to children's interests and thoughts about the physical environment is an important pedagogical idea (Carr, 2014; Kirch, 2007). There is a body of literature in early childhood education that promotes curriculum generated from children's interests (Carr & May, 1993; Ministry of Education, 1996). Curriculum generated from children's interest in more recent times has been referred to as "interest based curriculum" (Hedges; 2007). In general, the interest based curriculum presumes some form of attunement from teachers to children's interests in the physical environment.

In this study a frequent starting point for science learning was children's engagement in everyday and ECE communities of practice familiar to them. For example the everyday fictional story book provided the starting point for a discussion between children and a teacher about how rainbows are formed (Section 5.3.3). Another example from Chapter Five was children's interest in how objects moved (Section 5.2). How objects moved was a starting point for discussions about science-related ideas on force, speed, velocity and friction. Linking access to science through the everyday communities' practices has been referred to as relevant connections for older learners' when science is used in everyday life (Aikenhead, 2006). Science learning having relevance to the learner is an established science education understanding that links to student interest and motivation (Holbrook & Rannikmae, 2009). The idea of relevance in science education can be described in terms of the learners' perception of the science as being meaningful, useful or helpful to the learner (Holbrook & Rannikmae, 2009;

Levitt, 2001). An example was Claire and the reflection of her metal lunch box on the walls of the kindergarten. Claire could only say, “Look, look, look” as she pointed to the sun, the lunch box and then the reflection (Section 5.4.1). The researcher talked to Claire in that moment about how the light was reflected and at that moment a connection between the everyday experience and a science explanation was relevant to her interest. The moment was evidenced through Claire’s body language of approval, of the researcher’s comments, for connecting with something she was interested in and extending her understanding on reflection to explain her observations. The researcher’s attunement to Claire’s interest in the reflection of light gave an opportunity for a science explanation on reflection that was relevant for Claire.

7.4.5 Summary of chapter seven

The concepts of affordance and attunement describe more succinctly the teachers’ influences on children’s engagement in science learning. This thesis argues that a quality position for early childhood science education in a play-based curriculum requires teachers to be mindful of both the concepts of affordance and attunement to the potentials for science learning. The teachers’ influence on the physical environment was substantial. The teachers influenced the physical environment affordances to children’s potential science learning in two ways. The first was in the physical experience they created for children to explore. The second influence was teacher awareness of a range of semiotic everyday, ECE, science and science education physical artefacts that could be used to enrich children’s science community understandings. Teachers also influenced the physical environment through their affordance to the opportunities to promote the science learning for children and their attunement to children’s interests within the physical environment potential science learning by observing the ways children interacted with the physical environment.

The teachers influence on the social environment was a crucial component to children engaging in science learning. The children’s interests in the physical environment were a poignant starting point for when teacher mediated children into science communities of practice. The mediation into science learning happened within the existing play environments and then at times teachers planned further experiences through everyday, ECE and at times science-specific social semiotic artefacts. What became apparent was how crucial it was for teachers to be attuned to children's interests in the physical environment and how children's interests could relate to science communities practices.

7.5 Conclusion: Answering the research questions

This chapter incorporates the findings from this research project with literature on early childhood and science education. The chapter also considers the influence of the two professional learning sessions for the participant teachers related to both science and science educational ideas. The concluding comments in this section are framed using the two main research questions

i. *How is science learning and teaching being enacted in three kindergartens*?

Investigating the relationship between the four identified cultural communities of practice was a beneficial way of considering how science learning and teaching took place in the complex integrated play-based curriculum. It was evident that when the four communities met that science learning was most probable. The researcher has named the meeting place for the four communities *the quadruple move.* Whereas most literature considers two communities, namely science (academic knowledge) and everyday (Fleer, 2009a; Hedegaard & Chaiklin, 2005; Vygotsky, 1987), this study has identified four communities being present, in the teachers' mind, when science learning occurs in a play-based curriculum.

Similar to Fleer (2009a), this study has identified that teachers have limited confidence, not only about the science communities, but also about how to facilitate children's science-related learning. The main finding related to the quadruple move was that teachers could benefit from knowing and using the meeting places of the four identified communities of practice more intentionally within their work with young children.

The investigation of the four communities illuminated how hybridity of practices across the communities can benefit children's science learning. The identified areas of hybridity were processes of inquiry, visual representation and dialogue. The benefits of hybridity were twofold. Hybridity promoted the use of everyday practices children were familiar with being used within the children's science learning. A further benefit was children learning to use science-specific practices within their everyday play which familiarised them with the practices.

Children being actively involved in open-ended science investigations brought about increased participation and richer science learning (Gelman & Brenneman, 2004; Siry et al, 2012, 2013). The further benefit identified within a play-based curriculum from this study was that children remained interested for longer periods of time. Sustained interest in a play-based setting over a period of weeks resulted in children gaining richer and deeper science community practice and knowledge.

The findings demonstrated children were learning aspects of science through their engagement with everyday, early childhood education and science-specific semiotic artefacts. Everyday and early childhood education semiotic artefacts provided three types of potential science learning. The semiotic artefacts provided a starting point of interest in something in the physical environment related to science. The semiotic artefacts could offer opportunities to revisit science learning. The semiotic artefacts also gave opportunities for gaining experiences with the physical environment that could support science learning in the future. When teachers were aware of children's engaged in science-specific semiotic artefacts, the children's learning was richer and a greater depth of science learning occurred. The connections between semiotic artefacts and science learning add to the challenge to reflect on cultural artefacts within early childhood education (Robbins, 2007).

The concept of intertextuality gave insight into the many semiotic artefacts children used to begin to understand aspects of science. Intertextuality supported understandings on how children used a range of semiotic artefacts to contribute to their understanding about an aspect of science. The concept of intertextuality was also a reminder of how children can individually interpret a semiotic artefact in different ways dependant on their past experience with the artefact.

Teachers are a major influence on the contexts available for children to learn science (Anning & Edwards, 2006; McGee, 1997; Slattery, 1995). One of the contextual influences was teachers' affordances to potential science learning in the physical environment. The findings supported the idea that children learn science-related and science communities' practices through independent exploration as well as through guided play and open-ended science investigations facilitated by teachers. In relation to science learning, the findings in this study have revealed that teachers need to afford learning opportunities about the science communities, be attuned to children's interest in the physical environment and how to make the science connection relevant to the children's interest.

ii. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children?

There were three ways that the teachers' professional learning sessions enhanced science learning for young children. The first way was through increasing teachers' knowledge of science community practices about science processes of inquiry. The second was through increasing teachers' awareness of the different communities of science. The third was increasing teachers' knowledge of how children's interests in the physical environment can at times connect to potential science learning.

There were two significant influences on the professional learning sessions. The first was the links made back to the children and the environments where the teachers work. The second was allowing opportunity for the teachers to discuss what professional learning they thought would be of benefit. This happened in the first group interviews with the teachers. As well as teachers being attuned to children's potential science learning, those who facilitate professional learning sessions with teachers need to be attuned to how teachers are perceiving the professional learning experience relative to their work with children.

8 Conclusions

A summary of the main findings, implications and future research form the beginning section of this chapter. The final section focusses on answering the researcher’s curiosities mentioned in Chapter One. The curiosities were: How to integrate science learning and play. Considering how sociocultural framing impacts on how science learning is and could be enacted. How to describe the dynamic interactions between teachers and children that create moments of science learning based on children’s spontaneous interest in an aspect of the physical environment.

8.1 Findings, implications and possible future research

The findings related to early childhood science education in a play-based curriculum are set out below. They have emerged from the analysis of the three conceptual reference points of (i) multiple cultural communities of practice, (ii) semiotics within and across cultural communities, and (iii) Teacher influence on children learning science.

8.2 The quadruple move

A finding is that within an early childhood play-based curriculum a quadruple move describes the connections teachers can make between the cultural communities that make science learning most probable. The four communities that support science learning in a play-based curriculum are everyday, ECE, science and science education. The quadruple move provides a way for teachers to make connections between children’s interest in the physical environment, science and the ways children might learn science. This research project has identified that teachers were, at times, not confident in facilitating science learning beyond noticing children’s interest related to science within the physical environment. An implication of teachers becoming more cognisant of the four communities could enhance their confidence as well as their ability to engage *intentionally* with science learning and teaching with young children in a play-based curriculum. The quadruple move would provide a way for teachers to make connections between the children’s interests in the physical environment, science and the ways children might learn science.

The quadruple move describes when science learning and teaching is and can be privileged in a play-based curriculum. The privileging of science education can happen within the many cultural communities represented within the kindergarten. The privileging of children learning about the different science communities is supported through children’s interests in the physical environment and can be stimulated when a teacher perceives a connection to science knowledge or practice. The quadruple move could be used as a reflective strategy for teachers once they had noticed a connection between a child’s interest in the physical environment and science. The reflection would then be on what ECE and science education artefacts would enhance the children’s science learning.

A further implication of the quadruple move is the possibility of applying the move to other academic communities of practice within a play-based curriculum. The science education and science community would be replaced by the equivalent communities from another academic community; for example, mathematics or the visual arts communities. The quadruple move illuminates the benefit of the four communities when teachers think about introducing young children to an academic community in an intentional way within a play-based curriculum setting. Introducing student teachers and teachers to the quadruple move is a way of describing the components that teachers can reflect with and gain strategies from when creating science or other academic subject learning opportunities of children.

Future research is needed to trial teachers’ use of the quadruple move and establish how teachers might use the quadruple move within their science teaching or indeed other subject areas.

8.3 Hybridity of practices

The quadruple move also provides a platform to consider the hybridity of practices between the four identified cultural communities relevant to children’s learning and how this hybridity can support children's science learning. Two benefits of the hybridity across the communities of practice were identified in this study. The first was the value of everyday and ECE practices children were familiar with being used within their science learning and teaching. This hybridity was supportive to children's science learning in that it meant that there was some familiarity with some of the practices that made their use for science learning more accessible. The second benefit was children learning to use science related practices that they could then use in their everyday play. The findings identified three types of practice where hybridity was most prevalent in the three kindergartens. The three types are processes of inquiry, visual representation and dialogue. An implication arising from the study is that teachers' awareness of hybridity of practices, and of the practices of processes of inquiry, visual representation and dialogue, in particular, could lead to assisting them with intentionally facilitating further opportunities for hybridity of practices that support science learning.

8.3.1 Children learning science processes of inquiry

What this research project has identified is that children's interest in science learning can be sustained for longer periods of time when they are engaged in science processes of inquiry. The cultural practices of science are the scientific equipment and ways of thinking or processes of inquiry that the community uses to investigate, understand and explain the physical aspect of the planet Earth and the wider universe (Prain & Waldrap, 2010). This thesis has identified that young children can be involved in these aspects of science communities' practices but at their own level of understanding, as demonstrated in Chapter Four.

Processes of inquiry can, for example, be facilitated through teachers noting children's interest in the physical environment through their play. Mediating children's participation in science processes of inquiry happened through teachers a) modelling science practices, b) assisting children to interpret a science diagram, c) guiding children in developing and carrying out investigations, and d) engaging children in science related dialogue. Other research has explored using scaffolding with children's science learning but in more structured, teacher directed learning situations (Eschach & Dor-Ziderman, 2011). The implication for this study is to identify how teachers scaffold science-related and science-specific processes of inquiry from children's interest within a play-based curriculum.

It is also noted that teachers' facilitation of processes of inquiry can lead to children then using the science-related processes of inquiry in their general play. The advantage of children choosing to practice a science process of inquiry in their play is in furthering their experience with the skill and gaining an appreciation of that aspect of science processes of inquiry. The advantage of children gaining an appreciation of science practice is that it can lead to familiarity and a positive outlook on science as an academic subject in their later schooling.

There is benefit in enhancing teachers' confidence and knowledge about science communities' inquiry practices. This study illustrates that once teachers were more aware of some of the science processes of inquiry, they then used them with children more intentionally within the play environment. At the same time this study identified that teachers could benefit from learning more about science communities' processes of inquiry and to engage with them in the play environment. The implication is for teachers to provide opportunities for children to learn science processes of inquiry within their play interests and to explore ways of providing opportunities for children to continue using the science process of inquiry in their play.

A further implication for the findings on children's possible engagement with science processes of inquiry is the importance of student teachers and teachers learning about the possibilities. Further research is needed on science processes of inquiry in play-based early childhood settings to enhance teachers' understandings of the processes and how they can be enacted in a play-based curriculum.

8.4 Semiotics supporting children learning science

This study has described the variety of semiotic artefacts children engage with when science learning. It is important to note that the idea of semiotics means the emphasis is on *how children are* interpreting the signs and symbols of artefacts in creating their meaning-making. However, semiotics can also be about how teachers are introducing children to science interpretations of signs and symbols represented in different artefacts. With the idea of focussing on the children's interpretation comes teacher responsibility to being attuned to children's interpretations. One implication from this finding is teachers' knowledge of the everyday, ECE, science and science education semiotic artefacts would mean they could use them more intentionally to facilitate children's learning. A further implication is that the idea of semiotic artefacts within cultural communities could also be a beneficial way of assisting teachers to perceive the opportunities for learning within other curriculum subject areas. Further research is needed to illuminate the ways children are engaging with artefacts and interpreting *their* meaning related to their understanding of the physical environment and science. Research on how teachers might facilitate young children's induction into science semiotics would also be advantageous.

The study of semiotics is a useful framework for describing how artefacts within the four identified communities promote science learning and teaching in play-based early childhood education settings. The findings identified that teachers used everyday and ECE semiotic artefacts in two ways. The first way was as a starting point for children's interests motivated by a semiotic artefact. The second way was as a strategy for children to revisit science learning. However, science-specific semiotic artefacts provided children with opportunities to learn deeper and richer understandings about science community practices. The implication is for teachers to be mindful of the two ways that everyday and ECE semiotics can be used with children to facilitate science-related and science-specific learning.

The study also included the science-specific semiotic artefact of dialogue, terminology, visual representations, mathematics and science actions. The findings identified that children's science learning was enriched further by their engagement with science-specific artefacts. The implication is that there is value in teachers to be introduced to the science-specific semiotic artefacts and gaining knowledge about how they can be implemented into a play-based curriculum.

8.4.1 Prominence of dialogue and action semiotics for science learning

Both dialogue and actions were prominent semiotic artefacts for science learning and teaching in the study settings. Dialogue as a semiotic artefact has been well represented within the early childhood science education research (Campbell, 2012; Robins, 2007; Siry, 2013; Siry & Lang, 2010). What this research adds to the discussion is considering how children, when given the opportunity to engage in science-related processes of inquiry, naturally start to engage with the dialogical knowledge-processes (see Chapter Four; Duschul, 2008). An implication is that as teachers become more aware of science-related dialogue possibilities they will be able to promote its use within children's play to support their science learning. Another implication of the findings about dialogue is the benefit of teachers engaging young children in discussions about the science processes of inquiry they are using to learn about an aspect of the physical environment. This engagement seemed to work well when the science processes of inquiry were linked to something of interest to the children in the physical environment.

The analysis of semiotic actions as a study identifies three types of actions: children's physical actions that promoted meaning-making about the physical world around them, children's action through dramatic play, and children using action in a similar way to a scientist. An implication of the findings about actions is the usefulness of teachers noticing children's physical actions and dramatic play related to an interest in the physical environment that has a link to science. Teachers noticing as an assessment of the children's interest could then lead to teachers facilitating further science learning. Teachers could also use the strategy of action drama or science-specific actions as strategies to facilitate science learning. Some teachers purposefully used drama with children to revisit science ideas. At times children also instigated their own dramatic play about aspects of the physical environment they were learning about at the centre or at home. Further research on children's actions supporting science learning would expand the understanding of the use of actions as a semiotic for science learning.

8.5 Intertextuality illuminates connections between artefacts

The concept of intertextuality was useful in identifying how children were using a number of texts (artefacts with semiotic meaning) for science learning. Intertextuality illuminates how teachers can respond to children's interests in the physical environment related to science and provide ongoing experiences related to the children's interests. The implication from this finding is that it is beneficial for teachers to note the variety of artefacts children engage with, as a way to enrich their understandings of a specific science idea. Further research in this area would enhance the findings gained from this research to broaden the understanding of the possible variety of artefacts children can engage with in their science meaning-making.

A focus on intertextuality is useful in identifying that not all children will interpret the same artefact in the same way. The implication for teachers is the need for them to be attuned to how children are interpreting the ideas they have about the physical environment. This would suggest that teachers be aware of children's thinking about a physical phenomenon and science community practice within learning opportunities. Further research on this aspect of intertextuality would enrich teachers' understandings of how children are interpreting the physical artefacts related to science learning. The importance is teacher attunement to the signs and symbols children are attributing to artefacts in their physical environment.

8.6 Teachers affordance and attunement

The findings identified that teachers influence children's science learning within a play-based curriculum in three specific ways. The first way is how they afford opportunities for children to learn about each of the science communities through what they create in the physical environment and their interactions with children.. That is the opportunities they provide that affords children learning about the living (biology), material (chemistry), physical worlds (physics) or the planet Earth (geology) and beyond (astronomy).The affordance occurs through what the teachers give attention to within the physical environment that relates to a science community. In one example the teacher gave attention to the living world science (biology) by providing opportunities for children to learn about ladybirds, monarch butterflies and seed germination. Once the teachers had focussed the children's attention on ideas within the biology community, they paid attention to what the children were most interested in learning about biology. However, given the child interest-based emphasis of the curriculum at the kindergartens, it was evident that the science of most interest to children was the movement of objects related to physical world concepts. An implication from this finding is that aspects of physics (physical world) are the ideas children are most interested in learning. Another implication from this finding is the importance of teachers knowing about each of the science communities so that they can give attention to them within the curriculum they offer to children.

The second ways teachers influence science learning is how they afford science learning through the types of physical resources they set out in the environment for the children to explore. For example at Pohutukawa Kindergarten a teacher purposefully set out magnets for children to explore (Section 6.2.5). The prominence of CPE (children engaging with science related learning through their interactions with the physical environment with no teacher interactions: Section 6.2.1) within the curriculum suggests that teachers need to be aware that what they provide in the physical environment can influence the types of science learning that can happen. Although the teachers are not directing that only science learning will occur, they are thinking the experience will afford science learning. The implication of this finding is for teachers to think about the play environment in terms of having opportunities to support science learning.

The third way teachers influence science learning is through their attunement to children's interests in the physical environment and the possible connection to science learning. When viewed from this perspective, the value of the connection between the children's interest and science becomes a poignant moment for science learning and teaching. Within a child interest-based curriculum, teacher attunement denotes the privileging of the child through their interpretation of what the children are showing an interest in within the physical environment. The implication for teachers lies in how they might come to notice and appreciate the science possibilities within the children's interest to promote science learning within a play-based curriculum. Further research is needed to explore how teachers are and can act to afford science opportunities for children and how they are and might be attuned to children's interests that could be connected to science.

8.7 Teachers professional learning

Further to the comments already made on professional development for teachers in this chapter, the findings indicate the value of professional learning that is linked to what is happening for children in teachers' own centres. Drawing out and building on examples of children's engagement from teachers makes the examples more pertinent to and compelling for the teachers. This was evident when the researcher used her observations of the children in the teachers' kindergarten to illustrate some of the affordances to science in their learning environments.

8.8 Answering the researcher's curiosities

In Chapter One the researcher posed three curiosities. The first curiosity was how to integrate science learning and play. The findings of this study have provided some answers to this curiosity. The research observations demonstrated that children can and do explore the physical environment through their play. This play could involve children's explorative play of the physical environment, children's dramatic play and the teachers' guided play. The interplay between play and science learning happens through teachers noticing children's interests in the physical environment and then making connections between science ideas and practices and the children's interests. It was of particular interest to the researcher that children then took the science they had learnt back into their independent play.

The second of the researcher's curiosities was how sociocultural theory could help explain and be used to enhance young children's science learning. This has been answered through the connection of the three conceptual reference points. Specifically, children's science education benefits from and in many instances requires the quadruple move amongst the four communities of practice identified in this study. Within the four cultural communities, children are interpreting the signs and symbols of artefacts to create meaning related to science. These semiotic artefacts are part of and act to describe and make visible the science learning that can happen. At times children and teachers use a variety and combination of semiotic artefacts as texts to enrich children's science understanding through the process of intertextuality. The third conceptual reference point, teacher influence, addressed the situation and sociocultural nature of learning and the central role the teacher plays in facilitating science learning in a play-based curriculum.

The third of the researcher's curiosities was how to describe the dynamic interactions between teachers and children that create a spontaneous science learning moment. This study identified the importance of attunement to children's interests as they might relate or be related to an aspect of science. It also highlighted the need for teachers' to consider how they might afford opportunities for children to learn about the different communities of science through their organisation of the physical environment and their interactions with children.

Cultures meet cultures is a useful way of thinking about the interplay of cultural communities of practice and academic subject areas (science) within a play-based curriculum.

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10 Appendix

10.1 Appendix A: Research Permission

Includes:

Kindergarten Association

- Letter of introduction
- Information sheet about the research
- Consent form

Individual Kindergarten Teachers

- Letter of introduction
- Information sheet about the research
- Consent form

Participation sample of parents/guardians

- Letter of introduction
- Information sheet about the research
- Consent form for parent to agree to be interviewed

Participation sample of participant children

- Information sheet for children
- Assent form for child to be involved in the research
- Information sheet for all parents and children in each Kindergarten
- Consent form for their child(rens') image to be captured when engaged in play with the participant children
- Consent for the images captured to be used after the data collection phase for lectures with student teachers, at conference presentations and possibly in journal articles

Letter to the Kindergarten Association

Date

To

Dear

This is a letter requesting permission to carry out a research project with three kindergartens in your association. I would be grateful if you could identify three kindergartens I could approach to be involved in the research.

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years' experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?

2. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children?

I anticipate that the research will contribute to enhancing the understanding of early childhood science learning and teaching being enacted in kindergartens within the guidelines of the early childhood curriculum, Te Whāriki He Whāriki Mātauranga mō Ngā Mokapuna o Aotearoa: Early Childhood curriculum (Ministry of Education, 1996). Further information on the research project is attached as an information sheet about the research.

I am planning to carry out this research project during the first half of 2009.

If you are willing to have three kindergartens from your Association involved in the research can you please sign the attached consent form and return in the self - addressed envelope.

I look forward to your response.
Yours sincerely

Barbara Backshall

Doctoral Student

School of Education

The University of Waikato

Information sheet for the Kindergarten Association

Date:

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years' experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

To complete my Education Doctorate I am planning to carry out research in three Kindergartens. The research project will investigate how and what science learning is happening in each of the three Kindergartens and provide opportunity for the Kindergarten teachers involved to consider science education in more depth. It will enhance research knowledge on early childhood science education within the framework of Te Whāriki. As part of this research project I will also offer professional development on early childhood science education with the content negotiated with the teachers participating in the research.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?
2. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children?

I will be asking for participation from:

- All teachers in each of the participating Kindergartens

- A random sample of 6 children in each Kindergarten and their parents/guardians

The process for the selection of Kindergartens will follow any Kindergarten Association protocol stipulated to me as the researcher. I am seeking three Kindergartens in close proximity to the University of Auckland, Epsom campus (where I work). All the teachers at each Kindergarten will need to be willing to participate in the research.

The teachers' participation would involve them being observed and photographed one morning session a week for two terms. It would also involve them allowing the researcher to read through and take copies of the assessment and planning information they have produced on the sample of six children participating in the research. The teachers would need to be available for two group interviews of about two hours with the other teachers from their Kindergarten. They would also need to be available for two, two hour professional development sessions that the teachers from all three Kindergartens would attend. It is envisaged that, with the teachers' agreement, the interviews and professional development will occur in the teachers' non- contact times.

The children's participation (the 6 children in each Kindergarten) will involve being observed and photographed one morning session a week for two terms. The children would also be interviewed twice for approximately twenty minutes each time. The researcher would read through and take copies of their portfolios and any other documentation related to each of the six participant children's' learning at the Kindergarten. The six children will be selected randomly from those who attend the session in each Kindergarten that the researcher will be observing.

Other children in the sessions being observed by the researcher: It is important to note that other children are likely to be engaged in activities with the participant children but no detailed observation notes will be made of their activities. Notes will only to be taken to allow the actions of the participant children to be fully described and understood. As the participant children will be photographed engaged in learning experiences in the Kindergarten it is likely that other children will be captured in the photos. I will provide all parents in the Kindergarten with information on the research and request consent for the images of their children to be captured when photographing the participant children. I will also be requesting permission to use those images in future lecturers with student teachers, conference presentations and possibly in journal articles. I will not take images of any child that I have not got consent to do so. I would not use any images of children in future lecturers with student teachers, conference presentations and possibly in journal articles without prior consent.

The participant parent/guardians (six from each Kindergarten) will be interviewed twice for approximately 30 minutes in their own home or if they preferred at the Kindergarten. The interviews will be audio taped and transcribed.

Participants will be given a summary of the interview transcript for them to comment on and to change, delete and add any points.

Parents/guardians and children participating are free to withdraw information and involvement at any time up until the completion of the data collection.

Teachers are free to withdraw their involvement at any time and they are free to withdraw information up until the completion of the first group interview.

A Kindergarten can withdraw from the research at any time and they are free to withdraw information up until the completion of the first group interview of teachers from each Kindergarten.

For the individual interviews, the participants will be able to request that the tape be turned off at any time without giving a reason. For group interviews, the recorder can only be turned off with the agreement of all the participants.

If anyone other than the researcher transcribes the tapes into transcripts, then that person will sign a letter agreeing to the confidentiality of the information.

The Kindergartens and the participants will be invited to choose a pseudonym (if preferred I will create a code for their identity), rather than use their own name, in order to preserve anonymity and confidentiality. Only the researcher and her two supervisors will have access to the tapes and the transcripts. All consent forms and data collected during the study will be kept securely in a locked cupboard for five years and then destroyed.

The Kindergarten Association and the participants of the three Kindergartens involved will be given a summary of the research findings. At the completion of the research I am intending to use information from the research in my lecturing to student teachers, in presentations at education conferences and to publish aspects of my findings in academic journals. Before I complete the data gathering stage of my research I will seek written approval to use photos of the participant children in the work stated above. I give my assurance that no photos of children or teachers will be used without written permission being given by the individual parents. / Guardians or teachers. The photos would only be used for the purposes outlined above and children and teachers would not be identified by name. If permission is not given then the photos of those particular children and teachers would be returned to the parent or teacher concerned.

If you wish to discuss this further with me my contact detail are as follows;

Barbara Backshall

Email Barbara@backshall.org

Phone 09 623 8899 ext 48672

Mobile 0212632622

If you have any concerns that I am unable to answer you can contact my doctoral supervisor Bronwen Cowie at Waikato University email bcowie@waikato.ac.nz or phone 07 838 4987.

10.1.1 Consent from Kindergarten Association:

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

Researcher: Barbara Backshall

I have received the information sheet about the research project and understand the nature of the research request.

The Auckland Kindergarten Association gives consent for Barbara Backshall to complete the research as described in the information sheet in three Kindergartens.

Name

....

Designation

....

Signature

....

Date

....

Letter to the Kindergarten Teachers at XXXX Kindergarten

Date

Dear (Name of teacher)

This is a letter requesting your involvement in a research project in the Kindergarten where you are currently working.

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?

2. Does enhancing teachers' knowledge of science and science education enhance the learning of science for young children?

The research will contribute to enhancing the understanding of early childhood science learning and teaching being enacted in Kindergartens within the guidelines of the early childhood curriculum, Te Whāriki He Whāriki Mātauranga mō Ngā Mokapuna o Aotearoa: Early Childhood curriculum (Ministry of Education, 1996).

Further information on the research project is attached as an information sheet about the research.

I am planning to carry out this research project during the first half of 2009.

I look forward to your response.
Yours sincerely

Barbara Backshall

Doctoral Student

School of Education

The University of Waikato

Information Sheet for the Kindergarten Teachers

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

To the Kindergarten Teachers at XXXXXX Kindergarten

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years' experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

To complete my Education Doctorate I am planning to carry out a research project in three Kindergartens. The research project investigates how and what science learning is happening in three Kindergartens. As part of this research project I will also offer professional development on science and early childhood science education negotiated with the teachers participating in the research.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?

2. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children?

I will be asking for participation from

- All teachers in each of the three Kindergartens
- 6 children in each Kindergarten and their parent/guardians

The teachers' participation will involve you being observed and photographed one morning session a week for two terms. It would also require you to allow the researcher to read through the assessment and planning information the teachers' have produced. You will be required to be available for two group interviews of about two hours with the other teachers from the Kindergarten where you work. You will also need to be available for two, two hour professional development sessions that the teachers from all three Kindergartens will attend. The professional development content would be negotiated between the researcher and the teachers at the three Kindergartens

The children's participation (the 6 children in each Kindergarten) will involve them being observed and photographed one morning session a week for two terms. The children would also be interviewed twice for approximately twenty minutes each time. The researcher would read through their portfolios and any other documentation related to each child's learning in the Kindergarten. The six children will be selected randomly from those who attend the session in each Kindergarten that the researcher will be observing.

Other children in the sessions being observed by the researcher: It is important to note that other children are likely to be engaged in activities with the participant children but no detailed observation notes will be made of their activities. Notes will only to be taken to allow the actions of the participant children to be fully described and understood. As the participant children will be photographed engaged in learning experiences in the Kindergarten it is likely that other children will be captured in the photos. I will provide all parents in the Kindergarten with information on the research and request consent for the images of their children to be captured when photographing the participant children. I will also be requesting permission to use those images in future lecturers with student teachers, conference presentations and possibly in journal articles. I will not take images of any child that I have not got consent to do so. I would not use any images of children in future lecturers with student teachers, conference presentations and possibly in journal articles without prior consent.

The participant parent/guardians (six from each Kindergarten) will be interviewed twice for approximately 30 minutes in their own home or if they preferred at the Kindergarten. The interviews will be audio taped and transcribed. The interviews will be audio taped and transcribed. The participants will be given a copy of the interview transcript to change any inaccuracies made in the transcribing of the interviews. The parents/guardians and children participating are free to withdraw information and involvement at any time up until the completion of the data collection. The teachers are free to withdraw their involvement at any time and they are free to withdraw information up until the completion of the first group interview.

For the individual interviews, the participants will be able to request that the tape be turned off at any time without giving a reason. For group interviews, the recorder can only be turned off with the agreement of the participants.

If anyone other than me transcribes the tapes into transcripts, then that person will sign a letter agreeing to the confidentiality of the information.

The Kindergartens and the participants will be invited to choose a pseudonym (if preferred I will create a code for their identity), rather than use their own name, in order to preserve anonymity and confidentiality. Only the researcher and her two supervisors will have access to the tapes and the transcripts. All consent forms and data collected during the study will be kept securely in a locked cupboard for five years and then destroyed.

You will be given a summary of the research findings. At the completion of the research I am intending to use information from the research in my lecturing to student teachers, in presentations at education conferences and to publish aspects of my findings in academic journals. Before I complete the data gathering stage of my research I will seek written approval to use photos of the participant children in the work stated above. I give my assurance that no photos of children or teachers will be used without written permission being given by the individual parents. / Guardians or teachers. The photos would only be used for the purposes outlined above and children and teachers would not be identified by name. If permission is not given then the photos of those particular children and teachers would be returned to the parent or teacher concerned.

If you wish to discuss this further with me my contact detail are as follows;

Barbara Backshall

Email Barbara@backshall.org

Phone 09 623 8899 ext 48672

Mobile 0212632622

If you have any concerns about the ethical nature of this research you can contact my doctoral supervisor Bronwen Cowie at Waikato University email bcowie@waikato.ac.nz or phone 07 838 4987.

10.1.2 Consent from Kindergarten Teachers at XXXX Kindergarten

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures

Researcher: Barbara Backshall

I have received the information sheet about the research project and understand the nature of the research request. I am aware I can ask questions about the research at any time during the data collection phase of the research. I am also aware I can withdraw from the data collection of the research up until the first group interview. I am willing to participate in the research project.

Teachers Name..

Signature...

Date...

10.1.3 Letter to the participating parents

Date

Dear

This is a letter requesting for you and your child to be part of a research project at the Kindergarten where she/he attends.

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years' experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?
2. Does enhancing teachers' knowledge of science and science education enhance the learning of science for young children?

The research will contribute to enhancing the understanding of early childhood science learning and teaching being enacted in Kindergartens within the guidelines of the early childhood curriculum, Te Whāriki He Whāriki Mātauranga mō Ngā Mokapuna o Aotearoa: Early Childhood curriculum (Ministry of Education, 1996). I anticipate that the study will benefit children's learning by highlighting how science learning is already occurring and looking further to how appropriate science learning can be enhanced through the play and experiences Kindergarten children are involved in.

Further information on the research project is attached as an information sheet about the research.

I am planning to carry out this research project during the first half of 2009.

I look forward to your response.

Yours sincerely

Barbara Backshall

Doctoral Student

School of Education

University of Waikato

10.1.4 Information sheet for Participating parents/guardians

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures

My name is Barbara Backshall and I am an Education Doctorate student at the University of Waikato. I have 30 years' experience in early childhood education and am currently working as a lecturer in early childhood teacher education at the University of Auckland.

To complete my Education Doctorate I am planning to carry out research in three Kindergartens. The research project investigates how and what science learning is happening in three Kindergartens. As part of this research project I will also offer professional development on science and early childhood science education negotiated with the teachers participating in the research. The research will highlight what learning is already happening for your child. It will also gain insight into science learning that will benefit children's experiences of learning about science in their everyday lives.

The research is investigating two main questions

1. How is science learning and teaching being enacted in three Kindergartens?

2. Does enhancing teachers' knowledge of science and early childhood science education enhance the learning of science for young children?

I will be asking for participation from

- All teachers in each of the Kindergarten

6 children in each Kindergarten and one of their parent/guardians. The six children will be selected randomly from those who attend the session in each Kindergarten that the researcher will be observing.

The teachers' participation would involve them being observed and photographed one morning session a week for two terms. It would also require them to allow the researcher to read through their assessment and planning information they have produced on the six children participating in the research. The teachers would be required to be available for two group interviews of about two hours with the other teachers from their Kindergarten. They would also need to be available for two, two hour professional development sessions that the teachers from all three Kindergartens would attend.

Your child's participation will involve being observed and photographed one morning session a week for two terms. He/she will also be interviewed twice for approximately twenty minutes each time. The interviews would be taped and transcribed. The researcher would read through and copy their portfolios and any other documentation related to each child's learning in the Kindergarten.

As a parent/guardians I would like to interview you twice in your home or if you preferred at the Kindergarten for about 30 minutes each time. The interviews will be audio taped and transcribed. You will be given a summary of the interview transcript to comment on and to change, delete and add any points. The parents/guardians and children participating are free to withdraw information and involvement at any time up until the completion of the data collection.

If anyone other than me transcribes the tapes into transcripts, then that person will sign a letter agreeing to the confidentiality of the information.

The Kindergartens and the participants will be invited to choose a pseudonym (if preferred I will create a code for their identity), rather than use their own name, in order to preserve anonymity and confidentiality. Only the researcher and her two supervisors will have access to the tapes and the transcripts. All consent forms and data collected during the study will be kept securely in a locked cupboard for five years and then destroyed.

You will be given a summary of the research findings. At the completion of the research I am intending to use information from the research in my lecturing to student teachers, in presentations at education conferences and to publish aspects of my findings in academic journals. Before I complete the data gathering stage of my research I will seek written approval from you to use photos of your child in the work stated above. I give my assurance that no photos of your child will be used without written permission from you. The photos would only be used for the purposes outlined above and your child would not be identified by name. If you do not wish to give consent then the photos of your child will be returned to you.

If you wish to discuss this further with me my contact detail are as follows:

Barbara Backshall

Email Barbara@backshall.org

Phone 09 623 8899 ext 48672

Mobile 0212632622

If you have any concerns about the ethical nature of this research you can contact my doctoral supervisor Bronwen Cowie at Waikato University email bcowie@waikato.ac.nz phone 07 838 4987.

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10.1.5 Information Sheet for each participant Child

This will be shared with the selected sample of participants after permission has been gained from their parents/guardians. It will be shown and discussed with each child individually away from the other children. Each child will be offered a copy that they can take home and discuss with their parents before filling in the accompanying assent form.

Hi my name is Barbara Backshall and I want to find out more about what and how children learn things at Kindergarten.

I was wondering if you would be willing for me to.....

- watch what you do as you play at Kindergarten
- read and take a copy of your portfolio and other pieces of written material on what you are learning at Kindergarten
- talk with your teachers and your parents about your learning
- talk to you about what you are learning
- sometimes take photos of what you are doing
- talk to you about some of the photos

I would write down some of the ideas about children's learning at Kindergarten for others to read.

You do not have to agree to do this but if you do, can you show this by writing your name or drawing a picture on this other page.

You can ask me not to observe you some days.

You can decide at any time that you do not want to continue being part of what I am doing.

You can talk to me about what I am doing at any time when I am visiting the Kindergarten. me. I will be at the Kindergarten one day a week for many weeks.

10.1.6 Assent Form for each participant child

Researcher/ Observer: Barbara Backshall

Barbara has read to me the information sheet and I have had a chance to ask her questions about what she will be doing. I know I can stop being a part of what Barbara is doing at the Kindergarten if I don't want to continue being watched and talked to.

I agree to be part of Barbara's finding out about what children are doing and learning at Kindergarten.

Date ....

Child's Name ....

I agree to be part of Barbara's observing by writing my name or drawing a picture in the box below.

10.1.7 General information sheet for the children and parents at each kindergarten

Kia ora my name is Barbara Backshall and I will be visiting your Kindergarten once a week for the next two terms. I am a doctoral student at the University of Waikato and am carryout some research on children's learning. I will be working with the teachers and a small group of children in the morning session. The children have been randomly selected to be part of my research investigation. I am exploring ideas about how the children at the Kindergarten are learning about science in their everyday lives.

I have been involved in early childhood education for 30 years. This has included Kindergarten teaching and more recently I have been involved in early childhood teacher education. I enjoy seeing how young children learn through the engagement of play and other hands on learning experiences.

The research findings will be written up in a way that does not identify the Kindergarten, teachers, children or parents at the Kindergarten. I am happy to answer any questions about my research and look forward to my time with you here at XXXX Kindergarten.

10.1.8 Consent form for your child to be photographed with the participant children in the research project

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

Researcher: Barbara Backshall

As part of the research project I am carrying out at the Kindergarten that your child attends, I will be taking photos of the identified random sample of six children the research will focus on. It maybe that your child is playing with one of these six children, so I am requesting permission to photograph your child during my observation sessions if they are playing with one of the six children participating in the research. The photos would only be used when interviewing the six children who are participating in the research and with conversations with the teachers at the Kindergarten. The photos would be returned to the children at the end of the data gathering. Please sign below if you consent to your child being photographed.

Date ………………………………………

Name of Child attending XXXXXX Kindergarten

…………………………………………………………………..

Name of Parent

……………………………………………………………………….

Signature giving permission for your child to be photographed

……………………………………………………………………….

10.1.9 Consent form for your child photographs to be used…

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

Researcher: Barbara Backshall

As part of the research project I am carrying out at the Kindergarten that your child attends, I will be taking photos of the identified random sample of six children. You have given consent to photograph your child during my observation sessions if they are playing with one of the six children participating in the research. I am now asking for further permission to use those images in future lecturers with student teachers, conference presentations and possibly in journal articles. I would not use any images of your child in future lecturers with student teachers, conference presentations and possibly in journal articles without your prior consent.

Date ……………………………………………

Name of Child attending XXXXXX Kindergarten

…………………………………………………………………..

Name of Parent

………………………………………………………………………….

Signature giving permission for researcher to use those images in future lecturers with student teachers, conference presentations and possibly in journal articles.

………………………………………………………………………….

10.1.10 Consent from Participating parents from XXXXX Kindergarten for their child to be involved in the research project

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

Researcher: Barbara Backshall

I have received the information sheet about the research project and understand the nature of the research request. I am aware I can ask questions about the research at any time during the data collection phase of the research. I give consent for

Name of child ....

Parent / Guardian Name (s)

....

Signature. (s)

....

Date

....

10.1.11 Consent from Participating parents from XXXXX Kindergarten to be interviewed

Title of Project: A Culture of Science in Early Childhood Education: Where Cultures Meet Cultures.

Researcher: Barbara Backshall

I have received the information sheet about the research project and understand the nature of the research request. I am aware I can ask questions about the research at any time during the data collection phase of the research. I give consent to be interviewed during the research project.

Date ……………………………………………………….

Parents Name ……………………………………………………….

Parents signature ……………………………………………………….

10.2 Appendix B: Interviews

Includes:

Interview: Indicative Questions

- Teachers’ first group interview
- Teachers’ second group interview
- Children’s individual interviews
- Parent/ guardian individual interview

Interview transcripts:

- Each kindergarten group of teachers first Interviews
- Each kindergarten group of teachers second interview
- Children’s individual first interviews
- Children’s individual second interviews
- Parent/ guardian individual first interviews
- Parent/ guardian individual first interviews

10.2.1 First Interview: Questions for the Kindergarten Teacher Groups

Three Kindergartens – one group interview with all the Teachers from each Kindergarten

1. Please could you tell me about the types of knowledge you see represented in the Learning outcomes of Exploration goal four.

2. What aspects of knowledge about the physical world (natural and made) that we live in do you think is represented in the Learning outcomes of Exploration goal four.

3. What aspect of science do you see represented in the Learning outcomes of Exploration goal four.

4. Looking at Exploration goal three what knowledge domains do you see the learning outcomes relating to?

5. What science learning do you see happening in the Kindergarten?

6. Tell me what you know about science learning for young children from an early childhood education perspective?

7. What science or physical knowledge do you think is important?

8. What aspects of helping children learn science you like to know more about?

9. Through what experiences are children learning science?

10. What science learning do you think should be part of the children's Kindergarten experience?

Pohutukawa Kindergarten First Interview with Teachers

1. Can you tell me about the types of knowledge you see are represented in the learning outcomes in Exploration Goal Four of Te Whāriki?

Setting you know, a beautiful learning environment with the expectation that children will take hold of that. That it is not that, today children we are going to study X, Y or Z it's like an unspoken sort of feeling that if the environment is set up the children are so capable, we see them as being so capable. That's the main point I make at pre- entries, with parents, is the children are so capable, they can do anything, they can give you an answer to anything and they can do anything. We are just here to facilitate all of that and build on that.

I agree and also the respect and responsibility of that. The more they can do and the more you allow them to do the respect and responsibility comes along with that and I have definitely seen elements of that as well. Especially with the nature looking at bugs and bringing in bugs. They are very good at knowing how to look after them. It has surprised me a bit.

I would disagree with that in a way. I think that is probably something they have been taught. You see children deliberately squashing caterpillars on the swan plant and that kind of thing so that is something they really need to be taught in a really sensitive way. That is one thing they need to be taught.

I think I am talking about the ones I've seen who have been respectful probably learnt that at home.

Young children haven't reached that level of development with empathy.

I like the first one. Something that is of interest to them and they can go and you know pull it apart and take on their own journey of what they want to find out about it and usually have their own plan for that and you facilitate it by providing the environment and things for them to extend on.

I think it is really important for children no matter what age but especially young children just to have, get a feeling that there are no right or wrong ways of doing things that it's just sort of the nonsense one is really lovely and that wonderment and awe and excitement of the possibilities is the most important thing. That children have the confidence and are given the opportunities to develop the confidence to have that sort of knowledge- it doesn't matter what I do or what I try, it's never wrong it's just a process of examining and trial and error.

Researcher: "So you see the process words of goal four "exploring the environment and making sense of in their own way as a key to knowledge."

All teachers respond yes.

Yes because if they have got that then I think they are more likely I would think if adults go in and provide more actual knowledge they want to know about that because they are excited and want to know more.

2. What aspects of the physical world that we live in do you think is represented in Exploration Goal Four?

Well nature

Planet Earth and beyond

Their own place within that, because if they don't care for it and its goes we cease to be.

Yeah this one here about the working theories of the living world and knowledge about how to care for it

If we lose the natural environment we're dead

And that is even coming through with our garden interest at the moment isn't it, all that recycling stuff.

Again as I said it's the ones that know already that are leading us that know so much while others are just at the beginning of that knowledge.

3. What about exploration goal three, what aspect of science do you see represented there?

We've kind of covered the explorers' confident and competent learners

The ability to represent their discoveries – that's kind of a step on really isn't it.

And umm looking for patterns and classifying and guessing – classification and then representing that, those are the next steps.

Asking questions that just the next part of it and discussing planning.

What do you see is specifically "science learning" in Exploration Goal Four?
Relationship with the natural environment.
I think all of it.
I can't see anything there that isn't science.
Just in different forms I guess.
Researcher "so where it says material world what might interest children in terms of curriculum?
Is it like the type of things we are using?
Like magnifying glasses and all that type of thing. Also bugs and things.
Natural material
Material and what they do with it
Materials are the things they can handle.
That's what I would associate with material
Natural world is the bugs and things, social is the interacting with each other, the physical is how things work in relations to the world but the material is things they can get a hold of, that's how I see it.

What science learning do you think is happening at the moment in the Kindergarten?
Probably more than we recognise
Researcher "You can think back a bit into last terms of you like as we might have done this interview a few weeks ago if time permitted"

Lot of science and that in the water and in the frozen ice.
And that is an ongoing thing in a simple way with the water play. The water and the sandpit. How the water pools and then is absorbed.
In the sand there is wet and dry sand and how the water absorbs into the sand
And then there is the water trough and the different colours. Today there were bubbles in the water trough.

All of that water stuff and even the puddles left by the rain and Ben this morning looked in the little water trough and there were a lot of leaves in it and he said the water is dirty and why do you think that is happening

That spinning thing with the balls. Charlie discovered that if you dropped a big ball into there and he spun it and he noticed what was happening.
(Made for special needs to children to sit in and they can spin themselves around in it)
Then he ran off and got some ping pong balls and I was talking with him about the different ways that the big ball and the ping pong balls were going around in that.

Even when they were putting the acorns down the slide that was velocity and speed and they umm ah where to start.
They are still finding lady bugs and praying mantis. Praying mantis was on Charlie at mat time, he was freaked out and I really praised him for not swiping it away.
Discussed different types of ladybirds. Why don't we see the red lady bugs with block spots on them?
We took the praying mantis around the group and showed them the egg sack and then took it outside and then Hamish brought in the lady bug in. I was telling him when I was little they were all red with black spots (The lady birds). There's all that going on with the natural world. Lots of mat time stuff getting them ready for the gardens we are going to be having.
Tanya did a game with vegetable pictures. The children had to take a counter put it next to the vegetable they liked the best and they looked at what were the most popular vegetable and the ones the children didn't like so well. We made soup- how it turns from a solid to a liquid. These are some of the things but there is a whole lot more

Even the sewing has science ideas in it- how to attach things in different ways. Science is interwoven into everything

Can you tell me what you know about how children learn science?

The language that we role model perhaps

And the environment as well, like during the summer the caterpillars and the butterflies that is something that is just there and it kick starts it as well and you can elaborate from there. What they bring from home, a lot of the interests from home and what they like to do.

Like being involved, books, language, even songs and things.

What particular science or physical world knowledge do you think is really important for children to learn?

Having those words to describe what is happening and to describe what they have seen, opens up ideas

That things can change and you can make them change.

You can add things to it and take things away to make things different.

Textures as well. I notice when you (other teacher) were doing the vegetables the other week you talked about smooth, soft, how hard it was to cut the kumara. It is something they know is there but to describe it and discuss it further

Questioning is really important – to learn to be inquiring about things

Respect of the living world. Definitely

Science isn't just in a corner – it's happening all over the place.

Science is working with materials to make sense of the world, investigating and discovering, testing trial and error and then I thought ooh that's our curriculum!! Science is the curriculum.

What aspect of children learning science would you like to know more about?

In some ways it's not even what ....more would you like to know

It's the ratios and the time to do it. Time to extend that a bit more so you are doing lots of the questioning and awe and wonderment – but you are feeling you are always chasing your tail

Because you can always think of things but you don't always have the time to follow them up.

Talked about Charlie's exploration of the spinning thing and building on that. We could bring it inside and talk with the children about it. We could let them investigate different thing. We could get them to time it. Which on goes fastest, slowest?

That would be a good mat time thing because you have got that opportunity there and their ideas.

Researcher "One of the questions I wrote down quite early on, in fact I think it was after a session here I wrote - How do you choose which bits to notice and extend because you notice heaps – so which bits and you can't pick up on everything."

You notice so much

Researcher "So it is a bit about what can be enhanced and what is manageable and can be left for children to explore by themselves. What's manageable in a Kindergarten?" Yes, yes – from all the teachers

To help teachers feel not quite so guilty that they have had to rush off to something else.

That's right you want to catch the immediate and you can't.

What do you see as the kind of experiences children are learning science from (Artefact – things in the environment)?
Like books, Internet, through songs.
They usually use the books and the Internet to extend on what they have found and learn more about it.
A lot of them are very good at bringing in newspaper articles. E.g. elephant with the big ice block. Butterfly and they brought in the article about how they were tagging the butterflies. It is like they have got an interest and then it's being facilitated at home and then brought back and we are extending on it again – it's all that community involvement.

It is like we were talking about bones one time – a child had recently had a broken leg , so the Father who is actually a radiologist brought in a whole lot of x-rays for the children to look at. And he could describe it well couldn't he. Really good at showing the parts. It was great.

The environment sandpit, water. Everything in the environment. The acorn thing was great wasn't it for weeks and for weeks. And that has been extended; do you want to know how that has been extended? Lotta Mum today told me she (Lotta)took home an acorn months ago and now it has just sprouted so she is going to bring it in and we started to grow one here but it didn't eventuate.
We have had them sprouting in the sandpit and dug them out with the children and explained why – all turn around and look at the Oak tree

Researcher "So if you didn't have the tree you wouldn't have those experiences"
All teachers agree.

And what would happen if we let this grow in the sandpit you know- we wouldn't really have a sandpit any more, it would be a tree!

Researcher "Do the children use the magnifying glasses often?"
Yes, there are always children using them. They find a ladybug and they run in side – even in the afternoon. The magnifying glasses are always outside. We probably could put them on the outside trolley.

I find myself if they see a ladybug on the outside boxes they rush inside and get the magnifiers. Mainly in the afternoon session.
Sometimes they just take them for exploration – And actually doing that whole thing of I am looking for something - going on a treasure hunt. They have been talking about all going on something – like a mystery
Researcher "Do they still have that children's programme -Blue's clues.
Dora the Explora certainly has something to do with it.
That's how they use them alot I'd say – to get a closer look - use it to find a clue.

In fact one of the little girls that have gone now she had a bunny and it went missing they kept finding clues and putting them in a box.

What would you consider to be science equipment?

Everything

The environment and the materials within that environment including the natural worlds.

Though ERO last time they came when I was working in another centre, we didn't have a specific science area and they asked us where it was. They asked where are your magnifying glasses (they were scattered through the centre for the children to use but not all in one place, where is your weighing machines) asked where is your science area, even though we had magnifiers etc throughout the kindergarten. So my head teacher challenged them and they kind of revoked it a weee bit. Because they couldn't see one - so yeah

Researcher "Do you see that area over there as a science area?

No, aahh well it's got some science equipment in it. It got a slight focus on science. You can go there and investigate insects further but it is not an area where you go and start doing science experiments.

To me it is more of a little book corner and it's just got investigative tools.

It's an area where they can go and lay around

It does have those cylinder things – they line them up along the couch.

Viscosity cylinders – watch the liquids move from one chamber into another chamber.

One of them broke and it had terrible chemicals in it- awful smell.

In the past we have always had things set up, lovely tree trunks etc but when we cleared out the back room they seem to have vanished, and lots of little things in there.

They look beautiful but they don't always work because of the age group, well the high number of children.

I have seen them (science areas) working very well and no one went near it all day – it obviously stayed set up.
This Kindergarten is hugely problematic with few places to make corners with no through traffic – difficult to set up because of doorways.

You could set something up but you would have to be there.

It's more a place to put those kinds of things to be available for children.

Research "do you lose many magnifiers?" I hasn't been too bad.
I think myself if say there was a huge interest in praying mantis then perhaps you might modify the area and change to reflect that.

Researcher talked about participant child's (Lotta) interest in circuits.

Looked at the beginning analysis Feb/March notes from researcher.
Talked about the analysis so far.
This I did in March about what I had gleaned so far.
An understanding of your philosophy was gained from written material on wall and the children's portfolios.
Went through the experiences and science ideas being acted out in the children's experiences.

Discussed ancient animals like lizard, wheta and cockroaches – came from sharing that children were interested in dinosaurs.
At the moment the researcher is looking at each Kindergarten separately – maybe later I will look at similarities.

What science learning do you think should be part of the learning experiences at Kindergarten?
What science do you tend to repeat year after year?
Natural science because we have got the bugs in the garden. More so than physics- I'd love to develop that more I don't know as much about it.
Seasonal stuff like when it is summer you get the beach.

More so the spontaneous as it happens

Again it is vital that children understand about the care of our natural world or we are a “gonnas”.

Teachers First Interview Kina Kindergarten

1. Can you tell me about the types of knowledge you see are represented in the learning outcomes in Exploration Goal Four of Te Whāriki?

Working theories of making sense of the natural, social and physical worlds.

Things like changes of matter and things like that

It just says here how important it is for different cultures to have, for children to be familiar with different stories and basically oral fiction and nonfiction forms – important for this Kindergarten that children are exposed to that

There is a reference here about making understandings of relationships, friendships, social rules and understandings. This might differ at home from here because Pacific Island culture it is always the eldest the eldest if the most important and dictate what you do and how you do it while in other families it might be the youngest that has more of a say than the older.

Respect for living things, which kind of goes hand in hand with respect for objects.

Children’s awareness beyond the community like beyond their house and beyond their street. Like one tree hill means nothing to them yet it is just up the road. Yet chipmunks you know that playground they all knew what that was. Popular culture is important and it is like they are quite street wise. –what’s cool, what’s not.

Talking to the children after the holidays always amazes me and when I first came here I assumed that we would naturally unfold something to do with the beach that came from their holidays but they don’t go to the beach.

They are very religious church going people I remember two boys sitting on the grass looking up at the clouds talking about God.

If you put out natural products in the collage area they don’t get used where as in other centres children have made the most amazing montages with all these natural resources. Whereas these kinds love plastic crappy Mc Donald’s toys that we bring out on a rainy day and they will play with them for hours but they don't really do very much. That what they favour

Very physical children too – that relates to popular culture as well like rugby, rugby league. Very competitive and they like group sports/games. Do you think this relates to the group mentality like gang culture? We have had some children acting this out at Kindergarten. Like follow me and all the children falling in behind.

The other thing that is quite evident they don't come to you for the interest of the activity they come because you are there. It is the adult attention. The tables are never big enough – you start an activity and lots of children are there

2. What aspects of the physical world that we live in do you think is represented in Exploration Goal Four?

Talks about the living and non living environment- taking responsibility

Talks about cultural differences and the difference between manmade and natural.

Knowledge of their environment and their own place and how they fit in

- **What do you think Exploration Goal four means by material world?**

  Kind of the man made side of it – the computers, the resources anything like that – the actual things probably of a non natural base.

- **What do you think Exploration Goal four means by living world?**

  People, places, things, their own spatial perception, their environment.

  What in the physical world itself.

  And properties of matters – what things are made of – that's LO 2.

What do you see is specifically science in Exploration Goal Four?

Pretty much all of it

What do you see as all of it?

Making sense of the living world

Working through theories is hypothesising – researching and exploring

It talks about the changes in matter, properties of matter.

Living and non-living

Planet earth – and space

Different cultures – **do you see that as science?** Listen to other views and hypothesise is part of science. There may be views on god created the world verse evolution. It is social but at the same time it could be science.

I always remember “A” when we were in the garden planting peas he said ooh miss I didn’t know peas came from the ground – I thought they came from a packet. Wow he was really thinking about it. We did the same thing about where the egg came from and then we asked him where pork came from.

What about exploration Goal Three, what aspects of science is represented here?

The learning dispositions would probably be the main ones that stick out for me.

Ask questions

What science learning do you see happening in the Kindergarten?

Quite a lot – we started with the garden and we did a chart about how many children

Replanted a kumara to see what would happen to

Tried to grow some vegetables and some flowers

Then we had the butterfly and chrysalis

Shows and dancing – is that spatial awareness?

Then the insect thing kind of took off – kids looking for insects. They were interested in finding them

Even the sandpit – absolutely – huge group for one week they were so interested in the sand and water and how the sand soaked up all the water. They were doing this all day for lots of days that was a huge science

And the spouts

Vehicles, ramps – velocity

Most things we put out have some science.

Guttering for cars – put it on the roof. Going down the gutter and pushing it up

And the jumping board

Hitting things to see how far it would go, how hard it was.

What do you see as the most common science stuff?
The most common would be around biology – natural world but teacher initiated would probably be chemistry – the cooking and the little experiences we do.

The children do a lot of physical and material themselves by just you know in the sandpit, mixing colours. It is within their – very much available. It is happening in the environment without teachers. Definitely happening with and without teachers.

You can blow a balloon or a ball up and turn it into a learning experience

Blowing bubbles

If you've got the time and clarity to do it.

Can you tell me what you know about science learning for young children?
Exploration and trail and area and the ability to hypothesise, to guess, to question, to make prediction and try and test their theories.
Trial and error

Asking questions
Develop the sense of awe and wonder.
Discussions are really important to. Also respect on lookers – 'cause that's all they want to be.

What science knowledge do you think is really important and needs to be part of an early childhood centre?
Developing the respect for living things – years ago when I worked in a main stream white colour area in Australia I would have said it was more the concepts of science – going through your changes in matter and your floating and sinking and all those kind of things

The willingness to learn – talking about dispositions for learning

To be able to name animals

That activity I did about what is a plant? Flowers not a plant and a tree isn't a plant and grass wasn't a plant. Is leaf a plant – yes. Challenging and work through their ideas.

Accepting their thinking – meta- cognition – thinking and their thinking

For all the children to be exposed to the experiences – you know the natural and physical world and having the resources.

There shouldn't be limitation – some children have different knowledge – and different working theory

What aspect of helping children learn science would you like to know more about?

Kind of extending them on the basics

You know like when you do the ice balloons – what them melting and your talking to them about what it feels like – is that it? Like what can we do to go beyond that?

Through what experiences are children learning science?

Like hands on do you mean?

Like the sandpit

Cooking

Water, cleaning

They are the main ones

What are the science ideas happening in those places?

Volume (is that more maths?)

Observing change –

Discovering about the properties of matter- like when you mix flour with water

Buoyancy

Floating/ sinking

Gravity

Velocity

Speed

Motion

What science learning should be part of the children's kindergarten experience?

Is any science absolute or does it varies from Kindergarten to Kindergarten depending on the children's interest?

I think the natural world side of it is pretty absolute
Anything to do with animals or plants will be your basics- and it is a right for children to have that.

Some time ago the butterfly interest came through dressup – through spider main and then wings

Cooking – I think cooking is sometimes done more as a treat it should be a natural part of the curriculum. Because they're so interested in the food they interested in listening and hearing what's next, about what is going to happen. And the simple pleasure of mixing a dry ingredients and a liquid.

What role do you see that the wall display had?
To make their learning visual. To make the Kindergarten look beautiful.
And hopefully for them to revisit and for the parents to take an interest.
Informative about how the ideas are growing.
For children first and parents and everyone – community.
Also for student teachers
And we always invite for parents and the community have an inter3est to come and follow it up. And for other Kindergartens – love to see the ideas when I go to other Kindergartens

Can you tell me why you have a science area?

We developed it fourth term last year.
Throughout the year you kind of change things around – we didn't have a literacy area so we developed that. Then Kara brought up we didn't have a science area and that started it – it's just.

You have sensory area your art and literacy, your construction area I don't know asks the people who trained us. It is engrained

It is not like it is static play some of it is just resources for e.g – magnifying glass and this is how you use it and you bring it back here. It's a place to keep things. YOU keep the magnets and sometimes if something is happening like the monarch butterfly you need to give it a place (a focus area) so the children want to find more or look at the monarch butterfly they can go there and have a look. Doesn't need to be- but for me it is the resources and learning to use resources to me they need to have a place. Yeah that's true.

They know not to play roughly in these areas.
But also when we visited Ferndale they had a little science area on a table and lots of things in little baskets and I said to Carol I wonder who is it for – was it for the children? It was just a bit too attractive. But for us we have the baskets down here with things in and they take them out and put them on the light table.
And none of us are really leaders in science.

The other thing – when we first set up the science area I thought this is going to be hideous because everything is going to go outside and it does – we've lost all the magnets and we had to order more. We had ten new magnifying glasses in all but they disappeared – some of them broke.

Why the light table?
Because it is awesome
Got it recently – late last year. Kara had one at Pears Bark.
Kind of in teaching there are fashions and this is one of them but I think it's amazing. Regio Amila centres have light table and that's where it came from I think. Good for shadows.

What is a plant and how that started?

Because we did the kumara thing and tried to grow the flowers – who did it come from – it would have been in the back of my mind as it was one of the assignments I did with Dawn in 2006. Just when we were doing a bit of the planting it was the words the children were using – like Olly was calling everything a leaf and so their language for things – and then just asking them questions – like is this a plant, is this a plant and it kind of went from there really. Quite sadly their lack of knowledge. Like can you eat a plant (children "no").

Jandals Kindergarten First Interview with Teachers

1. Can you tell me about the types of knowledge you see are represented in the learning outcomes in Exploration Goal Four of Te Whāriki?

Children being able to differentiate between seasons, this morning talked about deciduous tree, owls - birds nocturnal, tides how the world works around them the teachers sees these concepts fitting into making sense of the natural world.

Understanding of properties of substances – like bubbles have been extremely popular today and yesterday and how moisture in the air effects bubbles – we looked at that particularly in the morning yesterday because a number of the bubbles landed on the ground and stayed up , didn't pop because of the moisture and that was interesting.

Worked a lot with Ice this year. Making ice blocks and using it as a sensory experience as well as an eating experience. Putting things in the ice and then freezing them. Some children wanted to put mint leaves in the water to be frozen and then eat the mint and ice when frozen.

Understanding the difference between nature and things that aren't natural.

We have used the vegetable garden as a place for children to see where food comes from, eaten food from the garden. They have been involved with planting it, harvesting it and taking it home.

Learning to care for the garden (and watering) I think that is knowledge. You know care for the plants and care for the insects and things they might find and hold in their hand like worms and not squashing them.
What insects eat and what insects need to live. Holding things carefully and not squashing them. There were a few fatalities, yeah but that's life.

Teachers' looked specifically at the learning outcome with interest ......"Familiarity with stories from different cultures about the living world, including myths and legends and oral , non-fiction and fiction forms. Researcher mentioned that this links with science but not all knowledge is science.

Children knowledge of their environment around them- how the environment relates to me. Things about what our local mountain is. Is it Mt Roskil.? Can we go up there? Can we take a bus up there? Yes you can.

2. What aspects of the physical world that we live in do you think is represented in Exploration Goal Four?
Researcher give example in LO 1 it talks about the natural, social, physical world etc – what do you think is meant by physical world?
Something tangible that we can see, feel, touch - Like sand, water – physics. The physical world and how it impacts on us and what we do.
What about exploration Goal Three? What aspects of science is represented here?
Children with magnifying glasses exploring the physical world- the trees, the grass the insects. Their asking questions, we're supporting that with literature and the computer- ICT.

Just this week there have been a lot of incline planes. Car going down hills, ramps.

Inquiry as part of learning in science. Definitely part of science .
Children's natural curiosity is always part of science.

I don't see science as one dimension it's everywhere and in everything.

We have had a new hose fitting set up in the sandpit and water won't go up hill. You know if you hold that hose up there is nothing coming out. Children are naturally learning about it. Some children try it putting the hose up and then down to see what happens to the water.

What do you see is specifically science in Exploration Goal Four?
Cooking ingredients what happens when something is raw and you cook it, it looks completely different. We do a lot of that (cooking) – it's kind of ongoing.

And the volcano thing which we do a lot of and it has happened again today with the reaction between the baking soda and the vinegar. You know that's a chemical reaction.
That's been repeated since last term

This one here about social relationships (indicates part of a learning outcome) that's just a huge part of Kindergarten isn't it. Friendship, authority, social rules and understandings that's happening all the time in the playground. **Research - *Do you see social relationships as part of science or separate from that?*** Well it is social science isn't it. Everyone laughs. Science of society – how we all interact with each other and our place in the world. Some people attract other people we don't know why.

3. What science learning do you see happening at the moment?
The whole insect thing was a big interest. Instigated by one boy but this kindled the interest for lots of other children.
Planting the garden.
The swan plants came in – actively saw the life cycle, there were books about it and a lot of talk about it. They sort of saw a life cycle in front of their eyes. It was really an opportune time to do it. – We went to the butterfly house to support that interest. We made it more holistic by bringing in music and literature and art – all areas of the curriculum really.

Anything from this week (first week of term two)?

Ramps. Smooth board for the morning children. Morning children used cars and used the board as a ramp but we put it away in the afternoon because the afternoon children were using it differently and trying to walk down it and were slipping.
The minute they saw the incline plain set up the used it.
Researcher asks: What are some of the science concepts you see there? Gravity, backwards and forwards, in and out.

Swing thing – twirling the swing – that's physics isn't it.

We have just started working with natural resources and doing some weaving and that is in and out you know That – we were talking about that its quite a hard concept – you need to be persistent.

They also pulled a whole lot of flower apart this morning – like a wedding. Some teachers might not like that but I like it. There was a beautiful carpet of flowers – a floral carpet.

4. Can you tell me what you know about how young children learn science?
Through their senses
Through exploration
Through trial and error
By doing, by seeing, by touching, by experiencing
By having the opportunities to touch and experience, do something real. To have real experiences. Planting real stuff
And with a purpose because we are going to eat it and that sort of thing.
Sometimes I think learning through failure - sometimes things won't work out its all trial and error.
But sometimes it doesn't always work out you might plant something and it doesn't grow – but that's learning about the world and thinking about why it doesn't happen. Discovering why things don't go as we have planned. It is all part of learning and we are learning to.

What particular science e or physical knowledge do you think is really important for children to learn?

The difference between hot and cold

Their place in the world.

Recycling – sustainability.

Taking care of our world.

How to look after the natural world, what plants need to grow.

What people need to grow – that nurturing.

The tree out there is a living thing so you don't pick the bark off – as I said to some kids the other day that's like picking its sink off. Because that is what they were doing.

Researcher asks: So mainly living world? If you were to look at all the worlds is there a world that is more important – say if you had to rank the worlds?

Maybe the physical world

Living world. "I'll tell you why for me. Because biology was the only science I was good at , at school" And my interest because I wasn't interested in chemistry.

Chemistry is like mixing. Vinegar and baking soda that's a reaction isn't it.

Yeah but it all got harder than that.

Mixing the colours – that's chemistry

For me living world is the priority world.

I like them both the physical and living world I like them both. I like the way people react with each other I like the way people bounce off one another and what people are attracted to one another, the dynamic of the whole thing. Communication – I'm interested in that.

What aspects of children learning science would you like to know more about?

Yeah – really understanding how much they can take in. How far you can really go with ummm explanations or tailoring explanations to their understanding "cause that's something I really don't know how far I can go. Like talking to children about dinosaurs millions of years ago what does that mean to a little child? What grasp does he have on that – it wasn't last year – you know there weren't any men walking around on the earth when the dinosaurs were here?

Because you here some children and they have some concept of time because you hear them talking about long, long, long , long time ago so obviously they have some concept haven't they.

It depends how much exposure they have had at home and in books, literature.
Researcher: Are you talking about sort of how far do you develop that science?
Yeah how far do you really need to extend it. How far and when and how much knowledge do you need – does a four year old understand and absorb.
It is different for different children Yeah.

And it's tailoring the language to the understanding of tailoring a concept.

I'd like to know more about what sort of resources other people have used that they have found valuable that we could also use – that we could purchase for the Kindergarten, or make or somehow get that might enhance you know science experience for our children.

Something that is quite – is actually durable.
The magnifying glasses have lasted a long time.

Research I have been so impressed at how your children use magnifiers – they just come and get them when they want to use them and put them back. How did that start? We just put them out and we talked about them. The first lot we got did get broken and they were all over the place. It's been a journey. Now children learn for their peers.

We looked at the digital microscope – can they really appreciate that that is a piece of cheese. Is it a waste of time in terms of do they have to look at the cells? Do they comprehend what they are looking at? How far do we take it?

I suppose as far as children want to take it.

Sometimes children amaze me because you think they won't understand that but they do.
But I think what you might be saying is we want children to appreciate what is naturally out there before they get into all that – it's like doing a marathon before you can walk – is that kind of what you mean. Yeah like get real with what is in front of you. Get in touch with what comes naturally and because you are four you have plenty of time to get to that electronic microscope. I feel sometimes we are rushing children to learn so much and then what's left - it's all too much too soon. And all this fantastic staff at Kindergarten and then they go to school and there is nothing like that – you know are we setting children up – is that kind of what you – Yeah I think so.

Talked briefly about negotiated Professional learning/ development.
Shared the first analysis: from the first four weeks of observations.
Researcher asks: Why have a science, **area is it a science area?** Just a place that holds bugs and stuff. It a discovery area. Science is everywhere – it's a PC place. A place for us to put things.
What you have done is you modelled how to use them and then children show each other – Yes, yes they show each other.

You know we've got those hot glue guns out there and we don't show each new child how to use them they learn from watching – from a more competent peer.

Talked a bit about the participant children

What do you see as the kind of experiences children are learning science from/ the artefacts of science?
Connections with nature

Experiences - hands on – in the dirt with the plants

Garden

Environment- observing people, places things

Changes in the environment

What would you consider to be science equipment in an early childhood centre?

Magnifying glasses

The garden

Plants, insects – the things that live in our environment

Garden tools

Plastic animals insects and things

Non -fiction books

Water and hoses – watering the garden

Pipes gravity ramps cars, swings

Sand

What science learning do you think should be part of the children's Kindergarten experience?

Care of the world to me is probably the most important. Yeah, yeah from the other teachers

Care of nature

Given the chance to observe the cycle of life

Respect for the living world. It part of our society today that young people have lost a bit of respect. The museum ANZAC service all being very respective. Māori and pakeha all together. Awesome felt neat it gives you hope for NZ. Respect is important.

Currently composting, recycling from city council. A lot more families recycle. Wearing hats in the outside environment – keeping our self save – sun smart – that's science

What science concepts to you tend to repeat year after year because they are often the focus of children's interest?

Water play and the whole thing

Gardens – spring – plant a new garden every spring

And you do the cycle of life every year one way or another

Going to a farm – went twice last year once visits in different seasons. Ambury Farm

Cooking – measuring reactions raw to cooked ingredients. What happens to ingredients when it is cooked?

Teachers Second Interview 04 September 2009

1. ***How has the professional development within this research project impacted on your teaching?*** Glynis - "I will just come back to one of the main things for me from the whole thing is that it has made me realise science is not just about living things, it is also as it says in the definition of the dictionary (Oxford mini dictionary) "A definition of science as being dealing with substances, life and the natural laws" and I think the natural laws thing is something I have learnt especially as our children were right into incline planes for quite a few weeks. They have moved on from that and are doing other things but umm yeah so that for me, the physics side of it. You know for me I have always thought of science as being living things, like earth and dissecting and all those types of things.

   Michelle –"And for me it's looking through a different lens like my observations skills have kind of more honed in more on science. So before I might have seen children doing things but I might not have necessarily seen them under a scientific lens. So now I know the things they do are actually science and I can observe them and relate to them as that, whereas before I might have thought they were just pouring water into different containers you know they were digging in the ground – I knew they were investigating but now I have the words and different observations that I can make now with more of a science focus I understand more about what that is."
   Vicki "Recognising the science that is in the environment and responding to it."

- ***Is there a difference in how you view science learning for children? If so can you give me an example?*** "We thought that was kind of the same question as the first one"

- Michelle "For me looking through that lens again and just realising that science is everywhere it is in everything that they do and like when I would observe before I might have seen that observation under a different context and not necessarily a science context, now I see it as a science context as well as the other. And it has made me realise that my own knowledge and my own perspectives and my own experience does impact on the way I observe children and that the things that I observe as being valuable or significant maybe different to the things that other teachers might view as significant or valuable. And this has opened my eyes to that fact it has been the crux of the whole thing for me actually."

- Vicki "It is a question of interest and prior knowledge that is how I feel about it. Science learning for children it's about the (science) possibilities is endless – now that we have done this with you looking at the possibilities and thinking about what they are – seemingly endless."

- ***What aspects of the professional development about science has been useful in your teaching and why? If so can you give me an example?***

- Vicki "Well we are definitely using different words, a different language – specially the one on movement that you did where you forced us to look at movement and force, trajectories and all that sort of thing.

- Glynis "the natural laws one, that's the one I found very interesting (This was Newton's three laws)

- Michelle "We've given children more opportunities to experiment themselves and have documented it. Like we <u>know</u> if you plant pea seeds in winter they probably won't grow but we've tried it (Because children asked to try) and found they do start growing but then they get eaten by something. Whereas before we might not have done that since the research we thought we would try that and see how it worked and lots of other things as well."

2. ***Is there anything in the Exploration Goal Four learning outcomes that you view differently after the professional development within this research project?*** This is the living, material, physical worlds and planet earth and beyond

No not really echoed by all three teachers.
Michelle "We looked at that but we thought not really, other than this looking at things through this new lens. You know children are out there exploring just as they always have been but perhaps now we see more opportunities, more scope and we understand now we are a bit better about the things that they are doing that are science whereas before we might have thought – oh they are making a great big mess out there but it is science and schema and maybe we find that more interesting than we have before – that's just for me."

3. **Is there anything in the Exploration Goal Three learning outcomes that you view differently after the professional development within this research project?** This is more about the process of inquiry

Michelle “ Well we know about these words now that we always did know but are coming more into our documentation you know investigating, comparing, experimenting. Just all those kind of words we use a lot more now like I know I have used the word force a lot more, gravity and propulsion , trajectory all those words that maybe I wouldn’t have used before but now I am starting to use”

4. **Science learning do you think has been happening this semester?**

We’ve come up with a list because we’ve thought about this. (I gave them the questions ahead of time). On behalf of the three teachers Michelle read out the list

- Investigating, comparing. Experimenting going on all the time
- Incline planes we’ve worked a lot this term we’ve added textures, paint, water to the inclines, speed bumps, sand, friction all sorts of things like that.
- We’ve worked with snails. Children have been interested in snails just recently and we have made a poster and got a picture of their anatomy from the Internet and looked at what snails like to eat and how they move and compared the garden snails with the Apple snails out of the tank.
- Cooking, ongoing cooking and transforming of food – transform the ingredients into something
- Observed children doing their own experiments
- Looked at movement schemas
- We’ve looked at trajectory schemas where children have been throwing all sorts of things – beanbags, balls, wet things dry things
- Research on the computer with children, used the camera
- Talked about Force, propulsion
- Talked about the human body – biology with the teeth cleaning
- Watched , observed children exploring floating and sinking
- Worked a - lot with scales weighing with scales.
- Planting
- There is probably a lot more but we can’t think of them at the moment

Show photos of Participant children and talk about the things I have noticed

The types of things I have picked up on and have been discussed with participant children

Bella's seed grow into plants all the participant children articulated that Michelle "Must make a sign with her actually I meant to do that the other day but Bella didn't come to Kindergarten the next day"

Children using magnifying glasses

Blowing the bubbles - talked about what Bella told me

Floating and sinking – Michelle "We do that quite a lot"

Bella talking about the glue gun – noticing melting and heat but calling it sloppy

I talked about how variety in the environment allows children to learn from the environment using the glue gun as an example.

Different ramps Glynis "You know some children got right into that didn't they. You know all we had was the plank, the water trough and the container of little plastic cars. They watched them going down. And also in the sandpit too with planks – actually it is still going on isn't it" Michelle "Yes it is because the children will come and ask me for them" Glenys "Mathew is quite into that isn't he" they all agree.

I talk about how when I have asked the participant children in each of the Kindergartens what makes the cars move – they have all responded the wheels. I had not asked further about what makes the wheels move.

Vicki talks about a child at Kindergarten last week who was floating a piece of wood in the water trough and Vicki asked her why do boat floats float. She replied "because they don't have wheels" Two boys had their cars in there and they were floating to but her's was a boat. She had made a boat "why do boats float? "Child "Because they don't have wheels"

Michelle "I tell you what I have noticed when I have been looking at the snails with the children. When you have a variety of sizes with the snails they relate that back to their family. The big one is always the Daddy, the small one is mummy and the smaller ones are babies and it is not just one child it is all the children, all of them that is what they say. That's the Daddy one, the mummy ones and the babies – isn't that interesting"

Glynis talks about

Michelle “to make sense of their world they have to relate it to something that is immediate to them, it’s amazing isn’t it”

Gardens

Levers Michelle “Is that what they are called – I call them the “flippy things” Vicki “Well it is a lever action” Michelle “children call them the yellow sticks”

Arya planting the tree branch after some time he realised it wasn’t going to grow

Michelle “That’s what he told me – no roots, it’s not going to grow”

Ayra’s ramps

Neeyanta and the water wheel Glynis “You know she can come across as a bit stubborn but once you get to know her she is very capable” Michelle “she has to get you on side” Vicki “ she likes physical contact”

Michelle “I suppose it doesn’t look like the wheel is turning in that photo”

Talked about the snails and had they tried the wheat germ to watch how the snails mouth worked. Michelle” Yes we did the table, with the different foods. I didn’t have any wheat germ so we used the bran. (Snails) they liked the bran and they liked the cheese and they wouldn’t touch the apple at all and wouldn’t touch the spinach but they liked the lettuce so it was interesting and the children really noticed it”

“I’m going to try it again with different snails and different food, we’ll keep it going. I’m going to make a big display on the board out there. You’ll be able to see it next time you come. We talked at mat time and if you look over there – those were the things they know about the snail” and we talked at mat - time and there is the list of things they knew after they talked at mat time. (I have a photo copy of what was written on the white board)

Michelle talked about how the snails make themselves fall so they don’t have to move down to the next level like stairs near the sandpit. They just push themselves until they fall off one step onto another then they continue crawling along. The younger snails with softer shells seem to know not to do this and just crawl across put slanted down the stair so that they get to the lower stair. Michelle talked about a boy (who just about decimated the snail population at the Kindergarten) that was at Kindergarten some time ago who loved snails and would put them up high on the rail and that all of a sudden they just all started falling off – propelled themselves off and then crawled away – totally amazing. Michelle “The children have picked up on it because I raved on about it because I found it so fascinating and they remembered it.”

Vicki “ We did have a little girl her one day who just stuffed her whole pack back with snails and her mother just about had a fit when she came to pick her up because it was full of snails. I’ve never seen anything like it and actually we find it hard to find snails now and in fact the snails we used the other day I had to bring from my garden”

5. Observation reading – what do you glean for the article that would be useful to enhance science learning for young children.

Acknowledged the article was hard going, in terms of reading.

Michelle “Once you got past all the birds and crickets and stuff and you looked how it was related to children it was interesting. To me the crux of it was the quality of the observer, the observer’s knowledge and how that impacted on how they observed and what they saw as valuable and relevant in their observation”

Michelle “And also that children do not document Children don’t document their observations and I know that for a fact – You know when we did that big thing about ants (March 2009), and then I thought I would get children to draw an ant, so I got a book of an ant and put it down over there and some children did draw it but not related in any way to the ants they had seen out there. So children do not document what they observe as a rule, do they, they don’t seem to?”

Glynis “I thought it was interesting to that they talked about like you were saying scaffolding and actually we do have a role it’s that whole thing about responding to their interests umm to be able to extend them – you know the inquirer really aren’t they and we often learn alongside them. We don’t know all the answers just because we are older.”

Vicki “Someone who has been away quite a bit lately is S... we could do more with in the living world”

Michelle “Ummm he loves the living world. He did that snail race down the slide remember Vicki”

Vicki agrees

Michelle "He finds snails every day" He has been away lately because of Ramadan. Discuss Ramadan.

I talk about working up another article that is more ECE focussed/ Friendly and pass it by you and see what you think.

Michelle & Vicki "I think it is similar to "Science in the play centred curriculum" that you gave us to read – very similar – I see correlation between the two articles."

6. What and when is it beneficial to use the label science in early childhood education?

Yes I do think it is important for labelling to let parent know what we do.

10.2.2 Second Interview: Questions for Kindergarten Teachers Groups

These questions and comments are indicative as the questions will develop from the first interview and first observation phase of the research project.

5. How has the professional development within this research project impacted on your teaching?
    - Is there a difference in how you view science learning for children?
    - What aspects of the professional development about science has been useful in your teaching and why?
6. Is there anything in the Exploration goal four learning outcomes that you view differently after the professional development within this research project?
7. Is there anything in the Exploration Gaol three learning outcomes that you view differently after the professional development within this research project?

Pohutakawa Kindergarten Second Interview with Teachers

Pre discussion: Discussing about the article and how it seemed pitch at a very high academic level. Teachers

Researcher "The interesting thing in the article is how is observation as a process different for the domains of science than other places and there may be times when that is true. I always parallel science education in early childhood with art education. We don't say to children unless you can draw a Rembrandt or draw like a contemporary artist you're not doing art but we say in science unless you are coming with the adult idea scientists idea in science you are not doing science. But I say rubbish, there is something else that we haven't put on paper yet, or we have in part um but there is more to it."

Rosemary "Do you feel the responsibility Barbara for putting this on paper"

Researcher "Not totally, no. No, I feel a passion to do some of it but I don't think one person every understands the whole picture to be quite honest. And nor do scientists because they have built on each other's ideas. I have watched children even here build on each other's ideas. (Teachers agree – yes they do don't they) We think of all they have thought and talked about with that birds nest. There is bits of that they have built from each other. They talk about when they get passionate scientists together they just talk about the science, well if you get children together that are really fascinated in something they just talk about it too. And it is about using those processes to enhance their knowledge of the discipline and enhancing what they know I think they are actually working at that level, at the level of practicing science at their stage of development. Because they are not going to be able to put together the more complex. See taxonomy (classification system) now is based on DNA it's not based on the physical features any more, in fact they have reclassified things because of that. I think the Daddy Long Legs is one of those – when the scientists looked at the DNA it was so different from the other spiders (DNA) it is no longer put in the spider classification, that's all I can remember about it."

Rosemary "That fascinating so it not the look of the thing"

Researcher "No they are talking about its evolutionary journey. So whatever animal's DNA is closest to it actually puts it in the classification. But the physical and morphological features have been almost accurate. But how do you do DNA with three and four year olds, you don't you start with what they can notice, I think."

Rosemary " Yes, what they are observing."

Liz "It is like what you said about the- what did you say a while ago it is the difference in knowledge between what you have been told and from what they have learnt from experience. I think you said that a while ago. There explanation can be completely different."

Researcher "That's right it is the difference between rote learnt information – and do they (children) really understand

All teachers agree about the importance of experience.

Tanya "I mean with the dissection of the birds nest there is no way that you would bring in dissecting, like an animal for them to dissect, I wouldn't know where you start to dissect because I don't have that knowledge myself to pull apart a...You know like in science labs. You know what I mean? You know I would feel like I wouldn't be able to umm facilitate. A great thing to do but I don't think it is at their level. When we were brainstorming what other things they (children) could dissect none of them said that. None of them said frog or a fish.

Rosemary "No 'cause that is from our perspective. What we dissected at school."

Tanya " Yeah that's right. See you don't take them (children) from one simple thing like a birds nest right up to a-you know what I mean. You need to keep it age development appropriate"

Researcher "also when you do that it is more like the old theme stuff than the emergent curriculum. It is what you as an adult are making the connections with. Whereas for their thinking"

Tanya "I was even interested that they didn't come up with any of those things you know"

Researcher "I love George's one about unwrapping the present (George's idea on what else the children could dissect). He got excited today when I talked about it with him again."

Tanya "He was very passionate about it. He got quite excited and Ned bought in a birds nest yesterday and we wanted to dissect it but umm "

Rosemary "He wouldn't let you he wasn't ready to have it broken"

Tanya "Lucky I asked Mum because I ooooh, nearly got into trouble."

Researcher "I think that is very respectful and that is the thing you all commented on last time (first interview) was the importance of ecology and looking after the world"

Tanya "We did talk about why was the nest no longer needed by the bird, we talked about maybe it was the night before that big storm, we talked about how the nest."

Interview questions and prompt comments for Kindergarten Teachers Second Group Interviews. *These questions and comments are indicative as the questions will develop from the first interview and first observation phase of the research project.*

1. **How has the professional development within this research project impacted on your teaching?**

Liz "I'll say I know that I have put quite a bit of it into my teacher registration, just because I thought it was something I could do as an action goal and going over it with Rosemary I think I put quite a lot of it in and didn't focus so much on some of the other things because it was something I wanted to do and I know I have shared a bit of it with you (researcher) as well. So for me that was something I enjoyed and some of the boys have gone now but there were a group of boys that were constantly doing something (Meaning science related) together, they were in the sandpit, digging for dinosaur bones, it was this group that were doing really interesting things together and talking a lot, lots of conversation and you could ask them and they were coming up with some incredible answers. So for me that would be what I got from that. Not so much looking for it but um working on it as part of an action goal.

Tanya "I don't think science has ever been my strong area. I remember playing up in it at school so I don't think science has ever been my most favourite subject, it's not really my interest but definitely by having you here and doing all this has opened my eyes up to looking out for different opportunities to extend on those sorts of concepts and learning a lot from them (children) as well and going with them."

Rosemary "I think the vastness of it is almost overwhelming in a way but certainly it has made me think more about the different kinds of sciences that are happening in the different areas whereas previously I might have thought ooh yeah that's balance or something and now I am seeing more varied range of science ideas in the different areas – so that has been really good for me even though I still have this terrible feeling of inadequacy because I am not responding to those as I would like to. But the fact that I have now got, rather than more knowledge it's more of awareness, of what is there and what I could do, given more teachers, more time and less children. (They all laugh) But it certainly also a fantastic thing to be involved in so that when we do get the solid team back again, then you know we can really start to get into some of those things.

- Is there a difference in how you view science learning for children? If so can you give me an example?

Liz "For me I don't think I view it differently it has just become a lot more vast. So I am not necessarily looking for it everywhere but I am aware that it is everywhere. But again it's really intimidating thinking gosh" Tanya "yeah I would have to agree."
Researcher "The potential is everywhere isn't it and then it becomes which bits do I pick-up and which bits do I leave"
Liz "That's it. That's exactly the way it is."
The others all agree

- **2. What aspects of the professional development about science has been useful in your teaching and why? If so can you give me an example?**
Researcher didn't ask question

- Is there anything in the Exploration goal four learning outcomes that you view differently after the professional development within this research project?

Rosemary " There again I think it's just I think I have more of an awareness and so that is a really good starting point because science is not a great strength of mine either and so I feel better about it as a teacher being able to give children more facts and use more scientific language- develop that for myself"
Tanya" I think it's OK not to know, it's OK not to have the answers I think a lot of the time but you can .research it"
Rosemary "Like we said in that first one (interview) it's the joy of discovery"
Liz "doing the same thing again"

Tanya "Even with the dissecting of the nest – I think we were all quite surprised what we found"

Researcher "What you found in the nest"

Tanya "Yeah very surprised"

Rosemary "Lots of plastic"

Tanya "Very surprised about the quantity of that plastic. We were talking yesterday what bird could have made you know Ned's nest– would it have been a sparrow or a hawk – you know we were trying to work out what sort of bird it would have been. Do all birds have nests? And you know do the large birds still have nests and we (meaning teacher and group of children) were trying to picture it and get that image."

Researcher "The Internet makes some of that easier today doesn't it?"

Teachers all agree

Researcher "And the internet makes that easier these days doesn't it?"

All teachers agree umm

- Is there anything in the Exploration Goal three learning outcomes that you view differently after the professional development within this research project?

Researcher "More about the different processes of inquiry"

Rosemary "Hard to say really"

- What science learning do you think has been happening this term?

3. **Researcher "Let's think we are about 6 weeks into the term – what science do you think has been happening, the birds next would be one?"**

Liz "There was a phase for a couple of weeks in the blocks where they were creating and there was lots of thing going on, they were building lots of ramps for the cars (Tanya - speed and balance and all that stuff)– but that was only for a period and for a couple of sessions it was outside. But then they transferred it to you know driving those trucks and tractors outside and there are a lot of that stuff going on. It wasn't really a big part of the term, there was that."

Rosemary "There hasn't been majors really mainly because we haven't picked up on them, but the seed thing. Ben finding that little seed (from the bochoy that the children had planted in the container garden – noticing the seed in the remains of the yellow flower)

Researcher “Ben remembered that today when I showed him the photo and he could talk about it.”
Rosemary” but there again I haven’t followed up on that as much as I would have liked to.”
Rosemary “And Cameron brought bean seeds along and I have got that story to write. He showed them to one or two of the other children and then we went out and chose a place to plant them and talked about what they were going to do when they started growing. His nanny said his father could come and tie them up with string because they are runner beans. Then each day we checked whether the seeds had come up, he watered the ground because the ground was a bit dry, so I have been doing that with Cameron.
Researcher “I think that’s it because in early childhood it’ not just that there are major things that happen within a term but there are other little things that just go on and that science doesn’t have to be prolonged, I don’t think. But that’s the picture I showed Ben and when he talked about it he said “it is the little thing, it wasn’t the flower Barbara it was the little thing”
Liz “yeah that’s right because that what he said at mat time. He was quite particular about showing everyone”
Researcher “and I said the seed and Ben said yes that’s it the seed. He was really excited about it and that was ages ago but he remembered the whole thing and it was about 3 or 4 weeks ago”
Rosemary “So there was him and Cameron”
Tanya “It’s amazing what they retain you know.”
Rosemary “One of the mothers was talking to me about strawberry plants and said ooh you know I’ve got some over and I said fantastic can you bring them tomorrow. She was parent helping the next day. So she brought the strawberry plants and we went down with the children and planted them and looked at the different parts of that (Parts of the plant). So there has been a bit of a continuing thread with that.”
Researcher “What’s exciting is that’s an observation and I guess the article would be saying can Ben now link to the life cycle of the flower well probably not at this stage, that’s where I think the story telling might come in. I’ve been talking about story telling science concepts with the student teachers I am working with at the moment in my science class because I think that’s actually really positive way of

umm giving science information without it being like a cold lesson. We have been making stories about how flower changes into an apple"

Rosemary "Yes, yes"

Liz "that's right that was part of your PD wasn't it."

Researcher " I have been talking to Rosemary about how I have been doing some story telling with student teachers about some the science concepts, because actually think that is a really positive way in conjunction with experiences to giving science information without it being like a cold lesson. We were doing stories about the flower on the apple tree turning into an apple.

Liz "That was part of our PD as well we got to look at the information (flower to fruit - handout)

Rosemary "Tanya and I were talking about that last week and thinking of maybe cutting an apple – we could dissect an apple and cut it through the middle and use the tweezes to get the seeds out and observe the bed that the seeds were sitting in and all that sort of thing."

Researcher "But it is really interesting because my last session Oranga and here today when talking with the participant children – they were all saying that the plants grow and they either have beans or they have flowers but not both. I asked "would bean seeds have flowers and they all answered no – because they are not flower plants. And that is probably because that is the way we talk about it socially. Because you don't talk in science perspectives all the time."

Rosemary "Yes we don't eat the flowers we only eat vegetables."

Researcher "Now I will tell you who was absolutely amazing and that was Isabel. For her a tree was plant, grass is a plant, flowers are plants- it was fascinating."

Liz " A long time ago (earlier this year) I had some pictures and I held them up and discussed where lettuces grow and each plant grows but all they could see in the picture was the green at the top. When I held them up some of them new they were lettuces because you could see them but pumpkins' grow on a vine which I didn't really know so printing them out and showing them to the children was quite interesting as well, cucumbers I didn't really know that was quite good but most of them grow underground they are just the same on top aren't they, the leaves on the top. Some of them are flowers and again they didn't think it was a plant or a vegetable at all. So that was quite good."

Researcher "yes I remember when you did the vegetables"

Researcher summarising science from term three

Movement, stuff again with the blocks and outside. The natural slope of the land lends itself to that."

Rosemary "Yes the vehicles and the speed

Researcher "And then the birds nest and the seeds"

Liz "And of course the dinosaur bones, which have been on and off for weeks and weeks and weeks."

Researcher " And the volcano which was interesting – when I talked to Charlie about that it quickly turned into chocolate –which is that lovely thing in Te Whāriki about the nonsense answers. "

Rosemary "Yeah, that's right."

Show photos and talk about the things I have noticed

Rosie's photo on sliding the blocks down the slide. Rosie is really interested in movement.

Researcher " the other day Rosie took ages and ages – like about 20 minutes sliding the blocks down the slide (foam blocks) and she would get them to the bottom and she would walk all the way back up and slide them down and then slide after them. She told me she wanted to sit on them but she never did."

Rosemary "Some of the children do. Isn't that interesting, maybe it is still in her mid that she might do that – she was so fascinated."

Tanya "So would she send the block down first and then follow it behind."

Researcher "Yes"

Tanya "So maybe she was trying to position herself on the block but it kept going before her."

Researcher "I ask the participant children what they were thinking – as I show them the photo and Rosey said I was thinking I want to ride down on the block. Then I asked her what made the block move? She said 'cause it goes down, down, down. I said do you mean down, down the slope and she said yeah down the slope."

Talked about her fascination with physical movement. Discussed other examples of her fascination with movement. Water and the gutting pushing the boats down, labyrinth.

Liz “She did that kind of thing when rosemary was observing me and she made a little ramp and then she built a train track to join it so the train could go up but it was all about using it. It wasn’t so much about the building the blocks and taping it was all about round. Holding the train at the top and then watching it go down the ramp and around in a circle and back to the little house. But it was all about the process of going round. Soon as you said that (about movement) I thought arrrr that is exactly what she was doing?

Tanya “ And George – Rosey hurt herself the other day and she was in a funny position so we had to lay her down and any how her friends were trying to cheer her up by showing her all those sea creatures and George, he knows his sea creature! He was talking about the Monterey (Rosemary – yes he loves them) and the stingray and how the Monterey is black and white and it doesn’t sting you, he knows the animals .He could name them all and what they do.”

Researcher “When I showed George the photo of the plastic small animals he said ooh goody my favourite toy and his whole face lit up.”

George’s photo with the kaleidoscope

Researcher when I asked George what he was thinking. “George says there were heaps of butterflies, interests – no giraffes though- colourful bunnies, dogs eating bones. I said nay shapes and he said squares and triangles going around in my head.”

Researcher – “then I asked how how it worked and he said, you just turn the thing and use your eye.”

Tanya “We over think things sometimes don’t us. We do. It is the same for children with their paintings they go and draw freely but we wouldn’t just go and draw would we, we would have to think of something to draw.”

Rosemary “Children don’t seem to think about it, it just flows out their fingers.”

Tanya “We over think things. You notice that with the painting, children draw freely but if someone said to us we wouldn’t just draw we would have to think of something to draw.”

Photo Rosie looking at the spider next to a mirror

Researcher “When I asked her what she was thinking about, Rosie said I was thinking about myself but I didn’t know how to draw myself. And then she said, I like the spider. So I said so you know some stuff about spiders. She said yeah because I saw one at Norfolk Island”

Tanya “Ooh she goes there quite a bit to Norfolk Island.”
Researcher “ But that really fascinated me because I was thinking reflection, learning about the anatomy of the spider, she stayed there for ages and played with the small animals and I would never have picked that up from her behaviour (her wanting to draw herself and not knowing how). I don’t think you could have. Interesting because I thought it would be about the insects but it wasn’t it was about drawing myself.”

Researcher “What it is I think, ‘cause if you look at Ben and most of his play has actually been around the office, being a police officer or workman and then all of a sudden in the middle of all that emerged as the only child who noticed the seed, that is what I want to be able to talk about, it is actually the spontaneous teachable moment (Rosemary – that’s right) and you can’t pick up on all of them. If you had not had that garden, the environment as the third teacher is so important because if you had not had that garden that wouldn’t have happened – he wouldn’t have noticed and he so - so – that is the photo meant the most for Ben because I did have other ones of him.”
Discussion about the portfolio and what goes in them in terms of have the children seen the photo before it goes in the portfolio and maybe the parents voice as well.
Researcher “But they (children) are using them (portfolios) here. I love the way the sit on the little couch looking at each other’s and talking about them.”
Rosemary “And when you see children you can sit down nearby and see if they want to look at them with you and quite often they do and sometimes they don’t – they don’t want to share it with you. Their body language shows, they just want to talk about it with their friends or just look at it quietly themselves and then others will bring it to you to share something.”
They all agree
Researcher “I think their interests come out strongly as patterns in their portfolios too, like Rosey with the movement and another girl at one of the other research Kindergartens that has a strong interest in sorting.”

4 Observation reading – what do you glean for the article that would be useful to enhance science learning for young children?
Adding to the earlier discussion

Tanya “Where it was asking those questions, (though I think we do ask the open ended questions. I Like that one, I’ve never asked a child” What were you thinking (Researchers question to participant children). Not like that.”

Researcher “I liked the break down into what, where, how. What is identifying, why is how it all interconnect and how is the function of the things and then I wrote a little note to myself about finding out what this means for the other science disciplines.”

Rosemary “ I think what would be hugely helpful would be for you or someone to simplify this down to an early childhood level, you know with that process made very clear in a simple way for teachers that they could practice using that process and gain confidence in therefore um then be able to undertake deeper science project with children. There is an awful lot in there and it is quite dense and a lot of it is geared toward older children, older age group. That would be so helpful, it would.”

Tanya “It’s almost too dense so you get lost. It would be a really good tool wouldn’t it?” (About developing the simplified tool on science observation skills with young children

All teachers agree.

Researcher” If I did something like that would you mind if I passed it by you and some of the others (Participant teacher)

Rosemary “I would love you to, I would love that. That would be really; really useful to me as someone who is not hugely confident with science. I would love you to. I would love that. I would really feel like I was being useful for science learning instead of “tiddling” around on the surface. That would be the most useful thing to come out of the research”

Tanya and Liz both agree.

Liz “As soon as you broke the what, where and how into those ideas suddenly it made sense.”

Rosemary “That would be fabulous, really useful. For me that would be the best thing that could come out of this research”

Tanya “Because sometimes it hard, If you don’t know the right questions to ask how you can extend, you know.”

5. What and when is it beneficial to use the label science in early childhood education?

Rosemary "When you are talking to parents about the curriculum, you know what sorts of thing that– well what the curriculum is. We talk about science along with all the other curriculum subjects if you like, area they young children are learning. And they can see it and their (parents) eyes light up – ooh it is there."

Tanya "It's all sort of encompassed."

Rosemary "I think it is a good thing to say with young children as well. You use those words like science, mathematics and reading and writing"

Tanya "Yeah that's right, you're just introducing them to their vocabulary really."

Research "Do you think it is useful for teachers to look at curriculum that way?"

Rosemary "It's so interwoven with everything else but personally it is a good thing to understand umm where the science is, even if you're not actually saying the science is here."

Liz "yeah I do, when you are using the word for it like classifying, sorting, so you are not necessarily saying science but it is an awareness"

Research "So it makes it easier at times to identify it, is that what you are saying

Rosemary "Yeah so that really is an answer to one of the questions up here – it has really highlighted umm the fact that oh yes that thing I did here was science, you do so many things and have so many conversations with children without realising that it was science."

All agree.

Tanya "You don't know it but it just sort of happens."

Liz "I was thinking about when you did the vegetable game on the floor and you got them were to sort – and you were doing different textures or something, remember you were showing them all the pictures of the vegetable game we got and you got them to sort them into the – remember you were saying the texture - some were shiny some were soft , suddenly you were sorting and classifying into different vegetables however science related you want to call it. It was quite good to talk about what they know and then taught them. But however you want to sort them, as soon as you start using those words it makes it a bit, you feel like you are going through a process of you know- you know I can't think of the words."

Researcher "Can go deeper?"

Liz “yeah or even classifying or sorting is quite simple to a point depending on what categories you want to put them in.”
Tanya “About different properties I think of the vegetables, what is a vegetable?”
Researcher “I think for me it is that they use the processes. Getting children to use classification and sorting in their own way – what are you seeing and I think to be science and what does that mean?”
Tanya “So is the process of eliminations classified as science?”
Researcher “Null hypothesis. The process of elimination in order to gain knowledge about the physical world – the knowledge that is considered to be science, then yes it would be a process that would be used. The Null hypothesis is that you put up an idea and you test to see if that doesn’t contribute.”
Tanya “Is that like with the birds and they (In the article) put them in the wrong places whereas if they had known the knowledge they would have put them in the right places – you know what I mean”
Researcher “Then you see I would never see that they were in the wrong place. Where ever you put them is fine because then you would say that’s - the conclusion you came to you would put them in a different place to see if you got a better result.”
Tanya “That’s right that is what I was thinking.”
Tanya “I think the processes are really important”
Tanya “You’re drawing on your own knowledge aren’t you”
Tanya “That is why I like the cooking so much, it’s not so much the product but the process – how it changes you know”
Liz “The flour and other ingredients, so much valuable stuff”

Teachers Interview Kina Kindergarten- Second Interview

About the article question five

A "It was talking about science is observation and then children right. It's said that although children are observing in everyday life you know the things that happen to them every day but it is not the same as scientific one (observation) because of – one of the reasons was that the content knowledge is not there – they kind of randomly observe – rather than looking for something specific and then aaah just classifying, you know because what the scientist do is taxonomy and putting them in you know classifying in classification and it was kind of talking about how/why children observation is not scientific. Then it was talking about how you can support children to make more scientific observations by using environment and tools. How the environment, tools and something else can you know. And the content knowledge if you just yeah– but the tools and the environment and something else. I read it quite a while ago. That we can – and I was just thinking about our children and how it can be related to that and I was just thinking specifically about velocity and speed and you know because we noticed that they are experimenting with water (Kara adds pipes) and then we got the balls out and then it (article) was talking about questioning – What, why and how and it said the what question is kind of normally the most important than the why and how. And then when we were experimenting with the balls and was quite actually impressed that when you asked what and why how the children (because I asked them about the balls- which ball do you think is going to go the fastest and why). Do you remember this and then you suggested bringing the golf ball (talking to J about the learning experience)"

J "ummm"

A "Immediately they said the yellow tennis ball is going to go the fastest"

J ""cause it's bigger."

A "Yeah it's bigger. So it (article) was talking about those questions.

Researcher "So you gleaned that bit about the what, why, how type questions?"

A "It was just kind of relevant."

J "Do you find though Azita if you ask them too many questions they aren't interested."

A "Oh yeah, I wouldn't. I find if you experiment too much and I just find that, yeah."

J “I do that I asked too many questions. I did that with the garden and I asked too many questions and they got irritated with me and turned away and when I stopped then they would come back and ask me what I was doing.”

Research “It’s a balance.”

K “It’s the same when you are reading a book isn’t it.”

J “Because they were loving watching - there was dirt on the leaves and they were watering the plants and watching the dirt roll away and then I started asking why the big bits of dirt were getting stuck and they kind of got frustrated and moved away and then when I stopped they came back to it.”

A “And I thing 3 – 4year olds they kind of normally learning more by doing you know and interestingly I was reading another thing by Vivian Gussin Paley reading that was about storytelling and somehow it was talking about science and it was talking about play being children’s first language and storytelling being their second language and how when they go to school they are being robbed of these two languages and how science when it is involved in a form of storytelling it can make so much more difference to children. It was so interesting. It made so much sense and it was actually talking about specific scientific experiment that when it is like a story telling and play it makes sense for children because play is their first language, storytelling is their second language and it makes sense for them rather than making it into you know. Even for age 7, 8, 9 year old. It would kind of make sense if it was in the form of storytelling.”

J “Then they get to school and it all stops and they get taught the number one and the letter A and the colour red”

A “They were talking about a two year old finding a snail, the snail was a big traumatic thing for them because it was slimey. It was a real story that Vivian Gussin Paley tells and then the child just said turns it into a story and it was the brothers name and it was a story she was making so she turned that experience into something different by telling the story.”

Researcher “You know the children seem to always name the snails- mother, father, brother or sister”

A “yeah”

J “They do that with everything don’t they.”

A” yeah with spiders all living”

J “But then we do that, it is sort of misconceptions we pass on – like when I see a child harming an insect or something I say Ooh don’t do that it might be looking for its mother or looking for its baby and if you kill it’s someone’s going to be sad. So I kind of personalise it.”

J “I apologise, I started reading it twice but didn’t have the time and just it’s was. Yeah I didn’t have the time.”

J “It was difficult, it wasn’t enjoyable” they all agreed with that point.

A “ It was quite a hard article to read.”

1. How has the professional development within this research project impacted on your teaching?

J “I’ve kind of, it’s been the incidental moments that have become more evident. Whereas before science to me was an activity I would have done, focus I would have had. (Kara said that is exactly what I would have done agreed with J). And it would have been something special. Science for me has always been something like a wet day type thing – where you would pull something out or take the kids. And do an experiment. Whereas now the kids will come and say something and I will say ooh look at the learning in that. Like on Friday when I was outside we were wiping down some of the equipment the water had puddle in some places and was speckly in others and just getting the kids to look at that whereas before I would have just wiped it down. Just those little everyday routine things I’m more aware of.”

K “I’m more aware that science is everywhere it’s not just in the area and we don’t even have an area now.”

Research “And yet good science is still happening”

All teacher “Yeah”

J “ But not as umm what’s the word not as curriculum based as it would have, like we are seeing it in the scooters and the water play and with the balls rather than setting up a science area with our science activities.” Others agree

Researcher “Do you think there is a place for both?

All “Yes absolutely”

J “We didn’t get rid of the science area because we thought science is everywhere we got rid of it because we wanted to make a new area”

A “And also it is (the science area) a seasonal thing because probably when it is spring – when the butterflies are coming and the gardening probably we will end up having an area because children are bringing things and we may do something and it may happen again”

J “And the culture of this Kindergarten. Like I was thinking about the little closed circuits that we bought of having them in an area how long would that last – less than a session and we would be looking in every bag and every pocket- so that sort of thing needs to be done with a teacher, yeah.”

J “You know doing the watering in the garden the other week – watching them experiment with the dirt and everything – trying to get them to taste the leaves (lettuce) and they didn’t want to eat it from the garden – it was almost wrong. I think it was John-boy and he just wouldn’t eat it and I had to roll it up the lettuce and eat it to show them this is lettuce the same as the one that you get from the supermarket, but this is how it growes but just those little things they just unfolded a lot more naturally than they would have in the past. I visited four Kindergartens a couple of weeks ago and all four of them (Franklin) they were quite middle class Kindys and they all had science areas and my immediate reaction was ooh aren’t they lovely and by the fourth Kindy I was like aren’t they lovely because they are not being touched because no one is interested and they had their little baskets of differnet things and artefacts and not one child went to any of them in the four Kindergartens and that is why they were so perfectly contained because it held no interest for the children. It was like a little adult area tucked away in the corner. So I kind of feel better we didn’t have one because we would only be doing it in a sense for lip service really”

Researcher “So anything particular from those two sessions we had that you found useful?

K “The discussion about Newton’s laws” All agreed

A “Talking about force”

K “I went home and talked to my husband engineer about it”

J “I just keep rereading it because it is stuck up on my wall, I read it every once and a while. I still don’t get the wall part.”

K “Ooh that what we were saying.”

Researcher “It’s just a way of describing what is actually happens.”

J “But a course pushing a wall it is not going to push back”

K “But it does”

Researcher “But it’s just describes that - what is happening because if it wasn’t strong and it is the strength that pushes back when you push it would fall over and that is all it is trying to say.”

All “ohh OK”

A “That means if it wasn’t a piece of wall but a piece of cardboard it would fall over –yeah.”

Researcher “Yes because it’s not pushing back as hard.”

Researcher “ It is a formulaic way of saying what is happening naturally”

J “From that PD the one thing that sticks in my mind is when we building – we had to make stuff. When I first started doing it I thought –what can I make that is “science” based that’s got an answer rather than whatever we did, out of the nine of us, whatever we “tutued” (Māori work for play around- try different things) around with everything had something. We all started thinking what we are going to do, what are we going to do is it going to be good enough. What are they doing? But everyone was doing it. But also just that belief that um science is more complex than the basics for what it really is”

K “Those laws at the moment were very appropriate because the children are really into everything that moves, they want to give it a go. From that concrete path there to the balls to the water.”

A “The hula hoops rolling down the hill”

J “That linked to the schemas of play when it is so repetitive.”

K “Then when it was windy you did the streamers and I got out the plastic bags.”

Then the researcher and the three teachers had a brief discussion about the digital micriscope. They would like to consider getting the one that magnifier attaches straight to the TV and asked the researcher for the contact details.

A “The one that for me was the bendy one (magnifier) – that’s the one we liked”

Researcher “the firm would make them up for you – I’ll get the number for you – It’s not a digital miscricope.”

2. Is there anything in the Exploration goal four learning outcomes that you view differently after the professional development within this research project?

J "Probably just more of a focus on listening more to the children's thoughts and how they work things out and their misconceptions that can be quite humorous but at the same time you know there is a bit of accuracy in them."

K "And them describing changes that they see like the growth of the garden."

J "But what's important to them as well."

K "Yeah" All agree

Researcher "What they (children) are noticing?"

All "Yeah"

J "Like the share pleasure of bubbles- just the share pleasure of bubbles being made, floating, popping. And just letting the children enjoy that aspect of it."

A "I was talking to Sandie (relief teacher) the other day – a group of children were playing in the water area and sandpit and they were doing amazing things and I went there and I just realised I better move myself away. I was there for two minutes. Because I just noticed that if sometimes an adult is there they would stop doing what they were doing and it would change the whole dynamic of what they were doing. But as soon as I went there one of them came and started coming and telling on the other one. They were doing so much with the water and you know."

J "And they kind of revert from being leaders in their play to wanting to make us cakes or do stuff for us to please us"

K "yeah" all agree

A "What they were doing was so amazing just running the water looking at lots of things but I thought I better move because otherwise - yeah -it would stop them."

3. Is there anything in the Exploration Goal three learning outcomes that you view differently after the professional development within this research project?

J "And taking what they know – sometimes it hard with children to teach them more or inform them on a science based level because they believe only what you know and if it is too obscure they just don't believe you ,they think you are mucking about with them or yourjoking or they just can't comprehend why it would be like that."

Researcher “It is like a two year old if you beat cream until it turns to butter they say how did you do that and think it is a trick but by four years of age they realise a substance can change – they know that what can happen.”
K “What about popcorn they didn’t realise that popcorn came from a cob.”
A “Cause we were talking that.”
K “But when we put it in the pot they know it is the heat that is making it pop.”
J “And when we went down to the shop the other day with them, would have been Friday, one of the kids that I took hadn’t been for ages and he said “I remember this when we went down to buy popcorn stones”, that was ages ago – that was winter - when they went to get the popcorn.”
K “Yeah it was in the winter”
A “I even bought the corncob in. It feels different this one is hard this one is soft”
K “Yeah you did”
J “Making comparisons with these children is quite difficult. I think language might have something to do with it but the whole concept (of comparison) seems quite foreign to them. You know getting something that is the same shape but a different colour or made of the same material but a different thing and asking them what something about it that is the same, what’s something different.
K They probably like more visual stuff like if you had something for reference”
J “Although all we were looking at was the colour and the size and nothing else.”
A “There was something else in that article that I found interesting (science observation article) – working with different communities and different children. It was talking about different cultures that in some cultures the children are expected to learn by practicing a culture. The parents and adults don’t explain you know verbally to children that when you know blab la bla – it is expected that you go and through participation and practice and whatever you learn and that’s it. Not a lot of talking. And with middle class white European the adults talk a lot before hand or just they talk a lot during with children so it is expected from the children to learn one concept at a time whereas with other cultures it id through participation and lots of mixed concepts at the same time rather than learning through talking about it. I found that very interesting. It is because of that lack probably of talking (children at Kina Kindergarten) they may have it somewhere but not be able to explain.”
J “They’re are exploring with all their senses”

Authenticity of seeing what is happening rather than trying to take it to a level that I think is science extension

J "It is also getting my head around that the children we teach here, it's a different level than probably what I am used to in my past teaching career and that coupled with my view you know I thought that science needs to be more of a curriculum based activity-it's kind of just stepping back and seeing that what they are doing is science, It's just base level."

Researcher "So for you it is about the experiences you provide"

J "Or just the authenticity of seeing what is happening respecting that rather than trying to take it too fat or to a level that I think is science or extension, yeah. Being authentic for these children in this culture, yeah."

4. What science learning do you think has been happening this term?

K **"**Probably the transformers – that's where awareness of two and three dimensional objects are coming together for movement."

J "That's the maths and the science coming together."

A "And technology yeah."

Researcher "but the movement aspect you are certainly seeing as part of the science."

All agree

J "And their explanations of it, because I've come back at the end of the transformer interest."

A "It's still going."

J "It's not the beginning of the interest their way into it and now their language is developed as well to describe what the parts are and what happening."

K "Carpentry for a while – like how things work, how tools and things

A "That is technology "

A "Speed and velocity that started from last term actually – beginning of last term and still going in different ways."

K " Did you do volcanoes as well"

J & A "Yeah"

A "That was happening for a few days because Luke was interested – he wanted to do volcanoes every day."

A "velocity which is happening everywhere in different forms"

K "Volcanoes"

A "Lots of sandpit play with water and sand and bubbles"

J "I've got a great bubble mixture where you put it away for three days it's got sugar in it. You put it away for three days and it makes it strong"

A "Fairy Claire she using a little bit of washing powder to in her bubble mixture and then glycerine and leave it and then she makes those huge bubbles.

Researcher "and the garden I guess would be the other thing"

All agree

J "And the whole baby growth thing because when I first came back they said – you got a baby in your tummy? – "No" – so now they expect we are all going to I think because they see it so often and Kara is and they see that link between home and here. Of the new babies that have been born some of them have been in here a bit was has been very nice."

All agree

Researcher "Yes because you started as them as babies at the end of last term beginning of this wasn't it?"

K " Oh we did too."

All agreed

K "We did sort of a measurement thing with that"

K "Did we do much cooking this term, I can't remember?"

A " ooh we were talking about –it was just an incident – they were talking about taste buds and they were talking about sweet and sour and then they were talking about smelling. The grapefruit. Because they were talking about taste and then"

Researcher "That's when you were making the potatoes pancakes."

They all agree

A "- but anyhow they were talking about sour lollies And they were talking about sour lollies and how they liked sour things and Jackie said oh they got grapefruit in the next door garden and you got some and I put out the lemon squeezer and they were using it and trying it."

K "wow – did they like it?

A "They liked it!"

A "And they were explaining about the taste you know sour and sweet – it was a conversation."

5. What and when is it beneficial to use the label Science?

J “I think it is in your everyday language. I think that is sort of what we said we have come away from the specifics of into what Kara was saying as seeing it everywhere.”

A “What does the question mean?”

Researcher “When do you need to call something science and why? We label some things as literacy and math so for what purpose”

J “Isn’t it normally an academic purpose between the staff. It’s an academic purpose between the team. Sometimes for the parents - you know sometimes when the parents say have you done anything today; oh you just play outside. That is when we can say well actually yes he focused on his interest in science at the moment, the velocity and movement. Sometimes you can maybe do that. It is almost like name dropping for parents.”

A “ It might – it’s just an idea - when you look at Te Whāriki with the input of it– with the continuity with the School curriculum perhaps. When you think of that continuity perhaps what happening here is kind of related that you know that continuity between two settings. Putting it on I suppose because when you look at science that continuum it doesn’t start at school, they don’t go blank its already there with science, so that’s yeah I suppose in a way

Researcher “Transition of the essential learning areas.”

A “Yeah”

J “Student Teachers – with students when you’re breaking it (curriculum) down for them”

10.2.3 First and Second Interview with each child

This will be instigated by using photos, children's individual portfolios and/or a discussion with the researcher about each child's participation in experiences in the Kindergarten. The experiences for each child will relate to possible science learning identified by the researcher and the Kindergarten teachers. The questions below are indicative and further probing question maybe asked. For each of the photos or portfolio contribution the child will be asked the following to questions;

1. Can you tell me what is happening here?

2. What are you thinking about when you were doing this?

Note: children in the Kindergarten setting are used to talking to adults about their portfolios and photos of their participation in the Kindergarten learning experiences.

10.2.4 Interview with individual parent/guardian

This interview is to see if any of the links to science learning are related to what each child is actively involved in at home.

1. Tell me about what XX likes doing at home?

2. Are there any experiences that XX is involved in the community?

3. What do you see as the main things XX is interested in at present?

4. Does XX talk about what he/she does at Kindergarten?

5. What kinds of things has he/she shared lately about Kindergarten?

6. Do you think he/she is learning anything related to science, if so what?

Pohutukawa Kindergarten First Parent Interviews

Interview One: Helen's Mother

Interview too place at their current home

Present at the time of interview was Isabel, visiting friend and her younger sister.

At times the nanny (Michelle) took part in answering the interview questions.

1. What does Helen like doing at home?

She loves having mummy and daddy time and Michelle time (Nanny during the week). Likes us reading a book or drawing pictures, really getting into drawing pictures.

Going through creative phase drawing pictures of the family. Draws her house with mummy, daddy, sisters and Michelle. Also writes a few letters – trying to label us all. Really enjoying drawing this is what she does with most of her free time.

Playing with their toys particularly when she has friends around.

They always go outside for part of the day – run around, ride on toys, hide and seek with us. Race track down the side of the house. Riding her bike fast down the track.

TV in the afternoon Likes the Nickelodeon channel 41 : Sponge Bob, I Carlie and Life with Dere6k and a new Geny programme, Dora. Watches DVD's occasionally Winnie the Pooh , tiger movie and animated movies for older children like Shrek movies, Monster Ink

Sometimes more TV in the weekend.

Morning drawing and things and Michelle takes them out to park, library, bus rides, walks, museum usually more so in the holidays than the term time.

2. Are there any experiences Helen is involved in, in the community?

Outings with the Nanny. Local library.

3. What do you see as the main things Helen is interested in at present? I

Drawing and being read to. Interest developed in the last six months

Loves anything pink anything to do with fairies.

Loves play-dates, playing with friends especially her cousin.

Imagination play at Kindergarten. Starting to show more of an interest in building blocks

4. Does Helen talk about what she does at Kindergarten?

Talked about doing a project with leaves.

5. Do you think Helen is learning anything about science?

Leaves project, earthquakes – natural phenomenon and earthquake safety

Interested picking flowers, watching insects but no sure this has been picked up on at the Kindergarten.

Coloured ice. Tub with coloured water. Made us make coloured Ice at home. Different colours – directly stemmed from Kindy.

Interview Two Helen's Mum

Barbara is the researcher

Tape starts with Susan talking about how Isabel likes cooking

" She sort of does quite like to get her fingers into the cooking mixture and squish it around in the bowl, obviously likes to lick the bowl and the spoon at the end of the process but she seems quite interested in the actual cooking side of thing – whether that extrapolates to science I don't know. It's sort of mixing different ingredients"

Barbara "The beginning of the substance stuff. For me it depends what they are noticing, so sometimes it does and sometimes it doesn't. They have been doing a lot of baking at Kindergarten."

Susan "It seems like they have, I don't know where it has stemmed from but it 's probably really only been in the last um three months that she has really got into it. And nearly every weekend - can I help you in the kitchen, or you know when we let her because it obviously gets quite wet and messy – every now and again she stands up on her little stool at the sink and um does her mixing of her own you know water and ingredients and makes a pie, a drink or smoothie or whatever it is she is concocting. It is usually some hideous combination of things, but you know we encourage her and she enjoys it."

Talk about the photo of Isabel in the family area and Isabel at the desk next to the keyboard outside.

Barbara "She does spend a lot of time in the family area but she does a whole variety of thing in there. Literacy, she spends a lot of time writing and pretending to be in the office outside."

Susan " Oh does she because I don't see any of that when I drop her off she goes straight to the dolly area and um I guess she is trying to get me interested in what is going on so she um yeah and we go and play in the area where the princesses and the castle is. She spends a lot of time painting and when I am there as well and sticking bits and pieces on a piece of paper for us to bring home. That is the sort of things I see but I am surprised to hear she is into the office , I mean because we spend a lot of time on the computer, Mark and I spend a lot of time doing computer stuff because that is part of our careers I guess."

Barbara "She does this for a bit (typing) and then she picks up the phone and she holds a baby."

Talk about the photo of Isabel on the swings

Barbara "The other thing I've noticed is she spends quite a bit of time on is the swings."

Susan "Ok, she asked me to put her on the swing today and have a swing which I did. She wasn't so keen on that one today." (rope with a knot on the end)
Barbara "I have shown Isabel this picture and asked what makes the swing move and she knew it was herself. And she talked about how she makes it move"
Susan "We talk about, we hang out in playgrounds a lot, so we do educate her into doing her own pushing and so we have talked about how you make the swing move so maybe that is part of how she has learnt from that, how you make the swing move."
Barbara "Does she talk much about the garden. You know the big wooden boxes they have planted in at Kindergarten."
Susan "Yeah occasionally she has mentioned it but it has not been a big focus. We did do some little sweet pea planting that she remembers it growing, you know from putting in the seed and hit almost grows before your eyes. She talks about that more than she does about the other."
Barbara "It is interesting because it is quite advanced in what she knows about what a plant is. Because she knows that a tree a plant and grass are plants and umm. Research has been done that show that children often think small plants are plants because that is the social language we use but that trees are trees (not plants) and grass is grass it's not a plant. So she has actually connected all those threads. Isabel know the plants needed both sun and water."

Susan "Oh OK we haven't educated her about that , she must have picked that up from somewhere
Barbara "Either at the Kindergarten or discussions she has had with other adults she began to build that understanding, she picks things up very quickly though, she does."
Susan "I haven't knowingly talked about it , my husband's probably is a lot better at discussing things like that with her and maybe he has done that. Michelle (nanny) was always excellent at that, they would go for walks up the road to Kindy or wherever and they would spend, you know and on their walk they would talk about the different flowers and maybe sneakily collect a few as they wondered along. She (Michelle) has been very good at keeping them stimulated and involved in the environment. I am sure at Kindergarten obviously do by

having that exercise (gardens) and doing that water play , the colour in the water and bits of ice. I think they had some ice out today didn't they."

Barbara " Yes they did , the boy that did it in term one looked at his portfolio and went to Tanya and said can we please do that again and then all the others children joined in. So they have been doing it all week freezing whatever they liked in the ice."

Susan "Was Helen interested in it at all?"

Barbara "Didn't see her showing interest today, but she may have been on the other days, but I didn't see her there today."

Susan "Oh, OK because she has been really interested in us freezing our ice cubes and putting different colours in the ice cubes and mixing the colours and making other colours. We have got out freezer with a couple of ice cube trays full of Isabel's colourful ice blocks. Just from the food colouring we've got. I think that's come from that Kindy exercise because you know once again we hadn't directed her towards it but she asked to freeze it. She asked to put some water in the ice trays and then she wanted us to put it in all the different colours and mix this colour with that colour and then you know then put it in the freezer to freeze up and then she gets it out and looks at it every now and again. And so I think that has come probably from that earlier exercise, it's been a wee while that we have had those ice blocks going on. And they did a bit of that at her other play centre (previous centre) as well with different colours and colourful glass cubes and she was quite interested in that back then. And she is really into her drawing and doing you know working out all the different colours with her paints, what different colours come with the mixing."

Barbara "And they have been doing that this week at Kindergarten"

Susan "Have they, at Kindy?

Researcher "What the teachers have been doing is giving them a mixing brush so that they don't mix the colours."

Susan "Oh and they have a separate brush for the mixing."

Barbara "They're mixing colours together, quite a few of them were doing that."

Barbara "About a month ago they dissected a birds next, has she talked about that? "

Susan "No not to me, she may have mentioned it to Mark or Michelle actually is the most likely person to be honest"

Susan “One other thing she has done a little bit recently, we bought her a little bug catcher and she has been interested in looking bugs down the bug catcher. Well there are a couple of little plastic bugs that she plays with. We had a live bug I think it was a cricket or something that we didn’t actually get into the bug catcher but umm she was quite interested to see what it was. I put it outside and she was keen to see where it was going and how many legs it had and all that sort of thing. And we had a cockroach, that wasn’t so nice, but she was fascinated by that, but I wasn’t so fascinated with that. I don’t think that got put in the garden actually I think that got put somewhere else.

Barbara “Well they do that at Kindergarten through the...”

Susan “ooh do they have a bug catcher there do they?”

Barbara “They do but I haven’t seen it used for awhile and it is not out at the moment but they do sometimes have... Phone rings and Susan answers it.

As she is talking with Mark he contributes that Isabel has been showing an interest in how the computer works as she has been watching Mark rebuild/ make alterations to their home computer

Begin again talking about the plastic bugs at Kindergarten.

Photo *of some of the children at a table with plastic small animals including insect and spiders with a mirror in front of them.*

Susan “Not that we have any plastic bugs but using little plastic things and drawing around them, so maybe that what she’s doing, where it has come from.”

Barbara “Because some of the children were drawing around the bugs and others were looking, so they could see the front and the back at the same time and talking about the bits, the anatomy.” (Holding the small animals up to the mirror).

Susan “Yeah I wonder if that is where she has got the idea to draw around the plastic things that we have. But as I was saying we don’t have any obvious bugs, we’ve got some monster things that she traces around, dear I say it the Mc Donald monsters that you get with the meals, not that I ever take her to Mc Donald’s but the nannies have taken them occasionally, those Mc Donald snacks when they go and play with their friend at the playground every now and then. It’s easy entertainment. So that is what she tends to draw.”

Barbara “And beside is a bug chart so they can see it and talk more thoroughly about what they are. The different ones they find.”

Susan “Does she seem to be interested in all of that side of thing.”

Barbara "A little bit, she spends a bit of time but not a lot of time, she flits in and out of it. It just depends. She is very chummy with two or three girls at the moment and they just play their games together and it's just whatever they are doing as a group that happens at the moment. But she has come and sat and looked and then moved away again. She can talk about all of this."

Susan "I was watching her this morning and there was a couple of little clusters of children that were doing their little activities and they all seemed to be very intent at discussing – particularly the Ice one. I was trying to get Isabel to go saying come and look at the ice but it was obviously not her group of friends things. "

Barbara "She was waiting for her friends."

Susan "Yeah her own cluster of friends G and Z and S, she didn't seem to be wanting to incorporate herself into any of the other groups. That made me a little bit sad but I guess that is what little kids do. I was thinking can't you be genuinely friendly with everyone, rather than have to be with specific children. Then when G turned up her face lit up and she was off. And it was sort of oh I remember what that was like you know when you are little. Being so into one or two little friends and not being able to see past the fact that there are other interesting people all around and interesting things to do and you didn't have to be with certain individuals to have a good time or be interested in what was going on around you. But I guess that's what four/five year olds are like. But I am assuming she is absorbing some of these things."

Barbara "We only see snippets of what she does as I am only there once a week but she definitely moves around the Kindergarten and looks particularly at a whole range of thing over a morning but she always starts like you say in that family area and at some point in the morning she always spends a reasonably amount of time either drawing pictures or painting pictures. Lots of butterflies and lots of houses."

Susan "We see a lot of that come home which is nice."

Barbara "She does quite a bit of writing."

Susan "She call it her work."

Barbara "Yes she does call it her work."

Susan "Yes she says you go to work and I go to Kindergarten work. It's her work to her."

Photo of science area – metal shelves near the reading books

Barbara "This is the sort of specific science equipment that is out all the time and Isabel doesn't tend to play with the containers that have liquid that moves from one end to the other when tipped. She does use the magnifying glass."
Susan "Yes she does, she was using the magnifying glass this morning actually. Was it this morning or another morning she was peering through it."
Barbara "I think it is wonderful. It has almost become like umm it's just part of the setting that whenever they find something that they want to look at they just come in and get a magnifier, they look at it , talk about it and they bring them back all by themselves and put them away."
Susan "Put them back in the tray."
Barbara "And what they are doing is they are looking at things. Tanya said they found a ladybird the other day and they didn't want to bring it inside they just wanted to look at it in its habitat."
Susan "And they came and got the magnifying glass and had a look at it closely. That's quite clever isn't it?"
Barbara "Yeah, it is quite clever. So she talks about how she looks at things and how the magnifier makes things bigger and I tried to ask what she had looked at with it but she just kept talking about how it made things bigger. So I think she had had enough by then and wanted to do other things think. It was a sort of op shopping place and they had a lava lamp and she was quite fascinated watching the bubbles. Umm so I guess that is a little bit similar to the concept with the liquid container. So that kind of attracted her attention."
Barbara "Is there anything else she is doing at home at the moment?"
Susan" Not really I guess those are main things, mixing ingredients the occasional assessment of certain insects and ongoing drawing. That is probably the main thing she tends to do. She gets a lot of that stuff at Kindy."

Interview one Jane's Mum Interview took place at Jane's home. Mum and researcher at the kitchen table – children were playing in the next room.

1. What does Jane like doing at home?

If she is with her sisters (big part of her current play time) lots of role playing and pretend games– she is the dog and they have a leash. At the moment a lot of writing and drawing. She gets the Tintin book and copies words she likes the look of them or the picture so we draw them. She loves her scooter and just learnt to ride a bike – one week ago.

Loves dancing – often have music on so she will dance around– quite physical in that way. We scoot up the road and to the park, walks up the road.

Computer and TV.

Sometimes a little cooking with me – more helping cooking dinner rather than baking.

Into playing with friends at the moment– enjoys having her friends over.

TV – Word world, number jacks, imagination movers on Play House Disney

Attenborough Earth series – sometimes watches part of that. Finds some parts

Computer Club penguin – game –ice breaker, likes solving the problems

2. Are there any experiences Jane is involved in, in the community?

"Music together" - American programme lots of pop music folk tunes lead into Violin. Watches older sister's violin lesson.

3. What do you see as the main things Jane is interested in at present?

Writing – as was mentioned before, loves expressive language

Father reads Tintin every night

Lots and lots of drawing and writing. Patterns like rows of hearts and rows of flowers and that sort of thing

Princess and ferries. Uses the toys for imaginary play no particular theme, the toy could be used to represent different things. All about role playing.

Transporting phase but coming to an end – collecting and gathering putting things in baskets

4. Does Jane talk about what she does at Kindergarten?

Say who she has played with rather than actual experiences.

5. Do you think Jane is learning anything about science?

At home with dad gardens, vegetable garden - plant cycle and some cooking stuff.

She enjoyed the wire things at Kindergarten. Electric circuits

There is always water play and sand.

Did she go to the butterfly farm? Yes really enjoyed the walk rather than the butterfly house.

Lotta likes doing a variety of things. Dramatic play around friendships is a major occupation of her time.

Interview One Harry's Mum

1. What does Harry like doing at home?

Just moved on from being obsessed with jigsaw puzzles. Loved them and was good at them

Now Loves building with his blocks

Likes his little key board- makes up his own songs and sings them to us. "We will be out somewhere and he will say Mummy I feel a rugby song coming on" He loves singing.

Number one favourite thing in life is to watch TV, Channel 45 "Play house Disney" bow on the go, wiggley....Loves "Ben Ten" (on channel 2) – has the cards – first collect he's had – trying to work out which is the toughest etc.

Does a lot of classifying who is the biggest, who's the strongest, who's first

2. Are there any experiences Harry is involved in, in the community?

Swimming

Main experience that has been a huge success is T-Ball. Brilliant. Everyone plays – everyone hits the ball, and has a turn at fielding. Real sense of a team

Also attends crèche two afternoons. Gone to Ponsy Kids since he was 2.

3. What do you see as the main things Harry is interested in at present?

Playing- he just keeps busy. George says "I never stop"

He loves playing with his sister (older) – run around, dress up

4. Does Harry talk about what she does at Kindergarten?

Not that much

Talks about playing with Nate

5. Do you think Harry is learning anything about science?

Yep- he was showing me a praying mantis – that was at Ponsy Kids

Colour the water- froze leaves in colour water. We took that through and did it at home and then took it in to Kindergarten and showed it to everyone.

<u>Interview Two Harry's's Mum- Kirsty</u>

1. What is Harry doing at home? He is spending much more time outside. He is very ball focused at the moment. He is spending most of his time shooting hoops. He's very good at it, practices a lot – we've moved the hoop down because he is so short. He is also kicking the ball around outside. He has been doing a lot of spying. I will be at the kitchen bench and suddenly this little face will pop up on the other side of the window. He will say "I've been spying on you mummy" Otherwise just the usual.

He is really into numbers at the moment – he's been doing his older sister's maths with her every day – he does the year two maths homework with her. He doesn't write it he just does it in his head. So it's just addition and subtraction. We've been playing a lot of Yatee , he loves that and so I am making them add them up. So the other day he shook a 6 on one dice and 5 on the other dice and he looked me in the eye and said "What's one less than twelve?"

He doesn't do any writing or much drawing and if he does do drawing it always machines.

He's got this thing at home and it's got the letters of the alphabet on it – sort of like a mini computer. It's got a thing on it where you can put in three letter words and if you spell a word it says that word and says "well done"" – so he 's playing with that a bit. And whenever I am reading a story he looks and when he sees a three letter word he immediately gets the thing (minicomputer) and puts the three letter in so he can hear what it sounds like, but again not writing any.

He'd just really happy – talks about all his friends

Looking at the photos

Talk about sonia and Harry on the little couch reading their portfolios.

Then show Liz reading a book about Amazon animals. Shared what Harry has said about the photo. Ooh really – he doesn't tend to show this interest at home.

Show the photo of liquid flowing in containers. Kirsty mentions that Harry loves this kind of thing and also the tracks you run marbles down. We confirm it is more the movement of these things that he is fascinated in. Doesn't have similar things at home but loves to play with them when he is out – Kirsty has other toys at home and sees that having different toys at home and out means the novelty of some toys is retained. Toys at home – he's got plain blocks and he makes ships and things like that and the kids are more into playing games now like junior monopoly, the cat and the hat.

Does he talk much about what he does at Kindergarten? Kirsty shakes her head.

Photo of Harry with the magnets. He talked about how they were sticky.

Photo rolling the balls big cylinder. Talked about Harry's interest.

Photo Harry and his friends making a home of the Meer cats. Kirsty thought their play was fantastic

Sandpit play – making the waterfall He has been coming home with sand in his shoes. It is only the last few weeks he has been playing in the sandpit. Kirsty confirmed this.

He loves doing things with insects. "That is interesting as he is scared of live insects, really doesn't like them at all." Confirmed that he is OK looking at the plastic insects and small animals but didn't like the real thing in his own bedroom in particular – he doesn't like spiders or flies or anything like that in his room. He really, really doesn't like them.

Science equipment photo Harry using magnifiers

Talked about the birds next Harry didn't talk about this at home

Talked about making ice Harry did talk about that and they did make some ice at home earlier in the year. He tells his Mum "The steps go like this, you put the water in the container, choose some flowers or leave and food colouring and put them in and you put it in the freezer and it makes ice.

Interview One Sonia's Mum

1. What does Sonia like doing at home?

Follows her older brother around. This has influenced what she plays with – she loves construction toys, loves lego.

Spends a lot time on the trampoline. Not really a dolls type of kid. Has dolls but doesn't play with them often.

Neighbours next door same age children so they play together a lot and are in and out of each other's homes.

Interested in Cooking – asks if we can bake stuff. The other day she wanted to make leaf soup so she went outside and she cut lots of leave painstakingly of the hedge outside with the nail scissors and came in and made leaf soup – adding all sorts of stuff to.

TV – cartoons

Likes drawing

Likes little things, she has got some small beads that she likes making designs with- anything small

Dolls house with animals in them, farm yard animals – spend a lot of time with small objects

Making books with paper stabled together – quite creative.

Just started taking an interest in music , dancing, Electric piano – just discovered that

Reading

Computer online little games like Dora the explora, my little pony

2. Are there any experiences Sonia is involved in, in the community?

Swimming lessons

Visiting friends

Learnt how to ski last winter

New to Auckland so doing excursions most weekends, to beach, natural parks, Manuakau Heads

3. What do you see as the main things Sonia is interested in at present?

More generalists – interested in a range of things as discussed above

4. Does Sonia talk about what she does at Kindergarten?

About the people she plays with.

When she was away last week she was dying to get back to "her people"

Butterfly farm – talked about the life cycle of the butterfly at home. Oscar and Sonia talking about the life cycle of the butterfly. Bus ride was fascinating- bendy bus, talked about who she went with. Mum bought swan plant seeds and they looked and talked about the seed pods and talked in the life cycle of the butterfly. Told mum about the ice making and asked if she could do this at home.

5. Do you think Sonia is learning anything about science?

Went and collected hail stones the other day, talked about how it was made.

Sonia's interested in the weather.

Picking up on science ideas from outside play .

Cooking melting and mixing – not consciously do science but see it is part of the everyday experiences

Science happening in the incidentals.

Has the Magic School Bus books – loves them

Interview Two Sonia's

Mum " So how did you get on with Sonia ?"

Barbara "What I love about Sonia is she goes to all sorts of places in the Kindergarten and she makes the most of everything. Like the carpentry table (Show a photo of Sonia working at the carpentry table, sawing a piece of wood). That is a recent photo. Did she talk about doing this at all?"

Mum " That is interesting No but we have a building site up the road, on our street and the other day my son and I we went and got a whole lot of scrap stuff from the building site and the kids started doing a whole bunch of hammering and building stuff with all these off cuts. So I wonder if that was before or after that (Meaning the photo of Sonia at the carpentry table)

Barbara "That was last week."

Mum "Yeah it would have been, that's funny isn't it." (Inference made to the timing of carpentry work at Kindergarten with the building with scrap wood at home.)

Barbara " You see that's what I was hoping to draw out of the discussions with the parents is what are some of the connections that in a busy life you don't get to see that are there.. That is obviously what's brought that about."

Mum "Yeah we certainly don't have saws and stuff at home but as I say with all these off cuts from the building site we have been building. Of course Oscar has been building guns, weapons but you know they have been building towers and all sorts of stuff. I wonder if that is a direct correlation."

Barbara "Before she did the sawing she was doing hammering. I wouldn't be surprised if the experience at home drew her to the carpentry area. I need to talk to her about that today"

Barbara "Sonia does a whole lot of stuff with movement. We kind of talked about this before. Oh yes the boats and the water and the other day she kept sliding thing down the slide "

I show the photo

Barbara “When I asked her about the picture she said she was really hoping to be able to sit on the foam block.”
Mum “she has got no fear either.”
Barbara “No she hasn’t, she has a go.”
Mum “At home she runs and jumps and dives and does all sorts of scary thing. I am surprised she is still in one piece actually.”
Barbara “They have done the research that shows that children that play outside like this and do a lot of stuff actually their maths skills develop well. “
Show the photo Sonia and Harry reading their portfolio
Mum “They are such good friends.”
Talked about giving photos to Mum - email seemed best. Talked about Sonia and Harry’s relationships
Then Barbara showed the picture of Sonia on the swing.
Barbara “She still likes to spend time on the swing.”
Mum “She still can’t get up on it on her own though. She still makes me put her up there.”
Barbara “I’ve never seen her hop up but found her on the swing.”
Mum “she has always loved swings.”
Barbara “Yeah the movement.”
Mum “the movement thing again.”
Show the photo of Sonia and Harry playing. Sonia is using the pulley to get a lift from one level to another
Barbara “ The other thing that they have been doing is using the pulley on this – on the garage in the block corner but Harry and Sonia use it with the dinosaurs and the other animal . Soniawas winding the handle watching how the pulley moved the lift from one level to the next. Looking at how it worked.
Mum “Looking at the mechanics of it.”
Mum “ we have got some old wooden block things at home that used to be my husband’s actually and they have lots of bits of dowel and wholes where you can join things together and there is a little pulley thing on there that you can make cranes and things with. I must get them out. You know how some toys get recycled. Maybe I should get those out and get the pulley working and see if she can figure it.”
Show the photo of liquid blocks

Barbara “ When I talked to Sonia about it, she talked about it going down, down, down, and then you turn them over and it can go down, down, down again. But it is because she doesn’t have the language to explain it further at the moment but she is fascinated and spent ages. Harry was into building a tower with the containers but Rosie was fascinated with the movement of the liquid from one end to the other.”

Barbara “ It has been interesting how Harry, and Mike have both gone back and played with then containers after being shown the picture in the participant children’s interviews. I thought the equipment was a bit gimmicky in the corner but have realised the children have a real interest. The concept for me is around viscosity but you can have some lovely conversations that you can have with children around that concept.”

Mum “We have a couple of these actually that we got from a nature place in Wellington when I was down there. In this particular one the stuff drips down and then goes through a wheel – beads of liquid go through the wheel and we have talked about how the weight of that is making the wheel turn around and then they are cool thing. And when I bought it Sonia was fascinated by it

Interview with Paul’s Mum Interview one and two combined

Can you tell me about what Paul is doing at home at the moment?

Lately in the last couple of weeks he enjoys the computer. I didn’t want to get him onto the computer but it was more games. It seems to like trying the chess game and things like that. He doesn’t know the rules but he seems to give it a try at moving everything. So it is quite interesting what he likes at the moment and just general games on there (computer). He watches a little bit of TV or plays cards with me. We read books. My home has not got an outside area so I have to take him out quite a lot whether it be parks or beaches or whatever. So when he is home he doesn’t have a lot of choice. He plays with his Lego and his toys. He can spend hours on his own which is quite neat and totally entertains himself. He has had to do it so basically being an only child and me being a single Mum.”

What are his favourite books at the moment? Oh actually it is funny how he picks up the same sort of books all the time and they would be books like Busy Places – that is one of his favourites and he will go over and over it.

Barbara “It is so linked to what he does at the Kindergarten.”

Mum “Is that right because he doesn’t necessarily pick up a story book he’ll pick up a book that he finds interesting. The other thing is he will pick up a book like Jack and the Bean Stalk and he will read me the whole story turning the pages, even though he doesn’t know how to read, he knows the story so well he actually goes page by page and tells me the story, so it is quite funny.”

Mum “I’ve been told at Ponsy Kids next door (to the Kindergarten) he reads to the kids, similar thing he doesn’t know how to read but he will read to them and they laugh about it all the time (teachers). So I don’t know what he is going to be.”

Are there are any experiences that Ben is involved in, in the community?
I share Paul with his father so when I am away he does quite a few different things with his father. His father is quite arty and they seem to do a lot of different sorts of parks or markets. Because he (father) is a landscaper Paul sometimes gets out there and helps out with jobs.

Barbara “and then you are taking him to beaches and parks and things?”
Mum “Sometimes I take him to the park down the road and it has a flying fox in it and he loves that. Sometimes I take him down to Mission Bay – we might go and have fish and chips down there and he might go and play in the playground or on the beach and we will do a picnic thing or whatever.”

What do you see as the main things Paul is interested in at the moment?
If I let him watch TV all the time he would love that. But I think that is a normal thing for kids. Loves his – you know he will build up like a construction site and park cars up and do all that sort of thing at home and he will get on the computer and play games. He is actually quite varied, he likes doing a variety of things. His concentration span – even though he can spend a lot of time on his own he will change and do a lot of different things.

What kind of programmes does he like to watch on TV?

Mainly children's programme but I have just subscribed to Sky which I get on Monday because I don't like, don't want him to watch channel two anymore because it gets a bit too aggressive. It starts off OK with the high Five and all that but as it continues on in the morning it gets onto more like the Ben Ten which is too aggressive for him. But I bring a lot of DVDs back from overseas and he gets to watch quite a lot of different films. So they are totally monitored then."

Does Paul talk much about Kindergarten?

Mum "He talks a lot about his friends like Theo, Mike, Harry umm but otherwise no. I will ask him questions like how was Kindy or how was that and he will say it was OK and I was there today and you know. And if I say what did you do he says OH I can't remember. I don't get a lot out of him."

Barbara "He is probably tired when he gets home."

Mum "Yeah he is."

Barbara "He enjoys it though (Kindergarten) doing lots of different thing."

Do you think he is learning anything about science at Kindergarten?

"I don't know really. I am not fully aware of what they are teaching on the science side. I actually don't know. In what way – what kind of science?"

Barbara "Oh anything really that you may have noticed. For me there are bits around the gardening."

Mum "Oh OK, he loves that."

Barbara " Yes he does love that and I've been doing a bit of work with the teachers on the physics stuff like movement and rolling things And talking about velocity and friction."

Mum "He is pretty bright and picks up things pretty quick, when they are explained to him."

Barbara “ They are more – I am getting them to look at the natural environment and what children are already playing with so it is a context children are already familiar with but to start to go into more depth about what the science is. That is what my research is about, looking at the connections there. Because the other thing is that we don’t always describe it as science so because we don’t give it a label that it is easy for parents to see that.”

Show the photo of Paul holding a seed at mat time.

Barbara “Paul found this seed inside the boch choy plant and he was really excited about that and so Liz had him tell the other children about it at mat time.”

Mum “And how did he go with that.”

Barbara “He was very proud. He felt he had something significant to contribute and that’s important for his wellbeing – for any child’s wellbeing that you have found something that the teacher thinks is valuable and so valuable that I can share it with all the other children.”

Mum “Very Cool”

Barbara “It is interesting learning about Paul’s father (Market gardening) because there is this link with Paul really enjoying the gardening bit and (show another picture about two weeks ago,Paul potting vegetable and flowers – (he absolutely adores Rosemary as well – one of his teachers) Paul spent ages doing that with Rosemary. So he does quite a bit of gardening.”

Mum notices the photo of Paul on the tractor

Mum “Oh he loves that”

Barbara “He spends a lot of time on the tractor but he also spends a lot of time with a jacket on.”

Barbara “He always has a jacket on and he always knows what the jacket is about in fact he told me the other week that Umm he went through all the jackets and he told me what they were for and he told me they don’t have any ambulance jackets but that is alright because I don’t think the kids mind. So he had thought it all through but that’s those busy books. When you said those Busy books I remembered them from Kindergarten teaching years ago, that this (point to the picture) and he is doing this a lot of the time. He says he is doing his work and he sets up little work places and then backs them away”

Barbara shows another picture of Paul at a building site he has made with cones out for safety and Paul with a jacket on.

Mum “I nearly didn’t recognise him with his blond hair.”

Barbara “Ohh that was quite probably April /May.”

Mum “Yep and he is very good at tidying up. He has to tidy up at home because we have such a small place. So he knows. He takes his plate back to the bench every night and clears the table”

Barbara “I’ve taken the photos of Paul that I think might have some science in it and asked him what he thinks he is doing at the time.”

Show the photo of Paul at the carpentry table – sawing a piece of wood.
Mum “He’s building something.”

Barbara “Yes when I asked him what he was doing he said that’s when I am working he was building something. I am thinking about what I am building. Look how amazingly intent he is at sawing and he sawed lots of bits of wood right through. Now I am thinking about friction and all sorts of things but what I am checking is that I am not over thinking for the children and in this picture I was over thinking."

Mum " Also when he is with my father he does a lot of , he gets into the tool shed and even since he was two my dad had him with a hammer and a nail so that 's how good he is . He has been taught to do it properly so he won't hurt himself. I will give credit to Dad on that one."

Barbara "And there are some lovely ones and your Dad will love looking at those photos."

Mum "Yeah definitely."

Barbara "When I talked about the scooter he said more about movement and he knew what he was doing."

Mum "I love that one. That's a great photo"

Barbara "It's the beginning of the physics ideas. So what makes it move Paul? He said your feet make it move it can make it go slower when you put your feet down and faster when your feet move. When I questioned him further he said it was the wheels because if it didn't have wheels it wouldn't roll."

Mum "He is using his feet as breaks."

Show the photo of Paulmaking a labyrinth

Barbara "This a funny one because he could talk about making the labyrinth and watching the marbles go down but when I asked him about what he was thinking and he said I was thinking I could have a sleep over at Theo's."

Mum "He has been nagging me for a long time about having a sleep over. It is only that I have a small place that I haven't been allowing it but I really just need to get another matric and start it up because he has been asking a lot and I think it will mean a lot for him to have a little mate stay over."

Barbara "It was obviously important because that what he remembered a week later (having the friend over).The children are very social at Ponsonby Kindergarten. I think that is a great thing."

Photo Paul working setting out cones and digging dirt
Barbara "No Barbara I am really thinking about working. There are a lot of underlying science and engineering concepts in there and you can never be too sure what they are picking up on (thinking about) and I could see lots of links between this and this and there were other times but I just did always take a photo. He is acting out that busy book at Kindergarten."

Mum "Isn't that interesting he loves that book. One of the best books my parents gave it to him actually. It is mainly that book that he seems to pick up every night."

Barbara "And then for me it is looking at things like the beginning of some of the chemistry stuff is mixing substances together and he can spend quite a bit of time with the hose in the sandpit and if you look he is really watching what is happening with the water and the sand."

Mum "Just the way he is kneeling down like that .

Barbara "So for him he definitely has an interest in the gardening side and he has been learning about seed and growth of plants and that flowers produce the seeds. He has been doing a lot of work around the movement stuff on the scooters, on the tractor; he always spends part of the morning doing something with those and really loves it. So that is quite a nice extension when he can't have those things at home and most kids don't have those sorts of toys at home that he can do that as an extension to the other things he is doing. He is doing a lot about movement."

Mum "And all these pictures are on the disk."

Barbara “Yes all these are on the disk.”

Mum “They are great photos they are typical him. The gardening you know when he working he really is working. He is so focused if it is something he is really interested in, yeah it is quite interesting.”

Barbara “Did Paul talk about the birds nest at Kindergarten would have been about. One blew out of a tree at Kindergarten and they dissected it.”

Mum “I think he did, it seems to trigger something. I think I might have said something like we found a bird’s nest and that is all that came out of his mouth I do remember something about it but I think that is all I got

Kina Kindergarten First Parent Interviews

Talis’s Mum

1. What does Tali like doing at home?

In the morning she is the one who always wakes up earlier. You know before the others.

She is an active girl. Tali is a helping girl. She always helps me. If I am folding washing, doing dishes she is always come and takes the clothes put in the draws of whoever the clothes belong to. Dishes she always comes and helps me. She is a little bit little for it – but I know she likes to learn these things.

Outside when my Mum comes up she know she is the helper in the family – weaving, crafts whatever.

Even reading she is always with the other sisters when they are doing their reading and all that. Spelling she know how to spell some words. For example on Friday night – our table cloth is in words abc... and words on the table cloth Every time we have feed we are always spelling words. So I said to my second one what is the s p o o n – (spelling out the letters) because she is eating with a spoon. Tali tried to spell it out and got the word before the others.

Sometimes she is naughty, she is cheeky and she is rough. Sometimes her sisters are crying because of her. I have to tell her she is the baby in the family you should not be cheeky to her sister's and she needs to respect her sisters'. Tali is clever and she knows why something makes her upset.

At church she is good. The other day in church the teacher says what do you want to thank God for Tali? Tali say a "I want to thank God for my Dad because he gave us a $5 each and he say to keep the five dollar for whatever you want. The teacher asks "OOh you don't want to say thank god for your Mum? And Tali says Yes I want to thank God because Mum spent the $5 "And the teacher just laugh.

She is talkative and sings alot. I know where she is by her singing.
She loves TV. Watch sky – Dora the Explora, Word Mind- try to minimise the TV.

2. Are there any experiences Tali is involved in, in the community?
She goes to church on Saturday. We are Seventh Day Adventists.
We always go to the church picnic and church trips.
Nothing much with the camps.
Some Sundays I take them out of the house shopping you know. Not to the supermarket – I hardly take them to the supermarket.

3. What do you see as the main things Tali's is interested in at present?
Not really – just doing normal things

4. Does Tali talk about what she does at Kindergarten?
Yes she does because I ask her, every day I ask her. She talks about her friends she mentions her friends' names and playing in the sandpit. Sometimes she comes home with wet clothes.

5. Has Tali talked much about what she did at Kindergarten last term?
Just the reading
She talked about the play dough
Did she talk about the monarch butterfly? No

6 . Do you think she is learning anything about science?

No About science no.

<u>Vasnati's Mum</u>

1. What does Vasnati like doing at home?

She always likes to take a piece of paper and draw something

Music and dancing

She uses the Internet with her sister- watch movies, songs – like High School Musical songs

They dance to the music

Outside they go and mix mud sand and something like that and chop up the flowers and make something like that – some little experiments

2. Are there any experiences Vasnati is involved in, in the community?

Sundays going to her temple to her school – I'm teaching there. She is studying in stage one class – Buddhist. Meet with people there

Goes ballet class

Another day she goes swimming

3. What do you see as the main things Vasanti is interested in at present?

I think all kind of things

She likes very much drawing – always drawing, drawing, and drawing. Her drawing are about the family, natural things and sometimes aliens. Sometimes cake and party

Not much TV – watch cartoon with her sister

4. Does Vasanti talk about what she does at Kindergarten?

Always – she talks about friends – teachers and what she did in the session – everything.

She likes to make friends – at first she did not want to come because she didn't have a friend. She is now making friends

Did she talk about the butterflies? Yes she did, she also made butterfly with the play dough.

6 . Do you think she is learning anything about science?

Yes because she is trying to make some colours by mixing. Mixing two colours and making another colour and she is asking me how to make pink how to make brown.
Sometimes does shading to mix up colours
Lots of things to start science.
In Shilanka they learn to write alphabet and numbers – they don't have much time like this condition to like to play – it is more like adult class room. This is very different experience.

Vasanti's Mum Second Interview

1. Can you tell me about what Vasanti has been doing at home lately?
She is doing paintings right now because her father is doing some arts work – he is an artist – canvas painting at home so Vasanti and her sister are doing canvas painting. She paints some butterflies and some small houses and things like this in the environment.

Both Vasnati and her sister enjoy music. Her sister is five years older. Vasanti is dancing with her and playing games.

Show her Mum photos of experiences at the Kindergarten.

- **Photo of the garden. DidVasanti talk about this?** Yes I remember her talking to me about the garden. She told me about the seedlings.
- **Photo Azita (the teacher) putting air into the balloons with a pump. When I asked Vasanti what was going into the balloons she said wind was going in there.** No she hasn't talked about that but she brought a balloon home from Kindergarten. We normally use it (balloons) in our house because every month when we are shopping we buy a bag (of balloons) for her. Because she likes balloons. Been buying balloons for a long time. We have a pump and we normally do this at home. Sometimes she ties the balloon. She knows air goes up because we bought a helium balloon for her in the shape of a horse – it's gone she let it go .
- **Photo of Vasanti blowing bubbles and catching them. Did she talk about this with you at all?** They did this last week. No she didn't tell me about that. Because they doing bubbles at home.

- **Another thing Vasanti has been doing a lot of is playing in the sandpit. Mixing water and sand and talking about cooking. Does she talk about playing in the sandpit at all?** No. She is mixing the mud and water at home. Sometimes I give them a flour mixture to pretend to cook with. (this seems like an extension of what Vasanti is doing at home with the mixing and pretend cooking. She is just extending it into sand and water play – my comment).
- **The other thing she has been doing is rolling things. Has she been on the new scooter boards?** I don't know – sometimes she is scared to go on things like that – scared she can't slow down. She is doing everything with Ruth so I don't know if she did or not. Sometimes she is nervous about doing dangerous things – like there is a skate board in our house but she never uses it. Vasanti is riding a bike with training wheels
- **The other thing that Vasanti palsy a lot with is the labyrinths. Rolling marbles and wooden balls down them. Does Vasanti have marbles and balls at home?** Just balls small balls and big balls and marbles but not a labyrinth. If they need something we get it.

Joy's Mum First Interview

1. What does Joy like doing at home?

Pretty full on – quite good at amusing herself. Playing with her toys. Like she will get one doll and have it talking to another doll – pretend voice – she is quite bright. She will play games with Dad. Funny games – play fight, being silly – last night she got out a blanket and wanted to be wrapped up like a cocoon – so they did that – she was having a great time.

TV – Word world – Play House Disney, Mickey Mouse club house, Number Jacks – quite fixed on that channel at the moment she loves watching it.

Have books read to her at night.

2. Are there any experiences Joy is involved in, in the community?

Visiting friends and family. Family get to together every Saturday.

Plays with the neighbour sometimes – loves playing with kids

3. What do you see as the main things Joy is interested in at present?

Not really. Every now and then she gets on the computer and plays a game. There are three different games. One is where you make a cake. You choose the tin, the ingredients, the colour icing and the lollies for the top.
There is a card memory game- can't remember what the other one is. There is also a pool game and she gets on and moves the balls around.

4. Does Joy talk about what she does at Kindergarten?
She is starting to. Sometimes we have to initially ask her.
The other week she talked about someone pulling her hair and I suggested that next time that happened she talked to the teachers about it.– Yeah she's starting to talk about it more – where she didn't talk much when she first started.
She might mention that one of the teachers help her to do something or she played with someone – about the children.

Was she involved much with the monarch butterfly? No not really.

6. Do you think she is learning anything about science?
To be honest – I don't think so.

Joy 's Mum Second Interviews:
Showing photos of what I have been observing Joy doing at the Kindergarten and discussing these with Joy Mum
I feedback to Joy's Mum that I have noticed that Joy's is really interested in animals. Acting out being a certain animal and playing with the toy animals. I ask is there a connection to this kind of play at Home.
Reply: Her Mum agrees this is an interest and says it probably comes from a favourite TV programme Joy likes to watch – can't remember the name. It's all just animals and they talk and all sorts. They teach you about all sorts of stuff about animals – it's one of those teaching programmes. It is the main programme that she watches.
I comment that it is obviously a natural interest that she follows through with in her play at Kindergarten.
I then talked of Joy helping to make a garden with a student teacher who was at the Kindergarten for a time. Joy is at the interview and comments "I helped Sam make a vegetable garden– it's just a garden Mum and those are all the vegetables"

I then talked about how Joy showed me the garden at the time and said plants need Sun to grow. The student teacher had put a picture of the Sun on the back fence of the garden area. Joy responds at the interview by saying “And water- they need water”

I ask her Mum if Joy has mentioned anything about a garden at home – though it was a while ago now.

Reply: Yes she might have mentioned something about a garden – it seems familiar but I can’t exactly remember what it was she said.

I then show Joy’s Mum a photo of Joy washing the dolls and talk about Paige being fond of washing the dolls.

Reply: Yes she does that at home with her little dolls.

Then I showed the photos of Joy playing with the large truck rolling it down the hills at Kindergarten. Joy gets excited and says “I carried it up the hill!” I talk about how Joy spent ages rolling the truck down the hill. Joy comments “I hold onto it and then I let it go”

I ask “And what happens when you let it go?’

Joy” It hitted a tree and it falled over – it rolled over and pussssh (makes noise and demonstrates truck moving with her hands).

I asked if Joy did any rolling things at home?”

Joy talks about how she has marbles at home.

Mum replies “Yes she has got marbles but she hasn’t played with them for a while”

I talk about how Joy often plays with the labyrinths at Kindergarten and show her a photo of Joy playing with the plastic labyrinth last week.

Then talked about Joy digging in the sandpit

Does Joy talk about her play in the sandpit at all?”

Mum replies “umm no, not lately she hasn’t.”

Then I talked about Joy being interested in creative play, dramatic play. Fantasy with dinosaurs (Mum nods in agreement that that is similar to what she does at home) and sometimes this has been acting out some of the stories she been watching on TV especially about animals because she takes on different voices and I can’t quite always work out what she is doing. I would say the kind of educational programmes she is watching have a significant link to her learning here. This is great

Mum replies “Now that you mention it I have heard her talk like you say – using different voices for different animals and I heard her do it at home.”
I comment that it is very creative.
I then summarise by saying that I have found that Joy has a real interest in the Living World – in plants and animals – especially animals. She also shows an interest in how thing move – related to the Physical world aspect of early childhood science learning.
I ask if there have been any new interests at home lately over the last two or three weeks?
Mum replies” uumm, not that I can think of – she has started to draw more – otherwise pretty much doing the same thing that she has always done.
Thank you so much for allowing me to observe and talk to Joy

Ruth’s Mum

1. What does Ruth likes doing at home?
She likes to play with the toys
Dollies (Barbie’s Dolls)
Riding her bike, running and playing outside
TV – watches cartoons with her brother and sister
Books they are always there– looking at them – tries to read – looks at pictures

2. Are there any experiences Ruth is involved in, in the community?
Mainly home or sometimes we go to different parks like Cornwall Park. She likes the parks and she plays with the children there.
Many times I take her outside to the park with her brother and sister.

3. What do you see as the main things Ruth is interested in at present?
Likes doing lots of different thing – like the normal things she always does like playing with toys.
Nothing particular.
Pretend cooking she likes doing this at home (the connection is she also likes doing this at Kindergarten in the sandpit – with sand and water)

4. Does Ruth talk about what she does at Kindergarten?

Yes – she tells me about the Kindy teachers – She loves the Kindy teachers
Her friends at Kindy and what she does
She talks about the songs they sing and sings songs to me; she talks about the type of toys she play with.
Did she talk with you about the butterfly? No I don't think she did.

5. What kind of knowledge do you think children should learn at Kindergarten?
Social with other kids– learning to get on with the other children.
That she is happy with her friends.
They get some knowledge at the Kindy here too – like she talked about the fire people when they came and she knows what to do if there was a fire.

6. Do you think she is learning anything about science?
I don't know

Second Interview Esther Mum
1. When Ruth is playing at home what is she playing with?
Just the same stuff.

2. Does she talk about Kindergarten?
Talking about just friends, teachers, yeah. The play with the toys, painting. All the stuff.

Researcher "Did Ruth talked to you about making the garden that was along time ago."
Reply "Yeah, they planted the vegetables, yeah."

Researcher "do you have a garden at home?
Reply "No, I have grasses but I don't have time to make a garden and I don't know if the landlord would accept –to make a garden. I don't know."

Researcher “In the last part when Robert (Ruth’s brother) and Ruth were coming to Kindergarten together in the morning they did a lot of cooking together in the sandpit and mixing stand and stuff” Show the photo

Then showed a picture of Ruth on the swings

Researcher “does she talk about the swings?”

Reply “Yes, yeah sometimes she says she swings with a friend, says the name. They like to talk about what they did at Kindy – playing, yeah. They talk about everything actually.”

Show photo of children rolling large metal truck down the sloping path

Barbara “Did Ruth talk much about going down the – rolling down the path and then they were (the children) riding the scooter down the sloping path. Did Ruth talk about that at all?”

Reply “Yes, yes she was doing it. She liked doing it.”

Researcher “So is Ruth interested in plants do you think?”

Reply “ AAR yes, even at home she does tell me to make a garden. She brings some flowers (from Kindergarten) she told me she wants to make a garden, to plant them. She did like making the garden.”

Researcher “Does she like watching and talking about the small animals, has she talked about that at all?”

Reply “Yes, yes she does. She likes but some of them she is scared of them.”

Brian’s Mum First and second Interviews together

What kind of things is he doing at home at the moment? He loves skate boards and anything like that. We have a long drive way so he goes down it like these kids are doing here. He loves computers and he has taught himself with the help of his brothers how to go onto one of the kids websites and called club penguin and they feed these little pets that they have got and they live in a igloo. He loves doing that. He into writing on the whiteboard at the moment – writing his name and faces. Loves the trampoline – loves hanging out with his older brothers.

Shows some photos

1. Small pebbles in the water tough with the water wheels.

He remembers because when was out recently he went back to it and he showed his younger brother. We have the water wheel at home as well and they use it in the bath. ***I talked about how Brian is interested in how things move. He seemed really interested in it.***

2. Sandpit digging. We have a sandpit at home with a kitchen set up for them to play with. It's on the concrete and they pretend to cook. ***So he is following on and doing the kind of things he does at home (MY comment) –***yeah and he talks about the sandpit here because he says if we had a really big sandpit like at Kindy it would cove our whole drive part eh mummy and our car would get stuck in it.

3. Brian shooting a gaol. He played shooting baskets for about an hour with a couple of other boys. Looking at the photo my 19 year old and my 13 year old boys they play a lot of basket ball at home and they actually - I was watching Brian and he said "look I can dribble the ball" and I asked "who taught you that" and he said "the boys" (He didn't seem that interested in balls when he was younger) - So he goes out there now a lot with them and they teach him – because the others a big into basket ball. He mucks about outside and Nathan teaches him. Ryan is enjoying that

4 Brian and his brother threading bead labyrinth . Again he is enjoying the movement. Mum talks about how he plays with a similar toy at the doctors – seems to prefer that type of toy to trucks and other toys. He hasn't really talked about playing with it at Kindergarten.

Barbara – So for me Brian does a lot of kind of emerging ideas about force and movement. Mum agrees this is an interest area for Brian.

<u>Jandals Kindergarten First Parent Interviews</u>

Claire's Mum First Interview

1. What does Claire like doing at home?

General play anything and everything

She loves playing with her soft toys and having voices for them and will often asks me "what are they saying mum?"

Even objects that can't possibly talk she will ask me what do you think it would say?

Loves playing with water – last few weeks more like a two year old again, I will go upstairs and there she is at the sink with her tea set filling it all up. The rules were no water upstairs. She will play with her tea set, lots of bath toys (little pots etc), bubbles, in the sink washing up, paddling pool

Board games with her grandma

TV 30 minutes to an hour a day. Nothing after 3.30 in the afternoon.

Loves tape/CD stories for an hour to two hours most days. Often asks questions about the language in the books. Listens to the same story over and over again.

TV likes "The go show" Little Bear, Franklin

Videos Happy feet and Clifford

Loves Dora the explora – gets the magazines

Loves comparison puzzles, finding the differences and into word searches

2. Are there any experiences Claire is involved in, in the community?

Swimming lessons

Library

Mum does respite with children with disabilities – Easter show and three kids came with us

Loved being in hospital last week with me while I was doing some respite care

Church

3. What do you see as the main things Claire is interested in at present?

Her animals and taking care of things

Animals more than dolls

Loves mice

Isabella has two gold fish and the neighbour's cat that is here most of the time.

4. Does Claire talk about what she does at Kindergarten?

I am always surprised she doesn't talk more

Talks more about people – like someone not wanting to play with her or who she is playing with.

Needed to talk to her about sharing friends early this year

Talks about the teachers – what they are up to and what they said

Likes it when different things happen – like earlier this year trip to the butterfly garden.

What she has missed about Kindy – she said paining

She talks more when I have the portfolio and we are looking at the photos

There is a picture Built 31 sandcastles

Tells me if she has done a drawing or a painting and want to find it and take it home

5. Do you think Claire is learning anything about science?

I think she is constantly learning about science. I always think of science as being "cause and effect" constantly all day long

Enjoyed the bus the most on the trip to the butterfly farm– in terms of the trip and seeing the cat at the gardens.

Animals – when she was in England at the animal farm she loved the animals and feeling their softness on their face. Loved having the rat on her head. Any animals she seems to be interested in.

Loves sorting.

Anything from this last semester you have noticed Claire learning at Kindergarten

Friendships developed to moving on to a phase where she is mixing with more children now and forming true friendships.

Second Interview Claire's Mum

Has Claire been talking much in the last Month about what she is doing at Kindergarten? She talks more than she ever has done. She is talking more about friendships – just bits come out. I can't get a picture of what her mornings like.

What is Claire's main activities at home over the last few weeks? Can you add something here.

Some of the science interests that have been happening this term have been things like the gardening interest. Claire bringing the swan plant seeds. They planted the seeds with Claire last week, did she tell you about that? No she didn't 'cause I wondered where they had gone.

The other thing they have done a lot of this term they have been talking a lot about ramps and things – ramps and things. Claire said she enjoyed that did she talk about that at all. No, no – I saw the ramps at one time they ran the cars through paint.

What do you think would be her favourite thing at Kindergarten. She has been taking her shoes off so I think she must be spending an awful lot of time in the sandpit. **I answer –she is at the moment.** Painting – she says she likes painting. Certainly when we went back at the beginning of this term I asked her what she has missed and she said painting. She always misses the teachers and wonders what they are doing.

Looking at the photo – shared what Claire has said about each of the photos.

Bubble blowing – Getting the concept of floating and blowing hard or soft

Corks in blue water trough the corks are sharks. She knew the corks were floating

Glue gun making a microphone – shared what Claire was saying. It is sloppy when hot etc

Sandpit picture –

Rolling the cars down the ramp -I mention how Claire said Yeah I like this. Bella hasn't talked about doing this at Kindergarten. She has cars at home though.

She has a road map. And also because I do respite care I have a range of toys Claire can play with.

I asked her if she used the magnify glass. She said yes and I look at lots of stuff and they When we were in England in December she was fascinated with my grannies one. Claire went everywhere with it and wouldn't put it down. So when Mum came over in May she brought with her a magnifier with a pot with the magnifier on top so you can put small animals into it. But this week is the first time she had really spent a long time with it. So yesterday she was in the garden and made me catch four spiders to put in there and then she put grass. Tuesday she got them out and yesterday really into them and proudly showing her neighbour.

About the snails interest that started on Monday. Oh yes I saw that. I did talk to Claire about it and she said you weren't allowed to touch them Mum. So I said "Can you disappear when your frightened" And Claire said "Yeah inside my head and then she went nooo". I told her about how some people say the snail has a house on their back but I don't think she really got that she was sort of pondering on it. That is the kind of activity I would expect to catch Isabella's attention because of her love of small animals.

I think she would want to hold it as well (talking about the snail). I find it very hard to keep her off animals to the point where I have given up telling her and I think she will learn through experiences once she been bitten or scratched – she just can't . We went to house sit back in June and Claire spent the whole time just carrying the cat around.

Researcher had talked about what Bella knows about seeds. Claire talked about when winter comes plants droop down. Claire looked out the window at home today and asked "Mum when are all the leaves coming back"

We were going to a party at a house we had never been to before, we were running late so we were rushing – then Claire just stops and says "Mum is that what Pandas eat?" there was bamboo growing down the drive.

Photo of Claire looking at the drift wood.

Nova’s Mum

1. What does Nova like doing at home?

She likes dancing and dressing up

Likes to help mummy baking and decorating cakes

Likes playing outside

Recently been into doing gymnastics (looking for a class to enrol her in)

Like you said she is a real drama queen

She does acting roles with her little brother- being princes and princesses or mummy and daddy

She lots playing on the swing. She has a trampoline at home and enjoys that

Playing with water

Loves Indian dancing and dressing up in Indian clothes

TV she is watching mainly cartoons

She likes the Barbie movies

2. Are there any experiences Nova is involved in, in the community?

Nothing as yet

3. What do you see as the main things Nova is interested in at present?

Nothing specific – likes a variety of things

She loves horses

Curious about animals, butterflies

She will ask me questions like “what do insects eat?”

4. Does Nova talk about what she does at Kindergarten?

Talks about her friends

Talks about baking

Playing outside

Fire drill

5. Do you think Nova is learning anything about science?

Not much really
What science do you think they should learn? (Researcher talked about biology, chemistry and physics)
She is curious and asks questions
She told her father about the visit to the butterfly farm – how butterflies are formed – in her own words

<u>Rhja's Mum</u>

1. What does Rhja like doing at home?

Mainly he loves to read stories and painting he likes to read them himself.
The main thing during the day is reading and writing, drawing and cartoons –Peep TVNZ website. About a bird and duck that are friends. Everyday there is a new story. He loves watching it and when come back in the evening he tells me about the day's story. 10 or 15 minute story.
He likes any story book that has picture with a few words in it – anything he can handle 10 – 15 words on a page. I've got to get 30 – 40 books per week from the library. The second day if you ask how many books he has read he has read most of the books. But he keeps reading until it is by heart. He can read but he can't spell it yet. Now he is starting to spell as well.
Yesterday he decided to make a restaurant. So he started to make up a menu and wrote the words out his own way. Then his Papa said "ooh do you want to add Panda to your restaurant? ",and he tried to sound the word out in his own way. He made a spelling himself.

2. Are there any experiences Rhja's is involved in, in the community?

Religious group (about 200 people)- Sunday
The other day the ladies had a competition making this religious symbol with the rice. Arya saw us doing it and ask if he could do it. So I gave him some rice and help and he made the symbol. He really enjoyed it and asked if he could do it again.
He likes to play with children older than himself.
Go to the story book library and the toy library
Every Saturday at 11 o'clock there is a story telling time at the Mt Roskil library and we go there. He talks a lot. He either tries to tell the story with the librarian or

ask questions about the story. It is our Saturday outing together – every second Saturday.. Every other Saturday Arya and I are going to the toy library.

Then some Saturdays we pack up and go on a picnic to the Park or chipmunks or something. Every second Saturday his papa is working so we have outings together.

3. What do you see as the main things Rhja is interested in at present?

Those three things I would say reading, writing and drawing.

He likes to make out of paper – craft type of thing

He likes to cook as well. Yesterday he had me making scones. He told me what ingredients he wanted in them. This one was not from any book or anything. Apples grapes and mint and I made it as he said and it was really lovely. The last few days he is saying he likes to make his own things. He makes his own sandwich and says he is eating subway. Eat subway, eat fresh.

What does he watch on TV? - Mainly cartoons.

4. Does Rhja talk about what she does at Kindergarten?

Yes he talks about what he has made or otherwise I have to ask him.

If I wont' ask he won't tell

5. What things has he been talking about lately about Kindergarten?

New friends or maybe friends that are going to school.

Did he go to the butterfly park? Yes he did. He said he liked it, it was a really good place and I saw five butterflies.

5. Do you think Rhja is learning anything about science?

How do you say that – any particular thing? I haven't seen anything

Because science is that basic theory of learning anything isn't it?

I didn't know about it.

Because I am working fulltime he is more with his grandpa. (Father -in -law). Arya will ask if they can go for a walk then he is asking his grandpa then he asks all these questions like how does the grass grow? Then another time his grandpa would say this is autumn and all the leaves will turn into yellow and fall down. Then the very next day there is a tree that is still green and Arya asks his grandpa why this one is still green and hasn't turned into yellow and not falling down. So all these questions he is asking why the seeds, how the grass comes? He is very curious about things – if he sees something he will be asking questions.

From the books too he is asking questions. I don't remember any particular instances. If he see any picture he will ask like – he needs to know why and what is the concept behind, things like that.

6 What knowledge do you think is important for Rhja to learn at Kindergarten? We didn't get to this question

Debra's Mum

1. What does Emma like doing at home?

Likes to read

Likes to play

Likes imaginary play

Kicking the football

Riding her bike

TV – not everyday – mostly the news with us

Books – girlie books – fairies etc

2. Are there any experiences Debra is involved in, in the community?

Ballet – she loves it

Swimming on Thursday

Play group

Comes with me when I do volunteer work for the SPCA – helps me to feed kittens, changing kitty litter loves animals - I encourage her to help with SPCA work

3. What do you see as the main things Debra is interested in at present?

Fairy tales. This morning she had to have Cinderella

Loves playing outside rides the two wheeler bike and the scooter – she manages the scooter uses the break

4. Does Debra talk about what she does at Kindergarten?

No not really. Only if I ask her sometimes she will talk about it

5. What things has he been talking about lately about Kindergarten?

Butterfly trip – I encouraged her to talk about it – I went on the trip with her

She likes the dress-ups

She likes playing outside – not really interested in the paint

6. Do you think Debra is learning anything about science?

Yes I do – her grandmother is a scientist, they do little experiences together – like the baking soda and vinegar reaction. Mixing things together

7. What knowledge do you think is important for DEbra to learn at Kindergarten?

Learn how to behave in a group

Make friends and have time for kids to be kids

Explore the environment. It is more important to me that she has a good time.

10.3 Appendix C: Consent from participant to use their Images

Includes:

- Consent form for teachers for approval to use their images from the research at future presentations at academic conferences and in educational journal publication
- Consent form for parents for approval to use images of the children from the research at presentations at academic conferences and in educational journal publication

Research Project: Culture of Science in Early Childhood Education: Where Cultures Meet Cultures

Consent form for each Teachers for permission to use his/her image to be used by the reseracher in the future

I understand that Barbara Backshall may use the images of me generated during the research she is undertaking at the Kindergarten where I work in future early childhood scinece education lectures, conference presentations or education journal articles.

I do / do not give consent for my image to be used

Name ....

Signiture ....

Date ....

Research Project: Culture of Science in Early Childhood Education: Where Cultures Meet Cultures

Consent form for each parent of children particpating in the research at xxxx Kindergarten for permission to use thier child's image

I understand that Barbara Backshall may use the images of my child generated during the research she is undertaking at the Kindergarten my child is attending for early childhood scinece education lectures, presentations at conferences or education journal articles.

I do / do not give consent for my child's image to be used

Name ....

Signiture ....

Date ....

10.4 Appendix D: Field Notes evidenced as referenced in the thesis

Kindergarten	reference	observation
1. Kina	Participant Observation field note p. 44-46	Joy and Ruth are playing with the large wooden Labyrinth. Ruth "Your turn, your, turn) and waits for Joy to put a ball down the labyrinth. Ruth "Put it, put it!" Joy puts the ball in the labyrinth and they both watch the ball move down, one ball at a time. Joy "I got." And picks up the balls and put them all onto the top of the labyrinth at the same time Ruth "No, no like this." Ruth takes the balls from Joy and demonstrates putting one ball on the top of the labyrinth at a time, so the balls fall down on at a time following each other. Ruth repeats this three times with Joy watching. The researcher asks "what's happening to the balls?' Joy replies "rolling" Researcher "What makes them roll?" Joy "here." As she point to the top of the labyrinth. Ruth keeps putting the balls on the top to roll down one at a times Ruth "Your turn, here get your one (laughing) this is fun." Ruth puts two ball down the labyrinth at the same time and then Joy does the same. Ruth " I got two too!" they both keep putting two balls down at a time. Two of the balls hit into each other and bounce apart as the two girls and watching and they both laugh. They watch as two more balls hit each other then roll together from first to second level of the labyrinth. Ruth then puts three balls down the labyrinth at the same time. Ruth "ooo. Oooh." One of the balls falls off the labyrinth track. Joy keeps putting two balls down the labyrinth each time and then she tries three balls- she stops the three balls with her hand at each level. Ruth joins in putting her hand at one of the levels. – She is anticipating where one of the balls will fall off the labyrinth; she puts a small bucket there to catch the ball. The play lasts for 8 minutes
2. Kina	Participation Observation field notes p. 79	Joy with one of the large metal trucks. She takes it to the top of a grass hill/slope. Joy puts the dinosaur plastic toy in that back of the truck, then she lets go of the truck and watches it go down the hill. She does this two times. On the second time the truck tips over and the dinosaur falls out. Joy picks up the dinosaur and the truck and walls up a different grass slope. Joy "get set go!." And she lets of of the truck again and the truck rolls down the hill. The librarian arrives and Joy runs off to mat-time to listen to a story read by the librarian.
3. Jandals	Participation Observation field notes p. 10	Debra, Clair and Nova are playing with a swing. They start to wind/twist the swing and then let it go and it twirls undone. They put a doll in the

		swing and Debra suggests twisting the swing again. They all help and Debra says “Now let go.” They all watch as the swing twirls and they repeat this four times looking and making excited noises.
4. Pohutukawa	Participation Observation field notes p.15-16	Sonia is at the water trough. She walks up to a container of toys and chooses a blue boat. She fills a jug from the water trough with water and then places the boat at the top of the PVC guttering that goes from the edge of the water trough to the ground. Sonia then pours water from the jug onto the back of the boat. Sonia exclaims “wooooow,” as she pours the water. She pours the water on the back of the boat three times and then says “Nearly.” She pours the water at the back of the boat again and the boat moves down the PVC gutting. The gutting drops off the water trough and Sonia puts it back. She then chooses a new boat and repeats placing it at the top of the PVC gutting and the boat moves down the guttering. Sonia then chooses a new boat and repeats the process. Sonia does this with seven other boats over a five minute period.
5. Pohutukawa	Sessional observation field notes p. 18	One of the teachers has a large cylinder cone shape container and is spinning marbles in it with the help of five children – all standing around the edge of the cone move it so that the marbles inside move. The teacher suggests putting a large ball in and then also putting two pin pong balls in the cone. The teacher says “They have got so much momentum.” She suggest the children predict which ball will get to the top of the cone shaped cylinder first. They all roll the cone to make the balls spin. The blue ball gets to the top first. She talks with the children about the blue and yellow ball feeling different. One of the children suggests that the blue one feels lighter.
6. Jandals	Sessional observation field notes p. 35-36	There were a number of ramps set up outside today. There was a drain pipe tied to a tree in such a way that children could put the small plastic cars into the pipe and watch them fall out the other side. There was also a wooden plank setup on the edge of the sandpit for vehicles from the sandpit to move down.
7. Jandals	Sessional observation field notes p.37	This particular day there were plastic car at the water trough and two wooden planks going from the edge of the water trough to the ground. The children were wetting the wooden planks and then putting the plastic cars at the top of the ramp and watching the cars move down the ramp. Four boys stayed and played in this manner for 9 minutes. One of the teachers talked with the research about having this set up the day before and talking to the group of boys about the difference in the friction between the plank with water on it and a plank without water on it. Today was a continuation of the play.

8. Pohutukawa	Sessional observation field notes p.16	There are five children sitting at a table with one of the teachers exploring what a magnet can and can't attract. One girl says "it will pick up these." Another child asks the teacher "Why can't we see the shadow anymore?" One of the boys responds" Because is no sun." The teacher and children talk about how shadows are made. The teacher was talking about the position of the sun. (researcher can't quite catch all the conversation) The day before the children had noticed a shadow on the wall and the teacher had drawn lines to show how the shadow had changed over the course of the morning.
9. Kina	Sessional observation field notes p.22-23	Talked with Joy outside by the newly developed garden. The children and teachers had been digging the garden with a third year student teacher last Wednesday when I was at the kindergarten. Today I observed that the garden was fully planted. On the wall behind the garden was a picture of the sun and another picture of a cloud that was raining. The student teacher had talked with the children about what the plants needing sun and water in order to grow. When I saw the garden I said "Wow what a lovely garden. Joy replied " Look they need sun and water." As she pointed to the pictures on the fence. Then Joy said " But the sun'd not out yet (because it was a cloudy day). Joy pointd to the pictures on the fence and nodded her head. Another child who had been watching us said "Look how the plants have grown" 0 she was referring to the change in size of the plants from the photos of the seedlings through to how they had grown even in the last week.
10. Pohutukawa	Sessional observation field notes p.27	One of the teachers has set out the bean seeds that have germinated on a table and also put paper pencils and magnifying glasses on the table. One of the participant children Lotta walked up to the table and picks up the one of the magnifying glasses and looks at the germinate bean seed. Loota takes one of the germinated seeds to the teacher and asks her to photocopy it for her. The teacher does just that and give lotta the photocopy of the germinated bean seed. Lotta goes back to the table and starts to draw her own germinated bean seed from the photocopy.
11. Kina	Participation Observation field notes p.34	Joy walks up to the insect poster and touches each of the insects on the poster and then says oooooh – it seems she is saying this in appreciation for the insects on the poster.
12. Kina	Sessional observation field notes p.33	A teacher is reading a fiction book to a group of four children. Joy is one of the children. The teacher is talking with the children about what makes a rainbow. Joy says "It's rainbow clouds that make rainbows." One of the boys says "The rainbows are inside the cloud and has a house inside the cloud." The teacher "Look Robert I

		have found a picture of a rainbow". The children all look at the rainbow in the story book
13. Pohutukawa	Sessional observation field notes p.14	The teacher is reading a story to all the children at a mat-time. The story is about a crocodile who wants the river to himself. The possible science-related ideas form the story are animals need water to live, there are lots of different kinds of animals, some animals have teeth and like ours they can get sore, anatomy of the crocodile, and animals drink and wash themselves in the river.
14. Jandals	Sessional observation field notes p.44	A teacher is taking a mat-time with all the children in attendance. One of the children is leaving the kindergarten so is asked to choose a story she would like the teacher to read to the group. She chooses the story "I like the rain." This story talks about the different types of weather e.g. rain, snow, wind, heat and hail. It is set to a musical tune and everyone sings along.
15. Kina	Participation Observation field notes p.74-75	Joy walks around the corner of the table and starts playing with the plastic animals. She plays picks up the lion and acts as if she is making the lion walk and then she picks up a horse and says "Mum ma." She then let's go of the lion and the horse and touches the plastic pig with her finger and makes oink notices three times. She touches the white tiger and says "Mum ma." Three times. She has a small white tiger and she then finds a larger one and says "Come and see."- She makes the two tigers walk along the self that is next to the table where the plastic animals are. She then leaves the leaves the tigers and goes back to the table. Joy tholds the panda bear and says "panda bear." She then says "Hi ya crocodile. What you doing." Joy "I'm just eating some food." "Really" "what kind of sound do you make/". Then Joy starts putting the animals that are the same together.
16. Jandals	Participation Observation field notes p. 45	Rhja is filling a container with water from the water trough. He pours this onto the concrete path. Then he runs back to the water trough and fills the jug with water. He says "I'm planning a stream." He pours more water down the concrete path and stands and watching the water move down the path and down some steps. He repeats this three times, laughing as her runs back to the water trough each time to get more water.
17. Kina	Participation Observation field notes p.52	Joy walks into the kindergarten first thing in the morning with her metal lunch box in hand. The sun shone on the lunch box and reflected light onto a nearby wall. Joy noticed this and said "Look, look ,look." As she pointed to the sun, then her lunch box and then the reflected light on the wall. I say to her "yes the sunlight is hitting your lunch box and then hitting the wall, your lunch box is reflecting the sunlight." Joy smiles at me and moves on to put her lunch box away.
18. Kina	Sessional observation field notes p.45 & 48.	When I arrived this morning I noticed that someone had planted a branch off a karaka tree in the kindergarten garden. One of the teachers tells me that it is Rhja's experiement. He planted it

		after a discussion with another teacher three days ago. When I arrive back at the kindergarten a week later the branch is still in the garden. I asked Rhja if her thinks the branch will grow. He says “No it doesn’t have any roots.”
19. Pahutukawa	Sessional observation field notes	When I looked at the documentation on the wall display I noticed that there was documentation on the children finding a best nest and then dissecting the birds nest with one of the teachers. The teachers think the bird nest got blown out of the large tree they have in the playground as there was a storm the night before the children found the birds nest on the ground under the tree. At mat-time today the teachers discussed how they had dissected the birds nest and that they had found more plastic than natural materials in the nest itself. The children had made predications about what they thought the nest was made out of.
20.		

10.5 Appendix E: Categories of how the participant children engaged in science related learning with the physical environment through their "Free play".

The categories

CPE – Children's engagement with science related learning through their interactions with the **physical environment** created by the teachers with no teacher interaction in developing children's engagement in the learning at that time.

THPE – Teacher highlighted - where a teacher's interactions highlighted an aspect of science learning within the **physical environment** with the child responding with interest.

NEPE – Natural events in the environment– events such as weather, which were beyond the environment that the teachers deliberately provided acted as a catalyst to children's interest in the **physical environment** around them.

Category	Experiences observed Kina Kindergarten
CPE	Ball hanging from a tree – two children either side hitting the ball to and fro with bats
	Child on the swing
	Child stirring sand and water with her hands
	Children rolling balls down a wooden labyrinth sometimes one ball sometimes two
	Child with a feather ,from a basket in the science area – runs the feather up and down her hand
	Touching insects on a poster and saying "oooo". No one was with her at the time
	Child pushing beads along a wire and bead labyrinth – did this for 10 minutes – concentrating on pushing and then watching the beads fall
	Dramatic play using the kindergarten bean bags – the bean bags became dinosaur eggs and the child the dinosaur looking after them – sitting on them until they hatched
	Pushing a train along a train track
	On the slide sliding down on her tummy
	Intentionally touching rain droplets on the ground

	Squeezes dough through a large syringe
	Exploring the plastic click together labyrinth –modifying the labyrinth and watching marbles move through the labyrinth
	Playing with the plastic animals – making some of the specific sounds each animal makes, then grouping the animals (classifying) into species – types of animals
	Child purposely flicked sand into the air and watched the sand move through the air and land on the ground- repeats this 4 times
	Child letting a large metal truck roll down grass slope repeating this on different grass slopes in the outdoor area
	Meticulously dissecting a flower with her hands
	On a scooter - rolling down the sloping concrete path
	Playing with corn-flour and water with a spoon and with her hands – adding more water – scooping the semi hard corn-flour from the bottom of the container
	Mixing sand and water and pressing the substance into shape of a cake – (square)
	Pouring small stones into the water wheel
	Digging sand – his facial expression shows he is using force and energy to do so
	Shooting goals – his facial expression shows her is pushing hard – to get the ball high enough to go through the hoop
	Pressing her clothes into the play dough and observing the pattern on the dough
	Twisting the swing and watching it twirl undone
	Bouncing on a plank – one end of the plank is in a tire Riding large metal truck down grass slope and then concrete sloping path
	Blowing bubbles and running after the bubbles
	Child joining the magnetic train and carriages purposefully together – 10 pieces altogether
	Three children playing with the puppet. One of the puppets is a ladybird at one point one of the children said “the ladybird is hungry, what does her eat?”

THPE	Art experience – dripping wax onto paper – the teacher talking about the changes in the wax – asks children what they are noticing
	Child asks what the noise is – the teacher explains it is the air escaping – as child is helping the teacher re inflate a rugby ball
	Teacher using the air pump to inflate balloon – she asks the children what is inside the balloon. One of the children replies “wind”
NEPE	While blowing bubbles child notices a seagull flying
	Child comes into kindergarten carrying a metal lunchbox – notices the reflection from the sun to her metal box to the light reflected on the wall - comments to the researcher about it “Look” as she changes the angle of her lunch box
	Sitting in the bark area looking at the flowers on the other side of the kindergarten fence, then reaches through and picked leaves off the bushes , deliberately running her hand over each leaf – not part of the kindergarten environment
Category	**Experiences observed Pohutakawa Kindergarten**
CPE	Child playing /exploring magnets by herself
	Two children playing with the magnets their magnets stick to each other’s – they pull hard to pull them apart and giggle
	Group of children hitting a balloon backward and forward to each other. Watching how the balloon floated between them
	Twisting the swing ladder and watching it twirl
	Pouring water down PVC guttering and placing boats (one at a time) in the guttering – watching the water push the boat down the guttering
	Playing with the plastic adjustable labyrinth
	Exploring the liquid containers that you can buy commercially – where liquid flows from one chamber into another
	Putting rectangular foam blocks down the slide
	At the carpentry table purposely rolling nails down incline made by a piece of wood placed again an edge at an angle
	Sifting sand several times and watching the sand fall through the holes of the sieve back into the sand-area

	Talking with a peer about how the holes in the sieve let the water out but not the corks
	Pushing cars across the floor
	Child playing with the plastic sword fish in the water trough – acting out how he thought a sword fish would behave
	Having races in the pedal car. Child talks about going to go speeding fast
	Watching water flow through the water wheel and make the wheel turn
	Scooter races
	Noticing leaves falling form the Oak tree – child stands and watches
	Mixing different colour paints to see what other colours could be made
	Building a Meer cat cage with large interlinking construction blocks
	Using a turkey baster in the water trough – watching the water get drawn into the baster and then squirting it out
	Three children in a circle moving fast and purposefully letting go hands – pleased with the sensation this caused the group giggles and repeated the fast circle dance another 4 times
	Sliding feet on cardboard
	Pretending to make a smoothie – the blending mixing up the fruit
	Watching water streaming down path
	At the carpentry table diligently sawing wood – pushing the saw with effort to achieve the sawing
	Child using the magnifying glass look at different surfaces outside and a leaf
	Throwing water from the water trough while saying “We are making a flood”
	Playing Nemo games on the computer – guessing what shell belongs to which animal
	Child feeling the stickiness of the stickers – putting her finger on and of the sticky side of the sticker. Then puts sticker on her paper

THPE	Planting seedlings into pots with a teacher – teacher talks about the roots of the plant and shows them to the children
	Child drawing a picture of the seeds. Teacher talks about how much they have grown. The shoot and the root are growing from the seed. Child asks to photocopy the germinated and sprouting seed – then draws a picture from the photocopied picture
	Teacher talking with the children who have been rolling in the large cylinder outside. "Need to push it when you go up hill, then it goes downhill by itself" the children grin and repeat their rolling game.
NEPE	The sun goes behind a cloud and the child said "for God's sake who took the sun away." Child noticing the change
Category	**Experiences observed Jandals Kindergarten**
CPE	Twirling friends on swing, then twirling doll in swing
	At another time a different child sits on the swing and twirls it then squeals with delight as it twirls with him in it
	Child pushing friend on a swing. The friend asks her if she can push a little higher. The child pushes harder and then said "That's all I can do."
	Running toy cars down the concrete
	Showing a peer how to make the swing move by moving your legs
	Balancing and walking along a log wall
	Weighing sand
	Notices and tells researcher about sparrow while having morning tea
	Pours water from water trough – He said I am making a stream
	Child talks about not wanting to wash his hand to another child – because it makes his hands slippery
	Trying to pop the bubbles others are making. Then she blows bubbles – noticing the different sizes of the bubbles – she seems to be concentrating to blow slowly to make big bubble
	Playing with plastic crab Child looked at the plastic crab with a magnifying glass. She said to the child next to her "I love crabs."
	Making a house for the kiwi (soft toy) in the block corner with the multiple blocks

	At the water trough sorting shell into the ones that are the same
	Child while using the glue gun talks about how the hot makes the glue runny
	Child feeling the bark on the tree notices some ants and watches them
	Notices that some of the animals in the water trough have holes in the bottom of them and can squirt. Tell the boy playing beside him "that can squirt." Picks up a blue seal and squeezes the seal then said with some surprise to the other boy "You can hear the air coming out of it!"
THPE	Teacher and three children looking at the leaves of a plant in the kindergarten garden – Child notices a small animal and the teacher says "these are aphids and they live on the plant."
	Teacher making play dough with two children. One child says as they mix the wet and dry ingredients together "it's very gooey" noticing the texture and properties of the mixture. The teacher replied –yes it is. The teacher also comments that the hot water helps it stick together better. The teacher also talks about adding blue and red food colouring and what colour did the children think it would turn into
	Teacher sitting watching a child mix colours together. Child mixes black, white and red together and said "It makes grey." The teacher agrees "it is grey isn't it." The teacher asks "what colour she was going to use next." Red the child continues trying different colours and discussing her choices with the teacher
	Child talks to a teacher about what has happened to the pea plant. The pea plants have gone black from the frost. The teacher talks about how the cold has caused them to die
NEPE	Child stops and watching rain falling for about 2 minutes
	Child notices the flower on the other side of the kindergarten fence – tells the other children to look at the flower

Same data coded for children's experiences relevant to science worlds: physical world, material world, Living world, planet earth and beyond. Where an experience relates to more than one world – the second world is indicated by colour in the far left row.

Category	**Experiences observed Kina Kindergarten**
ECT	Ball hanging from a tree – two children either side hitting the ball to and fro with bats
	Child on the swing
	Child stirring sand and water with her hands
	Children rolling balls down a wooden labyrinth sometimes one ball sometimes two
	Child with a feather ,from a basket in the science area – runs the feather up and down her hand
	Touching insects on a poster and saying "oooo". No one was with her at the time
	Child pushing beads along a wire and bead labyrinth – did this for 10 minutes – concentrating on pushing and then watching the beads fall
	Dramatic play using the kindergarten bean bags – the bean bags became dinosaur eggs and the child the dinosaur looking after them – sitting on them until they hatched
	Pushing a train along a train track
	On the slide sliding down on her tummy
	Squeezes dough through a large syringe
	Exploring the plastic click together labyrinth –modifying the labyrinth and watching marbles move through the labyrinth
	Playing with the plastic animals – making some of the specific sounds each animal makes, then grouping the animals (classifying) into species – types of animals
	Child purposely flicked sand into the air and watched the sand move through the air and land on the ground- repeats this 4 times
	Child letting a large metal truck roll down grass slope repeating this on different grass slopes in the outdoor area

	Meticulously dissecting a flower with her hands
	On a scooter - rolling down the sloping concrete path
	Playing with corn-flour and water with a spoon and with her hands – adding more water – scooping the semi hard corn-flour from the bottom of the container
	Mixing sand and water and pressing the substance into shape of a cake – (square)
	Pouring small stones into the water wheel
	Digging sand – his facial expression shows he is using force and energy to do so
	Shooting goals – his facial expression shows her is pushing hard – to get the ball high enough to go through the hoop
	Pressing her clothes into the play dough and observing the pattern on the dough
	Twisting the swing and watching it twirl undone
	Bouncing on a plank – one end of the plank is in a tire Riding large metal truck down grass slope and then concrete sloping path
	Blowing bubbles and running after the bubbles
	Child joining the magnetic train and carriages purposefully together – 10 pieces altogether
	Three children playing with the puppet. One of the puppets is a ladybird at one point one of the children said “the ladybird is hungry, what does her eat?”
TH	Art experience – dripping wax onto paper – the teacher talking about the changes in the wax – asks children what they are noticing
	Child asks what the noise is – the teacher explains it is the air escaping – as child is helping the teacher re inflate a rugby ball
	Teacher using the air pump to inflate balloon – she asks the children what is inside the balloon. One of the children replies “wind”
NE	While blowing bubbles child notices a seagull flying

	Child comes into kindergarten carrying a metal lunchbox – notices the reflection from the sun to her metal box to the light reflected on the wall - comments to the researcher about it “Look” as she changes the angle of her lunch box
	Sitting in the bark area looking at the flowers on the other side of the kindergarten fence, then reaches through and picked leaves off the bushes , deliberately running her hand over each leaf – not part of the kindergarten environment
	Intentionally touching rain droplets on the ground
Category	**Experiences observed Pohutakawa Kindergarten**
ECT	Child playing /exploring magnets by herself
	Two children playing with the magnets their magnets stick to each other’s – they pull hard to pull them apart and giggle
	Group of children hitting a balloon backward and forward to each other. Watching how the balloon floated between them
	Twisting the swing ladder and watching it twirl
	Pouring water down PVC guttering and placing boats (one at a time) in the guttering – watching the water push the boat down the guttering
	Playing with the plastic adjustable labyrinth
	Exploring the liquid containers that you can buy commercially – where liquid flows from one chamber into another
	Putting rectangular foam blocks down the slide
	At the carpentry table purposely rolling nails down incline made by a piece of wood placed again an edge at an angle
	Sifting sand several times and watching the sand fall through the holes of the sieve back into the sand-area
	Talking with a peer about how the holes in the sieve let the water out but not the corks
	Pushing cars across the floor
	Child playing with the plastic sword fish in the water trough – acting out how he thought a sword fish would behave
	Having races in the pedal car. Child talks about going to go speeding fast
	Watching water flow through the water wheel and make the wheel

	turn
	Scooter races
	Noticing leaves falling form the Oak tree – child stands and watches
	Mixing different colour paints to see what other colours could be made
	Building a Meer cat cage with large interlinking construction blocks
	Using a turkey baster in the water trough – watching the water get drawn into the baster and then squirting it out
	Three children in a circle moving fast and purposefully letting go hands – pleased with the sensation this caused the group giggles and repeated the fast circle dance another 4 times
	Sliding feet on cardboard
	Pretending to make a smoothie – the blending mixing up the fruit
	Watching water streaming down path
	At the carpentry table diligently sawing wood – pushing the saw with effort to achieve the sawing
	Child using the magnifying glass look at different surfaces outside and a leaf
	Throwing water from the water trough while saying "We are making a flood"
	Playing Nemo games on the computer – guessing what shell belongs to which animal
	Child feeling the stickiness of the stickers – putting her finger on and of the sticky side of the sticker. Then puts sticker on her paper
TH	Planting seedlings into pots with a teacher – teacher talks about the roots of the plant and shows them to the children
	Child drawing a picture of the seeds. Teacher talks about how much they have grown. The shoot and the root are growing from the seed. Child asks to photocopy the germinated and sprouting seed – then draws a picture from the photocopied picture
	Teacher talking with the children who have been rolling in the large cylinder outside. "Need to push it when you go up hill, then it goes downhill by itself" the children grin and repeat their rolling

	game.
NE	The sun goes behind a cloud and the child said "for God's sake who took the sun away." Child noticing the change
Category	**Experiences observed Jandals Kindergarten**
ECT	Twirling friends on swing, then twirling doll in swing
	At another time a different child sits on the swing and twirls it then squeals with delight as it twirls with him in it
	Child pushing friend on a swing. The friend asks her if she can push a little higher. The child pushes harder and then said "That's all I can do."
	Running toy cars down the concrete
	Showing a peer how to make the swing move by moving your legs
	Balancing and walking along a log wall
	Weighing sand
	Notices and talks with teacher about sparrow while having morning tea
	Pours water from water trough – He said I am making a stream
	Child talks about not wanting to wash his hand to another child – because it makes his hands slippery
	Trying to pop the bubbles others are making. Then she blows bubbles – noticing the different sizes of the bubbles – she seems to be concentrating to blow slowly to make big bubble
	Playing with plastic crab Child looked at the plastic crab with a magnifying glass. She said to the child next to her "I love crabs."
	Making a house for the kiwi (soft toy) in the block corner with the multiple blocks
	At the water trough sorting shell into the ones that are the same
	Child while using the glue gun talks about how the hot makes the glue runny
	Child feeling the bark on the tree notices some ants and watches them
	Notices that some of the animals in the water trough have holes in the bottom of them and can squirt. Tell the boy playing beside him

	"that can squirt." Picks up a blue seal and squeezes the seal then said with some surprise to the other boy "You can hear the air coming out of it!"
TH	Teacher and three children looking at the leaves of a plant in the kindergarten garden – Child notices a small animal and the teacher says "these are aphids and they live on the plant."
	Teacher making play dough with two children. One child says as they mix the wet and dry ingredients together "it's very gooey" noticing the texture and properties of the mixture. The teacher replied –yes it is. The teacher also comments that the hot water helps it stick together better. The teacher also talks about adding blue and red food colouring and what colour did the children think it would turn into
	Teacher sitting watching a child mix colours together. Child mixes black, white and red together and said "It makes grey." The teacher agrees "it is grey isn't it." The teacher asks "what colour she was going to use next." Red the child continues trying different colours and discussing her choices with the teacher
	Child talks to a teacher about what has happened to the pea plant. The pea plants have gone black from the frost. The teacher talks about how the cold has caused them to die
NE	Child stops and watching rain falling for about 2 minutes
	Child notices the flower on the other side of the kindergarten fence – tells the other children to look at the flower