Mathematically-rich interactions in early childhood centres

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Mathematically-Rich Interactions in Early Childhood Centres

by

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Submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

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Keywords

Mathematics, early childhood education, preschool, mathematically-rich interactions, educators, pedagogical content knowledge [PCK], pedagogical practices, socio-cultural theory, case study, photo-elicitation interviews [PEI], Australia

Abstract

This study investigated children's engagement in mathematically-rich interactions within three early childhood centres. The study explored what constitutes a mathematically-rich interaction, and how educators plan and scaffold for these in early childhood centres. The roles of the physical and social environments were also explored, along with the role children play in scaffolding these mathematically-rich interactions.

The participants in this study included the children and educators from a three-year-old kindergarten, a four-year-old kindergarten, and a three- to five-year-old long-day care room. Data include field notes and video records of extensive observations, and photo-elicitation interviews with the educators. Aligning with the socio-cultural theory that underpins this research, a thematic multimodal analysis of the video data in conjunction with the field notes produced a holistic view of the data, which is presented in the three case study chapters.

Analysis of the data identified six themes for further discussion: 1) Mathematics in the Set-Up of the Physical Environment, 2) Mathematics Embedded in Equipment, 3) Identifying the Mathematical Concepts, 4) Acknowledging Mathematics Within Other Curriculum Areas, and 5) Mathematics in Social Rules and Expectations.

The results show that mathematically-rich interactions were occurring with regular frequency in all areas of the early childhood settings. However, they also suggest that educators had difficulty identifying mathematical concepts, especially during planning and scaffolding interactions which they believed focused on other curriculum areas. Physical and social environmental factors were also shown to affect the opportunities for mathematically-rich interactions to occur through the purchase of equipment, the choices made by the educators as they set up their environments, and the social rules and expectations in the centres.

These findings help extend the knowledge base on early childhood mathematics and may be used to inform the content of early childhood education courses and professional development opportunities for practising educators.

Dedication

*To my three supervisors, Susie, Brian, and Sarah,
thank you for your support and encouragement.*

*Thank you to Deakin University and the Lean family
for the honour of receiving the Glendon A Lean Memorial Scholarship.*

Thank you to my PhD peers and staff at Deakin University for all the support along the way. Huge thank you to Kate for all the coffee and chapter swaps that helped us both get through the last stage.

*To the children and educators who participated,
thank you for welcoming into your world for a few weeks.*

To my parents and parents-in-law, thank you for being such wonderful role models, helping me to believe that anything is possible.

To the inspiration for this long journey: my children— Dan, Tina, and Josh. Thank you for all the conversations, discussions, and debates on mathematics we have had over the years.

To Mark, my husband, partner, biggest supporter. Thank you for your support as I explored a topic that I am still so passionate about, and for the belief that I was capable of completing this PhD. Without your support and confidence, this journey would have been much harder. Over the past few years, hearing you jump into conversations to explain to others, that "Yes, there IS maths in early childhood" always made me smile, as I'd realise again, how much you listened as I'd try to talk out my thoughts.

Thank you,
Kathy

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1 Rationale and Context for the Research

My own children's curiosity about mathematics influenced my choice of research topic; from a very early age, I watched them engaged in many mathematically-rich activities that included concepts such as sorting, counting, categorising, and sequencing. I started my career in early childhood education inspired by the profound influence of raising my own children, and this naturally shaped my understanding of how children learn and grow. Later, as an educator, I aimed to provide many opportunities for children to explore their surroundings within a play-based curriculum, with the freedom to ask questions, and build their own understanding of the world around them.

As I became more experienced, I realised that, despite a focus on child-initiated learning in formal early childhood settings, children's mathematical curiosity was not always followed-up by the educators; children were not always gaining the mathematical language that would allow them to understand, discuss, and develop mathematical concepts (McGoron, 2010; Sarama & Clements, 2009). While working in an early childhood centre I realised that I was observing and scaffolding affordances for mathematically-rich interactions while the children at the centre were playing. However, I was also aware that other staff appeared to be unaware of the opportunities available for such mathematically-rich interactions.

This led me to ponder how mathematics was being explored in early childhood, both by educators and by children. Was it important for children to gain an understanding of mathematical concepts and language at such an early age, or was it better to wait until the primary years for mathematical learning? What did child development theories say about children's abilities to learn mathematics? What did mathematics look like in the preschool? How were the educators shaping or supporting the children's mathematical development? What research had been undertaken in this area?

After completing my degree and honours in early childhood education, the opportunity arose to undertake a PhD and I submitted a proposal to explore this topic in depth. When talking about my PhD topic of mathematics in early childhood, the two most common responses I have heard are, “What mathematics is there in early childhood?” and “You mean children in primary school, don’t you?” These questions reinforced my determination to explore this topic in depth, and to find the means to create a better understanding with parents and within the early childhood community, that young children are capable of learning mathematics, and are constantly engaged in mathematics as they interact with their educators, peers, and families.

1.1 Early Childhood Education in Australia

Early childhood settings in Australia have traditionally focused on child *care* rather than *education*, with many childcare workers having little or no qualifications in educational pedagogy; this focus on *care* promoted the identity of a caring, nurturing person in a mothering role (C. Cross, Woods, & Schweingruber, 2009; Organisation for Economic Co-operation and Development [OECD], 2006). However, with an increase in recognition of the research highlighting the early years as a time of significant development, there has been a shift in focus from care toward education (Berk, 2012; Clements & Sarama, 2010; Lippman, Moore, & McIntosh, 2011; Thorpe, Boyd, Ailwood, & Brownlee, 2011).

In 1998, researchers in Australia joined with researchers from 11 other countries to create an international snapshot of the early childhood sector in a study commissioned by the Organisation for Economic Co-operation and Development [OECD] (2001). A second comparative report by researchers in 20 countries was released in 2006 (OECD, 2006). The title of this report, *Starting Strong II: Early Childhood Education and Care*, clearly indicates the significance of education, as the authors intentionally placed the word *education* before *care* in the title of the report. This decision, they state, was due to “the child’s right to development and education being considered a priority in all services organised for young children" (p. 22).

Government policy changes have occurred in Australia in response to growing recognition of "quality early education and care as a right of the child and provision of high-quality early education experiences as a prudent investment that benefits the individual, society and the economy" (Thorpe et al., 2011, p. 86). Changes included responsibility for Australia's Early Childhood Education sector moving from the Department of Families, Housing, Community Services, and Indigenous Affairs [FaHCSIA] to the Department of Education, Employment, and Workplace Relations [DEEWR] in 2007.

This was followed by the development and implementation of national and state early childhood frameworks in Australia in 2009 (DEEWR, 2009; Department of Education and Early Childhood Development [DEECD], 2009). These framework documents are entitled *Belonging, Being and Becoming – The Early Years Learning Framework for Australia* [EYLF] (DEEWR, 2009) and, in the State of Victoria, *The Victorian Early Years Learning and Development Framework* [VEYLDF] (DEECD, 2009). In Victoria, these documents are usually referred to as the *Frameworks*. Reforms also included the creation of a national quality rating system and assessment standard, to be overseen by the Australian Children's Education and Care Quality Authority [ACECQA] (2013).

Overall, these changes are effectively creating a new role and identity for Australian early childhood educators; what was once associated closely with motherhood and care, now must include the role of educator, requiring higher qualifications and a more professional identity (Ginsburg & Amit, 2008; Moloney, 2010; Ortlipp, Arthur, & Woodrow, 2011). Additionally, an increasingly large number of children are now attending out-of-home care in the form of long-day care or sessional kindergartens (DEECD, Adamson, 2008; 2011). Therefore, early childhood educators are now considered to share joint responsibility with children's families for providing a strong educational environment, which includes opportunities for mathematically-rich interactions and activities.

These recent changes to the early childhood regulations within the Victorian Education system have included changes in the ratio of children to educators and inclusion of educators with higher qualifications (DEECD, 2015). The ratios are now set at 1:4 for children aged birth to 24 months, 1:5 for children aged 25 – 35 months, and 1:11 for children aged 36 months up to and including preschool age. One or more degree-qualified educator is also required for each centre, depending on the number of children attending, see Table 1.1.

Table 1.1
Educator Requirements for Early Childhood Centres

Number of Children on Site	Requirements
For centres with less than 25 children	One early childhood teacher is required for at least 20 per cent of the opening hours
For centres with 25 to 59 children	One early childhood teacher is required for at least 6 hours per day (or a minimum of 60 per cent of opening hours)
For centres with 60 to 79 children	One early childhood teacher for 6 hours per day (or a minimum of 60 per cent of opening hours) plus an additional early childhood teacher for 3 hours per day (or a minimum of 30 per cent of opening hours)
For centres with 80 or more children	Two early childhood teachers are each required for 6 hours per day (or a minimum of 60 per cent of opening hours)

Within the Australian context, educators are encouraged to provide an emergent, play-based program (DEEWR, 2009; DEECD, 2009). In an emergent curriculum the educator observes a child or group of children as they are playing, and responds to their interests. By finding ways to “notice children’s questions and invent ways to extend them, document what happens, and invent more questions” the curriculum deepens and is “naturally individualized” (E. Jones, 2012, p. 67). The terms “child-initiated” and “educator-initiated” are frequently used to differentiate between activities and interactions children choose for themselves and those suggested by the educator (Pramling Samuelsson & Johansson, 2006; Robson, 2014). An effective emergent curriculum includes a balance of child-initiated and educator-initiated activities and interactions (DEEWR, 2009; DEECD, 2009).

1.2 Mathematics Education in Early Childhood

The importance of mathematics education in early childhood has been well established in the research literature, with studies highlighting the relationship between a child's early mathematical development and their later confidence and capacity to learn mathematical concepts (Aubrey, Dahl, & Godfrey, 2006; Duncan et al., 2007; Perry, 2000; van der Heyden, Broussard, & Cooley, 2006). Research by Aubrey et al. (2006) found that children who start school with higher mathematical skills and competencies, "appear to be advantaged in terms of their mathematical progress through primary school" (p. 44).

When a child's early experiences include positive interactions and experiences with mathematics, there is strong evidence to support the theory that they will develop a strong self-efficacy in mathematics (Duncan et al., 2007). This in turn, may motivate them to attempt higher mathematics classes throughout their school years, and therefore approach new mathematical experiences with confidence as they grow.

Although research shows that "young children develop an extensive everyday mathematics and are capable of learning more and deeper mathematics" (Ginsburg, Lee, & Boyd, 2008, p. 1), there is still a perception among early childhood educators that either young children are not yet capable of mathematical learning, or that teaching mathematics is not appropriate for their developmental age (Anthony & Walshaw, 2009; Arthur, Beecher, Death, Dockett, & Farmer, 2004; C. Cross et al., 2009; Ginsburg et al., 2008; Hatch, 2010).

This may be partially attributed to the strong influence of Piaget (Piaget, 1964; Piaget & Inhelder, 1958) who theorised that the child under seven had not yet reached the concrete operational stage, and "act[s] only with a view toward achieving the goal; he does not ask himself why he succeeds" (Piaget & Inhelder, 1958, p. 6) and therefore is incapable of mathematical processes such as "reasoning inductively or deductively … analyzing, synthesizing and evaluating thought … [and] may count the number but does not comprehend the meaning of cardinal and ordinal numbers" (Joubish & Khurram, 2011, p. 1262).

In an effort to negate perceptions such as these, a joint Position Paper, released in 2006 by the Australian Association of Mathematics Teachers [AAMT] and Early Childhood Australia [ECA], outlined the importance of early childhood mathematics. This position paper stated a belief that, "all children in their early childhood years are capable of accessing powerful mathematical ideas that are both relevant to their current lives and form a critical foundation for their future mathematical and other learning" (p. 1). Similarly, in the USA, the National Association for the Education of Young Children (NAEYC) and National Council of Teachers of Mathematics (NCTM) (2010), in an update to their joint Position Statement, stressed that, "A positive attitude toward mathematics and a strong foundation for mathematics learning begin in early childhood" (p. 13).

Mathematical development is also highlighted in the recently implemented EYLF in Australia as an important skill (DEEWR, 2009). Sims (2012) draws a connection between the EYLF and mathematical concepts by stating that they are "closely associated with skills identified in Early Years Learning Framework Outcome 4, such as problem solving, inquiry, experimentation, hypothesising, researching, investigating and transferring knowledge from one context to another" (p. 26).

Children are therefore considered to both benefit from, and be capable of engaging in, mathematically-rich interactions and activities. On this basis, early childhood educators are now expected to actively encourage children's exploration of mathematical concepts.

1.3 Overview of the Thesis

This research investigated children's interactions in three early childhood centres, to identify the mathematics in the activities in which the children were engaging, and to explore how these interactions were affected by their educators and peers, and by the physical and social environments in which they occurred.

The literature review in Chapter 2 explores Pedagogical Practices, Young Children's Mathematical Development

The research on young children's mathematical development is varied and, at times, conflicting (Doig, McCrae, & Rowe, 2003; Geary, 2006), but the importance of "building upon children's prior knowledge" is widely accepted (Aubrey et al., 2006; Bowman, Donovan, & Burns, 2001; R. Gelman, Meck, & Merkin, 1986). The literature has emphasized the importance of children having sufficient time to explore, and re-explore, their world to develop a strong foundation in mathematics (Clements & Sarama, 2010, 2011a; C. Cross et al., 2009; Fleer & Raban, 2005; Ginsburg et al., 2008; Sims, 2012). Fuson, Clements, and Sarama (2015) explain how "repeated experiences … give children time and opportunity to build their ideas, develop understanding, and increase fluency. Children also need time to elaborate and extend their mathematical thinking by exploring and sharing their own methods" (p. 68).

One of the initial mathematical goals set by adults is for children to learn to count. While researchers such as Piaget and Inhelder (1958) once claimed that children under seven do not fully understand the principles underpinning counting, many researchers (see, for example, Batchelor, Keeble, & Gilmore, 2015; Fleer & Raban, 2005; R. Gelman & Meck, 1983; LeFevre et al., 2006; Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010; Wynn, 1990) have now shown that children may develop this well before this age. However, while some children may initially use the numbers as labels (Ginsburg, 1977; Klibanoff, Levine, Huttenlocher, Vasilyeva, &

Hedges, 2006), Wynn (1990) argued that even infants have the ability to differentiate between small groups of objects.

In their studies with two and a half year old children, R. Gelman and Gallistel (1986) assert that it is important to “recognize that young children are motivated to count on their own, that they self-correct, and that they eventually come to count accurately” (p. 208). They demonstrate that children use schemes and procedures to gain an understanding of counting within an “environment that contains stably ordered lists to be assimilated, enables children to become skilful in the application of the how-to-count scheme” (p. 209).

Research shows that learning to count helps children build an understanding of a variety of numbers concepts (Batchelor et al., 2015; Geary, 2006; Levine et al., 2010). Geary (2006) stating that children’s mathematical development during the preschool years depends on counting skills in “representing cardinality, ordinality, and for making measurements” (Geary, 2006, p. 784).

Mathematical Content, and Pedagogical Content Knowledge to provide the context within which this research is based. Chapter 2 concludes with the Research Questions and a discussion of the significance of this research within the early childhood education context.

Chapter 3 establishes Vygotsky’s socio-cultural theory as the underlying theoretical framework used in this research. It also justifies the use of a theoretical perspective of symbolic interactionism, and discusses why a qualitative, case study approach with thematic analysis was appropriate for this doctoral study.

The research process is described in detail in Chapter 4; providing information on the context and participants, how the data collection was undertaken, the choices made to ensure the data collected answered the research questions posed, and how the data were analysed. This chapter also comments on the ethical considerations of working with educators, families, and young children.

Chapters 5, 6, and 7 present the case study findings for each of the three sites that were the focus of this study. Using vignettes from the data, these chapters explore the findings as the reader is taken through typical interactions that occurred each day in these centres.

The themes that emerged from the case study chapters are drawn together in Chapter 8, to provide a thematic discussion of the connections made between the cases.

Chapter 9 presents answers to the research questions posed in Chapter 2 and explores the implications for pre-service teaching programs and professional development; this chapter also discusses the strengths and limitations of this research and provides suggestions for further studies in this area.

2 Literature Review

This chapter focuses on four topics relevant to early childhood mathematics education. The pedagogical practices of the educators within a play-based curriculum are discussed in Section 2.1. Young children's mathematical development is examined in Section 2.2. The mathematical content identified in Australian and international curriculum documents, and in current early years research, is explored in Section 2.3.

Section 2.4 explains how pedagogical content knowledge links the pedagogical practices, the knowledge of children's mathematical development and the mathematical content to form the basis for the strategies educators use to involve and scaffold children in mathematical learning. The chapter concludes with Section 2.5, which outlines the research questions that this Doctoral study aims to answer, and Section 2.6, which outlines the significance of this research.

2.1 Pedagogical Practices in a Play-Based Curriculum

The term *Pedagogy* is generally defined as "the art or science of teaching" (Siraj-Blatchford, Muttock, Sylva, Gilden, & Bell, 2002, p. 27). *Pedagogical practices*, for the purposes of this study, are defined as the strategies used by the educators in the teaching of children. These practices are complex and multi-faceted, and are influenced by the beliefs and education of the educators. Pedagogical practices may include planned and incidental interactions with children, the scaffolding of activities, the choices made in the purchase of materials, the set-up of the physical environment, and the social rules of the environment.

In the Australian context, educators are encouraged to provide a play-based curriculum (Australian Government Department of Education Employment and Workplace Relations [DEEWR], 2009; Department of Education and Early Childhood Development [DEECD], 2009). These Frameworks encourage educators to include a mix of “child led, child initiated and educator supported learning” (DEEWR, 2009, p. 15) and reflect on ways in which they may use Intentional Teaching (Epstein, 2007).

Researchers and theorists such as Froebel, Erikson, Maslow, Montessori, Piaget, Vygotsky, and Bronfenbrenner have all contributed to the early childhood education knowledge base (Aldridge, Sexton, Goldman, Booker, & Werner, 1997; Berk, 2006; Lambert, 2003; Thomas, 2005; van Oers & Duijkers, 2012). These theorists have influenced how educators view the development and education of the child, which in turn, influence the pedagogical practices that occur within the classroom.

Research on pedagogical practices is vast. Some of the main ideas and philosophies underpinning pedagogical practices include: Constructivism (Dewey, 1938; Phillips, 1995; Vygotsky, 1978a), Developmentally Appropriate Practice [DAP] (Copple & Bredekamp, 2009), HighScope Curriculum (Epstein, 2008), Intentional Teaching (Epstein, 2007; Leggett & Ford, 2013), Montessori method (Montessori, 2013; Montessori & Gutek, 2004), Reggio Emilia approach (Malaguzzi, 1998; Soler & Miller, 2003; Vakil, Freeman, & Swim, 2003), Steiner Waldorf approach (Steiner, 2003), and the *Te Whāriki* curriculum framework (New Zealand Ministry of Education, 1996). Educators may follow one of these philosophies, or may choose facets and ideas from some and not others (Aldridge et al., 1997).

Educators or centre management can also purchase complete curriculum products. These may include a full curriculum or they may focus on specific content such as music or science. Some, such as *Creative curriculum®* (Dodge, Colker, Heroman, & Bickart, 2002) or *Building Blocks®* (Sarama & Clements, 2004), are authored by early childhood researchers. Others, such as *Musical Child®* (Biddiss, 2015), *New Child Montessori®* (Newcomb, 2015), or *Early Start®* (Trowbridge & Trowbridge, 2015) are written by practising educators. Still others such as *Teach Preschool Science* ("Teach preschool science," 2015) are sold through commercial websites with no information provided regarding the authors.

Soler and Miller (2003) note the difficulty educators face when choosing a pedagogical or curriculum model, stating that “curricula can become ‘sites of struggle’ between ideas about what early childhood education is for, and what are appropriate content and contexts for learning and development in early childhood” (p. 57). They also argue that a contributing factor can be the assumptions made regarding the role or place of the child and the educator, and that these assumptions can be portrayed as a continuum; at one end, the interests, needs, and abilities of the individual child are the primary focus; at the other end, the educator is viewed as the one with the knowledge, who decides what children should be taught in order to succeed.

Theorists such as Vygotsky (1978a) argued the importance of children being seen as active participants in their own learning; capable and competent of constructing their own knowledge through interacting with others, within their Zone of Proximal Development [ZPD]. It is through play in this preschool age, that children begin to develop the cognitive ability to imagine, and to separate what they see from what is possible. Vygotsky (1966) explains “in play activity thought is separated from objects, and action arises from ideas rather than from things” (p. 10).

Educators and centre management have a common aim of providing *high quality* early childhood services, which have been shown to improve outcomes for children (Peisner-Feinberg et al., 2001). However, choosing the pedagogical practices that individual educators believe will provide this high quality involves a value judgement that is affected by their individual pedagogical understandings and personal beliefs, as well as the context in which they are working (Ishimine & Tayler, 2013). Yet, whichever curriculum or philosophy educators choose, Siraj-Blatchford et al. (2002) argue that “in the early years any adequate conception of educative practice must be wide enough to include the provision of learning environments for play and exploration” (p. 27).

There has long been an emphasis on play and play-based learning within early childhood education research (see, for example, Pramling Samuelsson & Carlsson, 2008; van Oers & Duijkers, 2012; Vygotsky, 1966; Wood & Attfield, 2005). The "Right to Play" is listed under Article 31 in the *Convention on the Rights of the Child* by UNICEF (1989), and is also evident in Australian and International Frameworks (see, for example, DEEWR 2009; Department for Children Schools and Families (England), 2008; DEECD, 2009; National Council for Curriculum and Assessment (Ireland), 2009).

The research underpinning the Australian Early Years Learning Framework [EYLF] (DEEWR, 2009) and the Victorian Early Years Learning and Development Framework [VEYLDF] (DEECD, 2009) has a socio-cultural emphasis that suggests allowing children to learn through play, and for educators to actively engage and support this learning through conversations and interactions (Goodfellow, 2009).

The EYLF recommends educators support children's play within a learning context as it

> allows for the expression of personality and uniqueness, … enhances dispositions such as curiosity and creativity, … enables children to make connections between prior experiences and new learning, … assists children to develop relationships and concepts, … [and] stimulates a sense of wellbeing (DEEWR, 2009, p. 9).

Wood (2009) joins many researchers (see, for example, Brooker & Edwards, 2010; Pramling Samuelsson & Carlsson, 2008) defining play as "child centred". She explains that "what distinguishes play from other educational activities is that children have the freedom and autonomy to make choices based on their personal needs and interests, which enables them to control or direct play activities" (p. 167). However, she also argues that "early childhood specialists may have their own definitions of play, based on their pedagogical epistemologies, personal theories, values, beliefs, life experiences, and professional development" (p. 167). In their discussion of the overlap between play and learning, Pramling Samuelsson and Carlsson (2008) agree that play is often defined as child-initiated and fun, while learning is seen as adult-initiated and work. Yet, they also argue that it is easy to observe children learning through play and children playing while learning.

An advantage of mathematical play-based learning is the opportunities for children to engage in activities at their current level of development, which provides opportunities for them to “build on their individual knowledge and understanding. It also enables students to make errors in a supportive environment” (Holton, Ahmed, Williams, & Hill, 2001, p. 413). Copple and Bredekamp (2009) also point out that “Mathematics and literacy concepts and skills – and, indeed, robust content across the curriculum – can be taught to young children in ways that are engaging and developmentally appropriate” (p. 7).

Mathematics is included in the EYLF as part of a play-based education that helps to build lifelong learning as “children engage with increasingly complex ideas and learning experiences, which are transferable to other situations” (DEEWR, 2009, p. 19). However, the EYLF does not detail specific mathematical content to teach. The next section addresses this issue of mathematical content in an early childhood context.

2.2 Young Children’s Mathematical Development

The research on young children’s mathematical development is varied and, at times, conflicting (Doig, McCrae, & Rowe, 2003; Geary, 2006), but the importance of “building upon children’s prior knowledge” is widely accepted (Aubrey et al., 2006; Bowman, Donovan, & Burns, 2001; R. Gelman, Meck, & Merkin, 1986). The literature has emphasized the importance of children having sufficient time to explore, and re-explore, their world to develop a strong foundation in mathematics (Clements & Sarama, 2010, 2011a; C. Cross et al., 2009; Fleer & Raban, 2005; Ginsburg et al., 2008; Sims, 2012). Fuson, Clements, and Sarama (2015) explain how “repeated experiences … give children time and opportunity to build their ideas, develop understanding, and increase fluency. Children also need time to elaborate and extend their mathematical thinking by exploring and sharing their own methods” (p. 68).

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2.3 Mathematical Content

Research shows that preschool children may build vast stores of informal mathematics knowledge through their day-to-day activities, unlike the formal mathematics learning older children have in a school setting (R. Gelman & Gallistel, 1986; Purpura & Lonigan, 2013; P. Starkey, Klein, & Wakeley, 2004). There is substantial evidence to suggest that educators with strong mathematical content knowledge can help provide children with opportunities to build a strong foundation for mathematical development (Ball, Thames, & Phelps, 2008; Hedges & Cullen, 2005a; Ramani & Siegler, 2008; Shulman, 1986; Wang, Shen, & Byrnes, 2013). Engaging with other children or adults in these opportunities to explore mathematical content may place children in the ZPD (Vygotsky, 1978a) and provide the scaffolding to build children’s own mathematical knowledge and skills.

However, it is not easy to compile a definitive guide to appropriate mathematical content in early childhood. While many researchers have made suggestions on the specific content required for this age group (see, for example, Bronwell, Chen, Ginet, & Erickson Institute Early Math Collaborative, 2014; C. Cross et al., 2009; Ginsburg et al., 2008; Hedges & Cullen, 2005a), Clements and Sarama (2010) urge educators to look for the “Big Ideas” in mathematics. They define these as “clusters of concepts and skills that are mathematically central and coherent, consistent with children’s thinking, and generative of future learning” (p. 1).

Many government departments and educational organisations, both within Australia and internationally, have produced their own evidence-based curricula that include specific mathematical content. These have been expressed as *Big Ideas*, *Topic Areas to Explore,* or *Mathematical Goals.* Table 2.1 summarises the mathematical content listed in some of these Australian and International frameworks and curriculum guides for children in the early years.

Table 2.1
Mathematical Content in Curriculum Documents

Organisation/Department	Topic Areas or Goals
ACT Department of Education and Training (2008)	"Understands and applies number … chooses and uses measures … recognises and represents patterns and relationships" (p. 15).
Department of Education and Early Childhood Development [DEECD] (2009) [Victoria]	"Numbers, structure and pattern, measurement, spatial awareness and data, as well as mathematical thinking, reasoning and counting" (p. 52).
Department of Education - Western Australia (2013)	Algebra; Chance and Data; Measurement; Number; Space; Working Mathematically (p. 12).
National Council for Curriculum and Assessment (Ireland) (2009)	"Develop counting skills, and a growing understanding of the meaning and use of numbers and mathematical language in an enjoyable and meaningful way" (p. 35). "Develop an understanding of concepts like measures" (p. 47).
National Council of Teachers of Mathematics [NCTM] (2006) [USA]	Number and Operations; Geometry; Measurement (p. 11).
New Zealand Ministry of Education (1996)	"Develop early mathematical concepts, such as volume, quantity, measurement, classifying, matching, and perceiving patterns" (p. 79).
NSW Department of Community Services: Office of Childcare (2005)	"Familiarity with numbers and their uses by exploring and observing the use of numbers in activities that have meaning and purpose for children. … Skill in using the counting system and mathematical symbols and concepts, such as numbers, length, weight, volume, shape, and pattern, form meaningful and increasingly complex purposes. … Experience with some of the technology and resources for mathematics. … The expectation that numbers can amuse, delight, illuminate, inform, and excite" (p. 163).
Ontario Ministry of Education (2011) [Canada]	Number Sense and Numeration; Measurement; Geometry and Spatial Sense; Patterning; Data Management and Probability (p. 92).
Queensland Studies Authority (2006)	Number; Patterns & algebra; Measurement; Chance and data; Space (p. 54).

Scottish Executive (2004)	Number; Measurement; Shape (p. 23).
South Australia Department for Education and Children's Services (2001)	Exploring, analysing and modelling data; Measurement; Number; Pattern and algebraic reasoning; Spatial sense and geometric reasoning (p. 229).
Department for Children Schools and Families (England) (2008)	Problem Solving; Reasoning; Numeracy (p. 14), including “Numbers as Labels and for Counting … Calculating … [and] Shape, Space and Measures” (pp. 46-47).

These *topic areas* or *goals* cover various mathematical concepts using a variety of terminology, often to indicate similar ideas or topics. For example, where some use the term *Shape*, others may use *Geometry* or *Spatial Awareness*. The term *Number* appears in ten of the twelve curricula listed in Table 2.1, with each department or organisation providing a different definition as to what is included. In reviewing these documents, concepts such as Counting, One-to-One Correspondence, Ordinal and Cardinal numbers, Whole numbers and Fractions, Subitizing, Calculation, and Problem Solving can all be identified under the topic of Number. This demonstrates the variety of concepts that may be found within the mathematical content.

As an example of the complexity involved, the ACT Department of Education and Training (2008) state that within their Number topic, a child should gain an understanding of

> the meaning and relative size of numbers; counting and ordering; ways of representing numbers; relationships among numbers; and number systems. It also involves understanding the meanings of operations with numbers – addition, subtraction, multiplication and division – and the relationships between and among these operations. … [And] using reasoning processes to make sense of numerical information and to interpret and solve problems (p. 152).

Due to the complexity of the mathematical concepts in the curriculum documents in Table 2.1, the following sections aim to provide an overview of a range of the mathematical content topics mentioned.

2.3.1 Patterns and Sequencing

Seven of the curriculum documents in Table 2.1 include the term Pattern or Patterning. Papic, Mulligan, and Mitchelmore (2011) suggest “the term pattern to mean any replicable regularity” (p. 238). It has been argued that patterns are essential in mathematical development (Mulligan, Mitchelmore, English, & Crevensten, 2013; Papic, 2007; Papic et al., 2011; Warren, Miller, & Cooper, 2012). Björklund and Pramling (2013) go further, stating that “Learning to discern and communicate patterns could be seen as fundamental to human knowing and sense-making. Every domain of knowing is constituted by establishing patterns of various kinds” (p. 1).

The use of ordinal numbers and positional words or phrases, such as *first, second, before, after, last,* and *in the middle,* are an indication that children are gaining the language required to describe patterns and sequences (Ginsburg et al., 2008; Greenberg, 2012). Strong links between classification and patterns can also be found in the literature and curriculum documents. For example, in the curriculum documents for the South Australia Department for Education and Children's Services (2001) “Sorting and classifying a wide variety of familiar objects, and mathematical figures and solids, provides a sound basis for identifying the attributes that generate a particular pattern” (p. 249).

While exploring the connection between patterns and algebraic thinking, Fox (2006) suggests that “experiences with identifying, creating, extending and generalising patterns, recognising relationships, making predictions, and abstracting rules provide foundations for future algebraic development” (p. 226). Fox also reminds her readers that, “there is a need for teachers to have a deep understanding of the nature and power of mathematical patterning” (p. 227).

Equipment in early childhood centres often have opportunities for mathematical learning embedded in them (Hunting, Mousley, & Perry, 2012; Petersen & McNeil, 2013; Piaget, 1964), and this is especially true for learning about patterns. Standard equipment such as blocks, sorting sets, and craft supplies provide the children with the chance to create new patterns or extend the patterns of others.

2.3.2 Subitizing

Although Subitizing is not mentioned in the curriculum documents in Table 2.1, it can be defined as the ability to know the cardinality of a group simply by inspection (Kaufman, Lord, Reese, & Volkmann, 1949). Baroody (2004) argues that, “The development of an ability to mentally represent small collections exactly by means of a mental image, mental marker, or other non-verbal means – without number-word labels provides the foundation of a cardinal number concept” (p. 184). A common example of subitizing can be seen when children are playing dice games and recognise the numbers one through six by looking at the dots.

2.3.3 Counting

While the term Counting is only listed in Table 2.1 four times, it can be found included within the larger concept of Number in many of the curriculum documents. R. Gelman and Gallistel (1986) explain that children require an implicit understanding of five principles to be proficient in counting: One-to-one correspondence principle, stable order principle, cardinal principle, abstraction principle, and the order-irrelevance principle (p. 77).

Once language starts to develop, children are usually taught to *count*. However, like learning the alphabet, they “first learn [number words] as a list of words with no numerical meaning” (Björklund, 2010, p. 73) Many researchers (see, for example, Björklund, 2010; Clements & Sarama, 2010; Levine et al., 2010) agree that it requires varied and repetitive opportunities hearing the number words used in context to help “children coordinate these various uses and to understand the cardinal meaning of these words” (Levine et al., 2010, p. 1318).

2.3.4 Calculation

Calculation is included in the curriculum documents listed in Table 2.1 as *Operations* and within Number concepts. It can be identified in the curriculum documents through descriptors such as “Responds to the vocabulary involved in addition and subtraction in rhymes and games” (Department for Children Schools and Families (England), 2008) and “Manipulating groups of objects by combining and separating” (NSW Department of Community Services: Office of Childcare, 2005).

Research shows that young children are capable of understanding addition, subtraction, multiplication, and division problems in a foundational format (Bowman et al., 2001; Clarke, Cheeseman, & Clarke, 2006; Griffin, 2004; Warren, 2009). For example, Matalliotaki (2012) states that “younger children are fully capable of learning division, and this capacity should be cultivated sooner instead of later. … Giving [sharing] tasks to children of this age helps them create mathematical models of problem resolving that can be of great use in future formal learning of mathematics” (p. 298).

2.3.5 Fractions

In the curriculum documents in Table 2.1, the concept of Fractions was only identified explicitly by the ACT Department of Education and Training (2008) – “In the early childhood band of development, students have opportunities to understand and learn about: … the fractions of a half and a quarter” (p. 154). However, while the other curriculum documents listed do not use the term *Fractions* for the early childhood years, it is possible to identify ideas that can be interpreted as covering the foundations for fractions. For example, the Queensland

Curriculum and Assessment Authority (2010) notes that educators should explore "a whole and its parts, e.g. cutting a ball of dough into parts and then recreating the whole ball, putting together puzzle pieces" (p. 62), and the Scottish Executive (2004) give an example of "children calculating, dividing the dough and estimating equal portions" (p. 30).

Bezuk (1988) explained that it is important for children to gain an understanding of "what" fractions are, before being asked to do more advance operations with them. She suggested the use of concrete manipulatives to help develop an "understanding of fraction concepts" but stressed that manipulatives "must not be abandoned prematurely" (p. 57), encouraging their use through the early childhood years as well as in the early primary grades.

Many researchers (see, for example, Cwikla, 2014; Geist, 2009; Hunting & Davis, 1991, 2012; Siegler, Fazio, Bailey, & Zhou, 2013) have investigated the way children explore fractions, and the important role fractions play in more advanced mathematics. Siegler et al. (2013) explain that "Even infants possess a basic, non-symbolic understanding of fractions. … By age 3 years, children can draw analogies between pairs of non-symbolic fractions …. Somewhat older children use ½ as a reference point when matching non-verbal representations of fractions" (pp. 14-15). For example, even before they gain the mathematical language of fractions, children can be aware when manipulatives are not shared equally. Similar to the suggestions by Matalliotaki (2012) in the section on Calculations above, real life situations where children have an opportunity to share or divide manipulatives with others is a "natural introduction to fraction concepts" (Cwikla, 2014, p. 361).

2.3.6 Problem Solving and Data Analysis

Many of the curriculum documents in Table 2.1 mention problem solving or data analysis. The DEECD (2009) suggests children "use the processes of play, reflection and investigation to problem-solve" (p. 27). The Department for Children Schools and Families (England) (2008) have a similar focus, suggesting the child "uses developing mathematical ideas and methods to solve practical problems" (p. 46). Clements (2004b) included Data Analysis as one of the *Big Ideas*, and defined it as "classifying, organizing, representing, and using information to ask and answer questions" (p. 56).

Sarama and Clements (2009) state that it is important to provide children with opportunities to simply play with objects, as this increases their ability to later use the objects in problem-solving tasks. When including problem solving in activities or interactions with children, educators are also providing children with the opportunity to use various mathematical concepts they have used in other situations (Butera et al., 2014; Holton et al., 2001; Sarama & Clements, 2009).

2.3.7 Comparison

Comparison is a mathematical process that involves comparing objects using the same characteristic. The Scottish Executive (2004) suggests, to achieve the mathematical goals in their curriculum, children should be engaging in "activities that involve sorting, matching, comparing, classifying, and making patterns and sequences" (p. 23). When choosing the characteristic of the object to compare, children may compare based on a particular physical dimension (height, width, weight), functional use, colour, shape, or quantity (C. Cross et al., 2009). When working with numbers, "Children first learn the comparing relations equal to, more than, and less than for two groups of things or two numbers. They find out which one is bigger and which one is smaller (or if they are equal) by matching and by counting" (C. Cross et al., 2009, p. 33).

Comparing the numerosity of groups through both one-to-one correspondence activities and through the use of cardinal number, children gain opportunities to explore the concept of *numerical equivalence* and *non-equivalence* (Muldoon, Lewis, & Freeman, 2009). It is the combined use of both of these methods that

Muldoon et al. (2009) argue, provides “an essential step on the road to more mature mathematical problem-solving” (p. 207).

2.3.8 Classification

The concept of classification can be identified in the curriculum documents in Table 2.1 through terminology such as *Sorting, Matching, Classifying, Identifying Criteria, Organising, Grouping, Sets,* and *Categorise*. Aunio, Heiskari, Van Luit, and Vuorio (2015) state “the ability to classify is a fundamental element of mathematical reasoning in general” (p. 4). While early educational researchers theorised that young children are unable to classify objects prior to the “operational-age” of around seven (Piaget & Inhelder, 1964), others have argued that even infants are capable of classifying objects (Cohen & Strauss, 1979; D. Starkey, 1981).

It is now accepted in early childhood education that children have the ability to classify. This is reflected in the use of concrete manipulatives and materials such as sorting bears, blocks, and kitchen supplies. In most early childhood centres these provide children with opportunities to sort items into groups by criteria chosen by the children or suggested by educators (DeGroot, 2012; Stone, 1987). According to Platz (2004) there is a difference between *Sorting* and *Classifying*; with sorting being defined as “a beginning type of grouping task in which the way objects are to be sorted is shown or told to the children”, while classifying “requires children to discovery [sic] how a given set of objects might be grouped” (p. 89).

An important concept within classification is an understanding that the groups or sets can be sorted using different criteria (Bronwell et al., 2014; Platz, 2004; Rosen & Hoffman, 2009). Additionally, children need to become aware that once sorted into a group, objects may be counted, ordered, or compared with other groups (Bronwell et al., 2014; Swinkels, 2013).

2.3.9 Measurement

Measurement is explicitly listed in all of the curriculum documents in Table 2.1, demonstrating its perceived importance in early childhood education. The manipulatives that tend to be a standard feature of these early childhood environments also provide opportunities for measurement concepts to be explored by children in their everyday play (Copley, 2006; Yelland, 2014). It is through their everyday interactions with others that children gain numerous opportunities to learn the terminology and understand measurement with regard to height, distance, mass, volume, time, length, quantity, temperature, and area (Greenberg, 2012; Rudd, Lambert, Satterwhite, & Zaier, 2008; Swinkels, 2013).

As children build a complex understanding of measurement, research shows that they progress through stages: firstly, they will describe the size of a single attribute of an item with simple terms such as *big* or *little*, before moving on to comparing two items, then placing three or more items in order (Clements, 1999; Copley, 2006). Traditionally, children are then encouraged to measure numerically using everyday items such as blocks or by stepping, and then progress to formal units by using tools such as rulers showing metres and centimetres. However, research indicates there is the potential for young children to gain a better understanding of the formal units of measurement when they are given opportunities to use both formal and informal tools (Clements, 1999). Importantly, Copley (2006) also states that, as children increase their understanding of measurement, they also build an understanding of *Transitivity* – if Object A is bigger than Object B, and Object B is bigger than Object C, then Object A must be bigger than Object C.

2.3.10 Spatial Skills

Within the curriculum documents in Table 2.1, terminology such as *shapes, geometry, navigation,* and *mapping* were all identified within the topic of spatial awareness. Spatial skills have been shown to positively impact other mathematical domains such as classification, number concepts, measurement, and arithmetic (Casey, Erkut, Ceder, & Mercer Young, 2008; Clements & Sarama, 2011b). Casey et al. (2008) explain that “Spatial skills not only impact specific content areas in mathematics … which have strong spatial components, but also represent a strategy that is distinct from more analytical, verbal, logical-deductive strategies for mathematical problem solving” (Casey et al., 2008, p. 30).

Children’s spatial skills include the ability to move their bodies and objects through space and in relation to other people and objects around them (C. Cross et al., 2009; Joh, Jaswal, & Keen, 2011; Lee, 2012). Children need opportunities to engage in spatial activities and interactions that include verbal and written information; activities such as jigsaw puzzles, treasure maps, blocks, and games such as *Hide and Seek* help to build these skills (Clements, 2004a; Davis & Hyun, 2005). As C. Cross et al. (2009) point out, “humans are unique in that their spatial skills are extended through symbolic systems, such as spatial language, measurement units, maps, graphs, and diagrams” (p. 72).

Included within spatial awareness are geometric skills such as the recognition of, and terminology for, common shapes (for example, rectangles, circles, triangles). These are often the first geometric concepts that children are taught by their parents, providing them with a foundational knowledge prior to entering preschool (Clements, 2004a; Ginsburg et al., 2008). Clements, Wilson, and Sarama (2004) propose that children’s understanding of shapes develops through stages, moving

> from placing shapes separately to considering shapes in combination – from manipulation – and perception-bound strategies to the formation of mental images (e.g., decomposing shapes imagistically); from trial and error to intentional and deliberate action and eventually to the prediction of succeeding placements of shapes; and from consideration of visual “wholes” to a consideration of side length, and, eventually, angles (p. 166).

Block play has also been shown to provide children with many opportunities to explore these concepts in early childhood settings (Eberly & Golbeck, 2004; Park, Chae, & Boyd, 2008; Piccolo & Test, 2010).

Van Hiele (1999) suggests there are five phases in the exploration of shapes. First there is the “Inquiry phase”, where children engage with shapes as they play. The second phase, “Direct orientation”, includes tasks and activities that encourage children to explore the properties and structure of the shapes. The third phase, “Explicitation”, highlights the importance of the educator providing terminology and encouraging children to use these words and terms in their play. “Free orientation” is the fourth stage, where the tasks and activities suggested allow for flexible solutions. The final phase suggested by Van Hiele is “Integration” where the children are encouraged to create their own tasks and “pull together what they have learned” (p. 316).

However, further research by Clements and Sarama (2011b) found that, if educators do not have the content knowledge to effectively scaffold children’s geometric skills, this content may become “often ignored or minimized” (p. 133). This lack of opportunity may result in children only gaining a basic terminology of shapes, rather than becoming aware of more advanced ideas such as – shapes can be classified by their own attributes, that objects are able to be rotated and flipped, as well as combined or divided to form new shapes (Clements, 2004a; Park et al., 2008).

2.3.11 Mathematical Language

An important theme running through the research on early childhood mathematics is the importance of mathematical language (AAMT & ECA, 2006; DEEWR, 2009; Copley, 2000; Rudd et al., 2008). However, it is important to remember that, even before the age when children are able to communicate through spoken language, they are capable of pre-mathematical play; they demonstrate this as they use classification and seriation to sort and stack blocks, or respond to requests for particular objects (Geist, 2009; Hughes, 2010; Tizard & Hughes, 2003).

As children engage in mathematically-rich interactions with their educators and peers, they are practising their mathematical language which, like all language development, improves with use (Arthur et al., 2004). Therefore, educators who use open-ended questions and ask children to re-tell problems in their own words help to extend children's mathematical language, development, and thinking (DEEWR, 2009; C. Cross et al., 2009; DEECD, 2009; van Oers, 2010).

However, Clements and Sarama (2011a) highlight an issue for those children who lack conversational opportunities in their pre-mathematical play. Stating a belief that children learn from "their informal experiences by abstracting, representing, and elaborating them mathematically" (p. 968), they theorize that a lack of conversational opportunities may result in children not being "able to connect this activity to school mathematics … [or] bring implicit mathematical ideas to an explicit level of awareness" (p. 332). Therefore, educators with a strong mathematical content knowledge are better placed to provide these mathematically-rich interactions and support children as they engage in conversations and build these mathematical connections.

2.4 Pedagogical Content Knowledge

Shulman (1986) first identified Pedagogical Content Knowledge [PCK] as one of three categories of content knowledge; the other two being "subject matter content knowledge [and] curricular knowledge" (p. 8). He explained that PCK "represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8). Shulman clarifies this definition, stating, that PCK "goes beyond knowledge of subject matter *per se* to the dimension of subject matter knowledge *for teaching*" (p. 9).

While Shulman was not specifically discussing PCK in early childhood education, there are similarities to be found in the early childhood literature. Anthony and Walshaw (2009) argue that, if researchers and educators are to ensure an effective mathematics program for young children, they need "to develop an increased awareness of effective pedagogical practices within the preschool years" (p. 108). Ginsburg and Amit (2008) also refer to PCK in their study of mapping in an early childhood setting, and find that "the teacher has to know the content, has to use appropriate pedagogical content knowledge, has to motivate, [and] has to assess the children" (p. 284).

PCK is also referred to in the early childhood mathematics intervention literature. Clements and Sarama (2011a) found that, while "young children have the potential to learn mathematics that is both deep and broad" (p. 970), a lack of opportunities to engage in mathematical tasks can result in children in whom "this potential has been unrealized" (p. 970). They propose that an educator who understands the mathematical content and how to present this to children through "developmentally sequenced activities" (p. 969) has the ability to help these children. Similarly, C. Cross et al. (2009) list "a goal, a developmental progression, and matched activities … [as] effective in developing children's skills" (p. 249).

As discussed in Section 1.2, these researchers have highlighted the importance of educators' understanding that children's mathematical development follows *sequences* or *progressions*. When educators are unaware of, or choose to ignore, these developmental paths, children's opportunities to build on their experiences are reduced. In essence, "experiences may be so disconnected from one another that, while each is agreeable or even exciting in itself, they are not linked cumulatively to one another" resulting in an inability to build on the experiences (Dewey, 1938, p. 26).

Therefore, despite the possibility of children's interactions during free-play being mathematically-rich and providing incidental learning, many researchers regard the supporting role of the educator as essential if children are to develop strong mathematical concepts (see, for example, Anthony & Walshaw, 2009; Hatch, 2010; Papic, Mulligan, & Bobis, 2009; Wilcox-Herzog & Kontos, 1998). Wilcox-Herzog and Kontos (1998), exploring the various forms of educator-child interactions, found strong research evidence to suggest that "children play at higher levels, solve more problems, and display more on-task behaviors when they interact with teachers who use suggestions, open-ended questions, and elaborative statements" (p. 31). Anthony and Walshaw (2009) propose that, without scaffolding or support, children's free-play is "unlikely to provide sufficient support for young children's mathematical development" (p. 110).

These findings concur with Vygotsky's (1978a) socio-cultural theory of learning, which includes the "Zone of Proximal Development [ZPD]", where he proposes that it is within a group activity, or under the guidance of an experienced other (either adult or peer), that children's capabilities are enhanced and are able to develop from their current level. Hatch (2010) explains: "learning happens in the exchanges between adults (or more competent others) and children around tasks about which the adult is an expert and the child is an apprentice" (p. 260).

While the EYLF and VEYLDF do not clearly articulate specific core mathematical content goals, they do explain that *Numeracy* "broadly includes understandings about numbers, structure and pattern, measurement, spatial awareness and data, as well as mathematical thinking, reasoning and counting" (DEEWR, 2009, p. 43; DEECD, 2009, p. 52). Furthermore, the EYLF notes, "It is essential that the mathematical ideas with which young children interact are relevant and meaningful in the context of their current lives", highlighting the importance of educators having "a rich mathematical vocabulary to accurately describe and explain children's mathematical ideas and to support numeracy development" (DEEWR, 2009, p. 38).

The importance of educators' reactions and responses has also been noted in many of the international early years frameworks (Department for Children Schools and Families (England), 2008; see, for example, National Council for Curriculum and Assessment (Ireland), 2009; New Zealand Ministry of Education, 1996) with the framework from British Columbia (Government of British Columbia, 2008) clearly stating, "Adults' responses to children's activities – whether they respond, the appropriateness of their responses, and the creativity of their responses – affect young children's early learning capacities" (p. 10).

Unfortunately, these interactions do not always support mathematical development, because as van Oers (2010) claims, "many opportunities to promote the beginnings of mathematical thinking are missed in practise [sic]" (p. 31). Copley (2000) explains that planning for children "to reach their true potential in mathematics" is important, and suggests that this is achieved by educators who

> spend time observing, listening, and watching children. Pay attention to what they like, listen to their reasoning, ask them to explain their creations, challenge them with tasks that seem impossible, and give them the opportunity to show you what they can do in the way they want (p. 2).

Copley (2000) stresses the importance of connecting these observations and interactions with the educator's "mathematics content knowledge" and their "instructional strategies" (p. 11). Sarama and Clements (2009) also stress the importance of observing children's play for opportunities to scaffold or support mathematical learning, suggesting that "when mathematical thinking is stalled, the teacher can discuss and clarify the ideas" and that the educator needs to "be ready to alter materials and their interactions to give it encouragement, give it language, and give it their full appreciation" (p. 325).

According to Cheeseman, McDonough, and Ferguson (2012), when children are engaging in interactions that are mathematically-rich, they have the opportunity to build a “conceptual understanding in mathematics” and consequently, this may “challenge children to think, and foster the communication of mathematical reasoning” (p. 1).

Cruikshank, Fitzgerald, and Jensen (1980) describe the process as one in which children use these multiple experiences to abstract “the common property of several seemingly disconnected examples” and make a connection between them. “The abstraction that is made is a concept. Children learn their mathematics by abstracting concepts from concrete experiences” (pp. 7-8). S. Gelman (1999) explains that concept development assists children in tasks such as “identifying objects in the world, forming analogies, making inferences that extend knowledge beyond what is already known, and conveying core elements of a theory” (pp. 51-52).

Mathematical terminology is also stressed by van Oers (2010), who affirms that the foundations for later mathematical thinking are often laid during interactions when the educator “acknowledges the children’s (spontaneous) actions” as mathematical (p. 29). Referring to the Vygotskian theory of the Zone of Proximal Development [ZPD], he argues that it is only when the adult reacts to a child’s action by demonstrating its potential mathematical use and sharing mathematical terminology that a child will start to internalise this knowledge and build a strong mathematical base.

2.5 The Research Questions

Tudge and Doucet (2004) make the claim that much of the research exploring children’s mathematical abilities has been undertaken through “experimental studies or those involving short-term observations of carefully structured episodes of child or child–mother interaction with mathematical objects” (p. 22). These observations of individual children, in formal settings, raise the possible issue that removing the child from their natural environment may not provide a clear picture of the range of mathematical activities in which children may be participating, while playing in an early childhood setting. Anthony and Walshaw (2009) report that recent research has found that “many early childhood teachers are unclear about recognising mathematical learning” (p. 116), highlighting a gap in the research on how educators can identify the mathematical concepts in the activities in which children are engaging. Additionally, as Kokkinos (2009) argues, further study is required into “the frequency and quality of mathematics education in Australian prior-to-school settings” (p. 6).

A report from the National Association for the Education of Young Children (NAEYC) and National Council of Teachers of Mathematics (NCTM) (2010) has also noted that while continuing research is providing details on “the mathematics young children are able to acquire and the practices to promote their understanding. This knowledge … is not yet in the hands of most early childhood teachers in a form to effectively guide their teaching” (p. 2). Given this focus on mathematics in the early childhood sector, this research will investigate the mathematically-rich interactions that are occurring in early childhood settings.

To support this investigation, the study will address the following four research questions:

RQ1: What constitutes a mathematically-rich interaction in early childhood centres?

RQ2: How do early childhood educators plan and scaffold for mathematically-rich interactions?

RQ3: What roles do the physical and social environments play in mathematically-rich interactions?

RQ4: What role do children play in scaffolding mathematically-rich interactions?

2.6 Significance of This Study

Early childhood has been shown to be an appropriate time to build children’s foundations for later mathematical learning and success. In order to ensure that children in early childhood learning environments are provided with adequate opportunities to develop these often neglected understandings, concepts and skills, this study will explore the mathematically-rich interactions in which young children are engaging within a play-based curriculum, and explore the opportunities educators have for supporting these.

The exploration and analysis of the mathematics in these interactions will form the basis of a set of recommendations to assist educators and pre-service educators to develop appropriate PCK, so that providing opportunities for quality mathematics learning becomes a standard part of early childhood education.

3 Methodology

When planning the research design, it was essential to reflect on the research questions, purpose of the research, and my personal beliefs and values, to build a solid foundation on which to base the study (Crotty, 1998; Dew, 2007; Lewin & Somekh, 2011). Marshall and Rossman (2010) suggest that researchers take into account “the should-do-ability, do-ability, and want-to-do-ability of the proposed project” (p. 22). The challenge, which they describe as a “complex, dialectic process” (p. 22), is to design a research study that suits the abilities, resources, and time frame of the researcher, and which also answers the proposed research questions.

3.1 Socio-Cultural Theory

Crotty (1998) defines epistemology as “the theory of knowledge, embedded in the theoretical perspective and thereby in the methodology” (p. 2). Whilst Lewin and Somekh (2011) agree, they also highlight “the researcher’s own way of seeing the world” (p. xix) as an important factor when designing a research study. The range of epistemological positions is vast – objectivism, realism, positivism, and constructivism are just some of the possible choices. However, it is socio-cultural theory that resonates most closely with this researcher’s world view, and with the research questions being investigated.

Lev Vygotsky (1896–1934), a highly regarded theorist in education, was known as the “Father of SCT [Socio-cultural Theory]” (Swain, Kinnear, & Steinman, 2010, p. x). He believed that, through the use of cultural tools and symbols, children are able to understand their culture and community, and become full participants in their own society (Vygotsky, 1978b). Within this study, the children are all engaging in interactions outside of their family home, within the larger culture and community of their kindergarten or childcare centre. The role and influence of the environment in which children are living, according to Vygotsky (1994), provides differing roles and meanings depending on the age and abilities of the child. He argues that it is how children understand what is occurring around them and how they react that is important, explaining, “the relationship between the environment and the child and not just the environment in its own right, or just the child in its own right, [that] will always be central” (p.346) to the influence of the environment to development.

Participation in social activities, such as the interactions that occur in early childhood education and care settings, has been shown to assist in the development of children’s identity and their understanding of the cultural norms and values of their society (Bronfenbrenner, 1986; Entwisle, Alexander, & Olson, 2005; Vygotsky, 1978a). Rogoff (2008) argues that “participation involves creative efforts to understand and contribute to social activity, which by its very nature involves bridging between several ways of understanding a situation” (n.p.).

Rather than the teaching of specific content or skills, Vygotsky focused his research on “the development of children’s learning abilities – that is, their capacity to think clearly and creatively, plan and implement their plans, and communicate their understanding in a variety of ways” and argued that this is the true meaning of education (Doyla, 2009, p. 8). A similar focus can also be found in Australia’s national Early Years Learning Framework (DEEWR, 2009) which highlights the importance of children gaining strong “dispositions to learning” (p. 25).

Robbins (2007) discusses Vygotsky’s theory regarding the lower and higher mental processes children develop, stating that “over time, with the mediation of signs and other symbol systems, and tools, these processes progressively are transformed into (rather than being replaced by) higher mental functions” (p. 51).

These transformations are often observed in children who are working within their *Zone of Proximal Development* [ZPD] (Chaiklin, 2011; Vygotsky, 1978a). The ZPD, an important idea put forth by Vygotsky, can be defined as the space between the child’s current, independent ability and their potential ability when working with more capable others (Vygotsky, 1978a). Educators in early childhood centres, especially those with an emphasis on play-based curriculum, provide ample social activities and interactions that place children within this ZPD. Children interact with their educators and each other through conversations, arguments, imitation, and direct teaching. Hedges and Cullen (2005b) put forward the idea that "A socio-cultural view of children as capable and competent, suggests that children's beliefs might also impact on the curriculum and pedagogy they experience" (p. 67). Each of these activities and interactions has the potential to scaffold children's learning and development.

The use of Vygotsky's socio-cultural theory also helped articulate the research questions for this study. Terminology such as "interaction", "scaffold", and "each other" used in the research questions reflects the importance Vygotsky placed on the social connections that assist in the development of the child.

My own beliefs on the learning and development that occurs in the years prior to school correspond closely with Vygotsky's theory. Reflecting on Vygotsky's work helped provide a framework for the research process and analysis of the data. To stay aligned with this theory, the collected data needed to capture the interactions of the educators and the children within the social context of the early childhood environment. Further details regarding this aspect of the research can be found in Chapter 4.

3.1.1 Symbolic Interactionism

Crotty (1998) defines theoretical perspective as "the philosophical stance informing the methodology and thus providing a context for the process and grounding its logic and criteria" (p. 3). Wenger (2008) further defines the perspective as "a guide about what to pay attention to, what difficulties to expect, and how to approach problems" (p. 215).

The term *symbolic interactionism* was first used by Blumer in 1937 to help define the pragmatic social research undertaken by Mead (Barbalet, 2009). Barbalet (2009) explains that "symbolic interactionism is an approach that builds on the social formation of symbols, common or shared meanings, and their use in communication, both within the self and in self's orientation to others, in interactions between social agents" (p. 206).

Yackel (2004) explains that the core of symbolic interactionism is found in "the process of interpretation in interaction". It explores how individuals, when

> interacting with one another, … have to take account of (interpret) what the other is doing or about to do. Each person's actions are formed, in part, as she changes, abandons, retains, or revises her plans based on the actions of others (p. 4).

This is consistent with the work of Vygotsky, and was chosen as the theoretical perspective for this research project as it guides the researcher to take note of the social construction of the interactions under analysis. Blumer (1986) stresses that symbolic interactionism requires three assumptions:

> [firstly,] that human beings act toward things on the basis of the meanings that the things have for them … [secondly,] that the meaning of such things is derived from, or arises out of, the social interaction that one has with one's fellows … [and thirdly,] that these meanings are handled in, and modified through, an interpretative process used by the person in dealing with the things he encounters (p. 2).

I believe these assumptions resonate with research on children's early foundations of mathematical understanding and communication, which rely on the child's grasp of common symbols and the shared meaning held by the participants within their culture, as explored by Vygotsky (1978a). Therefore, symbolic interactionism is an appropriate theoretical perspective for this study.

3.2 Methodological Approaches

The range of methodological approaches available to researchers includes both quantitative and qualitative approaches (Creswell & Creswell, 2005; Denzin & Lincoln, 1994). Methodology, as defined by Crotty (1998) is “the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes” (p. 3). Therefore, the first of many choices that I needed to consider when planning this methodology was that of qualitative, or quantitative approaches, or a combination of the two approaches.

3.2.1 Quantitative or Qualitative Research

Once argued to be “the first and only research design choice” (Leech & Onwuegbuzie, 2009, p. 266), quantitative research lacked the subjectiveness that social scientists looked for in their studies on human interactions; many education researchers embrace qualitative approaches, which allow for a greater depth of descriptive information in the data (Babbie, 2008; Creswell & Creswell, 2005; Denzin & Lincoln, 1994, 2011; Leech & Onwuegbuzie, 2009). Additionally, social researchers have argued against the use of quantitative approaches due to the way they require the removal of context, and ignore the uniqueness of individual phenomena being studied (see, for example, Guba & Lincoln, 1994; Stake, 2010).

The differences between quantitative and qualitative approaches in research are well-documented (Babbie, 2008; Bryman, 2006; Creswell, 2009; Denzin & Lincoln, 1994; Neuman, 2006). An overview of these differences is set out in Table 3.1.

Table 3.1
Qualitative Versus Quantitative Reseach

Qualitative	Quantitative
Context rich	Context controlled or removed
Descriptive	Numerical
Experiential	Experimental
Data are observed and interpreted	Data are measured and counted
Data collection is less structured	Data collection is structured
Open-ended choices	Specified choices
Non-statistical	Statistical
Small sample	Large sample
In-depth details	Overview
Vignettes and Anecdotes	Tables and Graphs
Uniqueness	Replicable
Subjective	Objective

Many researchers argue that the aim or purpose of the research dictates which approach they choose. For example, Schofield (1990) explains that qualitative research “is often valued for its intrinsic interest, for showing the rich variety and possible range of human behaviour” (p. 202). Or, as Leedy and Ormrod (2013) write, “qualitative researchers rarely try to simplify what they observe. Instead they recognise that the issue they are studying has many dimensions and layers, and they try to portray it in its multifaceted form” (p. 139).

By way of contrast, quantitative researchers will often narrow the focus, and “isolate the variables they want to study, use a standardized procedure to collect some form of numerical data and use statistical procedures to analyze and draw conclusions from the data” (Leedy & Ormrod, 2013, p. 95). This allows for a larger representative sample to be analysed to explain and predict quantifiable patterns in the data. A purely quantitative study of children’s mathematics could produce valid and generalizable research; however, it would not provide the “rich variety” (Schofield, 1990) or the contextual factors that I aim to explore as I answer the research questions that underpin this study. Additionally, while large-scale studies will generally use a quantitative approach to allow for faster statistical analysis, this smaller doctoral study is better suited to a qualitative approach.

It is also important to understand that overlap of the two approaches within a research study often occurs. However, the dominant choice of approach for this study is qualitative.

3.2.2 Qualitative Research

Stake (2010) emphasises the great variety within qualitative research, stating that:

> There is no one way of qualitative thinking, but a grand collection of ways: It is interpretive, experience based, situational, and personalistic. Each researcher will do it differently, but almost all of them will work hard at interpretation. They will try to convey some of the story in experiential terms. They will show the complexity of the background, and they will treat individuals as unique, yet in ways similar to other individuals (p. 31).

Both Creswell (2013) and Wertz, Charmaz, McMullen, Josselson, Anderson, and McSpadden (2011) propose five qualitative research approaches. Both include – Phenomenology, Grounded Theory, and Narrative Research. Wertz et al. (2011) also include Discourse Analysis and Intuitive Inquiry, while Creswell (2013) completes his list with Ethnography and Case Study. However, Creswell also notes that Participatory Action Research may be considered a sixth valid approach (p. 4). The following sections will explore a selection of the approaches that were considered for this particular study, and justify my choice of case study as the preferred approach.

Narrative Research

The term *Narrative*, within research methodology, is used in the exploration of personal stories as told by the participants (Liamputtong, 2013). While the data may be collected through oral or written texts, these narratives offer the individual's account of lived experiences or events and include all their biases and personal background.

Using a narrative approach, I could potentially have collected data directly from the educators about their experiences teaching mathematics in an early childhood environment, or from the children about their experiences within these environments. However, this narrative approach would not offer the analytic processes for exploring the interactions that are the focus of my research. Therefore, this style of research was deemed not suitable for this particular study.

Grounded Theory

The main aim of grounded theory is to "develop theory that is grounded in data systematically gathered and analyzed" (Strauss & Corbin, 1994, p. 274). The research questions for this doctoral study aim to identify the mathematically-rich interactions occurring in early childhood settings, rather than develop a theory as to why they are occurring. Grounded theory, therefore, was not found to be an appropriate methodology for this study.

Phenomenology

Phenomenology, which was first described by Husserl (2008) as a philosophical method of research, is currently defined and implemented in many ways. In simplistic terms, it is the study or description of phenomenon, and the understanding of their meaning from the viewpoint or perspective of the participants involved (Giorgi, 2008; Schweitzer, 2002; Van der Mescht, 2004; Wiersma & Jurs, 2005).

My experience as an early childhood educator may provide the knowledge and experience within the early childhood context to contribute "the proper sensitivity to the analysis and provide a perspective that enables the data to be manageable" (Giorgi, 2008, p. 2). However, my aim was to identify the mathematically-rich interactions that were occurring and how these were supported, not to explore the essence of the phenomenon itself. Accordingly, the choice of phenomenology to research this general topic, or phenomenon, would be more appropriate if the research questions focused on the lived experiences of teaching mathematics to young children, rather than on identifying the mathematically-rich interactions that were occurring.

Participatory Action Research

As the name implies, participatory action research involves both participation and action on the part of the researcher. The researcher collaborates with participants in a cyclic pattern of assessment, reflection, and action to provide practical answers to problems affecting the participants, their communities, or workplaces (Jackson, 2011; Reason & Bradbury, 2008). Reason and Bradbury (2008) further argue that “it is not so much a methodology as an orientation to inquiry that seeks to create participative communities of inquiry in which qualities of engagement, curiosity and question posing are brought to bear on significant practical issues” (p. 1).

This approach takes a very practical form and can offer a valid approach to exploring and enhancing the mathematically-rich interactions occurring in early childhood centres. However, the intent of this research was to identify what was already occurring and to explore the factors affecting the interactions, not engage in a cyclic process to change outcome.

Ethnography

Ethnographic research explores a particular culture or sub-culture and the “shared and learned patterns of values, behaviors, beliefs and language” of its inhabitants (Creswell, 2013, p. 90). Early childhood centres can be defined as a “culture-sharing group” and therefore valid for an ethnographic study. However, this research was less focused on the many facets of “the group”, than on identifying the particular mathematically-rich interactions and activities that were occurring within the centres, and how these were planned and scaffolded. Due to this, ethnography was also discarded as an approach for this study.

3.2.3 Case Study Approach

The definition of a case study approach within the research literature varies, from the viewpoint put forth by Stake (1978) that the case study is what is produced and the form in which it is presented to the audience, through to Yin’s (1981a) proposal that the case study is a “serious research strategy” (p. 98) and comparable to methodologies such as experiments and histories.

However, there are commonalities that span these definitions, including an exploration of a particular phenomenon or real life events or situations, and the importance of collecting multiple sources of data (Burns, 1997; Easton, 2010; Stake, 1978; J. White, Drew, & Hay, 2009; Yin, 1981a, 2009). Burns (1997) proposes that case studies are “the preferred strategy when ‘how’, ‘who’, ‘why’ or ‘what’ questions are being asked … or when the focus is on a contemporary phenomenon within a real life context” (p. 365). Moreover, Yin (2009) and Bell (2010) concur, as they also recommend case studies as the appropriate tool for the researcher trying to identify the characteristics of a phenomenon. This is further discussed by Woodside (2010), who explains that case studies are used where a principal objective is the “deep understanding of the actors, interactions, sentiments, and behaviors occurring for a specific process through time” (p. 6).

Stake (2010) suggests researchers “try to observe the ordinary, and they try to observe it long enough to comprehend what, for this thing, ‘ordinary’ means” (p. 32). The socio-cultural context of each early childhood environment is highly relevant to the mathematically-rich interactions that occur and, as Yin (1981a, 1981b) discusses, when the phenomena is difficult to examine independent of its context, the use of a case study approach is highly appropriate.

There is a general consensus that data collected for a case study may come from multiple sources and may include surveys, field notes, interviews, archival records, documents, verbal reports, and observations (Bowen, 2009; Burns, 1997; Murray & Lawrence, 2000; Ritchie, Lewis, & Elam, 2003; J. White et al., 2009; Yin, 2009). The sources of data for this study are discussed in detail in Section 4.2 (p. 55) and include video observations, field notes, planning and policy documents, and photo-elicitation interviews [PEI].

A case study approach requires boundaries that are identifiable and defined, so that the reader may move from the specific case to a generalisation (Easton, 2010; Stake, 1978; Yin, 2009). The main boundaries defined for this study are that the sites chosen for investigation are all early childhood centres, as opposed to other contexts, such as the family home or a research-based experimental environment. By entering the formal early childhood settings rather than entering the child's home or creating an artificial environment, I aimed to observe a more naturalistic experience of the mathematically-rich interactions that are occurring in early childhood centres.

Regarding qualitative research in general, issues of validity and reliability have been raised in the literature (Flyvbjerg, 2006; Golafshani, 2003; Miles & Huberman, 1984; Noble & Smith, 2015). Traditionally, quantitative researchers use a Positivist approach, based on universal laws, true facts and mathematical data, to demonstrate the validity of their research (Golafshani, 2003; Yin, 2013). Golafshani (2003) however, states that "Reliability and validity are conceptualized as trustworthiness, rigor and quality in qualitative paradigm" (p. 604). Therefore, the case study approach, which provides in-depth details makes transparent the context, methods, and view point of the researcher so that the reader is provided with the information they require to trust the research (Noble & Smith, 2015).

Schofield (1990) describes the goals of a qualitative study as "a coherent and illuminating description of and perspective on a situation" (p. 203), while Stake

(2010) states "the qualitative researcher usually tries to assure the reader that the purpose has not been to attain generalization, but to add situational examples to the readers' experience" (p. 23). Therefore, while the choice of using a qualitative approach as opposed to a quantitative approach may reduce the generalizability of the results, the descriptive nature of a case study creates an opportunity for the reader to create their own connection to the research.

Included in the aims of this study is the identification of the mathematically-rich interactions in which the children are engaged; it is through the analysis of the rich descriptive data that a case study collects, that this aim will be realised.

3.3 Thematic Analysis

Thematic analysis is a systematic method of recognising what is being seen within the data so that it can be examined, sorted, and interpreted by the researcher. Thematic analysis is utilised in a multitude of research methodologies and, due to this, there is a broad range of terminology in use, each defined differently depending on the researcher's background and beliefs (Boyatzis, 1998; Ryan & Bernard, 2003; Schreier, 2012). Therefore, a discussion regarding the appropriate terminology to be used in this research is presented below.

Opler (1945) first used the term *Theme* "to denote a postulate or position, declared or implied, and usually controlling behavior or stimulating activity, which is tacitly approved or openly promoted in a society" (p. 198). He also defined the term *Expression* to indicate "the activities, prohibition of activities, or references which result from the acceptance or affirmation of a theme in a society" (p. 199). Ryan and Bernard (2003) draw our attention to the similarities between Opler's "Themes and Expressions" and terminology used by other social scientists, such as "categories and incidents" (Glaser & Strauss, 1967), "codes and chunks" (Miles & Huberman, 1994), and "labels and data-bits" (Dey, 1993). A more contemporary definition of the term *Theme* comes from Boyatzis (1998), where he states, "A theme is a pattern found in the information that at the minimum describes and organizes possible observations or at the maximum interprets aspects of the phenomenon" (p. vi).

Within this study, I have chosen to adopt Boyatzis' (1998) definition of the term *Theme* to describe ideas, thoughts, or patterns that emerge from the data during analysis. It is important to note that "themes are abstract (and often fuzzy) constructs that link not only expressions found in texts but also expressions found in images, sounds, and objects" (Ryan & Bernard, 2003, p. 87).

In this study, the term *Code* is used in the traditional sense, as the "tags or labels for allocating units of meaning to the descriptive … information" (Basit, 2003, p. 114). The sections of the interactions that can be used to demonstrate each code will be labelled as such. These codes will then be used to provide evidence of, and for, the themes.

An important task in research is to be explicit about the way in which themes and codes are gathered or identified. By discussing the process used to identify these, the researcher is ensuring that there is transparency available for other researchers to evaluate the methodological choices being made (Ryan & Bernard, 2003). Further details on the identification and sorting of codes and themes for this study are discussed in Sections 4.4 (p. 75) and 4.5 (p. 88).

3.3.1 Multimodal Analysis

Multimodal analysis techniques were also employed within the thematic analysis used in this study. In recent years, as technology has altered how we communicate, projects using data analyses that focus only on "speech and writing no longer appear adequate in understanding representation and communication" (Jewitt, 2011b, p. 3). As researchers have struggled with the complexities of modern day communication and possibilities for data collection, a multimodal form of analysis has become more popular (Dicks, Flewitt, Lancaster, & Pahl, 2011; O'Halloran, 2011).

An unambiguous definition of multimodality, however, is difficult to locate as the term is used throughout the literature in numerous ways, including “interchangeably with the terms ‘multimedia’ or ‘multisensory’, to refer to projects where data generated are not primarily linguistic or numeric” (Dicks et al., 2011, p. 228). Within this research study, the definition of multimodal analysis, offered by O'Halloran (2011), as “the study of language in combination with other resources, such as images, scientific symbolism, gesture, action, music and sound” (p. 120) will be used.

Multimodal analysis views all forms of data as “intimately connected, enmeshed through the complexity of interaction, representation and communication” (Jewitt, 2011b, p. 1) and therefore, explores them across traditional analytic boundaries and within the context of the situation. Kress and Van Leeuwen (2001) also highlight that, unlike meanings in traditional linguistic analysis, meanings in multimodal research can be fluid and change with differing contexts. To analyse this fluidity of meaning, an awareness of how the participants within the activity are embedded within the surrounding context is required. For example, for the researcher to be able to analyse an observation of children playing, an awareness and understanding of such things as the roles they are enacting, the classroom culture, the previous activities that led to this episode, and the scaffolding by the educators, is required.

The complexity of multimodal analysis therefore may require an analysis of video, photographs, and videoed interview data in their original modes, together with the traditional approach of using transcripts created from the multimedia data. Computer software allows the researcher to directly code video and photographic data, as well as create traditional and gisted transcripts to augment this analysis (see Section 4.4, p. 75 for further details).

3.4 Summary of the Methodology

The methodology chapter for this research study includes three sections, as shown in Figure 3.1. The theoretical framework for this research study design drew on influences from the socio-cultural theory of Vygotsky, and from the theoretical perspective of symbolic interactionism (Blumer, 1986) as discussed in Section 3.1. This theoretical framework influenced my choice to undertake qualitative research using a case study approach as the overarching methodological approach for the design and implementation of the research, as discussed in Section 3.2. Multimodal analysis techniques were then employed as a part of a larger thematic analysis, as discussed in Section 3.3.

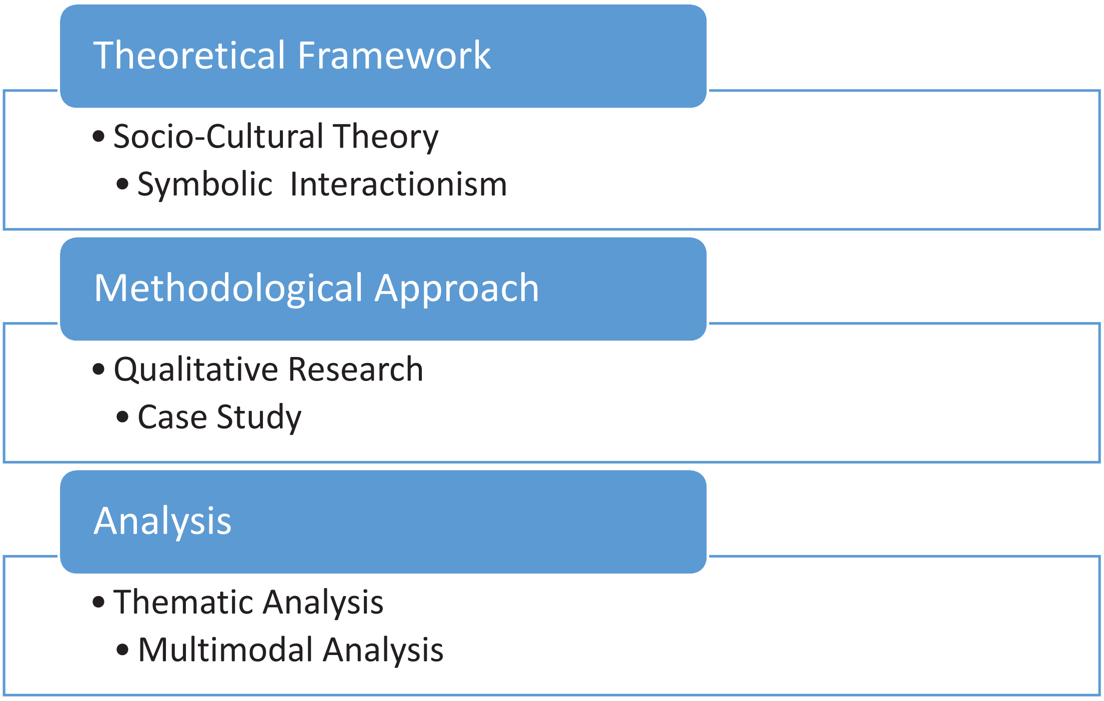


Figure 3.1 Methodology Summary

Due to the complex nature of the data collection in a doctoral study, the research process will be explained in the next chapter.

4 The Research Process

The purpose of this chapter is to provide the specific details of the research process and explore the methods used in this study. Crotty (1998), as previously discussed, defines methods as “the techniques or procedures used to gather and analyse data related to some research question or hypothesis” (p. 3).

The focus of this study was the mathematically-rich interactions occurring in early childhood centres. This study was undertaken in three early childhood centres located in Melbourne, Victoria. Over a two-week period at each site, I collected data through video observations, field notes, and the collection of programming and policy documents. Photo-elicitation interviews [PEI] were conducted with the educators after an analysis of the initial data.

Edwards and Westgate (1994) maintain that it is essential when designing research to continually refer to the research questions, thus ensuring that the participants, the data, and the data collection methods selected are appropriate to the proposed questions within the analysis design. Therefore, to recap, the research questions for this study that were posed in Section 2.5 (p. 32) were:

RQ1: What constitutes a mathematically-rich interaction in early childhood centres?

RQ2: How do early childhood educators plan and scaffold for mathematically-rich interactions?

RQ3: What roles do the physical and social environments play in mathematically-rich interactions?

RQ4: What role do children play in scaffolding mathematically-rich interactions?

4.1 Context and Participants

This study was undertaken in the state of Victoria, Australia. While there is flexibility, Victorian children generally need to be five years of age prior to 30th of April in the year that they first enrol in primary school. Families residing there have the choice as to whether or not their child attends an early childhood education setting prior to starting school, with a variety of options from which to choose. These options include sessional kindergartens, long-day care centres, family day care, and occasional-care centres. Sessional kindergartens in Victoria provide education and care for children in the year prior to primary school, with most centres providing an option for an earlier year of preschool education by enrolment in what is locally known as “three-year-old kindergarten”. Long-day care and family day care settings generally provide education and care for children from six weeks through to the year prior to school, while occasional-care centres provide education and care for the same age group but on an as-needed basis.

In 2010, the parents of 95.1% of Victorian children who would be attending school in 2011, chose to enrol them in either a long-day care centre or a sessional kindergarten (DEECD, 2011, p. 178). I therefore positioned this research study within these two main settings, including a three-year-old kindergarten group (3YOK), a four-year-old kindergarten group (4YOK), and a three- to five-year-old long-day care group (5LDC).

However, it is important to note that the exclusion from this study of other childcare settings, such as occasional-care, family day care, and the home environment, was due to the shorter attendance times in occasional-care, the impracticalities of gaining consent from families, and the ethical issues relating to entering private homes, rather than any perceived negative views about the mathematically-rich interactions occurring in these settings. A further study positioned within these settings would be a valuable addition to the research on early childhood mathematics.

4.1.1 Early Childhood Settings

As stated above, families have choices regarding the early education and care of their children. In 2009, as part of a national effort to ensure a high quality preschool education for all Australian children, the Victorian government introduced a state-wide initiative to subsidise 15 hours per week of kindergarten placement for children in the year prior to starting primary school. This financial subsidy was available for all children attending a Victorian early childhood education setting with a degree-qualified educator (DEECD, 2012, Council of Australian Governments [COAG], 2009). At the time of my data collection, in 2012, this initiative was starting to be implemented, and centres were in a state of transition, with four-year-old groups usually provided with 12 to 15 hours of placement over two or three sessions each week.

Anecdotally in Victoria, sessional kindergartens are generally perceived to provide a better preparation for the transition to school, while long-day care centres are perceived to be more focused on *care* than *education*, and to be aimed at working parents (Dowling & O'Malley, 2009). It is important to understand the differences, both real and perceived, in order to understand the context in which this study was positioned.

Firstly, in Australia, there is a difference in the number and flexibility of the hours available for children to attend these different types of centres. Long-day care centres have the flexibility for children to attend the centre on the day, or days that suit their families – this allows each child to enrol for a single day or up to a five full days per week; additional days may be available on a casual basis depending on space and centre policies. The opening hours may also range from 6:00 a.m. to 6:30 p.m. to allow children to arrive and depart at a time that suits their family's requirements. In comparison, sessional kindergartens offer group sessions that operate during scheduled times each week, generally held between the hours of 9:00 a.m. and 3:30 p.m., similar to primary schools, although some have longer hours to accommodate a greater variety of sessions.

Secondly, although both environments group children according to their age, long-day care centres usually have separate rooms for each age group, with all age groups attending each day. Depending on the number of children and rooms in the centre, the groupings may vary. Larger centres usually cater for the four- to five-year-old children in one room, the three-year-old children in the next, a toddler room for two-year old children, and a baby room for under two-year old infants. Smaller long-day care centres may group the babies and toddlers together and the three- to five-year-old children together. Sessional kindergartens usually have one or two rooms, with each sessional group using a room and the playground according to their scheduled sessions.

Thirdly, long-day care centres are open 50 to 52 weeks per year, with staff and children taking their holidays throughout the year on an individual basis. Additionally, children in long-day care centres are able to make the transition into a new room as soon as they reach the appropriate age, changing the group dynamics as the children adjust to new educators, new peers, and new routines. Sessional kindergartens, on the other hand, follow the school calendar; starting as a group in February with term breaks matching the official state school holidays and ending the year together as a group.

The fourth major difference between the settings concerns the staffing arrangements. The educators in long-day care centres are often placed on a roster system, rotating through different shifts every two weeks. A child attending a long-day care centre may arrive at 7:00 a.m. and have breakfast in the toddler room with all of the children and the staff members on the early shift – this is known as family grouping. The child will stay in this room until enough preschool children arrive to form a separate group. They then move to their room, with their regular educator or assistant arriving at their rostered time. For the majority of the day, the children will stay in this room (or in the playground) with their educator and an assistant; an additional staff member will cover morning tea, lunch breaks, and any planning time for the educator and assistant. Later in the afternoon, depending on the number of children remaining in the centre, the child may return to the toddler room for family grouping with the staff members rostered on for the late shift. Therefore, a child who attends a long-day care centre may be interacting with as many as five or six different staff members across two or three rooms each day, with the potential to interact with even more staff members as the rosters change. In comparison, children in sessional kindergarten start and finish as a group. They will normally spend their entire time with a single educator and assistant(s), occasionally with a floating staff member to cover lunch breaks, if required for longer sessions. The educator in a sessional kindergarten usually takes their planning time when the children are not attending.

These four differences affect the experiences of each group of children. The flexibility of the long-day care settings results in a different mix of children and educators each day, while the structure of the sessional kindergartens keeps the same children and educators together. These differences can also mean that each week, while the sessional kindergarten educator works with up to 25 children (or up to 50 if they take two groups), the long-day care educator may have as many as 70 children with whom they are interacting.

4.1.2 Sampling

The sites used in this research were identified through existing professional networks and were similar to many other early childhood centres within the state of Victoria. It may be argued that the use of these existing contacts attracted greater support from centre management and families, as the early childhood educators were able to offer a professional reference for both myself and the research being undertaken (Agar, 1980). Details of how each site was contacted are provided in the case study chapters: Chapters 5, 6, and 7.

The participants within each setting included the educators, teaching assistants, management, and all children whose parents gave consent for them to participate. I had planned to only observe the main educator and children at each site; however, it became apparent during fieldwork at the first centre that it was also important to observe other staff members, including a pre-service teacher on practicum, as they were often engaged in interactions with the children during the observations. A summary of the features discussed in Section 4.1.1 for these sites is presented in Table 4.1, with further details available in the three case study chapters.

Table 4.1
Case Study Particulars

Site	Participating Staff	Number of Children	Child's Age	Intake	Opening Hours	Weekly Hours	Weeks per Year
3YOK	Educator Assistant	17	3	February	Wed, Thu 2:00 – 4:30	5 hours	40
4YOK	Educator/Director Assistant Student Educator Wednesday Educator & Assistant	21	4 – 5	February	Mon, Fri 9:15 – 3:15 Wed 9:00 – 12:00 Wed (Optional) 12:00 – 3:00	12 – 15 hours	50
5LDC	Educator Assistant Director Relief Assistants	41	3 – 5	On-going	Mon to Fri 7:45 – 6:00	Varies per child	50

4.2 Data Collection

The design for this study included spending two weeks at each of the three early childhood settings. At each setting, I used video cameras and observations to collect data on the natural play of the children. Additional data were obtained through photographs of the equipment, the room and playground set-up, and through the collection of planning information in each setting. Photo-elicitation interviews [PEI] with the main educator at each centre were conducted after an initial analysis of the fieldwork data.

4.2.1 Video Observations

Young children communicate with their whole bodies – they wave, point, and drag you by the hand to show you their discoveries, whilst their facial expressions can change with each spoken word. Research on young children's play and interactions now regularly includes the use of video cameras for data collection, together with traditional observational field notes and photographs (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Flewitt, 2006; MacLure, Holmes, MacRae, & Jones, 2010).

Jewitt (2011a) explains that "video can provide a fine-grained multimodal record of an event detailing gaze, expression, body posture, gesture and so on, in which talk is kept in context – a record that cannot be made available using any other technology" (p. 173). Video recording also enabled the choice of multimodal analysis as part of the thematic analysis, as it allowed for the analysis of video data in context and in combination with other data sources (see Section 3.3.1 Multimodal Analysis). An additional benefit of using video is being able to review the data multiple times, and with multiple people, to uncover additional details overlooked during the field study (Jewitt, 2011a).

Equipment

The *GoPro®* HD sports video camera was chosen for this study. This model of camera was chosen for its durability and wide-angle lens. Built for use on surfboards, bicycle handle bars, or model aeroplanes, these cameras are waterproof and shock resistant (Woodman Labs, 2011) which was of benefit as they were accidently bumped off tables at least five times during the study. This choice of equipment helped to alleviate any hesitation the early childhood educators had with regard to being held responsible for damage to the cameras. The size of these cameras (approximately 4cm x 6cm x 3cm) was also of benefit, as they were small enough to be unobtrusive, yet offered wide angle, high definition video and sound.

Almost twelve months prior to the data collection, the cameras were loaned to an assistant educator at the 4YOK as he was interested in exploring the use of technology with preschool children. His feedback on the use of the cameras and equipment gave me the confidence that these cameras would be capable of capturing appropriate data. He made a number of suggestions including creating short videos and suggested the purchase of LCD screen attachments so that the cameras were able to be positioned more easily. The video equipment used included two *GoPro®* cameras, a suction-cup mount, an LCD screen attachment, additional batteries, and two flexible miniature tripods.

The original research proposal included leaving the cameras with each centre for a week or two prior to the data collection for the educators to use and to allow the child participants to become accustomed to their presence, as suggested by Flewitt (2006); however, this option was not taken by any of the centres. During the first week at each setting, the cameras were trialled to ensure their ease of use and to identify positioning opportunities. Field notes were taken to explore areas of the room that would best position the cameras to capture large group times, small group interactions, and individual play.

Camera Use

In order to introduce myself and the cameras to the children and explain what I would be doing, I joined in the initial group time with each centre on my first day. I discussed the care and safety of the cameras with the children, and demonstrated how they worked. During these initial meetings, I told the children that I was a teacher who wanted to understand what children did in preschools, and wondered if they would like to help me by letting me use my video cameras to record their play, and they all agreed. It was also important during this time to ensure children knew that they were allowed to change their minds and request that I stop or move the cameras at any stage and for any reason (Spriggs, 2010). With the help of the educators at each site, we role-played different ways to say “stop” both verbally and non-verbally in case a child was too shy to say it out loud; I explained to the children that they could tell if the cameras were filming by pointing out the light on the camera that flashed to indicate it was on. As the children at the 5LDC attended on different days, I repeated this discussion each day to ensure all children received the information. There are further details relating to the ethical issues when collecting video data with young children later in this chapter in Section 4.7 (p. 91).

While the small size of the *GoPro*® cameras allowed them to be unobtrusive, some children still checked if the light was on to indicate filming and asked questions about what the camera was filming. However, the majority of children ignored the cameras, allowing the cameras to capture the natural play interactions and activities of the children. There were times when children requested I stop filming, and a few times where I asked if they would like me to stop as their body language indicated they were not comfortable; at these times the cameras were stopped immediately. The educators all mentioned that they themselves were very aware of the cameras at the beginning of the data collection, and one commented that she attempted to "act naturally, but they really make you aware of everything you are doing" (5LDC Field Notes, 2012).

4.2.2 Field Notes and Journal

An important task within qualitative research is the writing of field notes, with many authors arguing the value comes not from the recording of facts and figures, but from the reflective process the researcher undertakes both during the observation and later through review (Holly & Altrichter, 2011; L. Jones, Holmes, MacRae, & MacLure, 2010; Potter, 1996; Shank, 2002). Flewitt (2006) also encourages researchers to keep a reflexive diary as they conduct their research, and to use quotes or extracts in their study as it "helps to make visible how the researcher's subjective values are woven into the texture of the research writing" (p. 35). Talob (cited in B. White, 2011) explains how journaling allows perceptions to be fixed before they are "subconsciously revised by subsequent events" (p. 251). For these reasons, I kept both field notes and a journal of my thoughts and feelings throughout the fieldwork as well as during the analysis.

Elliott, Ryan, and Hollway (2011) bring attention to the importance of including an awareness of oneself during this reflective process, warning, however, that it “can be uncomfortable as it exposes the petty, the unprofessional and the self-interested aspects of research practice” (p. 3). I found this to be true at times as I observed staff members with differing pedagogies to my own interacting with children in ways I felt were not good practice. I also found I was questioning why I was researching through observation of others’ practices rather than through participatory action research in a setting where I would be able to choose the activities and focus more closely on the mathematics.

However, despite this negative self-questioning, I also found my own prior knowledge of working as an early childhood educator to be an asset in this research. L. Jones et al. (2010) highlight that an advantage of the researcher being in a similar profession to the participants is that they may have a greater understanding of the “set of professional discursive practices” (p. 482) used by the participants within their day-to-day practice. They argue that this advantage may allow the researcher to become fully immersed in the environment and to understand the subtleties of the context. This advantage became evident as I found I was able to understand the routines and the educators’ possible goals without asking numerous background questions.

While taking field notes and recording video, I stayed as much in the background as possible to ensure that I avoided influencing the activities and interactions in which the educators and children were engaged. Stake (2010) identifies the need for qualitative researchers to try and “observe the ordinary” (Stake, 2010, p. 32), but also recommends that when researchers “cannot see for themselves, they ask others who have seen” (p. 32). At times I chose to discuss certain interactions and activities with the educators and their assistants to gain background information that was not evident – an example of this was asking for clarification of the rules and expectations for group time at the 4YOK (4YOK Field Notes, 2012).

For this research project, a tablet was used to record the field notes using *Evernote* software (Evernote Corporation, 2011). *Evernote* allows the user to create multiple typed and handwritten (using a stylus) notes, collect and annotate photographic images in real time, and capture voice recordings. Each note was time-stamped and then tagged so that it was searchable during analysis. Use of this software kept the field notes together and in chronological order. A small paper notebook and pen were also available in case of technical difficulties.

During data collection at the 4YOK, the tablet was successfully used to create field notes each day. However at both the 5LDC and the 3YOK, the children became overly fascinated with the tablet and it became such a distraction I reverted to the pen and notebook for the majority of the field notes, as these were only fascinating to one or two children who wanted to know the names I was writing. I continued to use the tablet to take additional photographs where required.

The field notes and the personal reflective journal were referred to during multiple stages of the research process, including during data preparation, transcription of the video data, the selection of images for the interviews, the data analysis, and in the writing of notes on the emergence of the thematic coding.

4.2.3 Planning and Policy Documents

Each early childhood centre creates policy and planning documents that are unique to their particular community, philosophy, and requirements. These documents affect the day-to-day operations of the centre, and play a strong role in the program choices of the educators, and the communication between the centre and the families (Arthur et al., 2004; Copple & Bredekamp, 2009; Grieshaber, 2010).

Bowen (2009) suggests that for qualitative research “documents can provide data on the context within which research participants operate” (p. 29), thereby allowing the researcher to gain background details that may not be obvious through observations or interviews. However, he also notes it is important to critically examine the documents, ensuring they accurately reflect the context, including being aware of “the original purpose of the document … and the target audience” (p. 33).

The documents I intended to collect included centre policies, the educator’s personal educational philosophy, program plans, and observations and/or children’s portfolio pages. Unfortunately for a number of reasons these documents were not as available or useful as expected. The centre policies concentrated more on day-to-day operational issues and procedures rather than any pedagogical issues, and none of the educators had a personal philosophy in written form although they were able to articulate and explain their philosophy during the interviews. The three educators were using a child-initiated programing style, and therefore there were very few programming plans available that related to the dates of fieldwork. However, photographs of previous program plans that were on display were collected as part of the field notes.

The educator’s observations of the children and the portfolios for each child demonstrated the children’s learning. However, these were observations of previous learning experiences rather than the current activities and interactions I was observing, and as such were also of limited value. Due to the lack of documents available, the photo-elicitation interview protocol was expanded to gather more of these details.

4.2.4 Photo-Elicitation Interviews [PEI]

The fourth technique used in my data collection was interviews. Interviews are a traditional method of data collection with numerous texts describing the many techniques available (see, for example, Babbie, 2008; Lindlof & Taylor, 2002; Potter, 1996). Due to the flexibility of open-ended questions and a free-flow style, interviews are a high priority in qualitative research (Babbie, 2008; Barbour & Schostak, 2011).

An appointment was made with each educator for approximately 90 minutes in a quiet setting with space to spread out the photographs. This setting, which was chosen with each educator to suit their location and available time, needed to be quiet enough to allow for the interviews to be video recorded. A digital voice recorder was also used as a back-up in case of technical failure.

In the original proposal for my research, video-stimulated interviews were chosen as the appropriate choice for this section of the data collection. Hsueh and Tobin (2011) suggest using short selections of video data "as a stimulus or cue for getting teachers … to reflect on the thinking behind their practices" (p. 111); arguing that video episodes used in interviews can encourage "the process of cultural insiders (the educators) identifying and sharing their thoughts and feelings about behaviors that are usually taken-for-granted and unremarkable" (p. 117).

However, due to the interview's 90-minute time constraints, a change to photo-elicitation interviews [PEI] was made, as this form of interview provided an opportunity to explore a greater number of images in the time frame. Similar to Hsueh and Tobin's (2011) arguments above, a strong justification for using photographs in interviews is put forth by Harper (2002) who explains "photo elicitation may overcome the difficulties posed by in-depth interviewing because it is anchored in an image that is understood, at least in part, by both parties" (p. 20).

The photographs to be used in a PEI can be sourced in various ways and each way has positives and negatives (Clark-Ibáñez, 2004; Harper, 2002). There is the option to use existing historical or personal photographs. Historical images for use in this study could include stock images of children playing, which are available from online image collections or early childhood books or journals; personal images were potentially available from the educators as these would be in children's records or in observational learning stories. These options are both appropriate for use in a study of mathematics in early childhood and easy to source; however, they would not have connected as closely to the video data that were collected. A similar doctoral study of mathematics in early childhood being undertaken in Sweden utilizes the photographs taken by the educators as part of their own reflective practice (Rostedt, 2013).

There is also the option to use specifically captured photographs for a PEI; these can be taken by the participants or by the researcher. Participant-taken photographs provide the participants with an opportunity to decide which images they feel are important; this, in turn, offers the researcher a glimpse into the priorities of the participant, and may reveal subtleties not evident to the researcher. In comparison, Clark-Ibáñez (2004) argues that "researcher-photographers may capture taken-for-granted aspects of the participants' community or life that prompt discussion" (p. 1509). As the data for this study already included video data collected during fieldwork, I chose to use researcher-taken photographs sourced from this initial data rather than participant-taken images.

The unit of analysis chosen for this study was the activities or interactions in which the children were engaged, which have been termed as *episodes* in this thesis (see Section 4.3.1, p. 67 for more details). The images needed to capture the essence of these episodes, so screenshots were taken directly from the video data. Further information on how the images were selected and organised for the interviews is provided in Section 4.3.3 (p. 70). McCray and Chen (2012) claim an additional benefit of discussing images that include contextual information is that these situations are what "teachers encounter in the classroom, and … allows the interview to assess PCK [Pedagogical Content Knowledge] as it naturally occurs [pause] in an integrated form" (p. 295).

The use of these images within the PEI also provided opportunity for discussions with the educator on the mathematics that had been identified in the images and increased the reliability and validity and trustworthiness of the analysis process to date. This provided a form of participant validation, as I was able to confirm or refute some of my initial analysis with the participants, who were also able to explain in greater depth the use of policy and planning documents (Kotsopoulos, 2010; Mavrou, Douglas, & Lewis, 2007).

Stake (2010) reminds researchers undertaking interviews that it is important to become “more disciplined – not necessarily more formal, but more tied into the themes of (the) study” (p. 2), so an interview protocol (see Appendix D, p. 390) was created for the interviews (Babbie, 2008; Barbour & Schostak, 2011; A. Brown, 2010). As noted above, the interview protocol was modified due to the availability of planning and policy documents being less than expected. This protocol helped to ensure that the interview responses were relevant to the research questions and that there were no gaps in the data collection. The interviews were undertaken more than a year after the data collection. This allowed me, as the researcher, time to become totally immersed in the video data, select the images for inclusion in the interviews, and finalise the Interview Protocol.

Each interview consisted of three sections. An initial section which contained open-ended questions to gain an understanding of the educators’ background, level of education, educational philosophies, and general information on their perceptions of mathematics in early childhood. The second section required the educators to sort a selection of photographs into three piles, marked *Obvious Mathematics* pile, *Not So Obvious Mathematics* pile, and *No Mathematics* pile (see Section 4.3.3, p. 70 for details regarding the selection of images). The video episodes that were the source of the images were available on the computer for use in the interview if required. However, this proved to be unnecessary. Once the photographs were sorted, the educator was asked to select a photograph from the first pile and discuss the mathematics they could identify in the image. The interview protocol contained a list of prompts to explore how these interactions were planned, organised, and scaffolded. This was repeated for the other two piles and, where time permitted, the educators chose additional photographs from each pile to discuss.

In the third section of the interview, the educators were handed the *Mathematical Concepts List for PEI* (Appendix E, p. 393); this list included the codes that emerged during the continuing analysis of the data and their definitions (see Section 4.4.2, p. 79 for details). The concepts were also written onto a set of small stickers. The educators were asked to indicate if the concept was identifiable in the images by placing a sticker on the back. The educators were then asked to read through the concept list again and provide an example of an interaction or activity that would support a child's mathematical development for that concept. The interview protocol finished with a request to the educators for any further comments or questions.

4.2.5 Data Collection Overview

To ensure there were no gaps in the research design, Table 4.2 was constructed to illustrate the connections between data collection and the purpose for which they were collected (Creswell, 2011; Johnson & Onwuegbuzie, 2004; J. Lewis, 2003; C. White, Woodfield, & Ritchie, 2003).

Table 4.2
Summary of Research Design

Data Source	Purpose
Video Data	Evidence of interactions
	Evidence of environment set-up
Field notes	Evidence of interactions
	Evidence of environment set-up
	Connect documents to video
Journal	Thoughts of field notes
	Thoughts on emerging codes
	Thoughts of emerging themes
Planning and Policy Documents	Background information
	Comparison with field notes

Photo-Elicitation Interviews [PEI]	Comparison with video data Intent of educator Evidence of interactions Intent of educator PCK of educator Clarification of background context

4.3 Data Preparation

Data that is labelled clearly and consistently helps to ensure that the data storage and management is efficient (Bazeley & Jackson, 2013). A naming protocol was required to avoid confusion when the video files were downloaded from the two cameras. All video files for each site were sorted by date and time, and renamed with a computer program entitled “Renamer” (Kozlov, 2012). I chose to use the site codes of 3YOK, 4YOK, and 5LDC as a prefix, followed by a sequential number to keep them in the order they were captured.

The suffix “aaa Original” was then added to all original files to differentiate them from later clipped or edited files; the “aaa” ensured these files stayed at the top when the files were sorted. For example, the first video taken at the 4YOK centre became “4YOK-0001 aaa Original” and the second video file “4YOK-0002 aaa Original”. These original files were then backed up and stored in a separate, secure location on a Deakin University server.

A total of 84 original video files were created from the data collected at the first site I visited, the 4YOK, ranging in length from 2.5 minutes to 35 minutes, some capturing single interactions and others capturing multiple interactions. In total, there were 14.5 hours of original video data collected. In addition to the video files, 54 photographs were taken of the site set-up and these were renamed to have the same naming protocol. Reviewing my field notes and starting the initial preparation and analysis of the video data from this first site, I came to understand the point Boyatzis (1998) made when he suggested that “short segments of audiotaped or videotaped material are easier to review repeatedly than long segments” (p. 43). During data collection at the second and third sites, I stopped the video cameras more often, creating a greater number of smaller files.

At the second site I visited, 5LDC, there were a total of 151 video files with lengths varying from 4 seconds to 34 minutes; in total, this amounted to 14 hours of video data. I also collected 102 photographs.

Data collection at the 3YOK site resulted in 84 video files, ranging from 19 seconds to 7 minutes amounting to a total of 6.75 hours of video data, as well as 19 photographs. This site has significantly less video data as the hours of operation for the week were much shorter than at the other two sites.

4.3.1 Unit of Analysis

Clarity in how sections of the data are selected for closer analysis is vital in qualitative research, as it provides the reader with a deeper understanding of the researcher’s focus and standpoint (Derry et al., 2010; Lincoln, 2010). Schreier (2012) explains:

> Data never speaks for “itself”, it does not “have” a specific meaning. Meaning is something that we, the recipients, attribute to the words that we hear or read, to the images that we see. This is a complex process in which we bring together our perception of the material with our own individual background: what we know about a topic, the situation in which we encounter it, how we feel at the time, and much more (Schreier, 2012, p. 2).

It is important, therefore, to define the unit of analysis to be used as this allows for consistency across the data analysis. Rogoff (2008) suggests that, when the unit of analysis is defined as an “activity”, the separate parts may be brought to the foreground for analysis “without losing track of their inherent interdependence in the whole" (n.p.). For the purposes of this study, and to avoid confusion with the multiple uses of the word "activity", the term "episode" is used to describe the interaction or activity that was analysed.

During the analysis of the episodes, the interactions of the children needed to be considered in relation to contextual factors, such as "the practices being carried out, the reasons the learner is carrying out particular practices, the resources being used, and the constraints of the particular task at hand" (Barab & Duffy, 2000, p. 30).

The decisions on which sections of the video data collected would be transformed into episodes for deeper analysis was informed by the research questions, the theoretical framework that underlies the study, and my professional understanding of early childhood settings.

Firstly, in order to answer the research questions, and in keeping with the choice of Vygotsky's socio-cultural theory as my theoretical framework, the episodes needed to show children's interactions with each other, their educators, and the environment. Within this study, *Interaction* is defined as "the act of talking [to] or doing things with other people" (Interaction, n.d.). However, as children often play individually, this definition also needs to include the individual's interactions with objects in their environment. My working definition of *Mathematically-Rich Interactions* is *children talking to or doing things with others, or with objects in their environment, to explore and use mathematical concepts and use mathematical language*.

Secondly, my experience as an early childhood educator also influenced which sections of data were selected as episodes. Schreier (2012) highlights the fact that, as a lone researcher, "you cannot help but read the data through the filter of your own world view, your own preconceptions, and your own motives" (p. 90). However, as previously noted, my professional background as an early childhood educator also provided an insider's view of the settings, thereby providing an understanding of many subtleties and nuances that might not have been visible to others (L. Jones et al., 2010).

4.3.2 Practicalities of Creating the Episodes

When reviewing the original video data to identify episodes for analysis, I found that there were often multiple interactions that conformed to the chosen criteria on a single video file. A computer program entitled *MPEG Streamclip 1.2®* (Squared 5, 2008) was used to convert these larger original files into individual episodes. As each new episode was identified, this program was used to create new smaller files by setting new start and stop times, or by removing sections in the middle of clips where children had left the area and no interactions were taking place. A second computer program, *Format Factory®* (JunHao, 2008) was used to crop the edges off video episodes where I identified an interaction occurring in the background, so I was able to bring the background interaction to the foreground for analysis.

I also deleted any section of video data that included images of non-participating children or adults. These programs were also used on a number of files where non-participating children or adults were seen moving through the episode or on the side of the action; by removing a short section or cropping the edge I was able to delete any trace of the child or adult. These programs were especially useful for some whole group times, which otherwise could not have been used due to the non-participating children. Some group times were still deleted as the non-participating children were impossible to crop out of the file. I made note of these files and updated the original backed-up files on the Deakin University server with new clipped and cropped files.

Each of these selected episodes was saved using the original sequential naming protocol, changing the suffix of “aaa Original” to a descriptive text. For example, the original video file named “4YOK-0002 aaa Original” included an episode which was saved as “4YOK-0002 Hands up if you can swim”. If the original video included more than one episode, the second also kept the original prefix and number with a different descriptive name – for example, it would become “4YOK-0002 Jack’s homemade book”. This naming protocol ensured I could reconnect the shorter edited episodes with the original video or photographic data if required. For ease of reading in the thesis, these titles were rewritten as *Hands Up if You Can Swim: 4YOK-0002* and *Jack's Homemade Book: 4YOK-0002* .

4.3.3 Selecting Images for PEI

As noted above, in Section 4.2.4, images from the video and photographic data collected at each setting were required for use in the interviews, so after the original data were converted into individual episodes, screenshots were captured from a selection of episodes. To keep the interviews manageable, I included approximately 30 images for each site. This, of course, meant that there were many interactions and activities that might have provided rich data that were not selected. The process used for selecting the images is described below in order to provide necessary clarity, avoid perception of bias, and ensure the research is open to replication (Derry et al., 2010; Lincoln, 2010).

After the video and photographic data were organised into episodes, they were sorted into activities and situations. For example, multiple episodes of the children playing in the sandpit were grouped together, as were episodes that included whole group times, or block play. Screenshots were created from each episode using a computer program called *Snipping Tool®* (Microsoft, 2014) to provide images of a variety of interactions and activities that occurred during the fieldwork. Each of these images was given the same descriptive name as the episode from which they were taken, to ensure that they could be connected easily to the corresponding episode during analysis.

As an early childhood educator, I was able to identify interactions and activities that are common to many centres and others that are less common, and I chose to include a mix of these interactions. There was the choice at this point to combine the images from each site and use a single selection of images for all three interviews. However, I chose not to do this for a number of reasons. Firstly, there was already a large number of photographs available for each site; secondly, there were possible ethical concerns regarding asking educators to comment on the practice of others; and thirdly, I wished to keep the contextual connection each educator had with their own site.

Each of the three sites therefore, required their own set of images. Where possible, I included similar images in each set. For example, each set contained images of interactions and activities such as group time, playing in the sandpit, a child/children using the blocks, a meal-time table, an art experience, and a small group activity.

Each image was printed individually onto an A5 page and laminated; a short descriptive paragraph, which included some details from the complete episode, was attached to the back, as shown in Figure 4.1. These descriptions were deliberately kept very short with no mention of the mathematical concepts identified in the analysis to ensure educators' responses were not influenced by my initial analysis. The full list of images for each centre and the narrative written on the back can be seen in Table 4.3, Table 4.4, and Table 4.5.

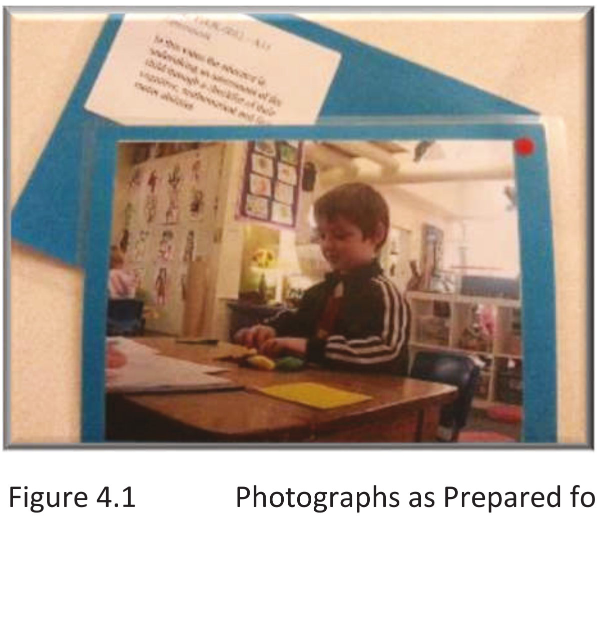


Figure 4.1 Photographs as Prepared for the PEI

Table 4.3
Image Titles and Descriptive Text for Interview – 3YOK

Image Title	Descriptive Text
Are the Strawberries Ripe?: 3YOK-0030	The educator and children are discussing the growth of strawberries.
Box Construction and Collage: 3YOK-0024	Chidren are using boxes, glue and paper during free-play.
Climbing Bridge: 3YOK-0027	A child is climbing over the bridge.
Climbing Frame: 3YOK-0036	Two children are climbing and swinging upside down on the climbing frame.
Cooking in the Sandpit: 3YOK-0040	A child is cooking a muffin in the sandpit.
Cushion Hat and Play: 3YOK-0041	The educator transitions the children by asking them for their cushion, then telling them to put on their hat and go out to play.
Discussion on Bikes: 3YOK-0041	The educator leads the children in a discussion on the differences between this bike, and the preschool and tricycles.
Drawing Materials: 3YOK-0019	A child is explaining which pencil he wants through words and gestures
Easel Stamping: 3YOK-0015	A child uses a selection of stamps at the easel.
Eating Carrots: 3YOK-0034	The child is explaining to the educator which part of the carrot you should eat
Educator at the Puzzle Table: 3YOK-0021	The educator is working with the children to complete the puzzle.
Explaining the Tape Measure: 3YOK-0090	The educator explaining the tape measure to the children
Finishing the Puzzles Together: 3YOK-0005	Three children work together at the puzzle table.
Flowers You Can Pick: 3YOK-0040	The child shows an educator parts of a flower.
Group Time with Flower Petals: 3YOK-0014	The educator discusses flowers and explains how to remove flower petals for potpourri.
Heavy Bucket: 3YOK-0003	Two children laugh as they work together to lift a bucket full of wet sand.
Hide and Seek: 3YOK-0002	A child calls out to her friend as he moves behind the garden and hides.
Obstacle Course: 3YOK-0042	The child tells the educator there is a gap and he will have to fly across
Parts of a Carrot: 3YOK-0037	The child is explaining to the educator which parts of a carrot you eat.
Patterns with a Rake: 3YOK-0040	The child is raking the sand into lines.
Separating Petals: 3YOK-0018	Flower petals are separated to make potpourri.
Play Dough Table: 3YOK-0096	Children playing with play dough.
Room Set-Up: 3YOK-0089	The set-up of the puzzle and block areas of the preschool.
Running on the Path: 3YOK-0033	A young child follows the path to run to his friends.
Sandpit: 3YOK-0001	Three children are playing beside each other in the sandpit, using buckets, shovels, rakes, and containers.
See Saw: 3YOK-0028	Two children are playing on the see-saw.
Snack Time: 3YOK-0004	Six children are sitting at the table and having their afternoon tea.

Swing Set #1: 3YOK-0023	Two children are swinging while another waits for her turn.
Swing Speeds: 3YOK-0026	Two boys are discussing which swing is faster.
Tricycles: 3YOK-0022	Two children are riding the tricycles around.
Two Boys and Blocks: 3YOK-0020	Two boys work together to fill the 100-space block tray.
Vegetable Garden: 3YOK-0031	The children are looking for carrots and counting how many they see.

Table 4.4
Image Titles and Descriptive Text for Interview – 4YOK

Image Title	Descriptive Text
A Long Long Long Tail: 4YOK-0003	A child is sitting with four friends and drawing butterflies; she is discussing the length of the butterfly tail and where it can fly.
Box Construction: 4YOK-0128	Two boys are creating box constructions including the use of stickers to connect the boxes.
Boys and Lego Roads: 4YOK-0083	Three young boys exploring with the cars and Lego road system.
Four Children at the Clay Table: 4YOK-0028	Four children are working independently with clay, creating their own individual items.
Two Children at the Clay Table: 4YOK-0093	The children are playing with the clay and the clay tools.
Easel for Chicken Drawings: 4YOK-0040	The easel set up ready for the children to draw chickens
Finding your Lunch Box: 4YOK-0080	The routine where the children collect their lunchbox from the table and take it to their place card to eat lunch.
Four Children with Cars: 4YOK-0006	Four children are playing on the mat with the cars.
Group Reflection: 4YOK-0129	The educator is discussing with the children what they have done that week, what they enjoyed, what else they would like to do, and what they would not like to do.
Hands Up if You Can Swim: 4YOK-0002	The educator is sitting with the children before group time, when they first enter the centre. They are discussing what they have done over the weekend, and are interested in who has been swimming and who can swim.
Harrison's Assessment: 4YOK-0007	The educator is undertaking an assessment of the child through a checklist of the cognitive, mathematical and fine motor abilities.
How to Make a Book: 4YOK-0053	A young boy explaining to his peer how to make a book.
Jack's Homemade Book: 4YOK-0002	Jack has brought in a book he made at home. The educator is showing the group the book during show and tell.
Kyle's How To Make a Book: 4YOK-0049	Kyle is explaining to the educator how he created his book.
Lego Baddies: 4YOK-0029	A group of boys are playing with Lego and creating vehicles for their Lego baddies.
Lunch Table: 4YOK-0121	The children are eating their lunch and engaged in conversations.
Marble Run Construction: 4YOK-0083	Two young boys connecting the pieces of the marble run.
Moving Chairs: 4YOK-0038	Two children are negotiating how to fit both chairs in next to the chicken hatch.
Outdoor Kitchen and Sandpit: 4YOK-0048	In this image, we see the outdoor sandpit and kitchen before the children arrive.

Paul's Assessment: 4YOK-0012	The educator is undertaking an assessment of the child through a checklist of the cognitive, mathematical and fine motor abilities.
Phil's Idea: 4YOK-0050	The children working with the educator to find a way to divide this table into two workspaces.
Photo Wall: 4YOK-0131	A variety of photos of additional equipment the children may ask for.
Picture of the Tooth Fairy: 4YOK-0027	A child is showing her picture to the educator and explaining about the tooth fairy.
Pictures and Hooks: 4YOK-0037	Bag hooks where the children hang their backpacks.
Puzzle with Educator's Help: 4YOK-0027	The educator is scaffolding the child by helping them complete the jigsaw puzzles.
Rules for the Mat: 4YOK-0133	The rules for sitting at mat time.
Samantha Reads to Jane: 4YOK-0052	The educator reading a story to a child one-on-one.
Self Portraits: 4YOK-0132	A selection of self-portraits created by the children.
Small Play Set Up: 4YOK-0047	A table set ready for individual play or small group play.
There Was an Old Lady Story: 4YOK-0129	The educator is singing with the children the song "There was an old lady who swallowed a fly".
Trucks on a Shelf: 4YOK-0036	The storage unit for the trucks and outdoor hats, etc.
Two Girls with Animals: 4YOK-0060	Two young girls playing with the zoo animals on the large boxes covered in green felt.

Table 4.5
Image Titles and Descriptive Text for Interview – 5LDC

Image Title	Descriptive Text
Ball Skills: 5LDC-0137	The educator is kicking the ball with the children.
Block Shelves: 5LDC-0185	The block shelves are ready for play during free-play.
Blocks on a Stick: 5LDC-0163	Two children are exploring the shaped blocks. One of the children is following the pattern board.
Building the Pirate Ship: 5LDC-0084	Three children are working together to create a pirate ship.
Burying the Dinosaur: 5LDC-0131	Children in the sandpit have chosen to dig a hole and bury the dinosaur.
Colouring with Pencils: 5LDC-0162	The children are drawing with the coloured pencils and trying to choose the right colour.
Cooking in the Cubby House: 5LDC-0133	Three children are cooking a birthday cake inside the cubby house.
Dancing at Group Time: 5LDC-0130	The educator is encouraging the children to form a full circle to dance as a group.
Days of the Week Poster: 5LDC-0219	A section of the notice board that is used in group time.
Down the Slide: 5LDC-0153	The educators have placed cushions at the bottom of the slide and the children are going down face first.
Exploring Recyclables: 5LDC-0130	The educator is discussing what items can be recycled and asking the children to describe them.
Face Sorting Set-Up: 5LDC-0170	The educator has set the table with the face sorting game for two children to engage with during free-play.
Geo Blocks: 5LDC-0038	The educator has set up the table with Geo blocks and cards as an area for children's play.

Madison and Ian and Magnet Shapes: 5LDC-0001	The children are seen exploring the Geometric magnets and discussing their shapes with each other.
Geometric Magnets: 5LDC-0167	The educator is discussing shapes with a child.
Long Jump: 5LDC-0134	The children are using the sandpit to practise their long jump.
Measuring Heights: 5LDC-0140	The children are discussing their heights with the use of a tape measure attached to the pole.
Olympic Rings Cooking: 5LDC-0115	The children are working as a large group to make Olympic rings with cookie dough.
On the Swings: 5LDC-0132	Two children are playing on the swings.
Pasta for Lunch: 5LDC-0096	The children are eating lunch.
Play Dough Table: 5LDC-0124	The children are playing with play dough in the home corner with the kitchen toys.
Puzzles: 5LDC-0128	A young child is struggling with the puzzle and a friend comes to help.
Reading Numerals: 5LDC-0126	Two children are using calculators, pens, and notebooks. They are discussing the numbers and pictures they draw.
Show and Tell: 5LDC-0011	The educator is discussing the photo album brought in by one of the children.
Show Me Your Dance Moves: 5LDC-0090	The educator has turned on the music and is encouraging the children to dance.
Skipping Rope: 5LDC-0141	Children are playing with the skipping rope and learning how to co-ordinate with each other.
Small Magnetic Block Play: 5LDC-0012	The children are exploring the magnetic blocks and discussing how to make a vehicle.
Somersault Time: 5LDC-0155	A child is practising her somersaults on the slope cushion.
Sorting Blocks: 5LDC-0025	The children are working with the educator to dry the blocks that were left in the rain.
Story Time: 5LDC-0130	The educator is reading a story to a small group of children.
Train on a Slope: 5LDC-0154	The child is pulling her Lego train across the floor and up the cushion.
What Size Paper?: 5LDC-0156	The educator is working with the children to decide on the size of paper they wish to use on the easel.

4.4 Data Analysis

Data analysis in qualitative research is never a clear linear process; it is continuous, cyclic, confusing, repetitive, and complex (Bazeley & Jackson, 2013; Ely, Vinz, Downing, & Anzul, 1997; Silverman, 2010). Ely et al. (1997) explain that “the entire process of data collections, analysis, and interpretation is tightly interwoven” (p. 169). As previously noted, the choices made throughout the design and implementation of the fieldwork can also be seen as a form of analysis. However, the following explains the more formal processes of analysis that occurred after the data was collected.

Nvivo® software (QSR International, 2012) was selected for use in the data analysis stage to assist with the transcription and coding of the video observations and the PEIs. Computer-assisted coding does not replace the researcher; it just allows the transcription, coding, background sorting, and collating of data to be faster (Hoover & Koerber, 2011; Leech & Onwuegbuzie, 2011). Nvivo's capacity to retrieve data from individual and overlapping codes "give[s] the researcher the ability to understand complex relations among the research data through a relatively simple process" (Hoover & Koerber, 2011, p. 70).

While Section 4.4.1 explains the Transcription Process and Section 4.4.2 explains the Coding Process, in reality they occurred simultaneously. The final coding list is provided in Section 4.4.3.

4.4.1 Transcription

The first step in analysing the data was importing the episodes into the Nvivo program and creating a transcript to assist with the coding. The creation of transcripts from video data is commonplace in qualitative research (Halcomb & Davidson, 2006; McLellan, MacQueen, & Neidig, 2003). At the beginning, I created verbatim transcripts for the episodes, and then, in line with my choice to use multimodal analysis, selected corresponding sections of the video episodes to code in order to identify the mathematical concepts (see Section 3.3.1 Multimodal Analysis).

However, I soon came to the realisation that traditional verbatim transcripts were not necessarily the best option for transcribing the episodes for this project. Halcomb and Davidson (2006) argue that "the use of analysis techniques such as thematic or content analysis seeks to identify common ideas from the data and, therefore, does not necessarily require verbatim transcripts" (p. 40). In line with this argument, I chose to modify how I was transcribing to ensure the transcription was comprehensive, efficient, and supported a multimodal analysis. The modifications to the transcription protocol included three main features.

Firstly, I changed to gisted transcription, describing what was occurring in the episodes that I was analysing. Dempster and Woods (2011) explain that a gisted transcription is “a summary transcript that captures the essence of a media file's content” (n.p.) and provides the contextual details that are not apparent in a verbatim transcript. These short gisted transcriptions described the content of the episodes in a short anecdotal format and these were informed by my knowledge of early childhood education. Secondly, I also included short sections of verbatim transcriptions for selected interactions if they stood out as important or added value to the descriptive text.

Thirdly, I included field note data and notes from my reflective journal directly into the transcription. Initially, these notes were entered into the Nvivo software program independent of the video data, and linked to the matching episode via the memo function. However, upon reflection during this stage, I realised that it was possible to include this information directly into the gisted transcriptions, allowing for clearer connections and less repetition.

The actual practice of creating transcripts can be seen as an initial form of analysis (McLellan et al., 2003; Poland, 1995). I chose to show this explicitly by including my thoughts on what I was observing as I created the gisted transcriptions. These reflections related mainly to the mathematical concepts and the role of the educator and children. To demonstrate the complexity captured in the gisted transcriptions, a screenshot of the transcription for *Samantha Reads to Jane: 4YOK-0052* (p. 185) is provided in Figure 4.2.

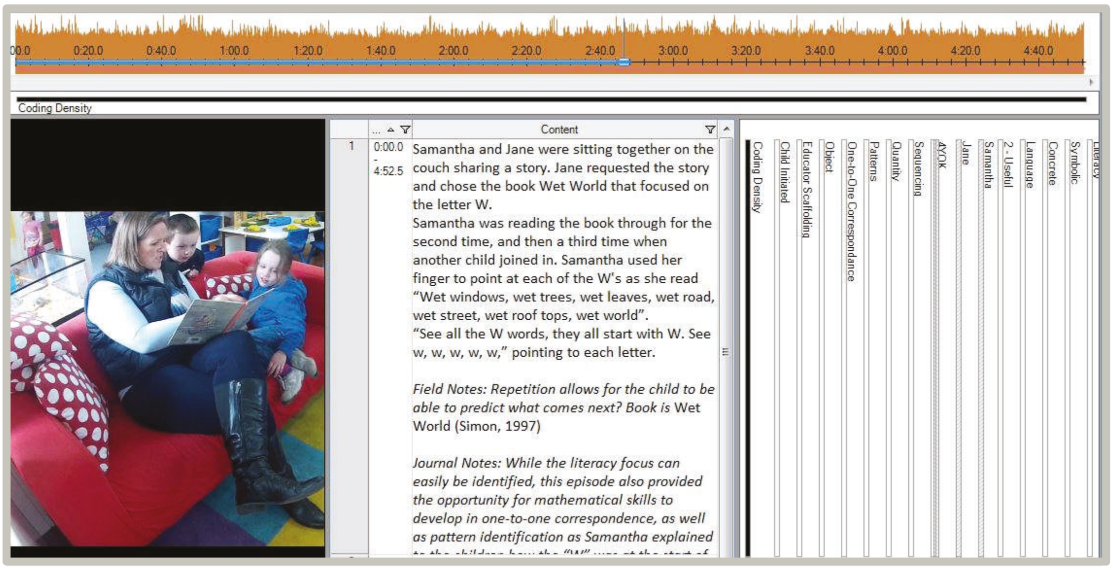


Figure 4.2 An example of a gisted transcription

This image in Figure 4.2, has four main areas – the timeline of the video episode (across the top), the video (on the left), the transcription panel (in the centre), and the coding bars (on the right). As can be seen in this image, I have included the field notes and reflective comments in the transcription.

This form of transcription also made it possible to create similar transcripts for any photographic data I was analysing in Nvivo and ensured a consistent approach across the data analysis. While this form of transcription was useful for the video and photographic data collected during the fieldwork, the three photo-elicitation interviews required a greater focus on the words of the educators and, therefore, a greater amount of verbatim transcription. However, these transcripts also included notes on the photo the educator was sorting or discussing, information from the field notes, and reflective thoughts as in the gisted transcriptions above.

Utterances such as "umm", "ahh", and "yep" were included in the interview transcripts where they indicated a pause or confirmatory response. However, to make the interview transcripts clearer to read, other extraneous utterances by either the educator themselves or myself, as interviewer, were left out of the transcription.

There are accepted conventions and formal transcript notations traditionally used when creating transcripts for Discourse Analysis or Conversation Analysis (Poland, 1995; Romero, O'Connell, & Kowal, 2002). However, due to the use of a multimodal analysis of the video data, the transcriptions created for this study did not require this degree of annotations as the coding would occur in conjunction with the video data (Halcomb & Davidson, 2006). A simplified version of notations evolved during analysis, through an iterative process of repeated viewings and updating of transcripts.

An additional reason to create these modified transcriptions included the benefit in time management, as they were less labour intensive to create than verbatim transcripts. I also purchased Dragon Naturally Speaking® software (Nuance Communications, 2013) to create the transcripts. This software is compatible with the Nvivo program and includes a head set with microphone, allowing the user to listen to the videos directly in Nvivo and verbally create the transcriptions.

As a final note on the transcription process regarding the use of personally identifiable information, there were times when children or educators mentioned individuals by name and these were recorded into the transcripts. However, to ensure anonymity, they were later converted to pseudonyms for reporting.

4.4.2 Coding

I chose thematic analysis as part of the methods for this study, as discussed above in Section 3.3 (p. 46). The following section will clarify the process involved in the construction and modification of the codes that were used as the basis for a thematic analysis. Coding and categorising is "done to enable the researcher to discern relationships, patterns, and themes that run through the categories" (Ely et al., 1997, p. 162) and, as with other processes in qualitative research, this is an iterative process.

I started with an *a priori* approach to coding, creating an initial list of codes during the preparation and design phase of the study (Boyatzis, 1998; Pope, Ziebland, & Mays, 2000). These codes emerged as I reflected on the research questions, the literature on early childhood mathematics, Vygotsky's socio-cultural theory, and my professional experiences as an early childhood educator. These initial codes were simply a list of mathematical concepts that I felt would be a starting point for coding. These were entered into the Nvivo software, which has the flexibility to easily modify the coding list at any point in the analysis, to make additions or deletions, or to combine codes.

Starting with this initial list of codes, the next step involved becoming fully immersed in the data (Green et al., 2007; Tesch, 1944), which for this project involved watching episodes and creating transcripts. As each episode was viewed and the transcript created, I also selected sections to code. Additional codes were added to the coding list as they were identified.

It is important to note here, that the coding included sections of interactions and activities that I felt had the *potential* to provide an awareness of a particular mathematical concept, even when the educator or child included in the episode were, at times, unaware of this potential. In addition to viewing new episodes, as additional codes were added, I would look back through the coded episodes for sections of data that could be coded with these new codes, resulting in each episode being reviewed multiple times.

The codes relating to mathematical concepts were defined and sorted into categories for use in the PEI. At the time when the PEI protocol was being finalised, there were four categories in the mathematical concept code group with nineteen individual codes listed (see Appendix E, p. 393). During the interviews, I also discussed with the educators the mathematical concepts identified in the analysis at that point, to ensure they understood the codes and their definitions, and to identify any missing or unclear codes. This resulted in the code *Speed* being added to the category of “Measurement”, and *Classification* code being moved into the “Process” category.

As I started writing the case study chapters, I reflected on the depth of detail required in the vignettes, and on the themes that were emerging, and realised there were more codes that would be of benefit and added contextual coding to the coding tree. Schreier (2012) argues that as qualitative researchers wish to provide in-depth details, “a simple coding frame will not provide enough detail and depth so as to be useful” (p. 65).

Further analysis demonstrated a need to adjust the code list through the addition, deletion, combination, and rearrangement of some of the codes. The coding list was not finalised until the end of the writing of the thesis, as the act of writing brought further ideas to explore. Schreier (2012) makes a strong argument for ensuring coding lists are as complete as possible, when she states these “are the ‘filter’ through which you view your data, anything that you do not include in your coding frame will be lost from view following your analysis” (p. 90).

In summary, the coding list was created using the following steps:

- Reflecting on personal background, education, and professional experiences.
- Reading the literature.
- Reflecting on the research questions, the theoretical framework, and the research design.
- Creating an initial coding list using an *a priori* approach.
- Conducting the fieldwork.
- Writing a reflective journal and analytical notes.
- Viewing the data for analysis and coding.
- Creating transcripts.

- Conducting the PEIs.
- Viewing the data again for further analysis and coding.
- Selecting data for conference papers and articles.
- Writing up the case study and discussion chapters.

However, this was not a simple linear process; it was an iterative process with each step providing an opportunity to re-examine the coding list and explore options to combine, amend, or remove codes.

4.4.3 Final Coding Lists

As discussed above, creating the coding list was an iterative process. In the final coding list there were 25 mathematical concepts, which were sorted into four categories: Measurement, Number Concepts, Process, and Spatial Awareness. However, as also mentioned above, I felt these were not sufficient by themselves to fully explore the data, and six non-mathematical categories were included to provide the contextual detail required in the analysis of the data and the exploration of the themes. These categories were: Pedagogy, Situations, Modes of Use, Environment, Developmental, and Curriculum. The definitions used to define the individual codes are listed in the tables below.

Measurement Codes

Measurement includes identifying the characteristics of objects so they may be quantified, using informal or formal units, or compare them to other objects. Table 4.6 lists these codes and their definitions.

Table 4.6
Measurement Codes

Code	Description
Area	The comparison or quantification of the area of objects or spaces, including terminology such as *covers*, *inside*, *more*, *fits into*, and *too small*.

Length	The comparison or quantification of the length of objects, including terminology such as *fatter*, *thinner*, *longer*, *shorter*, *tall*, *little*, and *wide*.
Mass	The comparison or quantification of the mass of objects, including terminology such as *heavy* and *light*.
Amount/Number	The comparison or quantification of the number of objects or amount of materials, including terminology such as *lots*, *more*, *this many*, and *few*. Note: in text the term Number is used when referring to discrete objects and Amount is used for continuous materials. Note: this code was not included in the PEI Protocol.
Size	The comparison or quantification of the general size of objects, including terminology such as *big*, *small*, *largest*, *more*, and *huge*.
Sound	The comparison or quantification of sound, including terminology such as *loud*, *soft*, *quiet*, *noisy*, *volume*, and *inside voices*.
Speed	The comparison or quantification of speed, including terminology such as *fast*, *slow*, and *quickly*. Note: this code was not included in the PEI Protocol.
Time	The comparison or quantification of time, including terminology such as *earlier*, *later*, *now*, *yesterday*, *in two minutes*, and *soon*.
Temperature	The comparison or quantification of the temperature of objects, including terminology such as *warm*, *hot*, *cold*, and *hottest*.
Volume	The comparison or quantification of the volume of objects, including terminology such as *full*, *empty*, *more* and *half-full*.

Number Codes

Number includes an understanding that objects may be counted, ordered, or compared, and may include the use of symbolic representation. Table 4.7 lists these codes and their definitions.

Table 4.7
Number Concept Codes

Code	Description
Fractions	Indications of fractions, including terminology such as *half*, *quarter*, *full*, *equal*, *all*, *some*, and *most*.
One-to-One	The matching of one object with another object, or with a number when counting.
Order	The placing of objects in order based on quantity or size. This is a combination of the original codes of “ordering” and “seriation”, which were found to be similar enough to combine. Note: in the *Mathematical Concepts List for PEI*, this code was in the “Classification” category.
Ordinal Numbers	Numbers and words used to indicate the position of objects, including terminology such as *first*, *second*, *before*, *after*, *last*, and *in the middle*.
Rational Counting	Finding the cardinality of a group by counting.

Reciting Numbers	Reciting the names of the numbers out loud without connecting them to any mathematical content such as counting or one-to-one correspondence. For example, singing songs or to gain children's attention.
Subitizing	Knowing the cardinality of a group by inspection.

Process Codes

The Process Codes include mathematical processes such as comparison and problem solving, and may include the use of symbolic representation. Originally, "Classification" was listed as a category which included the codes *Object* and *Role*. However, upon further reflection, and due in part to confusion by the educators, *Role* and *Object* codes were combined in the final analysis to become the code *Classification* and placed within the Process category. Table 4.8 lists these codes and their definitions.

Table 4.8
Process Codes

Code	Description
Calculation	The addition, subtraction, multiplication and division of quantities with, or without, the use of numbers. For example, when a child is calculating the number of people at a table with comments such as "There are two on that side and two on this side, so there is four people".
Classification	The matching or sorting of items (concrete and non-concrete) into groups by chosen criteria or characteristics.
Comparison	Comparing objects using the same characteristic.
Pattern	The observation, creation, or extension of patterns. Note: in the *Mathematical Concepts List for PEI*, this code was in the "Classification" category.
Problem Solving	Identifying and using mathematical concepts and processes to solve problems.
Sequencing	The progression through, or creation of, a list of tasks or items. Including terminology such as *first*, *then*, *next*, and *finally*. Note: this code was originally combined with the *Order* code in the "Classification" category but was later moved.

Spatial Awareness Codes

Spatial Awareness includes an awareness of space, position, or shape. Table 4.9 lists these codes and their definitions.

Table 4.9
Spatial Awareness Codes

Code	*Description*
Geometric	An awareness of two- and three-dimensional shapes, and their properties, and the transformation and rotation of objects.
Navigation	An awareness of direction, or positioning of themselves, or objects.

Pedagogy Codes

Pedagogy, the art or science of teaching children, covers the variety of ways educators plan, organise the activities within their room, interact with and scaffold the children. For the purpose of this research, I also included codes for instances when the children themselves were observed to be scaffolding and initiating mathematical activities. Table 4.10 lists these codes and their definitions.

Table 4.10
Pedagogy Codes

Code	Description
Educator Initiated	Educator initiated activities that led to mathematically-rich interactions.
Educator Scaffolded	Educator scaffolding a child or group of children in a mathematically-rich interaction.
Child Initiated	Child initiated activities that led to a mathematically-rich interaction.
Child Scaffolded	Children scaffolding their peers in a mathematically-rich interaction.

Situation Codes

To gain an understanding of when the mathematically-rich interactions were occurring, a category of “Situations” was also created. Table 4.11 lists these codes and their definitions.

Table 4.11
Situation Codes

Code	Description
Arrival/Departure	Episodes occurring as children arrived and departed each centre.
Assessment	Episodes occurring during educator assessment.
Eating	Episodes occurring during eating.
Floor Games	Episodes occurring when children were playing in small groups either with, or without, the educators.
Group Time	Episodes occurring during large group times.
Individual	Episodes occurring where a child was playing individually.
Outside Play	Episodes occurring outside. Note: any interaction that was not coded as outside can be automatically assumed to be inside.
Routines	Episodes occurring where children were following the regular routines of the centre.
Small Group	Episodes occurring where children were playing in small groups either with, or without, the educators.
Special Projects	Episodes occurring where children were engaged in special projects.
Table Play	Episodes occurring where children were playing at tables set up by the educators.

Mode of Use Codes

Mathematical activities can be further classified by modes of use. Table 4.12 lists these codes and their definitions.

Table 4.12
Mode of Use Codes

Code	Description
Concrete	The use of concrete manipulatives to show or explore mathematical understanding.
Language	The use of mathematical language. Both informal terminology such as *more*, *almost*, *over* and *lots* and formal mathematical terminology such as *half*, *length*, *edge*, *category* and *square*.
Symbolic	The use of symbols to show or explore mathematical understanding.

Environment Codes

Each of the centres has a different physical layout and social culture that may have influenced the mathematically-rich interactions and the scaffolding that was occurring. Table 4.13 lists these codes and their definitions.

Table 4.13
Environment Codes

Code	Description
Physical	The physical set up of the centre and activities, when they were seen to be a factor in the interaction or activity.
Social	The social influence of the families and educators when they were seen to be a factor in the interaction or activity.

Developmental Codes

As educators plan activities for the children, there is usually an attempt to cover the traditional developmental domains. Table 4.14 lists these codes and their definitions.

Table 4.14
Developmental Codes

Code	Description
Cognitive	Activities that are set up to develop children's ability to think and make sense of the world around them.
Fine Motor	Activities that are set up to develop children's fine motor skills, including their ability to grasp a pencil or draw finer details.
Gross Motor	Activities that are set up to develop children's gross motor skills, including whole body movement.
School Readiness	Activities that are set up to develop children's readiness for starting primary school, including following routines, numeral and letter recognition, recognising their name, and self-help skills.
Social Skills	Activities that are set up to develop children's social skills and abilities to engage in social activities with their peers.

Curriculum Codes

As educators plan activities for the children, there is often an attempt to cover a variety of school curriculum areas. Table 4.15 lists these codes and their definitions.

Table 4.15
Curriculum Codes

Code	Description
Art	Episodes that included exploration of art topics or creating works of art, including painting, drawing, box construction, clay, and play dough.
Drama	Episodes that included exploration of drama and role play.

Literacy	Episodes that are aimed at increasing children's awareness of literacy practices, including an understanding of text in various forms such as books and multimedia sources.
Mathematics	Episodes that are aimed at increasing children's mathematical understandings and skills.
Music	Episodes that are aimed at increasing children's awareness of musical practices, such as singing and chanting of songs or rhymes, playing musical instruments, and tapping to a beat.
Science	Episodes that included exploration of science topics, including technologies, animals, plant life, cooking, and the physical environment.
Sport	Episodes that are designed to develop children's physical skills and abilities to engage in sporting activities with their peers.

Reflective Codes

The data was also coded using four reflective codes to keep track of my impressions of the usefulness of particular examples in the data. These codes were used to assist in the reflective process of analysis and were helpful in the management of the data, as I was able to include them in the matrix searches performed in Nvivo to sort or rank the results. Table 4.16 lists these codes and their definitions.

Table 4.16
Reflective Codes

Code	Description
1 – Very Useful	Sections of the data that were thought to be very useful examples of the themes that were being coded.
2 – Useful	Sections of the data that were thought to be useful examples of the themes that were being coded.
3 – Maybe Useful	Sections of the data that were thought to be maybe useful examples of the themes that were being coded.
4 – Not Very Useful	Sections of the data that were thought to be not very useful examples of the themes that were being coded.
5 – More analysis required	Sections of the data that I needed to return to in order to carry out further coding.

4.5 Identifying the Themes to Explore

Undertaking thematic analysis requires the researcher to be aware of their thoughts, engage in reflection on the ideas and themes that may be emerging from the data, and explore the potential meanings of or connections between these themes to the research questions (Ely et al., 1997; Schreier, 2012). Notes were taken to keep track of the emerging themes during the research design, data collection, data preparation, and analysis stages of this study. These reflective notes were written in a variety of ways – as a few words with a question mark in the margin of the field notes, as in-depth notes in my reflective journal, or in the transcripts as they were created and reviewed. I collated and further reflected upon these emerging themes in the notes I was preparing for the thematic discussion in Chapter 8.

Through this reflective process, the following themes emerged:

- *Mathematics in the Set-Up of the Physical Environment*
- *Mathematics Embedded in Equipment*
- *Identifying the Mathematical Concepts*
- *Acknowledging Mathematics Within Other Curriculum Areas* and
- *Mathematics in Social Rules and Expectations*

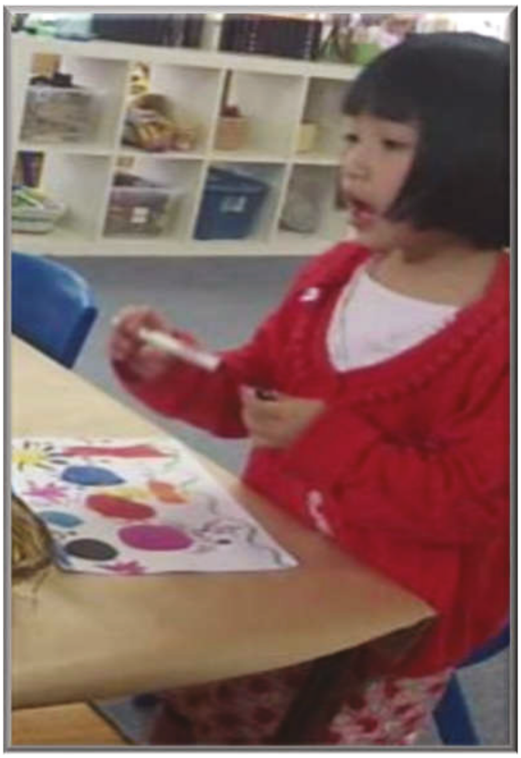
4.6 Writing the Case Study Chapters

Stake (1978) notes that a case study approach provides the author with the opportunity to use "a writing style that is informal, perhaps narrative, possibly with verbatim quotation, illustration, and even allusion and metaphor" (Stake, 1978, p. 7). He puts forth the argument that as most people have built their understandings "through direct and vicarious experience … one of the more effective means of adding to understanding for all readers will be by approximating through the words and illustrations of our reports, the natural experience acquired in ordinary personal involvement" (Stake, 1978, p. 5). Van Maanen (2011) also encourages researchers to focus on their audience when writing, stating, "what readers learn is what particular people, in particular places, at particular times are doing and what it may mean to them" (p. 229).

The case study chapters in this thesis – Chapters 5, 6, and 7, all follow the same format. The chapters begin with an overview of the early childhood setting in which each case is located, including details on how the centre was approached to participate in the study, and details about the participants. The second section in each chapter uses a narrative style to bring the reader into the early childhood environment. As explained in Section 4.3 (p. 66), episodes were created from the video and photographic data for analysis, and these episodes form the backbone of these case study chapters.

Each episode is presented through a short vignette to lead the reader through the range of interactions and activities observed during data collection, and in order to provide an understanding of the actual and potential mathematics that was identified during analysis. These vignettes include a photograph or a screenshot from the episode, some of which were used in the PEIs, as discussed in Section 4.3.3 (p. 70). Data from the PEIs are also included when they relate to the educator's pedagogical practices or their understanding of the mathematics identified. Information stating how the educators rated the images in terms of their mathematical content during the interviews is also included where applicable.

After each vignette, an image and the codes identified in that episode are displayed as a summary. The sample in Figure 4.3 includes all possible codes to demonstrate the layout used in the case study chapters. Where no codes for a category are identified in the episode, the line in that example will show "--". The definitions for the individual codes can be found in Section 4.4.3 (p. 82).



Category	Codes
Measurement:	Area, Length, Mass, Quantity, Size, Sound, Speed, Temperature, Time, Volume
Number:	Counting, Fraction, One-to-One, Order, Ordinal, Reciting Numbers, Subitize
Process:	Calculation, Classification, Comparison, Pattern, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Arrivals, Eating, Floor Games, Group Time, Individual, Outside, Routine, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor, Gross Motor, School Readiness, Social Skills
Curriculum Area:	Art, Drama, Literacy, Mathematics, Music, Science, Sport

Figure 4.3 Sample of an Episode Examples with all Codes

At the end of the vignettes, there are summary tables in Sections 5.3, 6.3, and 7.3 providing a full summary of the coding for all episodes in that site. Sections 5.4, 6.4, and 7.4 then provide the data from the PEIs to complete the case study chapters.

4.7 Ethics

Research that centres on human behaviour is required both legally and morally to be designed in an ethical manner (Babbie, 2008). For this study, ethics approval was required from the Deakin University Human Research Ethics Committee (see Appendix B, p. 376).

Ethical concerns can usually be classified as relating to issues such as "access/gatekeepers, consent/assent, confidentiality/anonymity/secrecy, recognition/feedback, ownership, and social responsibility" (A. Lewis, 2002, p. 110). While all of these concerns were addressed, working with young children highlights the issues of gaining access to children, and issues of consent (Babbie, 2008; Conroy & Harcourt, 2009; Roberts-Holmes, 2011). Gaining consent for this research project required permission from three levels of gatekeepers: the Department of Education and Early Childhood Development [DEECD], the centre directors and educators, and the children's families.

As this study was to be conducted in early childhood centres in Victoria, approval was required from the DEECD before I was able to approach the centres. Permission was granted as shown in Appendix B (p. 376). I then proceeded to make initial contact with potential sites through existing professional networks, as discussed in Section 4.1.2. I was able to gain permission from the directors and educators to conduct fieldwork in their centres. Informed consent from those under 18, or who are unable to provide informed consent due to reduced capacity, requires researchers to work with children's guardians (Babbie, 2008). Therefore, the final gatekeepers were the families who were asked to give permission for their child or children to participate.

Each of these gatekeepers required their own *Plain Language Statement and Consent Form*, which were approved by the Deakin University Human Research Ethics Committee (see Appendix C, p. 378). These forms were distributed to the centres a few weeks prior to each site visit and handed out to the families by the educator. Further details on how these were collected at each centre can be found in the case study chapters.

Consent was not received from the families of three of the children in the 4YOK setting, so any video of these children was cropped, clipped, or deleted to remove them from the data, as discussed above in Section 4.3.2. In hindsight, when submitting the application for ethics approval, I should have applied to "blur or remove" any images of a non-participating child or adult, as there were moments when they were observed in the background or walking through the camera frame and these observations needed to be deleted.

Whilst I gained informed consent from staff and individual families to collect data, it was also important to ensure the children were consulted. I therefore asked the children if they would like to be included in my study to ensure their rights to make decisions for themselves were met (Harcourt & Conroy, 2005). This occurred during initial group times in each centre as previously discussed in Section 4.2.1. There were moments when a child, or educator, became uncomfortable with being recorded and recording needed to be stopped. As some of the participants were young children, I needed to be watchful for their cues at these moments and make a judgement on when to pause or cease recording (Spriggs, 2010). The children at times made it very clear that they would like me to stop filming. However, due to the age of the children in this study, I was also watchful for the non-obvious "verbal and behavioural signs identified by child development experts" (Spriggs, 2010, p. 8). Behaviours such as silence as I approached, looking away, fussiness, and lack of eye contact were possible indications that the child wanted the cameras to be stopped; the camera was always stopped at their first request or indication, as the child's well-being was paramount.

Additionally, two original video files were deleted at the 4YOK centre. The first was when two parents stopped in front of a camera not realising it was there, and had a long discussion about their children, and the second was when a parent asked the educator for details of her child's development and the conversation was clearly heard in the background of an episode.

During the photo-elicitation interviews, it was important to ensure the educators did not inadvertently reveal any private or confidential information regarding the children in their care; they were reminded before each interview that the confidentiality of the children and their families takes priority over this research study.

5 The Three-Year-Old Kindergarten – 3YOK

This chapter presents the data from the three-year-old kindergarten site (3YOK). Pseudonyms have been used when referring to the educators and children to protect their anonymity. As set out in Chapter 4, the data from each site were collected in two stages. Firstly, video observations and field notes were collected at the 3YOK over a two-week period in November, 2012. The data were then analysed and coded to identify the mathematical content and contextual details. The second stage of data collection, a photo-elicitation interview [PEI] with the educator of the 3YOK, was undertaken in October, 2013.

To provide background and context for the 3YOK case study, Section 5.1 provides details on how I approached the early childhood centre in which the 3YOK was located, as well as information on the participants included in the study, and the pedagogical approaches used in the centre. Section 5.2 provides a detailed description of the 3YOK routine, including the set-up of the centre and the episodes observed during fieldwork. These episodes are written in the form of short vignettes, as discussed in Section 4.6 (p. 89), and include details of the mathematics, both actual and potential, identified in the analysis. A summary table of the coding for all vignettes is located in Section 5.3, while Section 5.4 presents the interview data, making connections with the vignettes and to educator's pedagogical practices.

5.1 Overview of the 3YOK Setting

Serena was identified as a potential participant through an early childhood professional network. After I discussed the study with her in detail, Serena agreed to participate and to approach her assistant, the centre director, and the management committee, to inquire if they wished to participate, and give their consent, using the *Plain Language Statements and Consent Forms* (see Appendix C, p. 378).

The sessional kindergarten in which the 3YOK was located was a converted house in a residential area. It included two classrooms, offices, meeting rooms, and a large shared playground. The centre ran weekly sessions for three groups of four-year-old children and two groups of three-year-old children, as well as a short Italian immersion session for a mixed group of three- and four-year-old children. Serena suggested I research the 3YOK group who attended on Wednesday and Thursday afternoons as there would be fewer children in the centre at these times.

5.1.1 3YOK Participants

The participants in the study from the 3YOK were:

- Serena – the educator for the three-year-old kindergarten group;
- Tahlia – the assistant for the three-year-old kindergarten group; and
- seventeen children aged between three and four years.

The centre had additional staff who were not participants in the study. These included Michelle, the centre director and educator for the four-year-old kindergarten groups, her two assistants, members of the parent management committee, and parent volunteers.

Serena's background information was collected during the PEI, and general information on the children as a group was collected through informal chats during data collection. Background information on individual children and other adult participants was not collected.

Serena's Background and Qualifications

Serena had been working in early childhood for 17 years, spending her entire career at this centre. She had held a variety of roles during that time including assistant, four-year-old group educator, acting director, and member of the management committee. At the time of the study, she was the lead educator for the three-year-old groups and for the mixed-aged Italian immersion group.

Serena had a Graduate Diploma in Early Childhood Education. She had also completed a Bachelor of Arts and Languages in Italian and Ancient Greek, a Masters in Linguistics, a Graduate Diploma in Editing and Publishing, a Certificate IV in Learning and Adult Assessment, and was completing a PhD at the time of this study. Serena stated in the PEI that her early childhood education training had little in the way of specific mathematics; there was just a single-semester unit in the Graduate Diploma. She also did not recall undertaking any professional development that focused on mathematics for early childhood.

As discussed in Chapter 2, the pedagogical practices of educators are closely linked with their educational philosophy. During the photo-elicitation interview [PEI], Serena explained that her educational philosophy included the use of a “child-centred, play-based curriculum … And I feel as if I err on the side of an emergent [programming style]”, mentioning that she was working each day from the children’s interests. However, she also clarified this by adding, “When we say child-centred, yes we are much more child-centred than our clichéd image of a primary school, I would define myself as child-centred, but in reality I do actually set, umm, you know, quite a lot of boundaries, and structure around what I do with the kids” (Serena - Interview with 3YOK Educator).

Within this child-centred, play-based curriculum, Serena’s pedagogical practices included an emphasis on English language development and providing children with opportunities for labelling items, which she described as a form of classification (3YOK Field Notes, 2012). While there was little in the way of written programming displayed within the room, Serena felt she was very aware of the individual needs of each child, and discussed her documentation during the interview, explaining, “Not much of it is forward planning. More of it is a record of what evolved and what we ended up doing” (Serena - Interview with 3YOK Educator). At the 3YOK, it appeared that Serena structured the session with routines due to both her personal pedagogical style and the age and language capabilities of the children in this session (3YOK Field Notes, 2012).

The Children in the 3YOK

According to Serena, the centre catered for a diverse range of nationalities in a multi-cultural, middle-class suburb in Melbourne. For most of the children participating in this study, this was their first year of sessional kindergarten, although a few had previously attended a long-day care centre. Serena mentioned that English was the second language for a large number of the children in this group, with some having few English language skills at the beginning of the year. However, as the data collection was undertaken close to the end of the year, the majority of children had a basic understanding of English, and were able to communicate with Serena and her assistant, Tahlia.

The seventeen children participating in this study attended the centre on Wednesday and Thursday afternoons from 2:00 p.m. to 4:30 p.m. – a total of five hours per week. On Wednesday afternoons, the 3YOK had exclusive access to the outdoor playground. On Thursdays however, they shared the playground with one of the four-year-old groups for part of the afternoon, thereby restricting my ability to collect video data due to ethical issues when non-participating children were present.

In the weeks prior to my visit, Serena discussed the research project with the children's families on a one-on-one basis, and explained the Plain Language Statement and Consent Form. Serena introduced me to the parents and guardians at the beginning of the first session of data collection to give them an opportunity to ask questions. Most questions dealt with privacy and the potential for children to be identified in articles or on-line; these concerns were allayed after chatting informally with interested parents and guardians. I received signed forms giving consent for all seventeen children to participate.

5.2 The 3YOK Routine

The sessions in the 3YOK were two and a half hours in duration and generally started with a whole group meeting, lasting approximately 10 to 15 minutes. Following this initial group time, Serena invited the children to choose which free-play activity they would like to go to first. The majority of time in the 3YOK sessions was available for free-play, as shown in Table 5.1.

Table 5.1
Daily Routine in the 3YOK Centre

Time	Activity
2:00 p.m.	Storing belongings, greeting friends, and gathering for group time
2:05 p.m.	Group Time
2:20 p.m.	Free-Play
2:30 p.m.	Educators open doors for Indoor/Outdoor Free-Play[1]
2:30 p.m.	Snack Time[2]
4:10 p.m.	Pack up and Group Time
4:30 p.m.	Parent Pick-Up

[1] Timing for Indoor/Outdoor Free-Play was dependent on weather
[2] Children are able to choose when they are ready for a snack from 2:30 p.m. onwards

5.2.1 Setting Up the 3YOK Environment

The room used by Serena with the 3YOK group was also used by other groups in the kindergarten and, therefore, equipment and resources were shared; the placement of the larger equipment and furniture was negotiated between the educators. Serena and Tahlia set up the rest of the activities before each session, ensuring the equipment available was appropriate for the three-year-old children in this session. The activities provided at the start of each day varied, depending on the interests of the children and Serena's programming aims and goals.

The layout in this room included a space for group meetings, which doubled as a reading area, a mat for the block area, a puzzle table, collage and box construction area, an easel, storage for wet paintings, additional tables, and a home corner. The home corner changed frequently depending on the children's interests and, during the fieldwork, it was set up as a hairdressing salon.

A selection of episodes were constructed from the video and photographic data and from the field notes showing how the room was set up, as shown in Examples 5.1 and 5.2 below. The main focus during the analysis of these first two episodes was to explore how the set-up of these areas supported the children's mathematical development, rather than the interactions observed during data collection. The episode *Room Set-Up: 3YOK-0089* , shown in Example 5.1, shows the block storage and carpet area, the shelves and baskets containing other toys, and the puzzle table.

Category	Codes
Measurement:	Area
Number:	--
Process:	Classification
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Floor Games, Individual, Routine, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor, School Readiness, Social Skills
Curriculum:	Drama, Literacy, Mathematics

Example 5.1 *Room Set-Up: 3YOK-0089*

The educators in this episode reminded the children to "Keep the blocks on the mat" and "Keep the puzzles on the table" providing an opportunity for the children to build classification skills as they gained an awareness that different toys belonged in different areas (3YOK Field Notes, 2012). These interactions also helped them gain an awareness of the area of the mat and table surfaces. The storage of materials, such as the block shelf and the baskets of toys on the right, also provided opportunities for navigation skills as the educator used positional language to describe where the toys could be found (3YOK Field Notes, 2012).

This episode also provides an example of the set-up of the table areas. Selected activities were placed on individual tables, such as the puzzle table shown above, with Serena paying particular attention to the number of children that each table could accommodate. She explained that this planning, along with the social rules of the group, provided mathematics incidentally as the children became aware that "there has to be a place free at the table, which means that they had to observe empty and taken, and there is a kind of inbuilt one-to-one correspondence in having to match one child to one chair" (Serena - Interview with 3YOK Educator). Serena and Tahlia were observed enforcing these rules, ensuring the number of children engaging in the activity matched the number of chairs placed at the table, thus providing practice in one-to-one correspondence and counting (3YOK Field Notes, 2012). However, as mentioned below in Section 5.2.4, this rule was not enforced at the snack table. The image of *Room Set-Up: 3YOK-0089* was sorted into the *Obvious Mathematics* pile by Serena during the PEI.

The outdoor environment was an important area of play for the children in the 3YOK as most days they had the option for Indoor/Outdoor free-play. There were permanent fixtures in the yard such as the sandpit, the swings, the bike area, the cubby house, the vegetable and flower gardens, and the pathways.

These permanent areas provided mathematical experiences incidentally, such as can be seen in *Running on the Path: 3YOK-0033* , shown in Example 5.2. This episode included length, speed, navigation and comparison, as children discussed where they would race, then raced each other along the path, and finally, compared how fast they could go (3YOK Field Notes, 2012). This image was placed in the *Not So Obvious Mathematics* pile during the interview, where Serena noted, "The experience of running down the path is, is a physical experience of length" (Serena -

Category	Codes
Measurement:	Length, Speed
Number:	--
Process:	Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 5.2 *Running on the Path: 3YOK-0033*

Interview with 3YOK Educator).

The educators provided additional resources each day to enhance the play in the permanent areas, such as buckets and spades in the sandpit, road signs for the bikes, and cooking equipment in the cubby house. They also provide non-permanent activities such as the obstacle course, which was set up daily. Further episodes of the children's engagement with these outdoor activities can be found in the vignettes in Section 5.2.6 (p. 116).

5.2.2 Arrival at the 3YOK

The children in the 3YOK gathered with a parent or guardian (hereafter called parent) outside the building until Serena opened the door for the session to begin. During this time, I observed the children climbing the tree and chatting with family and friends. Serena chatted with the children and families as they entered the room. The parent would then sign the roll while the children organised their belongings.

Parents were overheard in *Coming to the Mat: 3YOK-0070* , shown in Example 5.3, reminding children where their belongings went and listing what their child needed to do: telling their child to place their bag in their assigned locker, remove their jacket, place their drink bottle on the tray, find a spare cushion around the edge of the mat to sit on, and chose a book to read until everyone was seated (3YOK Field Notes, 2012). Tahlia, the assistant educator, would chat with the children as they were sitting on the cushions.

Category	Codes
Measurement:	--
Number:	One-to-one
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Arrivals, Group Time, Routine
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	School Readiness, Social Skills
Curriculum:	Literacy

Example 5.3 *Coming to the Mat: 3YOK-0070*

This arrival routine provided a simple five-step example of sequencing, which the majority of children appeared to be able to follow. As the children went to sit around the circle, they also practised their navigation skills, while choosing who to sit next to offered an opportunity to use their classification skills to determine who was a close friend and who was not. This episode was not included in the interview.

5.2.3 Morning Group Time at the 3YOK

Each morning, Serena would engage with the children in conversation once they were all seated. During the episode *Who is Here Today?: 3YOK-0041* , shown in Example 5.4, Serena asked the children if anyone was missing from the group. This regular feature of the 3YOK morning group time was a discussion of who was present at kindergarten that day, and Serena's set-up of the room simplified this task, as she had placed one cushion on the mat for each child. The children needed to either subitize, to determine how many cushions were empty, or use their one-to-one correspondence and counting skills, to determine the number of children around the mat and the number absent from the kindergarten, potentially also using their calculation skills. During this particular episode, the children were able to determine that one person was missing as there was one empty cushion. This interaction also provided an opportunity for them to gain an awareness of classification as they discussed the two groups – those present and those absent. This episode was not used in the interview.

Category	Codes
Measurement:	--
Number:	Counting, One-to-one, Subitize
Process:	Calculation, Classification, Problem Solving
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Time
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	School Readiness, Social Skills
Curriculum:	--

Example 5.4 *Who is Here Today?: 3YOK-0041*

When Jaden arrived, he brought his bike to use in the bike area at the 3YOK playground, and this led into *Discussion on Bikes: 3YOK-0041* , shown in Example 5.5. In line with her pedagogical beliefs regarding child-initiated, emergent programming, Serena chose to bring the bike into the circle and use it as a conversation starter. Serena showed the bike to the children and asked, "How many wheels has it got?" to which most of the children quickly called out "Two", demonstrating their ability in subitizing, and one called out "One, Two", showing her counting ability. Serena asked the children if Jaden's bike was the same as the kindergarten bikes, and this led the children to compare the bikes and the tricycles. They demonstrated an understanding of the number and size differences of the wheels, and they used classification to sort the bikes both by colour and then by the inclusion, or lack of, pedals. During this episode, Ava proudly stated she was "good at counting" and Iris replied "I'm great".

Category	Codes
Measurement:	Quantity, Size
Number:	Counting, Subitize
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Time
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Social Skills
Curriculum:	--

Example 5.5 *Discussion on Bikes: 3YOK-0041*

During this episode, they also discussed the size of the bikes in comparison to Saige's scooter, and Serena used dimensional gestures as she asked if the scooter was "big this way (spreading arm out wide) or big this way (moving arm up high)?" To which Saige replied, "It was bigger one way, but smaller the other way" demonstrating that she was aware that objects could be measured by various criteria and compared.

The third episode identified in this morning group time was *Cushion Hat and Play: 3YOK-0041* , shown in Example 5.6. To move from group time to free-play activities, Serena engaged the children in another routine as she asked each child by name where they would like to play *first*, providing terminology for ordinal numbers and for sequencing. She then had them follow a three- or four-step sequence that included choosing an activity, bringing up their cushion, putting on their hat (if they were going outside) and going off to play.

Category	Codes
Measurement:	--
Number:	Order, Ordinal
Process:	Sequence
Spatial:	Navigation
Mode of Use:	Language
Situation:	Group Time, Routine
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	School Readiness, Social Skills
Curriculum:	--

Example 5.6 *Cushion Hat and Play: 3YOK-0041*

5.2.4 Snack Time at the 3YOK

As the 3YOK sessions were only two and a half hours long, not all children chose to eat the snack they brought from home. Children were able to choose for themselves if, and when, they wished to have a snack and one child was overheard asking Serena how much time they had till the end of the session, demonstrating a basic curiosity with time measurement (3YOK Field Notes, 2012). In the setting-up of the snack table, the educators placed a container for garbage and another one for composting, in the centre of the table. This provided the children the opportunity to sort their scraps into these two categories.

Six children in *Snack Time: 3YOK-0004* , shown in Example 5.7, enjoyed their snack and engaged in conversation. These children, Mike, Brock, Fay, Saige, Iris, and Greg, discussed and compared the types and amount of the food at the table. At one point in the interaction, Mike reminded Greg that hats should not be worn at the table, and laughingly threw the hat to the floor; Iris quickly picked it up and placed it in the hat basket; this very simple interaction required classification skills to

Category	Codes
Measurement:	Quantity, Time
Number:	Counting, One-to-one
Process:	Calculation, Classification, Comparison, Problem Solving
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating, Individual, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	School Readiness, Social Skills
Curriculum:	--

Example 5.7 *Snack Time: 3YOK-0004*

understand where hats belong and where they do not.

While these children were eating, there was an interaction that occurred off camera that was also included as part of this episode. Serena was chatting with James, who was ready to have a snack, about where he should sit. There was only enough room at the table for the six children who were already sitting down, and James and Serena discussed the number of chairs at the table and compared this to the number of children already sitting; this required measurement, counting, one-to-one correspondence, and comparison skills. She then asked if he could think of a solution, which encouraged him to problem solve; he suggested they add another chair to the table so there were enough seats, demonstrating a beginning understanding of calculation (3YOK Field Notes, 2012).

5.2.5 Inside Free-Play Activities at the 3YOK

A table was set up in the centre of the room for box construction and collage, with a supply of small boxes, coloured paper, tape, markers, pencils, craft sticks, patty-pan papers, and a basket of cloth and paper shapes. This area had been a regular feature of the room for the majority of the year so the children had on-going experience with these materials.

Ava, Abbie, and Fay played side by side in *Box Construction and Collage: 3YOK-0024* , shown in Example 5.8. Abbie was attaching craft sticks to a sheet of paper and demonstrated an awareness of both amount and size, as she determined the approximate amount of glue and the size of the circle she needed. When she had completed her artwork, she used a pencil to write her name in the top left corner of the page before taking it to the drying rack. This routine three-step sequence of completing an art work, writing their name, and then placing the item on the drying rack was repeated by many children during the fieldwork. Additionaly, it provided practice in navigational skills when the educators reminded the child to write their name in the top right corner.

This episode also included Ava who also used the glue to attach craft sticks onto two boxes, lining the sticks up with each other in a pattern. As she ensured the whole side of the box was covered, Ava was building her awareness of the surface area of the object. However, Mia found when she was attempting to glue some cloth to her page that it would not stick and, realising there was not enough glue, she added more, using her problem solving skills to adjust the amount of glue she required. Mia also showed great deliberation as she chose particular pieces of cloth or paper, and placed each piece on her collage, demonstrating her developing sense of classification and spatial awareness.

Category	Codes
Measurement:	Area, Quantity, Size
Number:	--
Process:	Classification, Pattern, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Routine, Table
Pedagogy:	Child Initiated, Educator Initiated
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Art, Literacy

Example 5.8 *Box Construction and Collage: 3YOK-0024*

This image was used in the interview and Serena placed it in the *Not So Obvious Mathematics* pile. However, during the interview, Serena noted that, in her programming, she would often decide to supply materials in a single colour, in order to encourage the children to use their classification skills to sort the materials by other criteria, such as texture or shade (Serena - Interview with 3YOK Educator, 2013).

Saige, Mike, and Greg were playing beside each other with the play dough in *Play Dough Table: 3YOK-0096* , shown in Example 5.9. They explored the play dough, flattening it out and making balls and shapes. Serena joined them at the table, modelled how to make small balls, and discussed the size and shapes she was creating. She also encouraged one-to-one correspondence as she pointed to each ball as they counted them. She was also observed reminding the children to share the play dough equally, providing practice with size, fractions, and comparison (3YOK Field Notes, 2012). Included in this episode was a conversation I had with Serena off camera, where she mentioned that she had laminated the coloured card to encourage the children to keep the play dough on the card, unintentionally providing an opportunity for the children to gain awareness of area.

Category	Codes
Measurement:	Area, Mass, Quantity, Size
Number:	Counting, Fraction, One-to-one, Order
Process:	Comparison
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Fine Motor, Social Skills
Curriculum:	Art, Mathematics

Example 5.9 *Play Dough Table: 3YOK-0096*

While the children were playing with the play dough, Grace found a toy tape measure and asked Serena what it was – see *Explaining the Tape Measure: 3YOK-0090* , shown in Example 5.10. Serena demonstrated how the tape measure worked, explaining how Grace could use it to measure objects around the classroom and outside. This interaction provided an opportunity to practise finding the length or width of an object, and connecting this to the numerical symbols on the tape measure. This equipment could also help develop skills in classifying objects by size, and in comparison and calculation. Later in the day, Mia was using the tape measure to find the width of the see-saw, which was then included in this episode. She placed a section of the tape measure across the see-saw and called out that the see-saw was "6" – the number shown on the tape in the middle of the see-saw. Mia's inability to use the tape measure correctly was evidence that her current navigational skills and understanding of length did not include the knowledge that the edge of the tape measure needed to line up with the edge of the object she was measuring. The image for *Explaining the Tape Measure: 3YOK-0090* was placed in

Category	Codes
Measurement:	Length, Size
Number:	Counting
Process:	Calculation, Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Individual
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

Example 5.10 *Explaining the Tape Measure: 3YOK-0090*

the *Obvious Mathematics* pile by Serena.

Tahlia was assisting Teddy and Brock to complete their chosen puzzles in *Educator at the Puzzle Table: 3YOK-0021* , shown in Example 5.11. The puzzle Teddy had chosen consisted of geometric shapes of varying sizes, and Tahlia assisted him with the puzzle through the use of positional gestures and geometric terminology as she pointed to the spaces he needed to fill and provided suggestions such as “It’s the same shape as this one”. This interaction provided him with practice in classifying and comparing the pieces, navigational skills as he rotated the pieces to get them to fit. Due to the open-endedness of this puzzle, it was possible to place the pieces in various ways, providing an opportunity to create patterns. The puzzle chosen by Brock was a more traditional picture puzzle. Tahlia encouraged him to sort and place the edge pieces in first, and then work on the middle sections, providing opportunities to classify and work in a sequence. This image was placed in the *Obvious Mathematics* pile by Serena.

Category	Codes
Measurement:	Area, Length, Size
Number:	--
Process:	Classification, Comparison, Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	--

Example 5.11 *Educator at the Puzzle Table: 3YOK-0021*

At the end of one of the sessions, Tahlia asked Mia, Ava, and Iris to pack up in the puzzle area, they were completing the puzzles in *Finishing the Puzzles Together: 3YOK-0005* , shown in Example 5.12. Similarly, as in the above puzzle episode, during this interaction Ava was rotating the pieces to help find their place, as well as using classification and sequencing to sort the pieces into edge or centre pieces and then placing most of the edge pieces in first. In addition, Ava was placing pieces beside each other, appearing to measure the length or area of each piece, and then compare this to the space she was trying to fill. During the interview, Serena mentioned that both geometric and navigation skills were often promoted “in relation to doing puzzles … turn pieces around and so forth to make them fit” (Serena - Interview with 3YOK Educator). This image was placed in the *Obvious Mathematics* pile by Serena.

Category	Codes
Measurement:	Area, Length, Size
Number:	--
Process:	Classification, Comparison, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group, Table
Pedagogy:	Child Scaffolded, Educator Initiated
Environment:	Physical, Social
Development:	Cognitive, Fine Motor, Social Skills
Curriculum:	--

Example 5.12 *Finishing the Puzzles Together: 3YOK-0005*

The group time area, which was also used for floor games, was where Yanni and Mike were playing in *Two Boys and Blocks: 3YOK-0020* , shown in Example 5.13. After removing all the blocks, they were attempting to refill a 100-square block base by placing the longer and shorter blocks in various positions and orientations, and moving blocks around to try and get them all to fit. Yanni, on the left, was removing most of the smaller single square blocks and placing a larger block on the tray. He replaced the single blocks to fill the space and was then left with two long blocks that would not fit. He repeated this process twice. At times, he would test to see if he had removed enough single blocks and then remove additional blocks if required. Playing with these blocks gave the boys an opportunity to expand their spatial awareness in both geometric and navigational ways, provided practice in classification as Yanni chose only the single blocks to remove, as well as giving them the opportunity to further their understanding of measurement with regard to area and length as they tried to fill the tray. Mike spent most of this episode watching Yanni, and was later observed attempting to fill the base himself. Serena placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Length, Size
Number:	Counting, One-to-one
Process:	Calculation, Classification, Comparison, Pattern, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Individual, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

Example 5.13 *Two Boys and Blocks: 3YOK-0020*

To scaffold these concepts further, Serena, in the following session, chose to use the block tray in *Group Time with Block Tray: 3YOK-0014* , shown in Example 5.14. She demonstrated placing the larger blocks in first and then described how she needed to join sections of blocks to make lines of ten. This demonstration not only covered the geometric and navigational concepts the boys had been exploring in *Two Boys and Blocks: 3YOK-0020* , but also offered opportunities to explore sequencing and calculation, as well as a variety of measurement concepts, counting, and the comparison of the lengths of the blocks.

During this episode, Serena further explored counting, calculation, and time measurement, as she worked with the children to calculate the number of days until Christmas. Starting with that day's date, she stated "It's the 6th of November, no 7th. So November has got 30 days … so we take away 7" and counted with the children using one-to-one correspondence, "1, 2, 3, 4, 5, 6, 7" removing single blocks with each count. Some children appeared to be just reciting the number names rather than actually counting. One child then pointed to the three single blocks left in the row and proceeded to count them, "1, 2, 3".

Category	Codes
Measurement:	Area, Length, Quantity, Time
Number:	Counting, One-to-one, Reciting Numbers
Process:	Calculation, Classification, Comparison, Pattern, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Time
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Mathematics

Example 5.14 *Group Time with Block Tray: 3YOK-0014*

Serena continued, “And then we've got to have 23 [sic] days of December. Oh look, they look the same don't they? See that pattern? See look”. She points to the two sets of 23 blocks indicating the pattern, “the same on this side and [pause] so they match. So if we count all the blocks here, they will tell us how many days there are until Christmas. You have to be pretty good at counting, we'll put them all together now”. Serena joined the two groups of blocks together and then encouraged the children to help her with counting, pointing to each block individually, and again modelling one-to-one correspondence and providing a practical example of calculation,. One child was able to count to around 34, and Serena continued counting all 46 blocks. “Ok 46 days, that’s how many sleeps till Christmas, we can do it again next week”. While this image was not used in the interview, Serena did mention the teak blocks were one of her favourite pieces of equipment and contained in-built mathematical concepts (Serena - Interview with 3YOK Educator).

Greg and Grace were working quietly beside each other, with little interaction, at the writing table in *Drawing Materials: 3YOK-0019* , shown in Example 5.15. The episode started with Greg drawing with marker pens, and using classification and one-to-one correspondence skills as he matched the correct lid with each marker. As he decided where to draw his lines and shapes, he was also using early geometric and navigational skills.

When Greg had finished drawing, he used positional and navigational gestures and terminology to explain to Grace that, when everyone had finished with them, the markers went on the shelf. He then asked if she could pass him a pencil, and used size as the criteria for the one he was after, “I want this one, the fat one, the fat one … No, no, the fat one”. Serena placed this image in the *Not So Obvious Mathematics* pile.

Category	Codes
Measurement:	Size
Number:	One-to-one
Process:	Classification
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Fine Motor, School Readiness
Curriculum:	Art, Literacy

Example 5.15 *Drawing Materials: 3YOK-0019*

During the set-up of the room, Serena had replaced the regular paintbrushes at the easel with large stamps. Saige chose this activity in *Easel Stamping: 3YOK-0015* , shown in Example 5.16. As she worked, she was looking at the faces of the stamps appearing to compare them to her picture. Exploring and comparing the stamps also increased her awareness of geometric shapes, as most of the stamps provided were simple shapes such as squares, circles, and triangles. By checking to ensure there was paint covering the stamp, she also demonstrated her growing understanding of area. When finding space on the page to place each stamp, she also built her measurement and navigation skills. Serena placed this image in the *Not So Obvious Mathematics* pile.

Category	Codes
Measurement:	Area
Number:	--
Process:	Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual
Pedagogy:	Child Initiated
Environment:	--
Development:	Fine Motor
Curriculum:	Art

Example 5.16 *Easel Stamping: 3YOK-0015*

5.2.6 Special Projects at the 3YOK

During the data collection, the children at the 3YOK were making small bags of potpourri as presents for their mothers for an end-of-year celebration. As part of the preparation for these gifts, Serena had brought in roses and other flowers from her garden for the children to pull apart. During *Group Time with Flower Petals: 3YOK-0014* , shown in Example 5.17, she reiterated the way in which the flower petals needed to be removed

> Remember last week we took some of the roses that we had last week, and we pulled off just one petal, just one at a time, and put them down one at the time gently. And the people helped me do that, made a pattern with the petals that have different colours.

These instructions included the mathematical concepts relating to one-to-one correspondence, pattern, and classification as the children were asked to remove the petals individually, sort them by colour, and create patterns. Serena placed in

Category	Codes
Measurement:	Quantity, Volume
Number:	One-to-one
Process:	Classification, Pattern
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Group Time
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Art, Science

Example 5.17 *Group Time with Flower Petals: 3YOK-0014*

the *Not So Obvious Mathematics* pile.

During free-play, Saige was exploring this activity in *Separating Petals: 3YOK-0018* , shown in Example 5.18, and Serena came over to scaffold her play. Serena once again instructed Saige to remove the petals one at a time. During this interaction, Serena also reminded her to place the sticks and leaves in a separate container, and suggested she try to keep the petals sorted by colour. The sorting of sticks and leaves into one container, and petals by colour into different areas of the basket required the child to use her classification skills. Included in this episode was an interaction from the field notes where, later in the session, a child approached Serena to let her know the petal basket was full, demonstrating this child's knowledge of volume (3YOK Field Notes, 2012). The potential to explore fractions was also evident with terminology such as *half*, *almost*, and *all*, when describing how many petals they had removed. This image was placed in *the Obvious Mathematics* pile by Serena.

Category	Codes
Measurement:	Volume
Number:	Fraction, One-to-one
Process:	Classification
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Individual, Table
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	--
Development:	Fine Motor
Curriculum:	Art, Science

Example 5.18 *Separating Petals: 3YOK-0018*

5.2.7 Outside Free-Play Activities at the 3YOK

The sandpit in the 3YOK playground included rakes, buckets, and spades, as well as a pretend oven and cooking equipment such as mixing bowls, spoons, and baking trays. It was a popular area, with children engaging in various activities such as those in *Sandpit: 3YOK-0001* , shown in Example 5.19. The two girls on the left in this image discussed the size of the buckets they were using, comparing them by volume, mass, and by overall size. As these girls filled the buckets to create sandcastles, they had the opportunity to explore fractions, pattern making, and spatial navigation. They also explored one-to-one correspondence and counting as they pointed to each one with their hands and counted the castles they built, and then again as they jumped on each castle. Serena sorted the *Sandpit: 3YOK-0001* image into the *Not So Obvious Mathematics* pile.

Category	Codes
Measurement:	Mass, Size, Volume
Number:	Counting, Fraction, One-to-One
Process:	Comparison, Pattern
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Drama, Mathematics

Example 5.19 *Sandpit: 3YOK-0001*

The episode *Heavy Bucket: 3YOK-0003* , shown in Example 5.20, captured the moment these two girls were carrying the over-full bucket, and laughing about how heavy it was. This short interaction demonstrated their understanding of mass measurement. The girls then used their problem solving and calculation skills as they placed the bucket back on the ground to remove some of the sand, and decrease the mass. In the interview, Serena sorted the *Heavy Bucket: 3YOK-0003* image into the *No Mathematics* pile.

Category	Codes
Measurement:	Mass, Volume
Number:	Fraction
Process:	Calculation, Comparison, Problem Solving
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Mathematics

Example 5.20 *Heavy Bucket: 3YOK-0003*

The pretend oven and cooking equipment in the sandpit were used in *Cooking in the Sandpit: 3YOK-0040* , shown in Example 5.21, where Saige and Grace were pretending to cook some muffins. Saige was filling the container with sand, pretending it was a muffin about to go in the oven. During this short interaction, Saige talked about both time and temperature as she placed the “muffin in the oven to cook”. There was also the opportunity in this episode for Saige and Grace to become aware of other measurement concepts such as mass, amount, and volume. In addition, concepts such as sequencing, calculation, navigation, and fractions were explored as the girls filled the containers, mixed, cooked, and then pretended to eat their muffin. In the interview, Serena sorted *Cooking in the Sandpit: 3YOK-0040* into

Category	Codes
Measurement:	Mass, Quantity, Time, Temperature, Volume
Number:	Fraction
Process:	Calculation, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Drama, Science

Example 5.21 *Cooking in the Sandpit: 3YOK-0040*

the *Obvious Mathematics* pile.

In a very short episode, Teddy was creating a pattern in the sand in *Patterns with a Rake: 3YOK-0040* , shown in Example 5.22. This pattern making provided him with the opportunity to explore both length and area measurements, as well as develop his navigational and geometric awareness, as he moved the rake around, making patterns and shapes. This image was sorted into the *No Mathematics* pile by Serena.

Category	Codes
Measurement:	Area, Length
Number:	--
Process:	Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	--

Example 5.22 *Patterns with a Rake: 3YOK-0040*

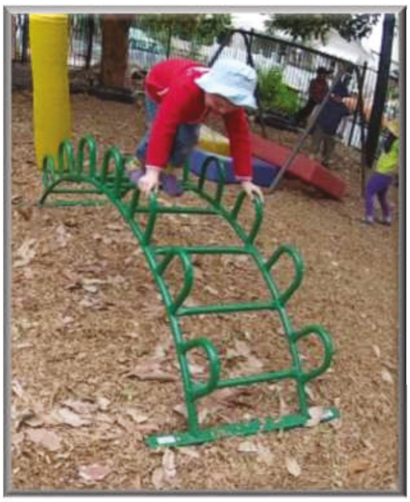
A regular activity in the playground of this centre was an obstacle course created with A-frames, planks and tyres. In *Obstacle Course: 3YOK-0042* , shown in Example 5.23, a group of children were observed. Brock commented on the size of the A-frames and the distance to the next obstacle, demonstrating a growing understanding of measurement. Included in this episode were field notes that documented the children racing each other through the obstacle course, providing an opportunity to explore sequencing, speed, and comparison. This image was placed in the *No Mathematics* pile by Serena.

Category	Codes
Measurement:	Length, Size, Speed
Number:	Ordinal
Process:	Comparison, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Gross Motor
Curriculum:	Sport

Example 5.23 *Obstacle Course: 3YOK-0042*

Two episodes, *Climbing Bridge: 3YOK-0027* and *Climbing Frame: 3YOK-0036* , captured during the fieldwork at the 3YOK, used similar outdoor equipment. The design and set up of these pieces of climbing equipment encouraged the children to build spatial awareness, sequencing skills, and understandings of measurement concepts, as they moved their bodies across the equipment.

In *Climbing Bridge: 3YOK-0027* , shown in Example 5.24, Olivia climbed over the metal climbing bridge and back again numerous times, demonstrating her one-to-one correspondence skills as she placed each foot carefully on each rung, getting faster and more confident each time. During the fieldwork, Tahlia, the assistant educator, was standing beside me as I was writing the field notes and asked what mathematics I could possibly see in this episode. I explained that Olivia was gaining an understanding of measurement as she moved across the climbing bridge, becoming aware of the length her legs and arms could reach, and an understanding of sequencing as she placed her left leg, then right leg, then left arm, then right arm on the rungs (3YOK Field Notes, 2012). This image was placed in the *Not So Obvious*



Category	Codes
Measurement:	Length
Number:	One-to-one
Process:	Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 5.24 *Climbing Bridge: 3YOK-0027*

Mathematics pile.

In *Climbing Frame: 3YOK-0036* , shown in Example 5.25, Abbie and Iris were hanging upside down and extending their navigational concepts as they gained an awareness of where their bodies were in this space, and an understanding of length measurement as they reached for the ground. Serena placed this image in the *No Mathematics* pile.

Category	Codes
Measurement:	Length
Number:	--
Process:	Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 5.25 *Climbing Frame: 3YOK-0036*

Another piece of outdoor equipment was the see-saw. Saige and Iris were laughing as they went up and down in *See Saw: 3YOK-0028* , shown in Example 5.26. This episode provided the opportunity to gain an awareness of height (coded as length), navigational awareness, and speed as they went up and down, as well as sequencing as they took turns being up, then down. This image was placed in the *Obvious Mathematics* pile by Serena in the interview.

Category	Codes
Measurement:	Length, Speed
Number:	--
Process:	Comparison, Sequence
Spatial:	Navigation
Mode of Use:	Concrete
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 5.26 *See Saw: 3YOK-0028*

The swing set was another popular outdoor area for the 3YOK group of children, and during *Swing Set #1: 3YOK-0023*, shown in Example 5.27, Grace and Ava were swinging. Swinging provided these children with an opportunity to explore length and navigation as they swung high and low. During this episode, Saige was standing next to the pole, which in this centre, indicated it was her turn next. Waiting for a turn provided an opportunity for these children to explore counting and quantities as they decided how many more swings each child had before their turn was over. This image was placed in the *Not So Obvious Mathematics* pile by Serena.

Category	Codes
Measurement:	Length, Quantity
Number:	Counting
Process:	Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Gross Motor
Curriculum:	Sport

Example 5.27 *Swing Set #1: 3YOK-0023*

A conversation between two young boys standing near the swings was captured in *Swing Speeds: 3YOK-0026* , shown in Example 5.28. During this interaction, the boys were discussing which swing they preferred to use, by comparing the speed of each, and then classifying the swings as fast or slow. Serena placed this image in the *Obvious Mathematics* pile and commented that it was, “Because they're talking about which swing is faster, faster is a comparison. And comparison is mathematical” (Serena - Interview with 3YOK Educator).

Category	Codes
Measurement:	Speed
Number:	--
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Cognitive, Gross Motor
Curriculum:	Mathematics, Sport

Example 5.28 *Swing Speeds: 3YOK-0026*

During *Tricycles: 3YOK-0022* , shown in Example 5.29, Mike, Greg, and Jadon were riding around in circles and laughing. This episode provided an opportunity for these boys to compare the tricycles they were riding and the speed at which they were going. It also helped develop an awareness of area and navigational skills as they pedalled the bikes around the bike area, mostly avoiding crashing into each other. Serena placed this image in the *No Mathematics* pile, noting that the "Bicycles, tricycles are mostly there for gross motor skill development and social play" (Serena - Interview with 3YOK Educator, 2013).

Category	Codes
Measurement:	Area, Length, Speed
Number:	--
Process:	Comparison, Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Gross Motor
Curriculum:	Sport

Example 5.29 *Tricycles: 3YOK-0022*

A very short interaction captured in *Hide and Seek: 3YOK-0002* , shown in Example 5.30, showed Fred moving behind the bushes to hide from his friend, Grace. When she asked where he had gone, he pointed to the path that ran behind the bushes, providing an opportunity for the children to gain an awareness of distance (coded as length) and navigational spatial concepts. This image was sorted into the *No Mathematics* pile by Serena.

Category	Codes
Measurement:	Length
Number:	--
Process:	--
Spatial:	Navigation
Mode of Use:	--
Situation:	Outside, Small Group
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	--

Example 5.30 *Hide and Seek: 3YOK-0002*

The gardens in the playground at the 3YOK provided Serena with an opportunity to scaffold measurement, classification, and comparison concepts through interactions such as those in the following vignettes. Firstly, in *Are the Strawberries Ripe?: 3YOK-0030* , shown in Example 5.31, Serena was explaining to the children that they should not pick the flowers or strawberries that were on the plants because they were not yet ready to eat. She explained, “Strawberries are yummy. But look, it's not the right colour. It's too white still. When it's red all over [pause]. It's not ready to eat. That's not ready to eat”. This explanation included comparison and classification as Serena was encouraging the children to understand the differences between ripe and unripe strawberries. Saige replied, “It's small. That's small” which demonstrated her understanding of size.

The conversation continued when Grace again tried to take the strawberry that was not ripe, and Serena reiterated, “No, no, no touching. When it's [pause] when they're ready to eat I'll tell you. You'll have to come and ask me though. Come and say [Serena] can I eat this yet? Ask me is it ready yet? Is it ripe?" These interactions also provided the children with an opportunity to learn about time and sequencing as they heard how the strawberry changes from the flower to a small white strawberry, to a larger strawberry, to a large red strawberry, over time. This image was placed in the *Not So Obvious Mathematics* pile.

Category	Codes
Measurement:	Size, Time
Number:	--
Process:	Classification, Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Science

Example 5.31 *Are the Strawberries Ripe?: 3YOK-0030*

Similarly, there were three short episodes in the gardening area where Saige was chatting with an educator or myself: *Eating Carrots: 3YOK-0034* , *Parts of a Carrot: 3YOK-0037* , and *Flowers You Can Pick: 3YOK-0040* . In all three episodes, Saige demonstrated further evidence of her developing classification and comparison skills as she explained which parts of the carrot were edible, and which flowers were allowed to be picked. The episode, *Parts of a Carrot: 3YOK-0037* , shown in Example 5.32, was placed in the *Obvious Mathematics* pile during the interview.

Category	Codes
Measurement:	--
Number:	--
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	--
Development:	Cognitive
Curriculum:	Science

Example 5.32 *Parts of a Carrot: 3YOK-0037*

The *Flowers You Can Pick: 3YOK-0040* episode, shown in Example 5.33, was placed in the Not So Obvious Mathematics pile by Serena.

Category	Codes
Measurement:	--
Number:	--
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Science

Example 5.33 *Flowers You Can Pick: 3YOK-0040*

The *Eating Carrots: 3YOK-0034* episode, shown in Example 5.34, was placed in the *No Mathematics* pile by Serena. She mentioned that “Looking at the carrot and which parts of that you can eat, I would interpret more as a scientific sort of activity” (Serena - Interview with 3YOK Educator).

Category	Codes
Measurement:	--
Number:	--
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	--
Development:	Cognitive
Curriculum:	Science

Example 5.34 *Eating Carrots: 3YOK-0034*

A similar episode, *Vegetable Garden: 3YOK-0031* , shown in Example 5.35, also included classification and comparison, as well as instances of counting and measurement of size as the two young girls counted the number of carrot tops they could see, using one-to-one correspondence as they pointed to each carrot top and chatted about the potential size of the carrots underneath. Classification was also involved, as the children only counted the carrot tops, and not the other plants in the garden. The *Vegetable Garden: 3YOK-0031* image was placed in the *Obvious Mathematics* pile by Serena.

Category	Codes
Measurement:	Quantity, Size
Number:	Counting, One-to-one
Process:	Classification
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Science

Example 5.35 *Vegetable Garden: 3YOK-0031*

5.2.8 End of the 3YOK Session

At approximately 4:15 p.m. each session, the educators started to encourage the children to return the toys they had been using to the correct place in the room so that they would be available for the next session. This routine again provided the children with practice in classification and using their spatial skills.

As was the case at the start of the sessions, the end of the 3YOK sessions included a group time; the children were asked to collect all their belongings and bring them to the mat. Serena used these meetings to reflect with the children on what they had been doing during the session, or what they would like to do at the next. These sessions were also used to read a story to the children as captured in *Reading in Group Time: 3YOK-0101* , shown in Example 5.36. In this particular group time, Serena chose a book that discussed the arrival of a new baby. After the story, Serena chatted with the children about who in the group had little brothers or sisters, and who was going to have a new baby soon. This short interaction provided the opportunity to classify the children into two groups, and to explore time and size measurements as they chatted about how small one child's little brother was, and how long until another child became a big sister.

Category	Codes
Measurement:	Size, Time
Number:	--
Process:	Classification, ASequence
Spatial:	--
Mode of Use:	Language
Situation:	Group Time
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, School Readiness, Social Skills
Curriculum:	Literacy

Example 5.36 *Reading in Group Time: 3YOK-0101*

After the group time, while Serena and Tahlia chatted with the children, the parents would enter the room and collect their child.

5.3 Summary of the 3YOK Episodes

Each of the vignettes discussed in this chapter, together with their codes, are shown in Table 5.2. Following this, in Section 5.4, the details from the PEI with Serena are presented. Details on the themes that emerged from these episodes, and those in the following two case study chapters, will be explored in Chapter 8.

Table 5.2.
The 3YOK Episodes and Their Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Are the Strawberries Ripe?: 3YOK-0030	(p. 127)					X				X										X	X			X			X	X							X		X		X			X	X	X	X										X	
Box Construction and Collage: 3YOK-0024	(p. 108)	X			X	X														X		X	X	X	X	X	X	X						X		X		X	X		X		X	X		X				X		X				
Climbing Bridge: 3YOK-0027	(p. 122)		X											X										X		X	X	X						X	X				X				X				X									X
Climbing Frame: 3YOK-0036	(p. 123)		X																					X		X	X	X							X		X		X	X			X				X									X
Coming to the Mat: 3YOK-0070	(p. 102)													X						X				X		X	X	X		X			X			X				X	X	X	X	X				X	X			X				
Cooking in the Sandpit: 3YOK-0040	(p. 120)			X	X				X	X	X		X						X					X		X	X	X						X	X		X		X	X			X				X				X				X	
Cushion Hat and Play: 3YOK-0041	(p. 105)														X	X								X		X		X					X			X					X	X	X	X				X	X							
Discussion on Bikes: 3YOK-0041	(p. 104)				X	X						X						X		X	X						X	X	X				X							X	X	X	X	X	X				X							
Drawing Materials: 3YOK-0019	(p. 115)					X								X						X					X	X	X	X						X			X	X	X	X			X	X		X		X		X		X				
Easel Stamping: 3YOK-0015	(p. 116)	X																			X				X	X	X							X					X							X				X						
Eating Carrots: 3YOK-0034	(p. 129)																			X	X						X							X	X				X						X										X	
Educator at the Puzzle Table: 3YOK-0021	(p. 111)	X	X			X														X	X	X		X	X	X	X	X						X			X	X		X	X	X	X	X	X	X										
Explaining the Tape Measure: 3YOK-0090	(p. 110)		X			X						X							X	X	X					X	X	X	X					X					X			X			X	X							X			
Finishing the Puzzles Together: 3YOK-0005	(p. 112)	X	X			X														X	X			X	X	X	X	X									X	X		X	X		X	X	X	X			X							
Flowers You Can Pick: 3YOK-0040	(p. 128)																			X	X						X							X	X				X				X	X	X										X	
Group Time with Block Tray: 3YOK-0014	(p. 114)	X	X		X					X		X		X			X		X	X	X	X	X	X	X	X	X	X	X				X							X	X	X	X	X	X								X			
Group Time with Flower Petals: 3YOK-0014	(p. 117)				X						X			X						X		X				X	X	X					X								X	X	X	X		X				X					X	
Heavy Bucket: 3YOK-0003	(p. 119)			X							X		X						X		X		X				X	X							X		X		X	X			X				X							X			
Hide and Seek: 3YOK-0002	(p. 126)		X																							X									X		X		X				X				X									
Obstacle Course: 3YOK-0042	(p. 121)		X			X		X								X					X			X		X	X	X							X		X		X	X			X				X									X
Parts of a Carrot: 3YOK-0037	(p. 128)																			X	X						X							X	X				X						X										X	
Patterns with a Rake: 3YOK-0040	(p. 121)	X	X																			X			X	X	X							X	X				X				X				X									
Play Dough Table: 3YOK-0096	(p. 109)	X		X	X	X						X	X	X	X						X				X		X	X						X			X	X		X	X	X	X	X		X			X	X			X			
Reading in Group Time: 3YOK-0101	(p. 130)					X				X										X				X				X					X								X	X	X	X	X			X	X			X				
Room Set-Up: 3YOK-0089	(p. 99)	X																		X						X	X	X	X			X		X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X			
Running on the Path: 3YOK-0033	(p. 101)		X					X													X					X	X	X						X	X		X		X	X			X				X									X
Sandpit: 3YOK-0001	(p. 119)			X		X					X	X	X	X							X	X				X	X	X							X		X		X	X			X				X				X		X			

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize
See Saw: 3YOK-0028	(p. 123)		X					X										
Separating Petals: 3YOK-0018	(p. 118)										X		X	X				
Snack Time: 3YOK-0004	(p. 106)				X					X		X		X				
Swing Set #1: 3YOK-0023	(p. 124)		X		X							X						
Swing Speeds: 3YOK-0026	(p. 125)							X										
Tricycles: 3YOK-0022	(p. 125)	X	X					X										
Two Boys and Blocks: 3YOK-0020	(p. 113)	X	X			X						X		X				
Vegetable Garden: 3YOK-0031	(p. 129)				X	X						X		X				
Who is Here Today?: 3YOK-0041	(p. 103)											X		X				X

Episodes		Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic
See Saw: 3YOK-0028	(p. 123)			X			X		X	X		
Separating Petals: 3YOK-0018	(p. 118)		X							X	X	
Snack Time: 3YOK-0004	(p. 106)	X	X	X		X				X	X	
Swing Set #1: 3YOK-0023	(p. 124)			X					X	X	X	X
Swing Speeds: 3YOK-0026	(p. 125)		X	X					X	X	X	
Tricycles: 3YOK-0022	(p. 125)			X	X			X	X	X		
Two Boys and Blocks: 3YOK-0020	(p. 113)	X	X	X	X	X	X	X	X	X		
Vegetable Garden: 3YOK-0031	(p. 129)		X							X	X	X
Who is Here Today?: 3YOK-0041	(p. 103)	X	X			X				X	X	X

Episodes		Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
See Saw: 3YOK-0028	(p. 123)						X		X		X	X			X				X									X
Separating Petals: 3YOK-0018	(p. 118)					X				X			X	X				X				X					X	
Snack Time: 3YOK-0004	(p. 106)		X			X		X	X	X	X	X	X	X	X	X				X	X							
Swing Set #1: 3YOK-0023	(p. 124)						X		X		X	X			X	X			X									X
Swing Speeds: 3YOK-0026	(p. 125)						X		X		X	X					X		X						X			X
Tricycles: 3YOK-0022	(p. 125)						X		X		X	X			X	X			X									X
Two Boys and Blocks: 3YOK-0020	(p. 113)			X		X			X		X	X					X	X							X			
Vegetable Garden: 3YOK-0031	(p. 129)						X		X		X	X			X	X	X										X	
Who is Here Today?: 3YOK-0041	(p. 103)				X							X	X	X	X	X				X	X							

5.4 Interview Data

The interview with Serena was undertaken in October, 2013, and lasted approximately 50 minutes.

5.4.1 Serena's Pedagogical Beliefs and Practices

The first few questions of the interview protocol (see Appendix D, p. 390) were designed to elicit information from Serena about her background and pedagogical practices, which was previously outlined in Section 5.1.1 (p. 95). Among other qualifications, Serena held a Graduate Diploma in Early Childhood Education, and had worked in this centre for the past 17 years. When asked about her educational philosophy, she labelled herself as a "Social-constructivist" and stated she believed

> That everybody, not just children, have to construct their own learning, and so they have to be actively engaged in learning and construct their own understandings of something. But that the environment in which they are learning conditions [pause] what learning opportunities are available to them, and what understandings are presented to them to choose from and so [pause]. In each case, you know, in the case of any possible interpretation, there is the choice to learn it or reject it … and so that often, children are not learning what we intended them to learn but are learning a type of anti-curriculum that because of what's in the setting.

When asked about mathematics in particular, Serena explained that she thought

> That it is important the children to start to observe the properties of things. And to work on things like patterning and categorising, and grouping. I think it's really important for them to have very concrete, hands-on experiences of whatever they're doing, and I

> think that naming concepts is secondary to experiencing, and I think it's good to have a lot of spatial, experiences and then also number.

The subsequent question inquired about her thoughts on whether mathematics should be included in early childhood education. She responded in the positive, stating

> I think maths is inevitably included in early childhood education because maths is in the world. And it's also very deeply embedded in our culture, and so that even without intending to, we include a lot of maths. But I think it would be good if we were more conscious of the maths that we are teaching and be able to make more intentional selections.

She went on to discuss the role of the educator, stating

> I think that the teacher controls the environment that is being offered to the kids. And, so that means that the teacher or the staff together are setting the framework for what mathematical learning is on offer at the time and also has an additional role in being able to draw attention to particular aspects of what mathematical learning is available.

In her explanation of the mathematical concepts she intentionally teaches, she mentioned

> Both numbers in sequence, you know, just learning numbers stream, and starting to count units. And I also intentionally try to extend that especially in the later half year into larger numbers and groupings and, umm, and demonstrating techniques for arriving at a bigger number. I don't intentionally work with written numbers much. Or with, like I don't encode number as sums, or

> anything. Will try to teach children how to write 10 or 100 or that sort of thing, but I do have [pause]. Often when I choose the materials that I want to buy or work with I can choose materials that I see as having mathematical properties. And one of my favourite ones that I keep in the room all the time is a set of teak blocks that have got [pause]. They're a bit sort of like Cuisenaire rods but they're teak. They've got ten, nine, eight, seven, and then a whole lot of singles. And so I quite often use those when, umm, an opportunity to try to arrive at a number comes up, and I'll demonstrate to the kids using those numbers, or will also use them for something like (example given was from her previous four-year-old groups).
>
> With the three-year-old group, one of the things that I did, that I thought of, that was intentionally mathematical, was that I had a board for the children to say whether they had had their snack or not. I used [pause] and I've got the children to move their own name and photograph from one side to the other. And I saw that as partly, as a visual graph of the group who had eaten, so we would often count how many people had eaten and how many people haven't eaten.
>
> And I also often get the kids to organise themselves into groups such as you know, who's three, who's four, who's five, and sit in groups and then count how many are in each group and then we will do that again over time.

The teak box discussed above was used in two episodes: *Two Boys and Blocks: 3YOK-0020* (p. 113) and *Group Time with Block Tray: 3YOK-0014* (p. 114), and both episodes included opportunities for developing multiple mathematical concepts.

Unfortunately, the snack graph mentioned was not in use during the data collection.

Serena admitted to not feeling “particularly confident” in teaching early childhood mathematics, partially as her own mathematical education was “close to non-existent”. However, it was a topic that she found herself returning to throughout her teaching, with the belief that while she was confident that the mathematics she did teach was valuable, she also wondered “if there are things I’m missing out on because I don’t know they exist?”

During the section of the interview that discussed programming, Serena explained that within her room, “not much of it is forward planning, most of it is a record of what evolved and what we ended up doing”. However, she also returned to the importance of the environment provided by the educators, stating

> There's a lot of intentionality in my purchasing materials, or choosing materials, so that like, I've been the driver of getting a lot of the more abstract geometric puzzles and materials into the place because I, I mean, I'm drawn to them but I also feel that there's a lot of embedded mathematics in those materials that is both [pause] Provides self-directed learning and also opportunities for staff to draw mathematical concepts out in relation to those materials, and so while I wouldn't sit down and write, you know, I will get this out so the children can learn that. The fact that I've got it, I might jot on a quick plan, you know, use stone blocks. It kind of carries that, that intention.

Serena felt that at home, the parents of the children in her centre were likely to explore

> quite a lot of number work with kids. I think parents particularly the ones who involve the children in cooking do quite a lot of

> measurement, and talk about quantity and stuff like that. I think quite a few kids have got materials like puzzles and things at home, and blocks that have got the obvious in-built mathematical properties. And I think it probably varies a great deal from one family to another, because some families, you know, and some parents treat [pause]. A lot is in their individual conversation styles with the children, and also with their own instinctive awareness of those sorts of things.
>
> I suspect that their [pause] their mathematical teaching are mostly less conscious, and I think they probably only have a conscious focus with language and literacy and reading to their kids [pause] and the things they do that are about mathematics are less conscious. While the other thing I meant to say was I think there is quite a lot of [pause] sorting and categorising, I think at that, at age 3, it's very [pause] it's really not possible to distinguish between learning that is part of a new language, and learning that is part of mathematics. And so I think, in parents' minds, it's mostly about getting kids to name things correctly and learn what goes together.

She did not feel as though the parents of the children in the 3YOK expected any particular mathematical concepts to be taught at the preschool, rather there was a focus on ensuring that children felt safe and secure. However, she was always responsive to individual requests from the families and tried to ensure there was a strong parental involvement in the programming.

5.4.2 Sorting the 3YOK Images

Following these background questions, Serena was handed the selected images (with the text written on the back) that were prepared for the interview as discussed in Section 4.3.3 (p. 70). I asked Serena to sort the images into three piles: those that she could identify as containing *Obvious Mathematics* , those that contained *Not So Obvious Mathematics* , and those in which she could see *No Mathematics* . After being reassured that there were no right or wrong answers, she sorted them as shown in Table 5.3.

Table 5.3
Serena's Sorting of the 3YOK Images

Image	Pile
Discussion on Bikes: 3YOK-0041 (p. 104)	*Obvious Mathematics*
Educator at the Puzzle Table: 3YOK-0021 (p. 111)	*Obvious Mathematics*
Explaining the Tape Measure: 3YOK-0090 (p. 110)	*Obvious Mathematics*
Finishing the Puzzles Together: 3YOK-0005 (p. 112)	*Obvious Mathematics*
Parts of a Carrot: 3YOK-0037 (p. 128)	*Obvious Mathematics*
Room Set-Up: 3YOK-0089 (p. 99)	*Obvious Mathematics*
See Saw: 3YOK-0028 (p. 123)	*Obvious Mathematics*
Separating Petals: 3YOK-0018 (p. 118)	*Obvious Mathematics*
Swing Speeds: 3YOK-0026 (p. 125)	*Obvious Mathematics*
Two Boys and Blocks: 3YOK-0020 (p. 113)	*Obvious Mathematics*
Vegetable Garden: 3YOK-0031 (p. 129)	*Obvious Mathematics*
Are the Strawberries Ripe?: 3YOK-0030 (p. 127)	*Not So Obvious Mathematics*
Box Construction and Collage: 3YOK-0024 (p. 108)	*Not So Obvious Mathematics*
Climbing Bridge: 3YOK-0027 (p. 122)	*Not So Obvious Mathematics*
Cushion Hat and Play: 3YOK-0041 (p. 105)	*Not So Obvious Mathematics*
Drawing Materials: 3YOK-0019 (p. 115)	*Not So Obvious Mathematics*
Easel Stamping: 3YOK-0015 (p. 116)	*Not So Obvious Mathematics*
Flowers You Can Pick: 3YOK-0040 (p. 128)	*Not So Obvious Mathematics*
Group Time with Flower Petals: 3YOK-0014 (p. 117)	*Not So Obvious Mathematics*
Heavy Bucket: 3YOK-0003 (p. 119)	*Not So Obvious Mathematics*
Running on the Path: 3YOK-0033 (p. 101)	*Not So Obvious Mathematics*
Sandpit: 3YOK-0001 (p. 119)	*Not So Obvious Mathematics*
Snack Time: 3YOK-0004 (p. 106)	*Not So Obvious Mathematics*
Swing Set #1: 3YOK-0023 (p. 124)	*Not So Obvious Mathematics*
Climbing Frame: 3YOK-0036 (p. 123)	*No Mathematics*
Eating Carrots: 3YOK-0034 (p. 129)	*No Mathematics*
Hide and Seek: 3YOK-0002 (p. 126)	*No Mathematics*
Obstacle Course: 3YOK-0042 (p. 121)	*No Mathematics*
Patterns with a Rake: 3YOK-0040 (p. 121)	*No Mathematics*
Play Dough Table: 3YOK-0096 (p. 109)	*No Mathematics*
Tricycles: 3YOK-0022 (p. 125)	*No Mathematics*

Sorting the images took Serena approximately 12 minutes and, during this time, she hesitated only once about the image, *Are the Strawberries Ripe?: 3YOK-0030* , which she at first placed in the *No Mathematics* pile, but then, after reading the short descriptive text on the back, she placed it in the *Not So Obvious Mathematics* pile. The text on this image stated "Educator and children discussing the growth of strawberries".

Following the sorting, I asked Serena to choose an image from the *Obvious Mathematics* pile to discuss in greater detail. She chose *Two Boys and Blocks: 3YOK-0020* (p. 113) and focused on the inbuilt mathematical properties of this piece of equipment, mentioning that

> some of [the blocks] are in lines that are marked as individual but it's actually a piece, so the kids can actually line up the individual ones to match the length and so forth, and that the tray, actually, makes them want to add them up to 10. So that you end up with 100 at the end.

She then chose *Swing Speeds: 3YOK-0026* (p. 125) as the second image to discuss, highlighting the comparisons the boys were making, stating as previously mentioned that, "'faster' is a comparison, and comparison is mathematical".

When discussing the *Not So Obvious Mathematics* pile, Serena started with *Snack Time: 3YOK-0004* , explaining

> There are a limited number of places at the table, and the kids can only sit at the table. We have a rule, there has to be a place free at the table, which means that they had to observe empty and taken, and there is a kind of inbuilt one-to-one correspondence in having to match one child to one chair.

She also discussed *Running on the Path: 3YOK-0033* (p. 101) and, as previously mentioned, simply stated that it provided "a physical experience of length".

When asked about the *No Mathematics* pile, Serena first chose *Hide and Seek: 3YOK-0002* (p. 126), identifying a goal of “object permanence which is a really important, cognitive stage, but not particularly [pause], I mean it's necessary for mathematics, because mathematics is necessary in everything, and it's also very social and, and involves language”. Serena then identified *Tricycles: 3YOK-0022* (p. 125) as “mostly they’re all for gross motor skill development and social play”.

5.4.3 Exploring the List of Mathematical Concepts with Serena

Serena was given *the Mathematical Concepts List for PEI* (see Appendix E, p. 393) for the next section of the interview, and asked to discuss how she would typically scaffold each of the concepts.

Starting with the Measurement concepts, she mentioned that, “*Size* comes up a lot so you can [scaffold] whenever you are working with any kind of object. Especially, a lot of things come in bigger and smaller. So opportunities come up frequently to use those kinds of terms and the same is true of *Length* words”.

She mentioned activities she would organise that would “tend to draw attention” to these concepts, such as “lining the children up by height. Which I do partly for the right ordering process but also, to demonstrate to them that tall is not necessarily older”.

She was less clear about *Area*, stating it “would generally come up when you are in the process of doing something”. Providing no specific examples, just that it would be “covered by the general patter that accompanies whatever you are doing”.

Volume, she felt required the “need to set up activities that, that have containers, working with water or rice or that sort of thing, and in cooking”. Mass was considered to be found in the environment, where it would be a case of “noticing” the opportunities that occurred, especially “in the garden where you’ve got rocks and things”.

As previously mentioned, the program schedule was highlighted as an example of when she would most often explore *Time*, “Measuring the passing of, you know, the structure of the program. You know, when is Mummy coming, and that kind of thing”. Serena felt that measuring *Sound* was usually found to be related to “inside voices and music and singing” although she also mentioned moments of “intentional silence”.

Spatial concepts on the list was divided into two sections: *Geometric* and *Navigation*. Serena was easily able to identify puzzles as a way to expand *Geometric* awareness, explaining how the children would “turn pieces around, and so forth to make them fit. But also there is often a lot of vehicle play, so kids are into wheels which rotate, and they can often be [pause]. We would often use some *Geometric* shapes for collage”.

Navigation, she felt was an area where “there is the least conscious need to, to actually intervene, to, to scaffold it. But it comes up in relation to, in relation to encouraging kids to find objects”. She mentioned that with her pedagogical style she was less likely to get things for the children, preferring to support “them to do it themselves”, usually providing “a series of suggestions and instructions about where something is, and where to find it, or what it looks like”. She also identified activities such as dancing and playing games, and moving from inside to outside.

Object classification was a concept Serena felt early childhood educators were “a bit obsessed with”, explaining that often the equipment or materials developed specifically for early childhood “have embedded sorting activities in them”. In addition to this, as previously mentioned, she had specifically chosen to “focus everything on one colour … because by making everything red, you removed colour, and that point of comparison, and then [they] start to focus on other kinds of categories”.

Role classification was not a concept Serena understood. When explained that, for this study, I had defined it to describe when children would take on the characteristics of a person or animal, she felt she would be more likely to “challenge their classification” as they were often the cause of conflict and more of a social justice issue then a mathematical one. (Due in part to this confusion by the educators, the *Role* and *Object Classification* codes were combined in the final analysis and included in the Process category).

Order was the next concept Serena discussed, referring back to her example of length where she would ask the children to line up by height or by age order. Reflecting that this may also have been a form of *Role Classification* “by grouping the kids by three-year-olds or four-year-olds, who belongs to which group, who belongs to [pause], and who is in that group, who is in this group”. This confirmed that Role Classification was not understood by Serena.

Serena also returned to the embedded mathematical concepts in early childhood equipment, stating, “A lot of our manipulative materials have built-in ordering in them”.

Serena identified *Patterns* in “bought materials and puzzles”, also mentioning that it could be included “a lot in [pause] art. Our provisional art materials and provocations. And choices of fabrics for decorating, that sort of thing”. Music was also used to explore patterns, specifically through “clapping and copying clapping patterns”.

One-to-one Correspondence and *Counting* were discussed together, “counting with a finger, actually counting each one and coming up with the right number is something that, I think, well most of us [educators] are pretty convinced is [pause] is an important way to interact with children, so it comes up a lot spontaneously” .

Serena also mentioned the progression throughout the year from simple counting to the use of ordinal numbers, “Then I start to add that [to the program], so I think I have an awareness of that as being, going up a notch in sophistication”.

Reciting number names was not a concept she would engage in “independently of actually counting objects”. While she was unsure initially of what Rational Counting meant, when explained that she had covered this with one-to-one correspondence, she replied, “Okay, right, so it’s working out what, what the actual finished number is? I will often build in a ritual into the day which involves counting”. She described an activity she would engage in with the older four-year-old children where she would ask them to line up and count themselves as they left the line. She mentioned that, as each child would “arrive at a different number. Because the line is getting smaller. So they're each getting their own opportunity to come up with the correct number”.

Subitizing was a concept that Serena was aware of but did not intentionally try to “work with”. However, she did “notice the skill of subitizing developing in kids … [and] that a lot of the materials that we worked with which are often frequently in small sets” provided children with “frequent exposure to that skill”.

The opportunity to explore *Fractions* was also apparent to Serena in the equipment, “particularly things like toy cakes and toy pizzas that divide naturally into numbers, and vegetables that can be … cut in half”. Mentioning that these also provided the educator with an opportunity to use fraction terminology. Cooking experiences were also identified as opportunities to talk about measurements. Serena mentioned that she had attempted in the past to purchase more materials to promote *Fractions*, including “graphical sort of things”. However, she had not received support from other staff members.

Due to time constraints, this section of the interview was stopped here and Serena did not continue through the list of concepts or re-examine the images to attach mathematical coding stickers as planned.

5.4.4 Additional Thoughts from Serena

To conclude the interview, I asked if Serena had anything else she would like to add and, after thinking for a moment, she replied

> I think most of us are probably doing a lot more mathematically then we are aware of, because I think a lot of the important mathematical experiences for the young children are embedded in the environment, either because they are there anyway naturally, or because the other expert people who have just had [pause] input into designing the materials.

Another point she felt important to discuss was the fear of mathematics that some educators may feel, mentioning that where educators “need most support is in learning to recognise the mathematical environment, and the mathematical activities that they are already doing, and understanding that this is what it is, that it's not some incredible, mysterious, bamboozling other thing”.

Serena felt that early childhood educators need support “with their own mathematical understanding, and their understanding of mathematical teaching” and that this should be similar to how children learn – by educators starting with the child’s past experiences, and making them feel “secure, and [then] supporting them … [to help] to take their learning to the next step”.

She explained that the best way to achieve a better understanding by the educators was to “start with saying, ‘What you are doing here is mathematical, and this is what we mean by this kind of concept’”. Additionally, Serena argued that “it should stay as close as possible, and as concrete as possible, to the everyday activities of the teachers”. The reason for this was two-fold; firstly, she felt that if professional development brought in “new ideas and new materials … and tried to graft them on to existing practice” it would fail, as educators may not be able to “transfer, if they are having trouble understanding … that strange thing into their own practice”.

Secondly, this failure to transfer the idea could present a “danger of knocking off the [educator’s] confidence in what they are already doing”.

Serena also argued for the educator to have an opportunity to be scaffolded themselves. She suggested they should be told, “Look, what you are already doing is this thing. This is what we mean by that. … That concept that was always abstract to you, you never grasped, actually you are already doing it, you just didn’t know”.

When asked if her practices had changed by participation in the study, Serena replied in the affirmative, noting that now she is looking for mathematical opportunities within her intentional teaching, and she is also aware that she is “open for opportunities to improve my own understanding of what constitutes maths in early childhood”. She is now curious about how she can implement more mathematics in her early childhood classroom, as well as ways to gain an understanding of the “difference between doing maths in year two, or prep, or year six”.

Serena continued to reflect on the implications of the push-down curriculum, feeling that “If we just start using … abstract language, I don’t think it will improve their mathematical learning at all. … I do think it has to be, umm, very concrete”. The appropriate level of abstraction for this age appeared to be a topic that was “in the back of my thinking in general, not in my day-to-day practice”.

The interview concluded at this point. However, Serena and I continued to chat for about 25 minutes after the interview regarding issues surrounding the push-down curriculum, and she appeared to be battling with her own understanding of where mathematics fits into both the three-year-old and four-year-old kindergartens

6 The Four-Year-Old Kindergarten – 4YOK

This chapter presents the data from the four-year-old kindergarten site (4YOK). Pseudonyms have been used when referring to the educators and children to protect their anonymity. As set out in Chapter 4 and noted in the chapter above, the data for each site were collected in two stages. Firstly, video observations and field notes were collected at the 4YOK over a two-week period in May and June, 2012. The data were then analysed and coded to identify the mathematical content and contextual details. The second stage of data collection, a photo-elicitation interview [PEI] with the educator of the 4YOK, was undertaken in October, 2013.

To provide background and context for the 4YOK case study, Section 6.1 provides details on how I approached the early childhood centre in which the 4YOK was located, as well as information on the participants included in the study, and the pedagogical approaches used in the centre. Section 6.2 provides a detailed description of the 4YOK routine, including the set-up of the centre and the episodes observed during fieldwork. These episodes are written in the form of short vignettes, as discussed in Section 4.6 (p. 89), and include details of the mathematics, both actual and potential, identified in the analysis. A summary table of the coding for all vignettes is located in Section 6.3, while Section 6.4 presents the interview data, making connections with the vignettes and to educator's pedagogical practices.

6.1 Overview of the 4YOK Setting

Professional networks were again used to identify Samantha and the 4YOK as potential participants for the study. The centre in which the 4YOK group was located was the first centre identified for the project, and approaching this centre was simplified as both the educator and assistant knew of my research and were keen to be a part of the study.

I provided them with the *Plain Language Statements and Consent Forms* (see Appendix C, p. 378) to read and discuss. Samantha, in her role as centre director, discussed the study with the parental management committee prior to my visit, and gained their approval for the research to be conducted at the centre.

This sessional kindergarten, in which the 4YOK was located, was a two-storey building with two classrooms, two playgrounds, an office, and a community hall. The centre ran weekly sessions for four groups of children – two groups for three-year-old children and two groups for four-year-old children. The participants for this study included one of the two four-year-old groups of children which, as previously noted, is identified as 4YOK within this thesis.

6.1.1 4YOK Participants

The participants in the study from the 4YOK were:

- Samantha – the centre director and educator for the four-year-old groups;
- Aaron – the assistant director and educator for the three-year-old groups;
- Lucy – the regular assistant for the four-year-old groups;
- Nicole and Holly – Wednesday afternoon educator and assistant;
- Jola – a student teacher on practicum; and
- twenty-one children – aged between four and five years.

The centre had additional staff who were not participants in the study. These included the educators and assistants for other sessional groups, a specialist educator who came in for music lessons, and a special-needs aide. Aaron had borrowed my video cameras on a previous occasion to explore the use of technology in his own teaching, and had offered some ideas on the practicalities of using the cameras in the centre, as discussed in Section 4.2.1, (p. 56).

Samantha's background information was collected during the PEI, and general information on the children as a group was collected through informal chats during the fieldwork. Background information on individual children and other adult participants was not collected.

Samantha’s Background and Qualifications

Samantha had been working in early childhood for 12 years, with groups of both three-year-old and four-year-old children. Her formal qualification was the Bachelor of Early Childhood Education, which she had recently upgraded from a three-year Diploma of Teaching.

Samantha taught both four-year-old groups and held the Centre Director position; additionally, she mentioned

> I also have written two early childhood books. I run my own consulting business, where I support educators in preparing for their assessment and ratings with ACECQA [Australian Children's Education and Care Quality Authority] and various other tasks in relation to meeting the framework requirements (Samantha - Interview with 4YOK Educator).

In addition to these commitments, Samantha also worked part-time as a sessional university academic and was studying for her Masters in Early Childhood Education.

Samantha stated in the photo-elicitation interview [PEI] that she believed that “children learn through play” and that educators need to “set up an environment that helps teach the children the skills that they learn”. Adding that, “the staff are there to support children in their development”. Through the use of an “emergent” programming style, the children’s interests were closely followed in the 4YOK, including those interests the families shared with the educators.

The Children in the 4YOK

According to Samantha, the centre drew enrolments from mainly white, upper-middle-class families, with a few identifying as Asian Australian. Each week the centre ran two four-year-old groups (Blue Group and Red Group) and two three-year-old groups (Yellow Group and Green Group). These groups rotated through the two purpose-built rooms and playgrounds. At the suggestion of Samantha, the Blue Group was chosen to participate in this study as she felt the children in this group were more settled into their routine and, in her opinion, were less likely to be disrupted by the research. This group is referred to as the 4YOK.

The 4YOK included 24 children who attended the centre on Mondays (9:15 a.m. to 3:15 p.m.), Wednesdays (9:00 a.m. to 12:00 p.m.), and Fridays (9:15 a.m. to 3:15 p.m.) for a total of 15 hours. In addition to this, 18 of the children also attended an additional three hours on Wednesday afternoon (12:00 p.m. to 3:00 p.m.) with Nicole as lead educator, for a total of eighteen hours per week.

The majority of the children in the 4YOK were expected to be attending primary school in the following February, with two or three children possibly returning for a second year of kindergarten. One child had funding for a known developmental delay, and external agencies were working with the educators to assess an additional two children for developmental concerns. Samantha did not specifically identify these children due to privacy concerns.

Samantha had spoken informally to most of the parents prior to my arrival, explaining the purpose of my visit and the video cameras I would be using. Before the children entered the centre on the first day of data collection, I spoke to the parents as a group; introducing myself, handing out *Plain Language Statements and Consent Forms*, and offering to answer any questions. The responses were varied but generally positive. One parent mentioned she had just completed her PhD and fully supported my research, and another felt the need to discuss consent with his wife before committing for their child.

Over the following two weeks, I continued to chat with parents before and after each session, answering individual questions and collecting completed consent forms. These informal chats provided an opportunity to build relationships with the children and their parents which, Flewitt (2005) explains, “can have a profound impact on the progress and outcomes of the study” (p. 4). Some parents were very interested in gaining an understanding of the mathematics in their child’s world and asked for specific examples, others were just happy to say “Hi”.

By the end of the fieldwork at this centre, 21 of the 24 families had returned the forms giving consent for their child to participate. One parent informed me verbally that she had chosen for her child not to participate, and two families did not return the forms with no explanation as to why; a consent rate of 87.5%. Details of how these three children were excluded from the data collection was discussed in Section 4.3 Data Preparation (p. 66).

6.2 The 4YOK Routine

The general routine at the 4YOK included structured whole group times, time for eating, an afternoon rest, and lots of free-play time, as shown in Table 6.1.

Table 6.1
Daily Routine in the 4YOK Centre

Time	Activity
8:45 a.m.	Arrival, storing belongings, greeting friends, and gathering for group time
9:00 a.m.	Group Time
9:20 a.m.	Free-Play Activities
9:30 a.m.	Morning Tea[1]
10:00 a.m.	Educators open doors for Indoor/Outdoor Free-Play
11:30 a.m.	Group Time and Movement to Lunch[2]
12:00 p.m.	Lunch
12:30 p.m.	Rest
1:30 p.m.	Free-Play Activities
2:45 p.m.	Pack up and Group Time
3:15 p.m.	Parent pick-up[3]

[1] Children were able to choose when they are ready for Morning Tea.
[2] On Wednesdays, six children were picked up by parents before lunch. The remaining eighteen children moved upstairs to the second room with Nicole for lunch, and followed a similar schedule for the rest of the day.
[3] On Wednesdays, parent pick-up is at 3:00 p.m.

At the 4YOK, all children were expected to come together during the group times and join in educator-led activities such as discussing the day ahead, reading a story, singing songs, and group reflections. Free-play activities included planned individual and small group activities, or the opportunity to engage in unplanned activities that arose from the children's interests on the day. Depending on the needs of the children and the activities planned, the educators either stayed with a particular activity or moved throughout the room, engaging with the children and scaffolding their play as required.

6.2.1 Setting Up the 4YOK Environment

As with most kindergartens in Victoria, the educators in the 4YOK arrived before the children to set up the room and to be organised for when the children arrived; this included setting out the equipment required on the program, such as the particular paints and brushes at the easel, the play dough and tools, selecting jigsaw puzzles, setting up the outdoor playground with swings, mini trampoline, and sand pit equipment.

Samantha noted the importance of the environment during the interview, stating

> I believe very much in Vygotsky's theory, I believe that children learn from other people that have got greater knowledge then themselves, so by watching and learning from others around them. Which is why it is so important to set that environment up well. Because sometimes the people are not there to necessarily teach them, so therefore, the environment, if it's well organised and well set up, can, in fact, work as a teacher.

Similarly to the 3YOK, the educators set up areas for individual or small group play; these provided provocations for children to explore the equipment in their own way. The *Doll House Activity: 4YOK-0042* , shown in Example 6.1, for example, included a variety of small dolls with a basket filled with furniture placed on the side to encourage the children to furnish the house. Deciding which furniture went in each room gave the children opportunities to build classification skills, area and size measurement skills, and navigational spatial awareness. Sequencing, time measurement, and classification were also identified as children were observed using the small dolls in dramatic play, assigning them the role of mother, father, or child, and then role-playing routines from their own homes and from the preschool.

Category	Codes
Measurement:	Area, Size, Time
Number:	One-to-One
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	Fine Motor, Social Skills
Curriculum:	Drama

Example 6.1 *Doll House Activity: 4YOK-0042*

The *Stones and Spoon Activity: 4YOK-0044* , shown in Example 6.2, was a small, open-ended activity that provided opportunities for the children to classify the stones by colour, make patterns, and use one-to-one correspondence as they placed individual stones onto each small circle. This activity also provided an opportunity to explore spatial concepts as the children made shapes in their patterns. Included in this episode were field notes of children counting the stones they had placed and counting the spaces left on supplied mat.

Category	Codes
Measurement:	Area
Number:	Counting
Process:	Classification, Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Table
Pedagogy:	Educator Initiated
Environment:	Physical
Development:	Fine Motor
Curriculum:	Art, Mathematics

Example 6.2 *Stones and Spoon Activity: 4YOK-0044*

The *Small Play Set Up: 4YOK-0047* , shown in Example 6.3, provided opportunities for the children to expand their navigational concepts, and explore a variety of measurement concepts, as well as engaging in comparison, sequencing, one-to-one correspondence, and creating patterns, as they placed objects inside and around the various sized boxes. This image was placed in the *Not So Obvious Mathematics* pile by Samantha during the PEI.

Category	Codes
Measurement:	Area, Length, Quantity, Size, Volume
Number:	Fraction, One-to-One
Process:	Classification, Comparison, Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Table
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Drama

Example 6.3 *Small Play Set Up: 4YOK-0047*

A notable feature in this centre was the *Photo Wall: 4YOK-0131* , shown in Example 6.4; a display of photographs of additional equipment available in the store-room.

The idea behind this display was to provide the children with the opportunity to extend their own learning through the addition of more equipment (Rosback & Wilson, 2012). These photographs provided the children with an opportunity to classify, as they were able to select equipment that could be matched with the toys they were currently playing with. Once the photo of an appropriate toy had been identified, the child also used navigational language to identify which photo to the educator. This image was placed in the *No Mathematics* pile, and was discussed in the interview by Samantha, where she hesitantly stated

> This one here, the children are able to make choices of what they want in the program. Umm, I don't know if they're trying to work out whether they need some rocks and some trees and some people. Is there a maths concept behind that? I mean if they want to stand there and count the different things, or they could sort it and have all the animals here and the stones over there, or the rocks and the natural things here in the man-made things there. So there's sorting, but the children don't generally move them they just come and point to them, so it depends on how you want to look at the experience. The experience itself is for them to make a choice.

Category	Codes
Measurement:	Quantity
Number:	--
Process:	Classification
Spatial:	Navigation
Mode of Use:	Language
Situation:	Individual
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Social Skills
Curriculum:	--

Example 6.4 *Photo Wall: 4YOK-0131*

6.2.2 Arrival at the 4YOK

Similarly, to the 3YOK, around 15 minutes before the session started, the children arrived at the centre with their parent or guardian, who signed the roll. As part of the arrival routine, it was the child's responsibility to place their drink bottle, snack, and lunch box containers on three trolleys, and then place their bag and jacket on the hook assigned to them in *Pictures and Hooks: 4YOK-0037* , shown in Example 6.5,. While this routine was in place to provide school readiness skills and ensure a smooth flow of the day, the children were also engaged in a mathematically-rich activity. This routine was one of many routines noted in my observations as a clear example of sequencing; often the child or parent would list explicitly what needed to be done, for example, one parent was overheard stating "Bag on the hook, bottle and snack on the trolleys, say good-bye, and go inside and sit on the mat" (4YOK Field Notes, 2012).

Category	Codes
Measurement:	--
Number:	One-to-One
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Arrivals, Individual, Routines
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	School Readiness, Social Skills
Curriculum:	--

Example 6.5 *Pictures and Hooks: 4YOK-0037*

A variety of children were observed engaging in this routine as they arrived; some were able to complete the sequence independently, while others required assistance from their parent or peers (4YOK Field Notes, 2012). In addition to sequencing, the children were also practising their classification and one-to-one correspondence skills as they matched their belongings with their assigned hook and the appropriate trolley.

The sequence continued as the children came into the room and chose a spot on the mat, forming a semi-circle, reinforcing their geometric and navigational awareness. As mentioned in the 3YOK vignette for *Coming to the Mat: 3YOK-0070* (p. 102), finding whom to sit next to was an important part of this sequence, providing further practice in classification and spatial awareness. Samantha placed this image in the *Obvious Mathematics* pile.

6.2.3 Group Times at the 4YOK

While waiting for Samantha to start the group time, a child mentioned they had been to swimming lessons and Nicole, the assistant educator talked with the children about swimming in *Hands Up if You Can Swim: 4YOK-0002* , shown in Example 6.6. Nicole used this interaction to chat with the children, and this simple chat also included an informal survey. Nicole used prompts such as “Put your hands up if you like swimming”, “Put your hand up if you can put your face in the water when you go swimming”, and “Put your hand up if you can do a torpedo like this when you go into the water”. Through answering these questions, the children were able to gain an awareness of who in the group liked swimming or not, who could put their face in the water or not, and who could do a torpedo or not; these opportunities to sort the group was a form of classification. Nicole finished the discussion with the comment, “Wow, we have lots of good swimmers” providing an opportunity to increase the children’s general understanding of amounts.

As well as the above concepts, these interactions provided opportunities to explore other mathematical concepts such as counting - when the educator or children counted the number of hands raised; comparison - as they compared the number of those raising their hands and those who did not; and spatial terminology of *raise*, *lower*, *up,* and *down*. Samantha placed this image in the *Obvious Mathematics* pile during the interview.

Category	Codes
Measurement:	Quantity
Number:	Counting
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Arrivals, Group Times
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Social Skills
Curriculum:	--

Example 6.6 *Hands Up if You Can Swim: 4YOK-0002*

This use of raising your hand to answer a question, was reinforced through a set of three pictures attached to the wall near the mat, in *Rules for the Mat: 4YOK-0133* , shown in Example 6.7. The educators and children both referred to these pictures on multiple occasions during the fieldwork; the field notes show that these pictures were usually referred to when the children were getting noisy or moving around during group times. At times, Samantha would become silent and simply point to the signs until the children followed the instructions. At other times, she would ask a child to tell the group what the rules were, listing them by number “Rule 1 says? Rule 2 says? And Rule 3 says?” Children were also observed reminding their peers of these rules (4YOK Field Notes, 2012).

The use of pictographs for rules such as these, provide children an awareness of symbolic mathematical concepts, and require classification skills for the children to understand that sitting on the mat requires this particular group of behaviours. The numbering of the rules also promotes an understanding of ordinal numbers, although, in this case, the rules were not necessarily required to be followed in sequence. Samantha placed this image in the *Obvious Mathematics* pile during the PEI, stating "This is definitely maths, the rules. Umm, because I know I will often just say to the children, "What is mat rule number two? Have we forgotten rule number two?" And they know which one it is".

Category	Codes
Measurement:	Quantity
Number:	Ordinal, Reciting Numbers
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	School Readiness, Social Skills
Curriculum:	Literacy

Example 6.7 *Rules for the Mat: 4YOK-0133*

In the 4YOK, group times were also used as a time of transition from one section of the day to another, for example from free-play to lunch. This use of group times as a routine way to change activities provided the children with opportunities to gain an understanding of time measurement, sequencing, and problem solving as they learnt to predict what activities were coming when.

One group time included Nicole, the Wednesday afternoon educator, reading the children a story in *Witch Story Group Time: 4YOK-0024* , shown in Example 6.8. This story, *Room on the Broom* (Donaldson, 2001), tells the story of a witch flying through the night and sharing her broom with new friends. There were numerous measurement concepts available for discussion in the story, such as *how long, and how fast was the broom,* or *how many, and how heavy were the passengers*. Terminology for navigational concepts were explored as the text described where the witch flew, with descriptions such as "Over the fields" or "Out of the bog". This story also provided opportunities for the children to match each animal with his seat on the broom through one-to-one correspondence.

Nicole kept pausing for the children to fill in the next line or words; this pedagogical practice provided an opportunity for them to practice the pattern concept of rhyming, or, for those who knew the story, sequencing. An interesting example occurred when Nicole read the line, “Over the moors and mountains they flew. The frog jumped for joy and the broom snapped in— ?” she paused for the children to respond with “Two”, which most children did. However, one child demonstrated his knowledge of fractions and called out “Half”, to which she responded, “yes, two or half”, and as she raised two fingers in the air, she also provided an opportunity for the children to build symbolic awareness.

Category	Codes
Measurement:	Length, Mass, Quantity, Size, Speed
Number:	Counting, Fraction, One-to-One
Process:	Classification, Comparison, Pattern, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	Cognitive, Social Skills
Curriculum:	Literacy

Example 6.8 *Witch Story Group Time: 4YOK-0024*

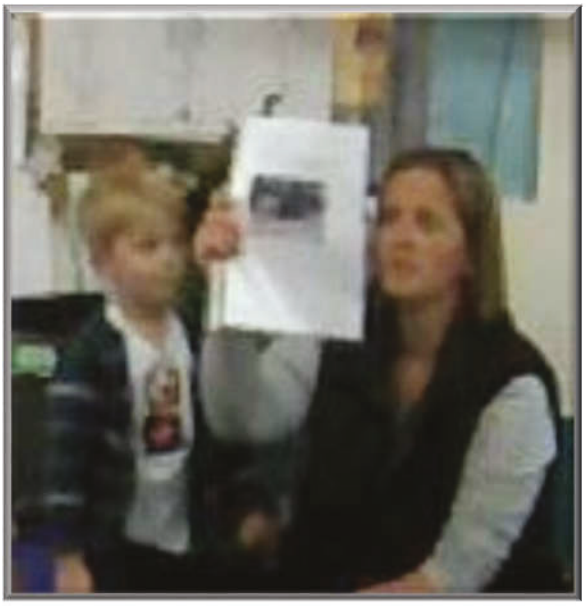
These group times often included music activities such as *Pass it to Your Neighbour: 4YOK-0049* , shown in Example 6.9. In preparation for this song, the children were asked to move to the edge of the mat to form a circle, providing an opportunity to expand geometric and navigational understanding. The bongo drum was passed around the circle as the music played and each child had a turn playing on it to the beat of the music, as the group sang “1, 2, 3, 4, 5, 6, 7, 8, pass it to your neighbour”. The song’s chorus included instructions to play loud, then play soft. This song provided an opportunity for the children to practice sequencing and counting, as well as patterns and measurement concepts such as speed and sound, as they kept to the beat, and played louder or softer.

Category	Codes
Measurement:	Sound, Speed
Number:	Counting, Reciting Numbers
Process:	Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Floor Games, Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Music

Example 6.9 *Pass it to Your Neighbour: 4YOK-0049*

A regular feature in the 4YOK group times was “The Magic Bag” which involved a child bringing in a book from home to show their peers. In *Jack's Homemade Book: 4YOK-0002* , shown in Example 6.10, Jack brought in a book he had made with his brothers. The book told the story of a camping holiday for Jack and his family; the story listed Jack’s favourite places and things to do. This grouping of places and activities as *favourites* was a form of classification.

Samantha asked Jack about one of the photos and he told her how they used charcoal to draw on wood. When Samantha suggested they use the black charcoal she had in the storeroom to draw on paper, Jack was hesitant as he wasn’t sure it would work as he had previously only used charcoal on wood, but decided to test it and see. This hesitation demonstrated that Jack was aware of the differences between wood and paper, showing a growing understanding of classification and comparison. His willingness to problem solve to test and see if both paper and wood were able to be grouped together as items that could be drawn on by charcoal, was an opportunity to explore the concept that objects can be sorted by various criteria. As with all stories, this book also provided an opportunity for sequencing. Samantha placed this image in the *Obvious Mathematics* pile during the interview. However, she also noted “I'd probably say it's more supporting literacy than maths”.

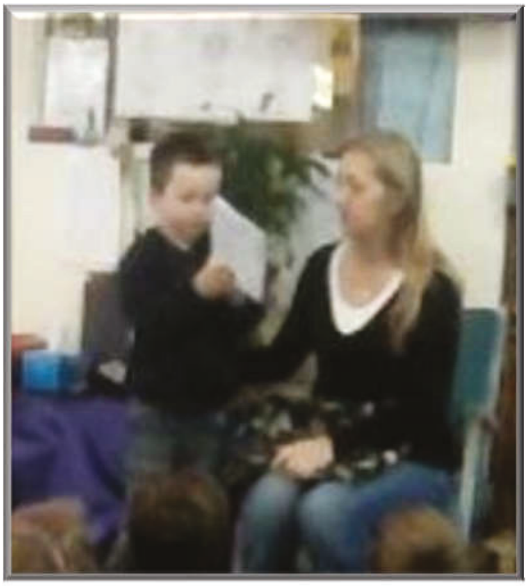


Category	Codes
Measurement:	--
Number:	--
Process:	Classification, Comparison, Problem Solving, Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor, School Readiness, Social Skills
Curriculum:	Art, Literacy

Example 6.10 *Jack's Homemade Book: 4YOK-0002*

Similarly, Kyle also brought in a book he had made at home in *Kyle's How To Make a Book: 4YOK-0049* , shown in Example 6.11. Jola, the student teacher, asked Kyle to explain how he made it and he offered a detailed reply, discussing the parts of the book such as the Title Page and the Author’s name. His in-depth knowledge of books even prompted a discussion on the Dewey Decimal System from Jola when, during his explanation, he pointed out the numerals written on the spine of the book, stating they were there “because this is a library book”. This awareness of the parts of books, as well as the differences between home books and library books demonstrated his ability in classification.

Kyle’s response when asked if he could show his peers how to make a book included, “Yeah, you have to get a stapler, and try and get the lot of paper together, and then you have to get lots of pens and write everything, and then get all the other colours and colour it in”. This use of terminology such as *then* demonstrated his awareness of sequencing. In his explanation, he discussed the size and amount of paper required and how to fold the paper in half. He also used many positional gestures as he described getting the paper together which demonstrated his navigational awareness. Samantha placed this image in the *Obvious Mathematics* pile during the interview.



Category	Codes
Measurement:	Quantity, Size
Number:	Fraction
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Child Initiated, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor, School Readiness, Social Skills
Curriculum:	Art, Literacy

Example 6.11 *Kyle's How To Make a Book: 4YOK-0049*

After each morning meeting, the children generally left the mat to choose an activity. Following Kyle’s lead, the children and educators decided to include a book making area for those who were interested; this was a typical example of this centre’s commitment to a child-initiated, emergent program. Lucy, the assistant educator, and several children discussed what materials would be required, providing another opportunity to practise classifying. This discussion led into *Phil’s Idea: 4YOK-0050* , shown in Example 6.12, where Phil suggested they use the box construction area to make the books because “there was tape there already”. Lucy helped the children set up this new activity by dividing the box construction area in half, through the placement of a small shelf as a divider. During this short episode, Lucy used terminology such as *half* and *divide* which assisted the children to learn both language and concepts of comparison and fractions. This episode also provided an opportunity for problem solving and the measurement of area, length, number, and size. Samantha placed this image in the *Obvious Mathematics* pile during the interview, laughing as she stated, "Well if you are dividing the table into two work places, there are definitely some mathematics concepts in there".

Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	Fraction
Process:	Classification, Comparison, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	--

Example 6.12 *Phil's Idea: 4YOK-0050*

Kyle was explaining to Christie how she could make a book in *How to Make a Book: 4YOK-0053* , shown in Example 6.13. He explained how the paper needed to be stacked, and pointed to where she should staple them together. This episode covered the same mathematics as those in *Kyle's How To Make a Book: 4YOK-0049* above. However this time, it was a one-on-one peer scaffolded interaction, rather than educator scaffolded, and also included area, length, and geometric spatial awareness as Kyle ensured the paper was the same length and was all rotated the same direction.

Category	Codes
Measurement:	Length, Quantity, Size
Number:	Fraction
Process:	Classification, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Cognitive, Fine Motor, School Readiness, Social Skills
Curriculum:	Art, Literacy

Example 6.13 *How to Make a Book: 4YOK-0053*

6.2.4 Inside Free-Play Activities at the 4YOK

A regular feature of this kindergarten was the jigsaw puzzle table, and the following three episodes provide an overview of how this area was regularly used. In the programming and set-up of the room, the educators made decisions on the difficulty level of the puzzles required for the particular group, and always allowed for a range of abilities.

In this first episode, *Puzzle with Educator's Help: 4YOK-0027* , shown in Example 6.14, Nicole was assisting Ben with a puzzle in a one-on-one interaction. She asked if he could find any edge pieces, a way to classify the pieces into two groups. Ben was also being encouraged to work in sequence, as she suggested he place the outside edge pieces first, and then look for the middle pieces. By completing the outside edge first, Ben was also exploring geometric and area concepts by creating the perimeter of a rectangle; there was the potential here to use terminology such as *edge, straight, sharp point,* and *sides* to extend the child’s geometric vocabulary. Samantha placed this image in the *Obvious Mathematics* pile during the interview.

Category	Codes
Measurement:	Area
Number:	--
Process:	Classification, Comparison, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Table
Pedagogy:	Child Initiated, Educator Scaffolded
Environment	Social
Development:	Cognitive, Fine Motor
Curriculum:	--

Example 6.14 *Puzzle with Educator's Help: 4YOK-0027*

The second episode involving jigsaw puzzles, *Christie Jack and Imogen at the Puzzle Table: 4YOK-0125* , shown in Example 6.15, included the children interacting at the puzzle table without adult help. This puzzle of a child's body consisted of five layers: a layer that showed bones, a layer of organs, a layer of muscles, a layer of skin, and a layer of clothes. Along the side of the puzzle was a colour-coded chart showing the background colours for each level. The difficulty level of this puzzle was much higher than the other puzzles at the table, and Christie and Jack were taking turns each completing a layer while Imogen watched on. After completing the puzzle this way, the children decided to sort the pieces into matching piles, i.e. all the head pieces together, all the chest pieces etc., and completed the puzzle this way. Therefore, as well as the mathematical concepts covered in the first jigsaw puzzle episode, the interaction for this particular jigsaw episode required a deeper understanding of classification to be able to change the sorting criteria from layers to body parts. Additionally, taking turns required that the children engage in, and articulate, a pattern, in this case "Christie's turn / Jack's turn / Christie's turn / Jack's turn".

Category	Codes
Measurement:	Area
Number:	--
Process:	Classification, Comparison, Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Cognitive, Fine Motor
Curriculum:	--

Example 6.15 *Christie Jack and Imogen at the Puzzle Table: 4YOK-0125*

Ben, who had been watching the children, attempted the puzzle himself after they left the table, in *Ben at the Puzzle Table: 4YOK-0125* , shown in Example 6.16. Ben chose to do this puzzle by exploring the size of the pieces through a trial and error process of lining them up against each other, appearing to sort the pieces for each layer through measurement, as each lower level was slightly smaller.

Category	Codes
Measurement:	Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Cognitive, Fine Motor
Curriculum:	--

Example 6.16 *Ben at the Puzzle Table: 4YOK-0125*

Art experiences were an important part of this early childhood centre and the educators held strong beliefs in the ability of children to create intricate art works.

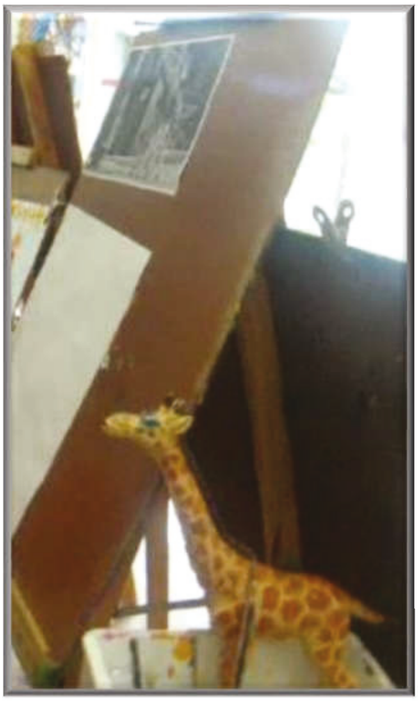
Each year, Samantha organised for small groups of the children and their parents to meet her at the State Art Gallery to look at the art works. Prior to this excursion, Samantha brought in posters of famous paintings and discussed the techniques used with the children. Mathematically, these discussions provided an opportunity for Samantha to use art-focused terminology such as *fore-ground, middle-ground*, and *back-ground*, and discuss the size and ratio of objects in each section of the paintings.

To scaffold this further, she placed provocations adjacent to some of the art materials for the children to use as models. In *Easel for Chicken Drawings: 4YOK-0040* , shown in Example 6.17, a photograph and a drawing of a chicken were placed beside the easel to encourage the children to paint a chicken. This episode included only the image, and was coded to demonstrate the potential mathematics within the educator's setting up of the environment. This episode included the potential for classification, one-to-one correspondence, comparison, and a variety of measurement concepts. It provided opportunities for both spatial concepts, as painting provides opportunities for children to explore shapes and build navigational awareness as they decide where on the page to paint.

Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	One-to-One
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Art

Example 6.17 *Easel for Chicken Drawings: 4YOK-0040*

The easel was also used in a later episode, *Giraffe Painting: 4YOK-0144* , shown in Example 6.18, where Samantha was chatting with Emma who was painting a giraffe. Previously, Emma had created a pencil drawing and a water-colour painting of the same giraffe, and it was time to create her final piece, an oil painting, for the annual art exhibition. Samantha had placed the small toy giraffe and Emma's original work beside the easel and was working one-on-one with the child. The interaction appeared close and friendly, in an otherwise fairly noisy part of the day. Samantha asked Emma if she had all the colours she needed and Emma pointed to each colour, naming them as she went. Samantha then asked her to think about how large she wanted the giraffe to be, prompting her with the question, "Was it up close or a long way away?" Emma responded, "It's really close, so it needs to be large". This interaction related back to the previous discussions Samantha had had with this class on creating art and the understanding that objects appeared smaller when they were at the top of a painting, as this was the background.



Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	Counting, Fraction, One-to-One, Subitize
Process:	Calculation, Classification, Comparison, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	Art

Example 6.18 *Giraffe Painting: 4YOK-0144*

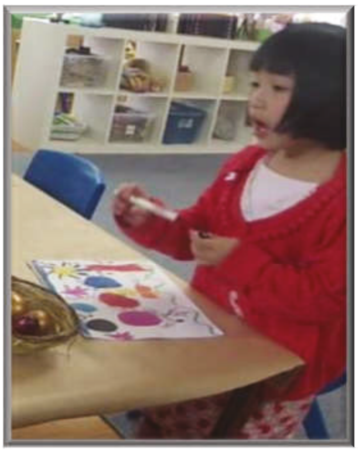
The episode continued for approximately 25 minutes, with Samantha and Emma discussing the height of the giraffe, the distance to the trees, and relating these to the size they needed to be on the page, as well as what size or shape items like the spots on the giraffe needed to be. In addition to these measurement concepts, I also observed Samantha and Emma mention many other mathematical concepts. For example, fractions and calculations, as Samantha commented, “That [tail] looks twice as long”; comparison was identified in questions such as, “Is the tree bigger or smaller than the giraffe?”; classification was discussed when Samantha asked “What do giraffes eat?”; navigational awareness was identified in questions such as “Where should the sun go on your picture?”; and one-to-one correspondence and comparison when Emma realised: “That [toy] giraffe has two spots on its neck same as mine”; as well as subitizing and counting, as they discussed the number of legs on the giraffe. Directly following this episode, Samantha turned to me and apologised, saying, “Oh, I forgot you were filming, I would have tried to put some maths into it”. This conversation is discussed further in Section 8.4 (p 311).

The cupboard doors in the 4YOK were used to display *Self Portraits: 4YOK-0132* , shown in Example 6.19. Group activities such as these, where all children were encouraged to draw themselves, provided an opportunity to discuss differences. This required the children to engage in comparative language, as they compared the images by various criteria. Children made comparisons relating to the size, colour, or shape of the body parts. Describing where the images were on the wall also provided opportunities to build spatial navigation skills (4YOK Field Notes, 2012). Samantha placed this image in the *No Mathematics* pile, after first placing it in the *Not So Obvious Mathematics* pile stating, “I mean, I think this supports their identity very nicely, you know … well-being, but I can't see how it supports maths”.

Category	Codes
Measurement:	Length, Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	--
Pedagogy:	Child Initiated, Educator Initiated
Environment:	Social
Development:	Cognitive, Fine Motor
Curriculum:	Art

Example 6.19 *Self Portraits: 4YOK-0132*

In *A Long Long Long Tail: 4YOK-0003* , shown in Example 6.20, Tomiko was drawing an outdoor scene with a small group of friends. During this interaction, she asked her friends if they were copying her work, as she could see similarities in the pictures; this demonstrated her ability to engage in comparison and classification. Then, as she ran her finger along the line, she described the butterfly she had drawn as having a “long, long, long, long, long, long tail”; this simple comment and gesture helped extend the child’s understanding of length and navigation in a physical way. Samantha placed this episode in the *Obvious Mathematics* pile in the interview, stating “There can always be maths associated with drawing. The children will draw things often and then count them or talk about them”.



Category	Codes
Measurement:	Length
Number:	Counting
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Art

Example 6.20 *A Long Long Long Tail: 4YOK-0003*

A second episode that included drawings was *Picture of the Tooth Fairy: 4YOK-0027* , shown in Example 6.21. In this episode, Imogen brought her picture over to the educator to show her. While this episode only lasted 21 seconds, the educator was heard commenting on the beautiful colours and asking if the Tooth Fairy had visited Imogen. The picture drawn by this child included geometric shapes such as the triangular dress, demonstrating her ability to draw shapes. This image was placed in the *Not So Obvious Mathematics* pile by Samantha in the interview, yet when she looked at this image in closer detail, Samantha was able to identify simple sentences in which she could include all of the mathematical concepts listed in the *Mathematical Concepts List for PEI* (see Section 6.4.3, p 220).

Category	Codes
Measurement:	Length
Number:	--
Process:	Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Table
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	--
Development:	Fine Motor
Curriculum:	Art

Example 6.21 *Picture of the Tooth Fairy: 4YOK-0027*

The box construction table was one of the busiest areas in the 4YOK setting. It was here that during most sessions I would find the same young boy, Kyle, building a variety of objects. In *Box Construction: 4YOK-0128* , shown in Example 6.22, he was making an “electric drum kit”. As Kyle concentrated on building his drum kit, other children would engage him in conversations about his construction and their own. He was explaining to a peer about the materials he needed for the cross he was making for the “base of the drum kit”; the criteria for this cross included using materials that were strong enough to hold up the rest of the drum kit which was quite heavy, and enough of the “white tape” to hold it all together. This demonstrated his understanding of classification, size, mass, and amount; he also showed an expanding geometric vocabulary through his use of the word *base*. The children were helping each other through discussions and modelling at the box construction table, including how to choose the best equipment and resources, and how to use them. As they discussed the size, shape, and uses of the various materials, they were exploring many mathematical concepts including problem solving, classification, and spatial concepts, as well as measurement of length, mass, size, and amounts. There was even a short discussion on how much pressure to use

Category	Codes
Measurement:	Length, Mass, Quantity, Size, Time
Number:	One-to-One
Process:	Classification, Comparison, Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	Art

Example 6.22 *Box Construction: 4YOK-0128*

when attaching the sticky-tape to make it stay on the box.

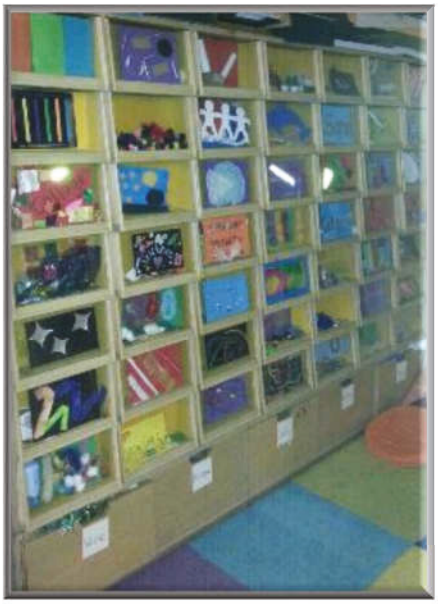
Included in this episode, the educator was heard asking the children to pack up for mat time. Kyle attempted to quickly finish his drum kit, but had difficulty getting one of the pieces to stay upright and became very frustrated. He asked the educator for more time to finish his project, and they agreed to place it on a special shelf for him to continue to work on it later in the week, providing an opportunity to build his awareness of time measurement.

The set-up of the box construction area included ensuring that there was always a variety of boxes available, providing the children with mathematical opportunities to sort, compare, measure, and problem solve, as they explored the geometric shapes of the boxes. The *Box Construction Supplies: 4YOK-0046* , shown in Example 6.23, were stored at the end of the table in a large bin. There were also pens and markers, staplers, sticky tape, and masking tape available on the table.

Category	Codes
Measurement:	Length, Quantity, Size
Number:	--
Process:	Classification, Comparison, Problem Solving
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated
Environment:	Physical
Development:	Fine Motor
Curriculum:	Art

Example 6.23 *Box Construction Supplies: 4YOK-0046*

The *Storage of Loose Materials: 4YOK-0144* , shown in Example 6.24, was adjacent to this area. This wall of clear storage boxes contained loose parts that were available for use in the box construction area, as well as other activity areas such as play dough, car mat, box construction, and collage. This form of storage provided the children with an opportunity to view the parts and decide if they were suitable for the activity in which they were engaged. These decisions involved identifying characteristics of each object, such as its size, shape, colour, and potential use. Therefore, similarly to the *Photo Wall: 4YOK-0131* (p. 155), the way these loose items are stored was identified as supporting mathematical development in measurement and classification. In addition, when the children required help from the educator or a peer in reaching their chosen objects, they had the opportunity to indicate which item by verbalising the criteria they had identified, to use navigational language and gestures to direct the educator or a peer to the correct container, and quantitative language to indicate the number of objects they required.



Category	Codes
Measurement:	Length, Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Individual
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated
Environment:	Physical, Social
Development:	--
Curriculum:	Art

Example 6.24 *Storage of Loose Materials: 4YOK-0144*

The children playing in *Four Children at the Clay Table: 4YOK-0028* , shown in Example 6.25, were negotiating the use of the clay tools. This negotiation process offered the children the opportunity to explain why they wanted a particular tool, which required them to describe the criteria of the piece they needed. Additionally, they also engaged in a discussion that included sequencing as they decided who would use the tools first, and who would go next, and then who would get a turn. The children also included time measurement in their conversations as they negotiated that “five minutes” was how long each person was able to keep the tools. It was clear, however, in this episode that these children did not yet understand how long five minutes actually was, as they would tell each other at random lengths of time “Your five minutes is up!! Now it is my turn” but they did understand that time could be measured and that “five minutes” was a reasonable amount of time to wait.

Category	Codes
Measurement:	Length, Mass, Quantity, Size, Time
Number:	Fraction
Process:	Classification, Comparison, Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	Art

Example 6.25 *Four Children at the Clay Table: 4YOK-0028*

Through their conversations, the children in this episode were scaffolding each other as they played, and the educator chose to observe from a distance, only asking questions as she came past. While each child chatted to the others, they were actively engaged in their own creations. Christie, on the left, was making pancakes and trying to make them all circular and all the same size; she was not only exploring geometric spatial concepts, she was also exploring the conservation of size and comparison by attempting to make the same size balls of clay into the same size pancakes.

Jack, on the bottom right, engaged in an exploration of pattern and geometry when he used his shoe to press into the clay, and shared excitedly with his friends “Look at my pattern!” Interestingly, this child appeared to be also aware that stepping on the clay was perhaps not something the educators would approve of, and he can be seen in the video checking to ensure they were not watching him as he did this. This awareness shows he has potentially used his classification skills to mentally sort out acceptable and non-acceptable behaviours. Samantha placed this image in the *Obvious Mathematics* pile during the interview,, stating, “definitely could [see maths] here, because, you know, sorting out like if one child had taken all the clay then we could work out how we could make it nice and fair”.

Similarly in *Two Children at the Clay Table: 4YOK-0093 ,* shown in Example 6.26, two children were engaging in play with the clay. While Tomiko only spent a few moments cutting the clay into two pieces, Ben spent his time at the table cutting the clay into smaller and smaller pieces, joining them back together, and then recutting them; giving him the opportunity for an early exploration of fractions. This image was placed in the *Obvious Mathematics* pile by Samantha during the interview.

Category	Codes
Measurement:	Length, Size
Number:	Fraction
Process:	Classification, Sequence
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Table
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Fine Motor
Curriculum:	Art

Example 6.26 *Two Children at the Clay Table: 4YOK-0093*

Dramatic play occurred in many areas of the centre. Unfortunately, two of the three non-participating children were actively involved in most of these episodes at the 4YOK and, therefore, these interactions were not able to be video recorded. However, the short interaction, *Home Corner: 4YOK-0025* , shown in Example 6.27, shows Emily and Cody pretending to cook dinner and discussing with two friends who would be the “mother” in this game. Similar to non-recorded episodes observed in the outdoor kitchen in this centre, this episode provided the children with an opportunity to explore role classifications, and the mathematical concepts found in cooking such as measurement, fractions, sequencing, calculation, navigation, fractions and one-to-one correspondence, as the children chose the bowls and foods they were going to use for dinner and discussed where each person was going to sit.

Category	Codes
Measurement:	Mass, Quantity, Time, Temperature, Volume
Number:	Fraction, One-to-One
Process:	Classification, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	--
Curriculum:	Drama

Example 6.27 *Home Corner: 4YOK-0025*

In *Boys and Lego Roads: 4YOK-0083* , shown in Example 6.28, the children were working together to join the Lego boards in such a way that the road continued around the table. These Lego boards included a variety of road orientations - some roads went straight across the board, others turned a corner, while other boards contained T-intersections or cross-roads. The children needed to rotate them to align the boards so the road would continue; this understanding of rotational positioning is a prerequisite for developing geometric and navigational skills. The children were working together during this episode and were heard discussing distances and where the roads were leading, with remarks such as “This road goes to [Melbourne]” and “It’s a long way to [Melbourne], so we need another road piece in here”.

Emily joined in the play and looked at the Lego instruction booklet. Following written or pictorial instructions such as these provided her with an opportunity to increase her awareness of symbolic mathematics, and practise her one-to-one correspondence, classification, and sequencing skills. Samantha placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Length, Size
Number:	One-to-One
Process:	Classification, Comparison, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Drama, Mathematics

Example 6.28 *Boys and Lego Roads: 4YOK-0083*

As I was collecting data, Phil, the young boy in stripes in *Lego Baddies: 4YOK-0029* , shown in Example 6.29, built a "flying machine" and gave a detailed explanation of the various features and the blocks required to build the machine. This descriptive narrative was filled with mathematical terminology that covered concepts such as classification, measurement, and spatial awareness.

Category	Codes
Measurement:	Length, Quantity, Size, Speed
Number:	One-to-One
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Individual, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Drama, Mathematics

Example 6.29 *Lego Baddies: 4YOK-0029*

Phil's discussion also demonstrated an awareness of speed and comparison as he went on to explain that his vehicle needed "to be faster than the police, because the baddies needed to be able to get away, so it goes this fast", at which point he spun in a circle with his arm out wide, demonstrating the speed through gestures. During the sorting of images in the interview, Samantha was very decisive with the image of *Lego Baddies: 4YOK-0029* , and placed it in the *Obvious Mathematics* pile.

There were many children observed playing with the car mats and cars at the 4YOK. *Four Children with Cars: 4YOK-0006* , shown in Example 6.30, shows the children playing with the cars and accessories that were set up by the educators. The four children had a long discussion as they chose which car to drive on the mat. This discussion provided the children with opportunities to use classification as they listed the characteristics of each car. These included such things as the colour, length, overall size, and number of wheels, and were used to compare and debate the importance of one characteristic over the other. This discussion also included sharing information on the phone number to call if you needed an ambulance or firefighter, demonstrating an awareness of how they were able to use numerals in a concrete way. Once they had chosen their cars, Olivia spent almost 15 minutes pushing the fire engine along the roads on the mat; she even made the fire engine make a three-point turn to ensure it did not drive over a building; moving the vehicle around the roads like this provided practice of her developing skills in navigational concepts. This image was placed in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Fine Motor, Gross Motor
Curriculum:	Drama

Example 6.30 *Four Children with Cars: 4YOK-0006*

Following on directly from *Four Children with Cars: 4YOK-0006* , Olivia was demonstrating an awareness of measurement as she discussed with Cody how high the emergency helicopter was able to fly in *Emergency Vehicles: 4YOK-0009* , shown in Example 6.31. During this episode, another young girl, Gina, tried to get Olivia to go and play elsewhere; she gave numerous reasons to move including the statement, “Girls don’t play with cars!” This statement brings to light Gina’s perception of sex roles, which required the use of classification skills to sort what activities she felt were acceptable for children to do, depending on their sex.

Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Cognitive, Gross Motor
Curriculum:	Drama

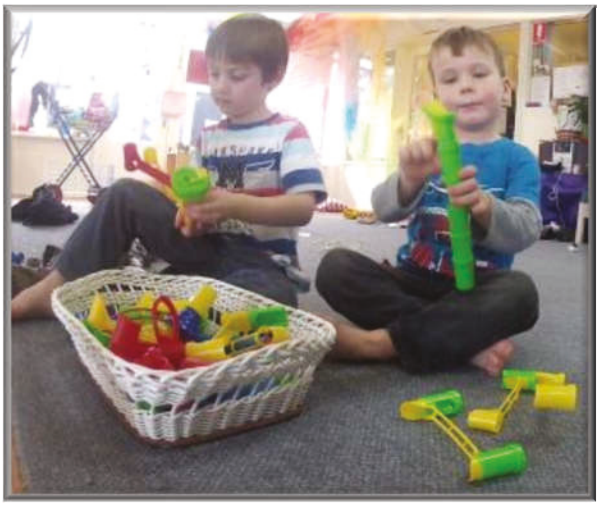
Example 6.31 *Emergency Vehicles: 4YOK-0009*

Similarly to the above episodes, Rohan and Michael were also playing with trains in *Checking the Speed of Trains: 4YOK-0019* , shown in Example 6.32. They were exploring speed measurements as they experimented to see how fast they could make the trains go before they crashed off the tracks. Rohan excitedly described what had occurred with words and gestures, using his hand to trace the path his train had taken and describing where it had left the tracks. This episode required an understanding of measurement and comparison concepts.

Category	Codes
Measurement:	Length, Speed, Time
Number:	One-to-One
Process:	Classification, Comparison, Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Drama, Science

Example 6.32 *Checking the Speed of Trains: 4YOK-0019*

In *Marble Run Construction: 4YOK-0083* , shown in Example 6.33, Rohan and Harrison were building a marble run. To work out which pieces would take the marble to the bottom, these boys needed to use their classification and measurement skills to choose the appropriate piece. Connecting the pieces helped build their geometric and navigational skills as well as building their awareness of sequencing as they tracked where the marble went through their marble run. This episode also included the measurement of speed as the boys discussed how fast the marble went. Samantha placed this image in the *Obvious Mathematics* pile.



Category	Codes
Measurement:	Length, Size, Speed
Number:	One-to-One
Process:	Classification, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Individual
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Science

Example 6.33 *Marble Run Construction: 4YOK-0083*

In *Two Girls with Animals: 4YOK-0060* , shown in Example 6.34, Jodie and Emily were playing with a set of animals on a green cloth they had placed over some cushions. During their play, they were placing animals that were the same together, as well as pairing adult and child animals, resulting in opportunities to practise classifying using different criteria. This episode also included one-to-one correspondence and navigational awareness as the girls moved the animals around the rug in pairs and small groups.

Category	Codes
Measurement:	Area, Size
Number:	One-to-One
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Fine Motor
Curriculum:	Drama, Science

Example 6.34 *Two Girls with Animals: 4YOK-0060*

In *Samantha Reads to Jane: 4YOK-0052* , shown in Example 6.35, Samantha and Jane were sitting together on the couch sharing a story. Jane chose the book *Wet World* (Simon, 1997) that focused on the letter W. Samantha was reading the book through for the second time, and then a third time when another child joined in. Samantha used her finger to point at each of the W's as she read “Wet windows, wet trees, wet leaves, wet road, wet street, wet roof tops, wet world”. While the literacy focus can easily be identified, this episode also provided the opportunity for mathematical skills to develop in one-to-one correspondence, as well as pattern identification as Samantha explained to the children how the “W” was at the start of each word, and classification as she pointed out the “W” words. As with most story-books, this episode also included sequencing. Samantha placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Quantity
Number:	One-to-One
Process:	Classification, Pattern, Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	--
Development:	Cognitive, School Readiness
Curriculum:	Literacy

Example 6.35 *Samantha Reads to Jane: 4YOK-0052*

6.2.5 Meals in the 4YOK Centre

Morning snack time at the 4YOK was very informal and the children were encouraged to collect their food from the trolley when they were hungry. In *Morning Snack Time: 4YOK-0000* , shown in Example 6.36, an educator had ensured a space was kept clear on the main mat for the children to sit in small groups to eat.

This part of the day provided the children with opportunities to engage in an exploration of time and sequencing as they chose for themselves when it was an appropriate time to eat. Awareness of fractions and measurement concepts were also expanded as they used subitizing, counting, and comparisons in their discussion of the amount of food they had brought with them, or had left to eat. Additionally, there were opportunities to explore classification and comparison as they discussed the foods they had brought from home and the foods they liked or disliked.

Category	Codes
Measurement:	Quantity, Size, Time
Number:	Counting, Fraction, Subitize
Process:	Classification, Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating, Small Group
Pedagogy:	Child Initiated
Environment:	Physical, Social
Development:	School Readiness
Curriculum:	--

Example 6.36 *Morning Snack Time: 4YOK-0000*

Lunch also provided these opportunities for mathematical discussions. Lunch was a structured time where children sat in small groups at the tables and ate food brought from home. As previously mentioned, at the start of the session the children had placed their lunch boxes on a trolley near the door; just before lunch, an educator spread all the lunch boxes out on two tables, and placed name cards on the tables where the children would be eating. The children moved from group time to collect their lunch box in an episode called *Finding your Lunch Box: 4YOK-0080* , shown in Example 6.37, and then go and find their name card on the tables, and due to the three-step routine involved the children were experiencing sequencing.

The children also needed to use their emerging skills in classification to identify their own lunch box as many of the lunch boxes looked similar.

Category	Codes
Measurement:	--
Number:	--
Process:	Classification, Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	School Readiness
Curriculum:	--

Example 6.37 *Finding your Lunch Box: 4YOK-0080*

Lizzie, Cody, Gina, Ben, and Jack found their lunch boxes and name tags and sat together for lunch and engaged in a lively conversation in *Lunch Table: 4YOK-0121* , shown in Example 6.38. Most children in this centre brought sandwiches, cheese and crackers, chopped vegetables, and fruit to eat for lunch. The conversation at this table provided another opportunity for the children to practise classifying as they discussed the items in their lunch boxes. As most children ate their sandwiches before eating any sweet foods, such as fruit, they also built their sequencing skills as they discussed the order in which they would eat their food.

In this particular episode, the children were also discussing where each child was sitting using navigational terminology such as *opposite, next to* and *across from* to specify the position of others in relation to themselves. Jack also demonstrated his subitizing and calculation skills when he stated “There are two on that side and two on this side, so there is four people”.

Category	Codes
Measurement:	Quantity, Size, Time
Number:	Counting, Fraction, Subitize
Process:	Calculation, Classification, Comparison, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Eating, Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Social Skills
Curriculum:	--

Example 6.38 *Lunch Table: 4YOK-0121*

When reviewing this image during the interview, Samantha was quick to point out that the lunch table had many options for discussing such things as fractions, amounts, and comparison, for example, “If the children say ‘my sandwich is cut into four and your sandwich is cut into two’”. She placed this image in the *Obvious Mathematics* pile, yet, stated that the children may also be chatting about other non-mathematical topics as well.

6.2.6 Outside Free-Play Activities at the 4YOK

Outside at the 4YOK, the constant fixtures in the yard include a swing frame, a cubby house, a sandpit with kitchen area, a digging patch, a large pipe to climb through, flower gardens, a hula hoop attached as a large basketball hoop.

The storage of equipment in *Trucks on a Shelf: 4YOK-0036* , shown in Example 6.39, provided opportunities for the children to engage in classification, one-to-one correspondence, comparisons, navigational and geometric awareness, and measurement concepts in area, length, and number, as they discussed the contents of the shelves and where the equipment belonged. This image was placed in the *Obvious Mathematics* pile by Samantha.

Category	Codes
Measurement:	Area, Length, Quantity
Number:	One-to-One
Process:	Classification
Spatial:	Navigation
Mode of Use:	Concrete
Situation:	Outside
Pedagogy:	Educator Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	--

Example 6.39 *Trucks on a Shelf: 4YOK-0036*

Ben was observed in *Boy Climbing Over Tunnel: 4YOK-0013* , shown in Example 6.40, playing on the large tunnel, repeatedly climbing up and over it. Simple explorations such as this provided an opportunity for him to gain an awareness of the height, size, and area of the tunnel, as well as build his spatial navigation skills.

Category	Codes
Measurement:	Area, Length, Size
Number:	--
Process:	--
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 6.40 *Boy Climbing Over Tunnel: 4YOK-0013*

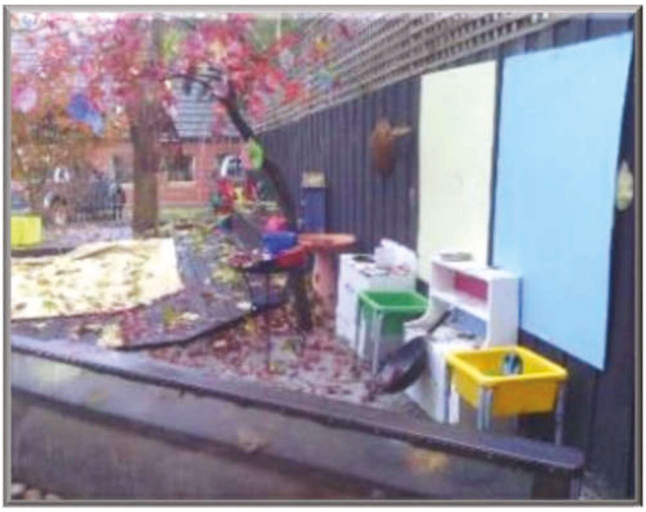
During *Hula Hoop Basketball: 4YOK-0071* , shown in Example 6.41, a number of children were throwing balls into the hula hoop attached to the wall. At the start of their play, they were randomly shooting hoops, but eventually they decided to try and keep score. This involved keeping track of how many balls each child had managed to get through the hoop, and included continual comparisons to the number of goals their friends had scored, “I’ve got two and you are on one!” During their game, they applied their problem solving skills to explore ways to make the game “more fair” for the children who were losing. To do this, they chose to allow losing children to shoot the ball into the hoop from closer distances, and classified the balls they had by how difficult they were to get in the hoop; this classification included a discussion on the weight and size of the balls.

Category	Codes
Measurement:	Length, Mass, Quantity, Size
Number:	Counting
Process:	Calculation, Classification, Comparison, Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor, Social Skills
Curriculum:	Sport

Example 6.41 *Hula Hoop Basketball: 4YOK-0071*

The *Outdoor Kitchen and Sandpit: 4YOK-0048* , shown in Example 6.42, was a busy section of the preschool yard. Unfortunately, one of the three non-participating children spent most of her time in this area, and so no episodes were able to be collected here. The activities I observed here were very similar to those in the sandpit in the 3YOK and 5LDC (see, for example: *Cooking in the Sandpit: 3YOK-0040*

, p. 120; *Sandpit: 3YOK-0001* , p. 119; *Burying the Dinosaur: 5LDC-0131* , p. 265). The field notes, however, provided examples of children engaged in one-to-one correspondence, measuring, fractions, sequencing, and classification as they pretended to cook. Therefore, the image was still analysed and used in the interview with Samantha, where she placed it in the *Obvious Mathematics* pile.



Category	Codes
Measurement:	Area, Length, Mass, Quantity, Time, Temperature, Volume
Number:	Counting, Fraction, One-to-One
Process:	Calculation, Classification, Comparison, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Individual, Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded, Educator Initiated
Environment:	Physical
Development:	Fine Motor, Gross Motor, Social Skills
Curriculum:	Drama, Science

Example 6.42 *Outdoor Kitchen and Sandpit: 4YOK-0048*

Phil and Jack spent some time in the digging patch in *Filling Containers: 4YOK-0075* , shown in Example 6.43. They were using the long handled spades to fill the tyres with dirt and leaves. Free-play activities such as this provided opportunities to gain an awareness of size, amount, and volume, as well as navigational skills with terminology such as *inside* and *outside* of areas.

Category	Codes
Measurement:	Area, Mass, Quantity, Size, Volume
Number:	Fraction
Process:	Classification, Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Science

Example 6.43 *Filling Containers: 4YOK-0075*

Samantha had the choice of a variety of swing options including regular swings, a tyre swing, and the monkey-bar swing that was in place during the fieldwork. The swings were positioned in the middle of the 4YOK yard and, for safety, there was a space surrounding the swings that children needed to avoid. The swings were very popular during one of the sessions I observed, and the order in which children would get a turn, as well as the length of time each child could stay on the swings, were topics of great discussion.

As an example, in *Tomiko on the Monkey Bars: 4YOK-0023* , shown in Example 6.44, the children chose to count to 20 after the child had been on the monkey bar "for long enough", showing a growing understanding of time measurement. They also demonstrated the use of non-standard units of measure to explore time when they chose to use "three songs" as the time they had to wait for the next turn. Interestingly, these songs were not always sung at a regular speed, indicating that the children were also potentially aware that when they sang faster, the song would finish sooner. The educator in this episode also encouraged the children to form a straight line whilst they were waiting; this provided an opportunity to explore length, order, and geometric awareness.

Category	Codes
Measurement:	Area, Length, Speed, Time
Number:	Counting, Order
Process:	Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded, Educator Scaffolded
Environment:	Physical, Social
Development:	Gross Motor, Social Skills
Curriculum:	Sport

Example 6.44 *Tomiko on the Monkey Bars: 4YOK-0023*

6.2.7 Special Projects at the 4YOK

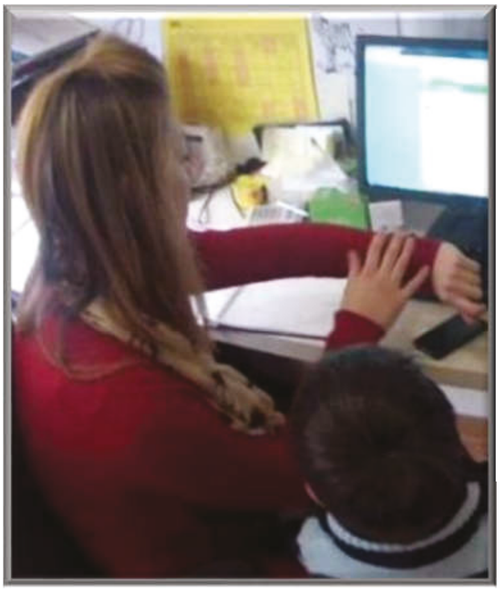
An annual event at this centre was the opportunity to observe chicken eggs hatching. Each morning the educators would discuss with the children the number of eggs that had hatched overnight, and they would calculate the total amount. Some of the children required the use of one-to-one correspondence as they pointed to count, while others were able to use subitizing to quantify the number of chickens that had hatched. The chickens were also categorised by colour or size, with the children comparing the number of chickens of each colour. With scaffolding from the educator, there was also the opportunity to also gain an awareness of fractions through comments from the educator such as "Half the chickens are white" (4YOK Field Notes, 2012).

These observations were included in an episode where the children were observing the hatching eggs in *Chickens and Temperature: 4YOK-0020* , shown in Example 6.45. This episode provided opportunities for children to discuss temperature, and while the children were perhaps not mature enough to understand the quantification of temperatures needed for the chickens to hatch, the educator compared the temperature inside the hatch to how warm they would feel when well or when ill to assist them in gaining an understanding of how warm it would be.

Category	Codes
Measurement:	Quantity, Size, Temperature
Number:	Fraction, Subitize
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Science

Example 6.45 *Chickens and Temperature: 4YOK-0020*

There was an opportunity to research chickens on the Internet after a child asked if chickens could fly. The assistant educator, Lucy, sat in the office with two children researching this, and engaged in a very mathematical discussion in *Googling Chickens: 4YOK-0001* , shown in Example 6.46. During this discussion, she talked about how high and how far some chickens were able to fly, comparing this to how far and high the children were able to jump, and how far other birds may fly. She also took the opportunity to discuss the differences between boy and girl chickens, and the types of feathers the chickens needed to be able to fly. These short discussions provided strong examples of classification and comparisons as well as the measurement concepts relating to length, mass, and size.



Category	Codes
Measurement:	Length, Mass, Size
Number:	--
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Small Group
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	--
Development:	Cognitive
Curriculum:	Literacy, Science

Example 6.46 *Googling Chickens: 4YOK-0001*

The skills required for navigational concepts were also scaffolded when Aaron, an assistant educator, noticed an egg was hatching in *Watching Eggs Hatch: 4YOK-0145* , shown in Example 6.47. Aaron led a discussion with the children about what they could do so everyone could observe the egg hatching. They chose to move the computer and camera next to the incubator and display the footage on the monitor above. The children all sat on the mat, and then, in groups of two at a time, came closer to look at the chicken hatching.

Category	Codes
Measurement:	Area
Number:	--
Process:	Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete
Situation:	Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Social Skills
Curriculum:	--

Example 6.47 *Watching Eggs Hatch: 4YOK-0145*

There were also moments of incidental mathematical interactions near the chickens, such as when Jodie and Emily chose to sit and observe the chickens in *Moving Chairs: 4YOK-0038* , shown in Example 6.48. The children spent a few minutes negotiating where they could place their chairs so they could both see. As they attempted to place two chairs into a small space, they were gaining an awareness of size, area, and navigational concepts, as well as engaging in problem solving through trial and error. Samantha placed this image in *Not So Obvious Mathematics* pile.

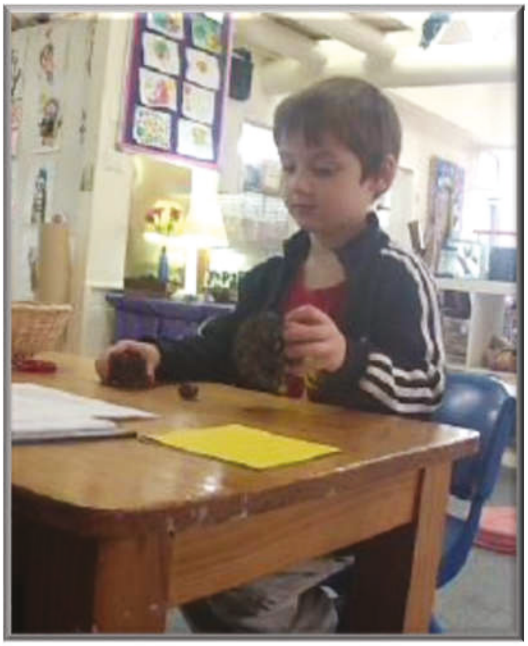
Category	Codes
Measurement:	Area, Size
Number:	One-to-One
Process:	Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete
Situation:	Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	--
Curriculum:	--

Example 6.48 *Moving Chairs: 4YOK-0038*

6.2.8 Assessments at the 4YOK

During my observations at the 4YOK centre, Samantha was undertaking assessments of the children for use at up-coming parent-teacher interviews. Using an informal interview approach, she set up a small table and asked individual children to join her for some one-on-one games. Two assessments were captured during the data collection and used in the PEI: *Harrison's Assessment: 4YOK-0007* and *Paul's Assessment: 4YOK-0012* . When these episodes were analysed they were found to contain the same mathematics, therefore only *Harrison's Assessment: 4YOK-0007* is presented below.

After assessing the child's ability to write their name, these assessment tasks mainly focused on mathematical concepts. In *Harrison's Assessment: 4YOK-0007* , shown in Example 6.49, Samantha assessed Harrison's ability to compare the three pine-cones by size, asking "Can you put the biggest one here, the middle size one here and the littlest one here?" After placing the three pine-cones in the correct positions, he was asked to continue a pattern of blocks, which also required problem solving and sequencing skills. Harrison then sorted a selection of blocks by colour, and then by shape, illustrating his classification and geometric abilities. He was also asked to cut a piece of paper in half; this assessed his fine motor skills as well as providing terminology and practice in fractions. Samantha also assessed his navigational terminology and ability by asking him to place an object *above*, *behind*, *below*, and *on top of his body*. Finally, Harrison was asked to count as high as he could. These assessments also illustrated how the educator was able to assess a child's ability to understand mathematical concepts through simple tasks. Samantha placed these two images in the *Obvious Mathematics* pile.



Category	Codes
Measurement:	Length, Size
Number:	Counting, Order, Ordinal
Process:	Classification, Comparison, Pattern, Problem Solving, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	--
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	Cognitive, School Readiness
Curriculum:	Mathematics

Example 6.49 *Harrison's Assessment: 4YOK-0007*

6.2.9 End of the 4YOK Session

At the end of each session, Samantha gathered the children on to the mat for a final group time. During my fieldwork, this final group time included a variety of activities, including *There Was an Old Lady Story: 4YOK-0129* and *Group Reflection: 4YOK-0129* .

In almost all closing group times I observed, Samantha would read the children a story. In *There Was an Old Lady Story: 4YOK-0129* , shown in Example 6.50, the story chosen was *There was an Old Lady who Swallowed a Fly* (Adams, 2008). This story provided opportunities to explore numerous mathematical concepts; the story starts with the old lady eating a small fly, and proceeds through the animals she eats in size order, allowing for the exploration of size, sequencing, and comparisons. Samantha placed this image in the *Obvious Mathematics* pile and stated “there was an old lady who swallowed a fly is definitely maths because we're moving from the smallest object through to the largest object”.

Category	Codes
Measurement:	Size
Number:	Counting, Order
Process:	Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Floor Games, Group Times
Pedagogy:	Educator Initiated
Environment:	--
Development:	Cognitive, Social Skills
Curriculum:	Literacy

Example 6.50 *There Was an Old Lady Story: 4YOK-0129*

During the *Group Reflection: 4YOK-0129* , shown in Example 6.51, that followed this story, Samantha reflected with the children on the set-up of the room, and the activities available. To do this, she asked the children for their thoughts on how the room was set-up and the activities “you like best?” These questions required the children to use their classification skills to choose one thing they liked and one thing they would like to change. She also surveyed the whole group of children after some of the answers, and used terminology such as *almost all, about half, nearly everyone,* and *everyone* to describe the results, which helped develop the skills and mathematical language for both quantity and fractions. Samantha placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Quantity, Time
Number:	Counting, Fraction
Process:	Classification
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Group Times
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	Cognitive, School Readiness
Curriculum:	--

Example 6.51 *Group Reflection: 4YOK-0129*

6.3 Summary of the 4YOK Episodes

Each of the vignettes discussed in this chapter, together with their codes, are shown in Table 6.2. Following this, in Section 6.4, the details from the PEI with Serena are presented. Details on the themes that emerged from these episodes, and those in the following two case study chapters, will be explored in Chapter 8.

Table 6.2
The 4YOK Episodes and Their Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
A Long Long Long Tail: 4YOK-0003	(p. 171)		X									X								X	X					X	X	X									X	X	X	X					X	X				X						
Ben at the Puzzle Table: 4YOK-0125	(p. 167)					X														X	X				X	X	X	X						X				X	X	X				X	X	X										
Box Construction Supplies: 4YOK-0046	(p. 174)		X		X	X														X	X		X		X		X	X						X			X	X	X	X	X		X			X				X						
Box Construction: 4YOK-0128	(p. 173)		X	X	X	X				X				X						X	X		X		X	X	X	X						X			X	X	X	X			X	X	X	X				X						
Boy Climbing Over Tunnel: 4YOK-0013	(p. 189)	X	X			X																			X	X	X							X	X				X				X				X									X
Boys and Lego Roads: 4YOK-0083	(p. 179)	X	X			X								X						X	X		X	X	X	X	X	X	X								X	X	X	X					X	X					X		X			
Checking the Speed of Trains: 4YOK-0019	(p. 183)		X					X		X				X						X	X		X			X	X	X				X					X		X	X			X		X	X					X				X	
Chickens and Temperature: 4YOK-0020	(p. 194)				X	X			X				X					X		X	X						X	X	X				X								X	X	X	X	X										X	
Christie Jack and Imogen at the Puzzle Table: 4YOK-0125	(p. 167)	X																		X	X	X		X	X	X	X	X									X	X	X	X				X	X	X										
Doll House Activity: 4YOK-0042	(p. 153)	X				X				X				X						X				X		X	X	X						X			X	X			X		X	X		X			X		X					
Easel for Chicken Drawings: 4YOK-0040	(p. 168)	X	X		X	X								X						X	X				X	X	X							X							X		X	X		X				X						
Emergency Vehicles: 4YOK-0009	(p. 182)	X	X		X	X														X	X				X	X	X					X					X		X	X			X		X		X				X					
Filling Containers: 4YOK-0075	(p. 192)	X		X	X	X					X		X							X	X					X	X	X							X		X		X	X			X				X								X	
Finding your Lunch Box: 4YOK-0080	(p. 187)																			X	X			X			X	X			X										X		X	X				X								
Four Children at the Clay Table: 4YOK-0028	(p. 176)		X	X	X	X				X			X							X	X	X		X	X	X	X	X						X			X	X	X	X			X	X	X	X				X						
Four Children with Cars: 4YOK-0006	(p. 181)	X	X		X	X														X	X				X	X	X	X				X					X		X	X						X	X				X					
Giraffe Painting: 4YOK-0144	(p. 169)	X	X		X	X						X	X	X				X	X	X	X			X	X	X	X	X						X							X	X	X		X	X				X						
Googling Chickens: 4YOK-0001	(p. 195)		X	X		X														X	X						X	X									X			X	X	X			X							X			X	
Group Reflection: 4YOK-0129	(p. 199)				X					X		X	X							X							X	X					X								X	X		X	X			X								
Hands Up if You Can Swim: 4YOK-0002	(p. 158)				X							X								X	X					X	X	X		X			X						X			X	X	X	X				X							
Harrison's Assessment: 4YOK-0007	(p. 197)		X			X						X			X	X				X	X	X	X	X	X	X	X	X	X												X	X		X	X			X					X			
Home Corner: 4YOK-0025	(p. 178)			X	X				X	X	X		X	X						X				X			X	X									X		X	X			X								X					
How to Make a Book: 4YOK-0053	(p. 165)		X		X	X							X							X				X	X	X	X	X	X								X	X	X	X				X	X	X		X	X	X		X				
Hula Hoop Basketball: 4YOK-0071	(p. 190)		X	X	X	X						X							X	X	X		X			X	X	X	X						X		X		X	X			X				X		X							X
Jack's Homemade Book: 4YOK-0002	(p. 162)																			X	X		X	X			X	X	X				X							X	X	X	X	X	X	X		X	X	X		X				
Kyle's How To Make a Book: 4YOK-0049	(p. 163)				X	X							X							X				X		X	X	X	X				X						X		X	X	X	X	X	X		X	X	X		X				
Lego Baddies: 4YOK-0029	(p. 179)		X		X	X		X						X						X	X				X	X	X	X				X		X			X		X	X			X		X	X					X		X			
Lunch Table: 4YOK-0121	(p. 188)				X	X				X		X	X					X	X	X	X			X		X	X	X			X						X	X	X	X					X				X							

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Marble Run Construction: 4YOK-0083	(p. 184)		X			X		X						X						X			X	X	X	X	X					X		X					X	X					X	X									X	
Morning Snack Time: 4YOK-0000	(p. 186)				X	X				X		X	X					X		X	X			X			X	X			X						X		X				X	X				X								
Moving Chairs: 4YOK-0038	(p. 196)	X				X								X									X			X	X										X		X	X			X													
Outdoor Kitchen and Sandpit: 4YOK-0048	(p. 191)	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X	X	X	X					X	X		X		X	X	X		X			X	X		X		X				X	
Pass it to Your Neighbour: 4YOK-0049	(p. 161)						X	X				X					X					X		X	X	X	X	X	X			X	X							X	X	X	X	X		X								X		
Paul's Assessment: 4YOK-0012	(p. 197)		X			X						X			X	X				X	X	X	X	X	X	X	X	X	X												X	X			X			X					X			
Phil's Idea: 4YOK-0050	(p. 164)	X	X		X	X							X							X	X		X	X	X	X	X	X									X	X	X	X		X	X	X	X											
Photo Wall: 4YOK-0131	(p. 155)				X															X						X		X						X					X			X	X	X	X				X							
Picture of the Tooth Fairy: 4YOK-0027	(p. 172)		X																		X				X	X	X	X						X				X	X			X				X				X						
Pictures and Hooks: 4YOK-0037	(p. 156)													X						X				X		X	X	X	X	X				X		X					X		X	X				X	X							
Puzzle with Educator's Help: 4YOK-0027	(p. 166)	X																		X	X			X	X	X	X	X						X				X	X			X		X	X	X										
Rules for the Mat: 4YOK-0133	(p. 159)				X											X	X			X				X		X	X	X	X				X							X	X	X		X				X	X			X				
Samantha Reads to Jane: 4YOK-0052	(p. 185)				X									X						X		X		X			X	X	X								X		X			X			X			X				X				
Self Portraits: 4YOK-0132	(p. 171)		X		X	X														X	X						X	X											X		X			X	X	X				X						
Small Play Set Up: 4YOK-0047	(p. 154)	X	X		X	X					X		X	X						X	X	X		X	X	X	X							X				X			X		X	X		X					X					
Stones and Spoon Activity: 4YOK-0044	(p. 154)	X										X								X		X			X	X	X							X				X			X		X			X				X			X			
Storage of Loose Materials: 4YOK-0144	(p. 175)		X		X	X														X	X				X	X	X	X	X					X					X	X	X		X	X						X						
There Was an Old Lady Story: 4YOK-0129	(p. 198)					X						X			X						X			X			X	X	X			X	X								X				X				X			X				
Tomiko on the Monkey Bars: 4YOK-0023	(p. 193)	X	X					X		X		X			X								X		X	X	X	X	X						X		X		X	X		X	X	X			X		X							X
Trucks on a Shelf: 4YOK-0036	(p. 189)	X	X		X									X						X						X	X								X						X		X				X									
Two Children at the Clay Table: 4YOK-0093	(p. 177)		X			X							X							X				X			X							X				X	X				X			X				X						
Two Girls with Animals: 4YOK-0060	(p. 184)	X				X								X						X	X					X	X	X				X					X		X	X			X			X					X				X	
Watching Eggs Hatch: 4YOK-0145	(p. 195)	X																					X			X	X						X							X	X	X	X	X	X				X							
Witch Story Group Time: 4YOK-0024	(p. 160)		X	X	X	X		X				X	X	X						X	X	X		X		X	X	X	X				X							X	X	X		X	X				X			X				

6.4 Interview Data for the 4YOK

The interview with Samantha was undertaken in October, 2013 and lasted approximately 42 minutes. This interview took place in a meeting room at the 4YOK centre. The first few questions of the interview protocol (see Appendix D, p. 390) were designed to elicit information from Samantha about her background and pedagogical practices.

6.4.1 Samantha's Pedagogical Beliefs and Practices

Samantha's educational background, previously outlined in Section 6.1.1 (p. 148) showed she had completed her degree in Early Childhood Education and, at the time of the study, was enrolled in a Master of Education program. She recalled no formal mathematics unit in her first degree, mentioning, "There might have been a subject that ran for the 10 weeks and they would do like, one week on one thing, and one week on another, so it would have been pretty insignificant if I did do anything". As she had been upgrading her qualifications, the Early Childhood Mathematics unit was not a required subject for her second degree.

At the 4YOK, Samantha described her programming style as "emergent", noting that it was highly focused on the activities and interests of the children. She believed "children learn through play. I believe that we need to set up an environment that helps teach children the skills that they learn, umm. That we are there to teach them life skills and, umm, the staff are there to, to support children in their development" (Samantha - Interview with 4YOK Educator). Samantha elaborated on her programming, stating there were "six aspects" covered. These included the program plan, the learning experiences, learning stories, parent contributions, a reflection, and a layout of the room showing where activities would be situated.

Connecting with parents was clearly an important factor in Samantha's pedagogical practices. At the centre entrance where the parents and children gather for arrivals and departures, she displayed photographs and narratives of the children on her *Programming Wall: 4YOK-0134* in Figure 6.1 to share her programming with the families, and for the children to recall and reflect on their own learning.

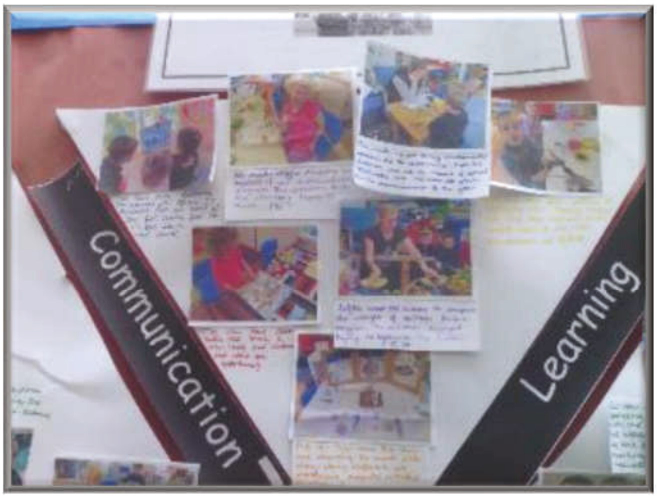


Figure 6.1 *Programming Wall: 4YOK-0134*

Observational photographs with short written descriptions, such as those in *Programming Wall's Observational Photograph: 4YOK-0136* in Figure 6.2, formed the basis of the documentation wall in this centre. The text in this particular observation reads, "The Chn (children) have enjoyed learning about chickens, the life cycle of a chicken and what else comes out of eggs. This experience has inspired our creativity".

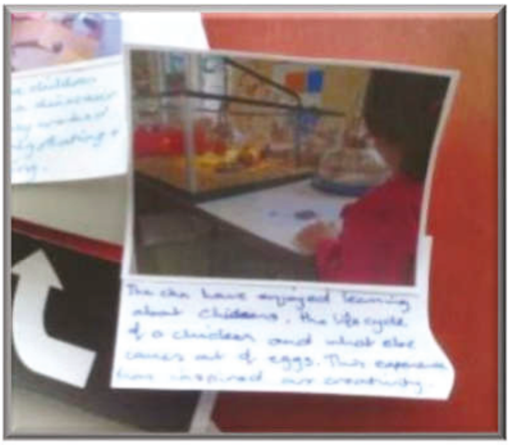


Figure 6.2 *Programming Wall's Observational Photograph: 4YOK-0136*

During the interview, Samantha mentioned “families are encouraged to … share with us any information in relation to the children that may assist us in educating them … Particularly in following the children's interests” (Samantha - Interview with 4YOK Educator).

The 4YOK staff and committee also had a strong commitment to ensure the families were able to contribute to the program, and provided a sheet on the programming wall for parents to share information and stories on what their children were engaged in at home, shown in *Programming Wall's Parent Contributions: 4YOK-0141* in Figure 6.3. This sharing of information allowed Samantha the opportunity to build strong connections with the families, and provided documentation in a very holistic and contextual form.

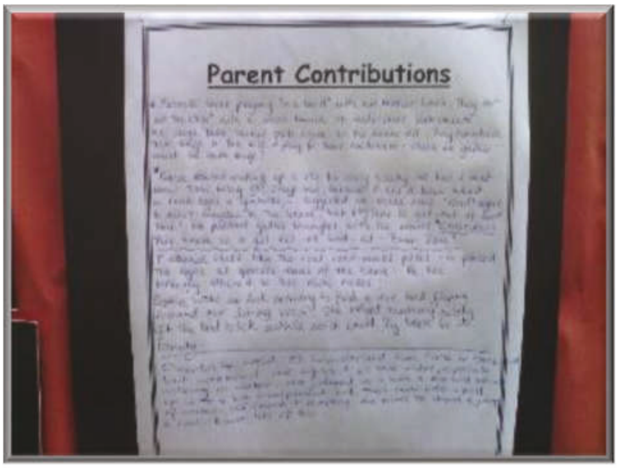


Figure 6.3 *Programming Wall's Parent Contributions: 4YOK-0141*

When asked directly about how she felt children learn, Samantha stated that she believed

> very much in Vygotsky's theory [pause]. That children learn from other people that have got greater knowledge than themselves, so by watching and learning from others around them, umm. Which is why it is so important to set that environment up [pause] well. Because sometimes the people are not there to necessarily teach

> them, so therefore the environment if it's well organised and well set up can in fact work as a teacher.

The mathematical skills that Samantha thought were important for this age group included, “sorting, categorising, umm. Learning about patterns, shapes, all of those sort of basic”. She felt that these were really “the foundation of maths” and while “some children may get to the point where they are doing basic addition, and maybe some subtraction but basically it's about teaching them the concepts behind maths”.

She continued on to mention the importance for children to “recognise the numbers, as well as to count the numbers” and “learning about patterns is really important but, learning to, umm, learning to sort things” providing the example of “sorting by colour or sorting by number and then categorising, you know, say animals, zoo animals as opposed to farm animals or African animals as opposed to farm”.

Samantha did not feel that mathematics needed to be a “specific subject” in the early childhood setting. She stated, “I don’t look around my room and think, ‘Oh I need to put a maths activity out’ because there’s probably maths incorporated in half the activities or more that are out there anyhow”.

This was clarified further by adding “I know when you came, it suddenly occurred to me all the things that I was doing that did actually include maths in our program [pause]. Educators need to be aware of HOW they incorporate maths or how it is incorporated”.

Reflecting on this, Samantha mentioned, “but you are talking to someone who didn’t do it as a separate subject, so maybe I would see more value in it if I had done that”.

In response to a question on the role of the early childhood educator in teaching mathematics, Samantha felt “that role is actually really important” and focused on the importance of providing children with school readiness skills. She mentioned that it was “really important for children to go off to school with the skills of knowing their colours, knowing their numbers, knowing how to categorise and sort, and doing those sort of things”. Without these, she felt “it’s going to be very hard for them when they get to prep [pause] and they’re expected to do various tasks that [pause] would need those skills”.

Samantha acknowledged

> I was never really good at maths, and yet in terms of actually, you know, doing adding and subtraction and stuff like that I'm actually pretty fast, but as soon as it got beyond basic maths, that was not really my thing at all. Umm, so because I don't class myself as very mathematical, I think, I, umm, the concept scares me, it puts me off, I think that oh, no, I don't want to teach maths.

However, she clarified this by mentioning, “If you talk to me about [pause] the concepts of sorting, categorising, those sort of thing [pause] [I] feel very comfortable with doing all that”. She also felt now that she was able to mentor her staff, explaining

> I've got other staff that if I said to them how do you incorporate maths into your program? They would go, “Oh, I don't”. And then I could point out to them around the room what they're doing, and they'd be like, “Oh, okay yeah I do”. But, they wouldn't necessarily class it as maths.

She also mentioned that she “wouldn't write [it] on my program as maths, but I might say occasionally [pause] this supported the children’s development of mathematical concepts”.

Samantha did not plan "specifically for mathematics, but I don't necessarily plan specifically for literacy or other areas". She reiterated that her planning was based on "children's interests, or based on their developmental needs", mentioning

> I don't look at my puzzle table and say what are the maths skills here? And I don't look at my play dough table and say we are working on maths skills. And I don't put the scales out and say, you know, we are developing our concepts of measurement or weight or whatever [pause] I would have different reasons for having them out.

The five learning outcomes from the recent frameworks endorsed by both the state and national governments (DEEWR, 2009; DEECD, 2009) were mentioned as the guide for Samantha's planning, but she acknowledged, "in my heart of hearts, I plan very specifically for children's social and emotional development [pause] for me that's paramount [pause] If you are working on those skills [pause] all the other stuff is kind of incorporated in all that".

Whole group goals in the 4YOK were formed around the learning outcomes previously mentioned as well as "all the different outcomes underneath those areas". While Samantha attempted to write "a goal per term" for individual children, she admitted that she "was not as diligent on that as I should be". Samantha clarified this by stating, "The issue is, that it's not something I write down a lot, and yet if you walked into the room and said tell what you working on with that child there, I could probably prattle off a whole heap of stuff".

Samantha works as part of a team, "my assistant staff [pause] does 50% of the planning [for the 4YOK]. She plans the outside, and I plan the inside. Plus, she does some of the indoor things [pause] like the play dough". They also plan in conjunction with the educator and assistant of the three-year-old groups, each writing a

> Learning Experience Plan, which is an intentional teaching plan and that we photo copy those and share them amongst the two groups and so we got for intentional teaching plans for each group each week. [Each] plan may have come from a child's interest, or it may have come from parent feedback, or it might have come from something that staff member wants to add in to the program.

When asked about the activities that are always available, such as puzzles and play dough, Samantha stated that these “might be changed according to an area of interest [pause] [or] a celebration of different cultures [pause] [or for] Christmas and Easter we always bring those out”. She also mentioned that the staff would ensure they “were going to challenge the children”.

Samantha stated that “parents would definitely be counting with their children” and would sing songs to teach both the alphabet and numbers, “but in my opinion, it's more probably important that they can recognise the number or letter then be able to sing the song”. She also mentioned measurement could occur with some parents spending “a lot of time cooking with their children, others probably not”.

When asked if there were any mathematical skills families expected her to include, she observed

> When we have our parents' surveys, the parents always say there is not enough literacy, you know, are you teaching the children the names and sounds of letters? But they NEVER ask if we are including numeracy and mathematics. So that's interesting isn't it?

Yet, she herself felt “that the two have equal value”. I probed further into the assessments I had observed (see *Harrison's Assessment: 4YOK-0007* , p. 197) which had appeared to contain mainly mathematical tasks, and she pondered, “maybe if we put more emphasis in those assessments … on literacy, maybe they wouldn't be asking for it so much”. Further reflecting, that perhaps parents think “we're doing the maths stuff really well”. Yet, she also commented that she “just never really heard a parent say ‘how are you supporting my child in their mathematical development”.

As this section of the interview concluded, Samantha mentioned the centre’s commitment to

> the chicken or duck rearing, and the rabbit rearing program that we're about to launch into. And for us that is a very mathematically based program [pause]. We've bought scales specifically for that experience [pause] that we used to weigh and measure them. And then we draw graphs up with the children, and see how quickly they are growing, and which ones are growing, how fast, you know how big they were when they first came and how big they were when they left.

Samantha paused to reflect that while she was aware of the mathematics in these experiences, she was “not sure if you ask anyone else if they would be aware of the fact that that is very much specifically maths based”.

6.4.2 Sorting the 4YOK Images

For the next section of the PEI, Samantha was handed the selected images (with the text written on the back) which were prepared for the interview as discussed in Section 4.3.3 (p. 70). I asked Samantha to sort the images into three piles: those that she could identify as containing *Obvious Mathematics* , those that contained *Not So Obvious Mathematics* , and those in which she could see *No Mathematics* . Over the next seven minutes, Samantha sorted them as shown in Table 6.3.

Table 6.3
Samantha's Sorting of the 4YOK Images

Image	Pile
A Long Long Long Tail: 4YOK-0003 (p. 171)	*Obvious Mathematics*
Boys and Lego Roads: 4YOK-0083 (p. 179)	*Obvious Mathematics*
Easel for Chicken Drawings: 4YOK-0040 (p. 168)	*Obvious Mathematics*
Finding your Lunch Box: 4YOK-0080 (p. 187)	*Obvious Mathematics*
Four Children at the Clay Table: 4YOK-0028 (p. 176)	*Obvious Mathematics*
Four Children with Cars: 4YOK-0006 (p. 181)	*Obvious Mathematics*
Group Reflection: 4YOK-0129 (p. 199)	*Obvious Mathematics*
Hands Up if You Can Swim: 4YOK-0002 (p. 158)	*Obvious Mathematics*
Harrison's Assessment: 4YOK-0007 (p. 197)	*Obvious Mathematics*
How to Make a Book: 4YOK-0053 (p. 165)	*Obvious Mathematics*
Jack's Homemade Book: 4YOK-0002 (p. 162)	*Obvious Mathematics*
Kyle's How To Make a Book: 4YOK-0049 (p. 163)	*Obvious Mathematics*
Lego Baddies: 4YOK-0029 (p. 179)	*Obvious Mathematics*
Lunch Table: 4YOK-0121 (p. 188)	*Obvious Mathematics*
Marble Run Construction: 4YOK-0083 (p. 184)	*Obvious Mathematics*
Outdoor Kitchen and Sandpit: 4YOK-0048 (p. 191)	*Obvious Mathematics*
Paul's Assessment: 4YOK-0012 (p. 197)	*Obvious Mathematics*
Phil's Idea: 4YOK-0050 (p. 164)	*Obvious Mathematics*
Pictures and Hooks: 4YOK-0037 (p. 156)	*Obvious Mathematics*
Puzzle with Educator's Help: 4YOK-0027 (p. 166)	*Obvious Mathematics*
Rules for the Mat: 4YOK-0133 (p. 159)	*Obvious Mathematics*
Samantha Reads to Jane: 4YOK-0052 (p. 185)	*Obvious Mathematics*
There Was an Old Lady Story: 4YOK-0129 (p. 198)	*Obvious Mathematics*
Trucks on a Shelf: 4YOK-0036 (p. 189)	*Obvious Mathematics*
Two Children at the Clay Table: 4YOK-0093 (p. 177)	*Obvious Mathematics*
Two Girls with Animals: 4YOK-0060 (p. 184)	*Obvious Mathematics*
Box Construction: 4YOK-0128 (p. 173)	*Not So Obvious Mathematics*
Moving Chairs: 4YOK-0038 (p. 196)	*Not So Obvious Mathematics*
Picture of the Tooth Fairy: 4YOK-0027 (p. 172)	*Not So Obvious Mathematics*
Small Play Set Up: 4YOK-0047 (p. 154)	*Not So Obvious Mathematics*
Photo Wall: 4YOK-0131 (p. 155)	*No Mathematics*
Self Portraits: 4YOK-0132 (p. 171)	*No Mathematics*

During the sorting, Samantha discussed most of the images, providing great detail on her thought processes. When looking at *Pictures and Hooks: 4YOK-0037* she questioned her ability to sort the images, "You know, how do you [pause] it's really hard to judge".

Moving on to the *Box Construction: 4YOK-0128* image which she placed in the *Not So Obvious Mathematics* pile, she continued, “I mean here, you know they’re making decisions and they’re problem solving, and they’re sorting, I suppose in their own mind, aren’t they? And the same here” pointing to the *Easel for Chicken Drawings: 4YOK-0040* image, which was placed in the *Obvious Mathematics* . Further reflecting

> You know, matching up, here (Box Construction: 4YOK-0128) I mean, it could be mathematically-based, or it could just be [pause] I don’t know, a lot of it depends really on the, some children might take it to a whole different level. You know, if they were making a rocket, they would know they needed a bigger one on the bottom and then work up to smaller ones on top, so that is definitely a mathematical sort of skill.

However, she reiterated that the mathematics was “not as obvious to me there as it is over here”, pointing back to the image of *Pictures and Hooks: 4YOK-0037* .

Continuing on to *Lunch Table: 4YOK-0121* , Samantha talked through her decision to place this image in the *Obvious Mathematics* , reflecting

> It’s like here, trying to try to decide, okay, well they've got to find their name, and they have to sort out their lunch. You know, if they sit there and talk about my sandwich is cut into four and your sandwich is cut into two, then they're doing maths. But it's hard to know what conversations, you know, it's [if] their conversations are just about something else and they're not really focusing on the [mathematics].

When questioned if she would be able to easily scaffold mathematical development in this scenario, she felt she would “easily be able to”.

Samantha placed *Four Children at the Clay Table: 4YOK-0028* into the *Obvious Mathematics* , commenting, “definitely could here, because, you know, if one child had taken all the clay then we could work out how we could make it nice and fair”.

The *Marble Run Construction: 4YOK-0083* was also placed into the *Obvious Mathematics* pile, with Samantha mentioning the importance of getting the heights correct “so that the marble actually travels down”.

Lego Baddies: 4YOK-0029 was confidently placed on the *Obvious Mathematics* pile with the comment, “Always with Lego, you can always sort out some sort of maths, and you know, planning, working out where things go, how you are going to go about doing it. How much [pause] how many pieces of Lego do you need? This and that”.

For both *Finding your Lunch Box: 4YOK-0080* and *Two Girls with Animals: 4YOK-0060* , Samantha mentioned the children were able to sort, “This is a sorting activity, choosing their own lunchbox. … This could [also] be a sorting activity, let’s put all the zebras over here and we will put all the leopards over there, with the zoo animals”. She added that *Finding your Lunch Box: 4YOK-0080* could also include “decision making, problem solving”. She placed these images into the *Obvious Mathematics* pile.

The second image of children with clay, *Two Children at the Clay Table: 4YOK-0093* was also placed in the *Obvious Mathematics* pile, with Samantha identifying counting as something the child may have been doing.

Samantha required clarification of what the children were doing in *How to Make a Book: 4YOK-0053* , but then placed it in the *Obvious Mathematics* pile also, and was able to clearly acknowledge, “there is some maths in that because they might be counting up the number of sheets that are needed to make the book, and then working out how to fold them in half. So that's definitely a maths concept”.

Placing *Samantha Reads to Jane: 4YOK-0052* in the *Obvious Mathematics* pile, Samantha reflected, “We were probably talking about things in the book. I would always take the opportunity to sort of say, ‘Look there are two of those there’ or … that sort of thing”.

With *Hands Up if You Can Swim: 4YOK-0002* , which was also placed in the *Obvious Mathematics* pile, Samantha mentioned, “Well, our mat discussions have got multiple opportunities for mathematics. I mean, every morning we count the children, … to start with just the most basic, they’ll all know how to count to 21”.

The *Outdoor Kitchen and Sandpit: 4YOK-0048* was added to the *Obvious Mathematics* pile, with Samantha exclaiming, “Oh, hundreds of maths. Yes absolutely, so, sharing, dividing, moving, you know, how many scoops full. … There’s lots of opportunities”.

Samantha then placed *Kyle's How To Make a Book: 4YOK-0049* onto the *Obvious Mathematics* pile mentioning, “He will be talking about how he divided the book in half and that sort of thing”.

Sorting was again identified as a potential mathematical concept in *Trucks on a Shelf: 4YOK-0036* which was placed on the *Obvious Mathematics* pile, Samantha stating “Sorting the trucks into different shelves, putting the hats on other shelves, putting the cones on other shelves”.

When looking at *Jack's Homemade Book: 4YOK-0002* , Samantha reflected that while, “once again, you know, you are talking about the child counting out the right number of pages”, she also felt that she’d “probably say it’s more supporting literacy than maths”. When I mentioned that, during this episode, Jack had gone into great detail about the numbers on the book spines in the library, she agreed that that was mathematical and placed the image in the *Obvious Mathematics* pile.

Returning to her previous comment about the mathematical potential of Lego, Samantha placed *Lego Baddies: 4YOK-0029* into the *Obvious Mathematics* pile.

Stating, “Creating anything with Lego takes maths … working out how many pieces [you] need and so on”.

Rules for the Mat: 4YOK-0133 was confidently placed in the *Obvious Mathematics* pile as well. “This is definitely maths. … I will often just say to the children ‘What is mat rule number two? Have we forgotten rule number two?” And they know which one it is”.

Looking at *Self Portraits: 4YOK-0132* , Samantha hesitated, and placed the image in the *Not So Obvious Mathematics* pile, and then moved it to the *No Mathematics* pile, observing, “I think this supports their identity very nicely, … I can’t see how it supports maths”.

The image of the *Photo Wall: 4YOK-0131* also had Samantha hesitating

> This one here the children are able to make choices of what they want in the program. Umm, I don't know if they're trying to work out whether they need some rocks and some trees and some people … Is there a maths concept behind that … I can't really think.

After looking for reassurance, she continued

> I mean, if they want to stand there and count the different things, or they could sort it, and have all the animals here, and the stones over there, or the rocks and the natural things here, and the man-made things there. So there's sorting, but the children don't generally move them they just come and point to them, so it depends on how you want to look at the experience. The experience itself is for them to make a choice. So if making choices is a mathematical concept? Then I would say yes, but if you looked at those and thought, “Well the children could move them and sort them”, then it would definitely be a maths concept.

Looking for further clarification, I encouraged Samantha to sort the image according to how she would use it, and she placed it in the *No Mathematics* pile and reiterated, “The children just tell us what they’d like”.

There Was an Old Lady Story: 4YOK-0129 “is definitely maths because we are moving from the smallest object through to the largest object”. This image was confidently placed in the *Obvious Mathematics* pile.

The *Puzzle with Educator's Help: 4YOK-0027* was placed in the *Obvious Mathematics* pile and Samantha explained the mathematics included, “Puzzles … Problem-solving skills … . Sorting things out looking at shapes size and all the rest of that”.

When she placed the *Picture of the Tooth Fairy: 4YOK-0027* image in the *Not So Obvious Mathematics* pile, she reflected that, “I suppose it depends what the conversation’s about. I think that's not so obvious”.

Both *Paul's Assessment: 4YOK-0012* and *Harrison's Assessment: 4YOK-0007* images were placed in the Obvious Mathematics pile, with Samantha stating, “So definitely it was sorting, categorising, patterns, and so on”.

For the image *Four Children with Cars: 4YOK-0006* , Samantha noted that, “in this one the children are creating a car mat with bits and pieces, I would say there is definitely some maths skills in there … In sort of how they're going to set it up and so on” and placed it in the *Obvious Mathematics* pile

A Long Long Long Tail: 4YOK-0003 was also placed in the *Obvious Mathematics* pile because Samantha felt “there can always be maths associated with drawing. The children will draw things often and then count them or talk about them”.

Samantha chose the *Obvious Mathematics* pile for the *Group Reflection: 4YOK-0129* image, and explained

> Once again mat time there is multiple opportunities for doing…umm this one say is we asked the children what they were

> doing during the week and what they enjoyed … So they are actually reflecting on the program. … So in this children might talk about some of the experiences that they enjoyed that were maths-based as well.

Once the images were all sorted, Samantha was asked to choose one she had placed in the *Obvious Mathematics* pile and discuss it in greater detail. She chose the two images of assessment, *Harrison's Assessment: 4YOK-0007* and *Paul's Assessment: 4YOK-0012* , and stated

> Okay, so in this experience here we are doing an assessment with school readiness and the child would be doing a number of tasks one of them she would be sorting um, different things to different files so you putting the fabric hearts in one pile, the sticks in another pile and can't think of the third thing is that we used but anyhow putting the different types of product into each pile and then we asked them to create a pattern and see if they can continue the pattern on where we started they continue on and then we also asked them to sort things by colour so "Put all the green things here, all the blue things here", so lots of sorting, categorising and pattern making

This was an activity that Samantha had planned, but not one that the children engaged in often with this level of assessment. However, Samantha did note that they often, "have other sorting out around the room. So we often have things like um, baskets were already things in them. … [And] you could do other sorting activities. Lots of pattern making experiences and things like that".

The next image Samantha chose was the *Marble Run Construction: 4YOK-0083* , where she stated

> In this one the children um, have to create marble mazes that

> actually work so the idea is we want the marble to travel from the top down to the bottom so they have to work out how many of the little pieces they need to have in each different section of it in order to make it run. So they need obviously just one piece at the bottom and then two for the next level up and then three for the next level up and so on. Um, they need to work out where they need to put each of the pieces so that they can actually watch the marble go down. Like, how are they going to design it? What's the design going to be? Sharing them out between two children, if two children are using it, and they both need the same piece, they have got to work out how they going to manage their time and in relation to using it.

This was an activity that Samantha planned for, and an activity that the children engaged in often. She mentioned that, “We pretty much always have a marble maze available to them to pull off the shelf if they'd like to do it”. The goals for this activity included, “For the children to work on those maths skills, work on you know measurement and height and um, problem solving skills. You know to work out how to actually get that marble to run from top to bottom”.

Samantha mentioned that the educators

> would probably sit there and discuss it with them and say well if you know, for instance I'd wait and see what they came up with, and if it wasn't working I'd say “well if you have a look at the height of this one and if you have a look at that, you know, it needs to travel downhill” and talk to them about that and they would probably put on other pieces

Samantha mentioned that with a younger group of children she would probably use the timber marble run “because it is a little bit easier to sit all the pieces on”. She also felt the children “could count the number of pieces they are using. They could sort by colour one children could want to use all the green bits and instead of the yellow or the red".

Samantha was then asked to choose one off the *Not So Obvious Mathematics* pile and she chose *Moving Chairs: 4YOK-0038* where she explained that for

> these activities sometimes is only one person allowed, so there might be some amount of negotiation in terms of the well, you know, if only one person is allowed, can I take over a chair. Um, how much I sorta said that but how much room is needed to fit two chairs at that particular table. … Because there are always a certain number of chairs at the tables which sort of indicate the number of people that generally are invited to that experience. So you know you got to work out if you're flexible with that or with some experiences there is no flexibility because there is only a certain number of things at the table. Where other experiences it doesn't matter if six people pull chairs up to the table of four because you just share, share the experience out if you can.

Samantha felt that if she interacted with the children in this, she might say to the first child sitting down

> "Can you see that your friend is trying to move her chair in here? What can you do? Could you move over a little bit so she can fit her chair there too?" Um, that's getting both children then to estimate how much room is required.

In reflecting on this image, Samantha further explained how

> When we put out a new activity, sometimes they are just specifically for a couple of children. So we might talk about it with them on the mat and say "look we have pulled out the tent today and you can see the tent is over there. How many children do you

> think it would be reasonable to allow in the tent at any one time?" And the children would go "Five" "two" "one" and we would say "two, I think two was a good idea". So then we make them draw a picture of two people and stick that on the tent so that the children know that's a reasonable number, and that would be a safety precaution. … You know that, that obviously don't want more than two children in the tent, then you are going to have banged heads and bits and pieces …

When asked to choose another image from the *Not So Obvious Mathematics* pile, Samantha chose *Small Play Set Up: 4YOK-0047* and commented that this image looked like it had been

> a little bit pre-loved for, you know, a few days. Usually there would be a lot more bits and pieces in there but you can see that these pineconey things have obviously come out of one of those so it is a bit of a sorting activity which we might put the shells in one, and stones in the other, pinecones in the other, and so on and so forth. In that the children could then, you know, if there were more of the snakes, they could have divided them by colour, or bits and pieces to create more of a mathematical kind of experience.

Samantha explained that her interactions with an activity such as this would include talking and

> sorting these things back into this little box with the four compartments. I may also get them to count them out. So we might look and say "Oh how many pinecones do we have? How many snakes do we have today? Where have all the other snakes gone"? We might go on a treasure hunt.

She also commented that it would be possible to discuss volume and weight measurements as she chatted with the children. She mentioned the interaction could include questions such as “What happens then if you fill the basket up? Is it going to hold properly? No it might still be too heavy for that. It might be better to put the rock in the big box because it is going to be sturdy enough to hold”.

When asked to choose an image from the *No Mathematics* pile, Samantha then chose the *Photo Wall: 4YOK-0131* . She commented that this was “So the children can come up … and choose various animals and pinecones and things like that and then we go into the store room and find those things and give them to the children”. She felt it was useful to “to allow children to make choices”.

When Samantha looked at the other image she had placed in the *No Mathematics* pile, *Self Portraits: 4YOK-0132* , she commented

> Well I suppose I could count the people. People's fingers, people's feet. They could sort out which ones are the girls and boys. I could try and identify which ones are their friends. I can see they don't really have the names on them really. Most of them don't. So could be a bit of a guessing game “This one’s got really curly hair, who do you think might be?” Yeah that's maths.

6.4.3 Exploring the Mathematical Concepts List for PEI with Samantha

Samantha was then asked to look through the *Mathematical Concepts List for PEI* (Appendix E, p 393) and she quickly read through the list providing examples of her understanding of each concept.

> Size, so you might be the Play-Doh table and divide the Play-Doh into three different balls, which one is the largest, which is the smallest.
> Length I understand is smaller, shorter, taller.

> Area, I suppose that table, the two girls coming up to the table (Moving Chairs: 4YOK-0038), is there enough space there?
> Volume - filling some cups and then emptying them things like that.
> Mass, looking at that rock is it too heavy too light?
> Time, yesterday, now, Monday, Tuesday, Wednesday, Thursday, the seasons – summer, autumn, winter, spring.
> Sound, quiet noisy, we do lots of that in music.

When Samantha read *Geometric*, she stated, "Shapes and their properties. So looking at different shapes and talking about those. [pause] We make a circle on the mat can we make a square on the mat". She then went into greater depth, describing an interaction that had taken place a few years ago

> A four year old group searched on the Internet, came up with the name of a shape that we'd never heard of that described the shape that we made on the mat. So it was like a circle within a circle [pause] I don't know, but it was interesting.

Returning to the list, she easily provided examples for the next concepts listed:

> Navigation, so position themselves and other objects and other things like that.
> Object classification umm, so yep putting things into groups. Role classification, so mums and dads yep. Order, umm that a sequencing thing isn't it like order, morning afternoon night time.
> Patterns: red blue red blue red blue. Blah, blah, blah, that sort of thing.
> One - two - one correspondence so counting the correct number of objects and putting their finger on each one.

Reading from the list, she reflected, "'Ordinal use to indicate the position of objects first second last' yep got that". She was nodding as she continued to read aloud, "Reciting number names, rational counting –'using numbers to find the cardinality of a group'".

Reading the definition for Subitizing resulted in a questioning look and "Huh?" After explaining the term, she nodded and said, "Yep, right, okay". Finishing with Fractions, she explained, "Yep, yep, half that's no problems".

Samantha was then asked to look at each photo again and indicate by placing stickers from the *Mathematical Concepts List for PEI* for the concepts she now felt were possible to identify in that image.

For the image Small Play Set Up: 4YOK-0047 (p. 154), Samantha started with Object Classification, then reflected out loud, suggesting sentences she could use with the children as she placed more stickers

> Count, I suppose I can do that … Yep that one, fractions "half of them are here, half of them are there", I guess we could go first, middle, last, (ordinal), one - two - one correspondence (nods), we could create patterns - you could go rock, pine cone, rock pinecone order, and eventually sequencing yes we put them in order and things like that. (Samantha reads definitions of Navigation and Geometric and places these stickers) Umm, yes we could do shapes. Is it Time if they say "Yesterday I did this and I did such and such with it?" (I nod) okay. Then mass, definitely. "Yes I filled that one right up" so yes (Volume). "There we are too small", yes, I guess. Length "this one is bigger that one is shorter, wider". And size so, yes.

The next image, Samantha looks at is Picture of the Tooth Fairy: 4YOK-0027 (p. 172) and she places stickers for all of the concepts except Mass. She talks these decisions through, almost to herself, providing further possible statements she could use in her interactions with the child

> “The tooth fairy, look the fairy is really big. The tooth fairy is taller then you in the picture”. You could talk about area “I see that you've only drawn on a small part of the page”. “Your book is really full, you got halfway through and then you decided to stop”. Umm, no (looking at Mass). Yesterday? Yes. Sound, “Ohh, it looks like the fairy has bumped into a thing and that made a big bang”. Shapes and properties umm? (Reading definition) Oh yes you could talk about various shapes on the page. Yes, “I can see you put you and the fairy in the house together”. Yes, we are classifying objects. Yes we are talking about Roles, the fairy is the tooth fairy after all. Ordering, sequencing? “See in the morning, the fairy did this, than at lunchtime she did that”. Patterns? That could be patterns drawn on the outfits or something like that. We could do one-to-one correspondence. “How many teeth did you pick up that night?” Before, after, last? Definitely. Recite - if she had put the page numbers on the book? Counted the– things. Subitizing? Can’t see why not. Fractions? “You've coloured one half of the book what about the other half?”

The next image Samantha picked up was Box Construction: 4YOK-0128 (p. 173) which she had previously placed in the Not So Obvious Mathematics pile. For this image, she placed all the stickers except for Patterns, talking through her decisions, saying, “Size? Definitely. Area, volume, all of those [Measurement] most definitely”.

Samantha looks up and smiles, “And I said it didn't have so obvious mathematics. How hilarious is that?” Then continues on

> “I'm heavy”. Right okay good. Time? “I might complete this tomorrow”. Or even they could say “I have five more minutes to

> complete this". "Ohh, your drums are going to be really loud". Geometric shapes? Yes. Navigation, yes? If they're creating things they are classifying them as objects. If he's going to be a drummer (Role), yes. "I'm going to put the biggest one here because that's the way the drum is made" (order). I don't know about patterns? No. One-to-one? Yes, he could be counting them. Yes because this one has to go there and then I'll have to go on put that one there (Ordinal).

Samantha reads definition of recite number names and pauses, before placing the sticker and finishing with "Counting, subitizing? Yes. (Fractions) yes"

Due to the time, I suggested Samantha identify the concepts she could not scaffold for each image, and she then looked at Moving Chairs: 4YOK-0038 (p. 196) which had also been placed in the Not So Obvious Mathematics pile previously. For this image, Samantha identified four concepts she could not scaffold – Volume, Geometric, Order and Patterns. Her reasoning went, "okay, volume maybe doesn't, time, sound. Hmm [geometric] yes, it does have that". Stopping to confirm that the episode was about moving the chairs not the chicken activity she placed stickers to indicate Order and then Pattern were not identifiable, then hesitated and said "I might be wrong with that one" I reassured her there were no wrong answers, explaining that it was what she could see or identify not anyone else.

The next image she chose to re-examine was Four Children with Cars: 4YOK-0006 (p. 181) which she had placed in the Obvious Mathematics pile and after reading the definitions quietly, nodding and saying the occasional "Yes" or "No, I can do that". She placed no stickers, indicating that she felt it would be possible to scaffold all of the mathematical concepts on the list and handed the photo to the interviewer.

Looking at A Long Long Long Tail: 4YOK-0003 (p. 171) next which she had also placed in the Obvious Mathematics pile, she looks up and says "I think this is going to potentially have everything in it too, isn't it?” She looks quickly through the lists, and continues, “Yes, really” and again placed no concept stickers.

Picking up *Group Reflection: 4YOK-0129* (p. 199) which she had also placed in the Obvious Mathematics pile, Samantha looked through the list, shrugged her shoulders and added, “Mat time you can include anything in” and she again placed no concept stickers on the image.

Looking at *Easel for Chicken Drawings: 4YOK-0040* (p. 168) also identified as containing *Obvious Mathematics* , she read through the lists, placing only Mass and she picks up *Pictures and Hooks: 4YOK-0037* (p. 156) another identified as containing *Obvious Mathematics* . She hesitated on volume, “I could say my bag is half full”. Then, looking at sound, she joked “The children are very noisy when they are putting their bags on, does that count?” but then placed the Sound sticker on the image before reading the rest of the list. Only hesitating once more as she says “Geometric shapes? Okay, you can have that one”.

The next four images were all identified earlier as *Obvious Mathematics* by Samantha. For *Lunch Table: 4YOK-0121* (p. 188) Samantha read the list, and hesitated only on the Object Classification, but left it, and all the other stickers, off before moving on to *Two Children at the Clay Table: 4YOK-0093* (p. 177) which she handed quickly to me stating, “Just take that one”. Just as quickly, she handed over *Boys and Lego Roads: 4YOK-0083* (p. 179) saying, “and that one. I think”. Picking up *Finding your Lunch Box: 4YOK-0080* (p. 187) she reflects, “This is the experience of getting their lunchboxes” she looked through the list saying “Yes” quietly for various concepts and placed no concept stickers, she handed over the photo.

Samantha looked across the table and in almost a whisper said, “It's too embarrassing, there's just so much mathematics”.

The next seventeen images were also from the Obvious Mathematics pile and Samantha went through them very quickly. For *Two Girls with Animals: 4YOK-0060*

(p. 184) she commented, “I'm going to think all this can be done” and *for Four Children at the Clay Table: 4YOK-0028* (p. 176) she said “and definitely that one”. She questioned whether the image *How to Make a Book: 4YOK-0053* (p. 165) was only about the making of a book, or what could go in the book, and when I replied it was about the making of the book, she reflected, “Okay. I don't know if this is right?” then places concept stickers for Sound, Object Classification, and Patterns on the image indicating these were concepts she could not scaffold in this activity.

Samantha took a quick look at *Samantha Reads to Jane: 4YOK-0052* (p. 185) and handed it to the interviewer, she repeated this with *Hands Up if You Can Swim: 4YOK-0002* (p. 158), simply stating, “Mat time again”.

Samantha read through the list while looking at *Phil’s Idea: 4YOK-0050* (p. 164) and placed concept stickers for Object Classification and Role Classification. She hesitated before placing Patterns and mumbling something quietly to herself.

Outdoor Kitchen and Sandpit: 4YOK-0048 (p. 191) was also handed across with Samantha reflecting, “Hard to find the favourite [concept??]”.

For *Kyle's How To Make a Book: 4YOK-0049* (p. 163), Samantha again placed no concept stickers, commenting “Oh, that's when he created his book. Well if the book is actually created then, depending on what's in it, you could cover all the areas”.

Looking at *Trucks on a Shelf: 4YOK-0036* (p. 189), Samantha read through the list and silently handed the image to the interviewer. While both *Jack's Homemade Book: 4YOK-0002* (p. 162) and *Lego Baddies: 4YOK-0029* (p. 179) were handed over without even looking at the list.

Samantha took a little longer with *Rules for the Mat: 4YOK-0133* (p. 159) and as she looked through the list, she placed concept stickers for Length, Volume, Mass, Sound. Looking next at *There Was an Old Lady Story: 4YOK-0129* (p. 198) Samantha looked at the list, and placed a Geometric sticker before handing the image to the interviewer.

Puzzle with Educator's Help: 4YOK-0027 (p. 166) and *Paul's Assessment: 4YOK-0012* (p. 197) are handed across, with Samantha reflecting on the assessment image that "The whole idea of this is look into all the stuff, isn't it?" *Harrison's Assessment: 4YOK-0007* (p. 197) is also handed to the interviewer with Samantha stating "You can have that one as well".

Samantha read through the list and nodded her head as she looked *at Marble Run Construction: 4YOK-0083* (p. 184) then handed the image over, placing no concept stickers.

Self Portraits: 4YOK-0132 (p. 171) which was placed in the *No Mathematics* pile was discussed in depth earlier in Section 6.4.2 and Samantha laughingly commented "Well we already discovered that there's all the maths in that didn't we? My non-maths activity!"

When looking at *Photo Wall: 4YOK-0131* (p. 155) which was placed in the *No Mathematics* pile, Samantha asked if I want her to comment on this "as it's designed?" When told yes, she read through the list and although she hesitates on Geometric and Navigation, she placed no stickers on this image, indicating that she felt she could scaffold all of the mathematical concepts.

Samantha looked up as she handed over the last image and, shaking her head, she reflected, "Wow. Okay. That's interesting".

6.4.4 Additional Thoughts from Samantha

Although the last few questions on final thoughts were skipped as we had ran out of time, after the video stopped, Samantha mentioned how she was now more aware of the mathematics the children were exploring through being involved in the study and said she felt more confident that she was able to plan and scaffold these concepts. She also asked if she could have a copy of the Mathematical Concepts List for PEI to share with her staff as she felt it would be an excellent resource to help them identify the mathematics in the interactions in which the children were engaging.

7 The Three- to Five-Year-Old Long-Day Care – 5LDC

This chapter presents the data from the three- to five-year-old long-day care site (5LDC). Pseudonyms have been used when referring to the educators and children to protect their anonymity. As set out in Chapter 4, and noted in the chapters above, the data from each site were collected in two stages. Firstly, video observations and field notes were collected at the 5LDC over a two-week period in July and August, 2012. The data were then analysed and coded to identify the mathematical content and contextual details. The second stage of data collection, a photo-elicitation interview [PEI] with the educator of the 5LDC, was undertaken in October, 2013.

To provide background and context for the 5LDC case study, Section 7.1 provides details on how I approached the early childhood centre in which the 5LDC was located, as well as information on the participants included in the study, and the pedagogical approaches used in the centre. Section 7.2 provides a detailed description of the 5LDC routine, including the set-up of the centre and the episodes observed during fieldwork. These episodes are written in the form of short vignettes, as discussed in Section 4.6 (p. 89), and include details of the mathematics, both actual and potential, identified in the analysis. A summary table of the coding for all vignettes is located in Section 7.3, while Section 7.4 presents the interview data, making connections with the vignettes and the educator's pedagogical practices.

7.1 Overview of the 5LDC Setting

The 5LDC was the second centre I approached and was identified through professional networks. A colleague suggested approaching this centre, as the staff were known to be interested in research studies and would potentially be open to participating. I approached the centre director, who indicated that she would be very happy to assist, and I was introduced to Nikki, the educator, for an impromptu discussion on the study. I provided them with the *Plain Language Statements and Consent Forms* (see Appendix C, p. 378) to read and discuss, and returned a week later to be told that they would participate.

This long-day care centre mainly catered for families where both parents were employed or studying, and who required longer hours than a sessional kindergarten. It was a medium-sized centre, catering for 53 children each day in four rooms and was open from 7:45 a.m. to 6:00 p.m. Each room catered for a set age group, whilst the playground was shared by all rooms.

7.1.1 5LDC Participants

The participants in the study from the 5LDC were:

- Nikki – the educator;
- Alice – the permanent room assistant; and
- forty-one children aged between three and five years

Consent forms were also collected from additional staff members who were likely to be captured in the background of the videos. These included Skye, the centre director, Sabrina, the assistant director, and Terri, Katie, Roz, Jenny and Mari – the floating room assistants and chef. Additional staff at this centre who were not participants included educators and assistants in other rooms.

Nikki's background information was collected during the PEI, and general information on the children as a group was collected through informal chats during data collection. Background information on individual children and other adult participants was not collected.

Nikki's Background and Qualifications

Nikki had been working in early childhood education for seven years, starting when she was 18 years old. She had worked in four centres in total, starting as a volunteer while completing her Certificate III qualification in 2005. She then completed her Bachelor of Early Childhood Education and had been at the 4YOK centre as the degree-qualified educator for three years. At the time of data collection, Nikki had just enrolled in a Master of Education course.

Nikki could remember very little mathematics being covered in her training, “I remember, it was, umm, I'm just trying to think, it was Maths, Science, and Environment, was the subject it was called, and it touched very briefly on maths. I think it was one very small task” (Nikki - Interview with 5LDC Educator). None of the professional development opportunities she had undertaken had focused on mathematics either.

Nikki stated in PEI that she believed in a “play-based curriculum, where children are able to express themselves and learn through play, with the guidance and support from educators [pause] I believe in connecting with families and always having their involvement as well in the programs” (Nikki - Interview with 5LDC Educator).

Nikki, as pedagogical leader for the long-day care centre, had been influential in the development and refinement of how all educators in the centre programmed and documented activities and observations of children. During the PEI, she commented that her pedagogical practices had changed since participating in the research as “I always feel nowadays, that especially a large group of children sitting on the mat is not necessarily what I believe in any more really; but that was something I used to think was very important” (Nikki - Interview with 5LDC Educator). Explaining that her beliefs had changed to an awareness that “small groups, one-on-one interaction, just children playing, I think is when, is really when, they are learning the best. And when I see [pause] that's when I see the maths, and that's when I hear the maths” (Nikki - Interview with 5LDC Educator).

The Children in the 5LDC

The children participating in this study attended the centre in the room catering for three- to five-year-old children. The *kinder room*, as it was called in the centre, had a capacity for 25 children per day. Due to the flexibility of enrolments, there were 41 children enrolled across the week at the time of data collection.

Unlike the 3YOK and 4YOK centres, each family at the 5LDC had the option to choose the day or days for which they wished to enrol their child, with some flexibility for attending additional days on an as-needed basis. Most of the participating children attended two or three days per week. The children in the 5LDC ranged in age from three years and two months to five years and eight months; a difference of 30 months, creating a challenge for any teacher. Nikki felt that an additional challenge in this group was the inclusion of four sets of twins, and two sets of siblings.

Nikki had discussed my research with the families during her parent-teacher interviews in June, so they were aware that I would be attending the centre. Introducing myself to parents and guardians was more difficult at the 5LDC as the children did not start each session as a group. Some children would arrive before the 5LDC room opened for the day, and start with family grouping in a younger room. However, I spoke with many of the families who dropped their children off directly into the kindergarten room or during pick-up in the afternoon. During these brief chats, I explained the research I was undertaking and answered any questions that arose. I placed the *Plain Language Statements and Consent Forms* (see Appendix C, p. 378) in a basket near the sign-in sheets, with a folder for returned forms for the parents I was unable to meet in person.

While most parents signed immediately, one parent explained that her English was not strong and would prefer her husband to read the forms before committing. Another laughed and said her twins were probably “too wild to sit down and do any maths, but good luck!” Four parents wanted more information on the data I collected, with questions such as “Who would see the data?”, “Would the data be freely available on the Internet?”, “Was I looking for positive or negative examples of maths?” These questions were answered both verbally and through the Plain Language Statements.

By the end of the data collection, all 35 families had signed consent forms for their 41 children. One parent, who signed the form for her child, requested that I not focus on her child or use episodes in which this child was a major participant; however, the parent stated she would consent for her child to appear in the background, walking past, or during group activities. This was written on her consent form and noted in my field notes; I was careful to not film any interactions in which this child participated.

The start of data collection at the 5LDC was not smooth. While I had organised the dates I would be attending with Skye, the centre director, illness hit the centre with Nikki and eight of the children not attending the first day. When Skye explained that Nikki would not be back the following day either, I organised to postpone the data collection until later in the week. However, by the end of the first week I became ill and required my own time to recover. Finally, due to Nikki’s planned vacation time, it was almost a month before I was able to return for the remainder of the data collection.

7.2 The 5LDC Routine

Drop-off times for the children in the 5LDC varied, with the majority arriving between 8:30 a.m. and 9:00 a.m. each morning. However, some children did not arrive until 11:30 a.m. or later. Children would begin to be picked up between 2:30 p.m. and 3:30 p.m., with most having left by 5:00 p.m. Some children, however, were picked up at lunchtime and, during my data collection, four children were taken home early due to illness.

The general routine at the 5LDC included family grouping in the toddler room at the beginning and end of each day, structured whole group meetings, supplied meals, an afternoon rest, and lots of free-play time, as shown in Table 7.1.

Table 7.1
Daily Routine in the 5LDC Centre

Time	Activity Options
7:45 a.m.	Children start to arrive, store belongings in kindergarten room and start in family grouping
8:20 a.m.	Children move into kindergarten room[1]
9:00 a.m.	Group Time
9:20 a.m.	Morning Tea
9:45 a.m.	Free-Play Activities
10:00 a.m.	Educators open doors for Indoor and Outdoor Free-Play
11:30 a.m.	Group Time and Movement to Lunch
12:00 p.m.	Lunch
12:30 p.m.	Rest and Quiet Free-Play Activities or Outside Play[2]
2:45 p.m.	Wake up and Free-Play Activities
3:00 p.m.	Afternoon Tea
3:20 p.m.	Free-Play Activities
5:00 p.m.	Return to Family Groupings[3]
6:00 p.m.	Centre Closes

1 Timing is dependent on number of children arriving and may be earlier or later than this.
2 Rest time is for children who require a rest, or whose parents have requested they rest; remaining children are offered quiet activities or an opportunity to play outside if weather is appropriate.
3 Timing is dependent on number of children being picked up and may be earlier or later than this.

The educators shared this daily routine information with the children, building their awareness of numerical symbols, time, and sequencing concepts. An example of this occurred when a child asked Alice when they were going outside, and she replied that they would go out “when the big hand on the clock is on 6” and the children then informed her where “the big hand was” every five minutes (5LDC Field Notes, 2012).

7.2.1 Setting Up the 5LDC Environment

The set-up of the 5LDC kindergarten room was an ongoing task. Some table activities were set up by the educators at the end of the previous day for the children who moved into the room from family grouping with a floating staff member. Then when Nikki or Alice arrived, they would set up further activities according to the program plan. Throughout the day, the children had the option to request individual games or activities that were not already available. Providing the children with free-play activities was an important part of Nikki's pedagogical practice. "We have activities set up for the children every day, we have a wide range of activities for the children to choose from, to pick and choose as they please. Umm to support obviously science, maths, literacy [pause] All those learning areas" (Nikki - Interview with 5LDC Educator).

There were usually four tables set up with activities each day; one example of these was the *Geo Blocks: 5LDC-0038* , shown in Example 7.1. This table was set up for small group play, and the three cards and three chairs provided an example for the children of one-to-one correspondence. While no children were observed using this equipment, the potential was there to sort and classify the geometric shapes and to build navigational skills as they rotated pieces to create or extend the patterns. Additionally, they may gain an awareness of measurement concepts such as area, length, number, and size, as well as fractions, one-to-one correspondence, and classification. Nikki placed this image in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Area, Length, Quantity, Size
Number:	Fraction, One-To-One
Process:	Classification, Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Small Group, Table Play
Pedagogy:	Educator Initiated
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Art, Mathematics

Example 7.1 *Geo Blocks: 5LDC-0038*

A second example of how Nikki set up the room, *Face Sorting Set-Up: 5LDC-0170* , shown in Example 7.2, provided children with opportunities to match faces from the basket with the faces on their boards, providing practice in one-to-one correspondence and comparison skills. Additionally, the children were able to discuss the facial expressions and classify them by emotions. Nikki mentioned this in the PEI, “Just the fact that they’re classifying different kinds of emotions [pause]. We could put the faces in a particular kind of order, [pause] we could put all the boys [pause] first, and the girls” (Nikki - Interview with 5LDC Educator).

Category	Codes
Measurement:	--
Number:	One-To-One
Process:	Classification, Comparison
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Small Group, Table Play
Pedagogy:	Educator Initiated
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

Example 7.2 *Face Sorting Set-Up: 5LDC-0170*

The set-up of the outdoor yard was shared by all rooms in the centre, with each educator able to set up additional equipment suitable for their group of children. Generally, the educators scheduled time outside in their individual groups, however, at times, there were multiple groups outside playing together. There were also permanent features of the yard such as the sandpit, cubbyhouse, swings, and paths. Further details regarding the activities in the playground can be found in Section 7.2.6 (p. 261).

7.2.2 Arrival at the 5LDC

As previously mentioned, the children in the 5LDC arrived at a time that suited their families, rather than the specific times seen in sessional kindergartens and formal schooling. Depending on the time of each child's arrival at the centre, the children would start the day with the younger children for family grouping or go straight into the Kinder Room.

The routine on arrival included putting their hat and backpack on the hook that had their name and their allocated picture. Children's jackets were hung on another rack, and their drink bottles were placed on a tray in the room. If the child had brought any toys from home, these needed to go into the *Personal Tubs: 5LDC-0206* , shown in Example 7.3, until required for sleep time or show and tell. As with all early childhood centres in Australia, parents or guardians were required to sign their child in and, at this centre, Nikki had placed a sign-in sheet for the children to practise writing their own names. This activity was typically provided to promote literacy. However, the opportunity to gain an awareness of size was also promoted as the children learnt to write their names in the correct size for the lined paper provided. This routine, like many others, promoted an understanding of sequencing and classification concepts.

Category	Codes
Measurement:	--
Number:	One-To-One
Process:	Classification, Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Arrivals, Individual, Routines
Pedagogy:	Child Scaffolded, Educator Initiated
Environment:	Physical, Social
Development:	School Readiness
Curriculum:	Literacy

Example 7.3 *Personal Tubs: 5LDC-0206*

7.2.3 Group Times at the 5LDC

The timing for the morning group time in the 5LDC was different from the 3YOK and 4YOK, as the children did not all arrive at the same time. The group meeting therefore usually occurred at 9:00 a.m. when the majority of children had arrived and just before morning snack. The children at the 5LDC had many opportunities to engage in musical activities during these group times. The educators and children routinely sang and danced in episodes such as *Dancing at Group Time: 5LDC-0130* , shown in Example 7.4, where the children were getting ready to sing their Good Morning song. This regular part of the 5LDC routine involved forming a circle by holding hands, which provided practice in both navigational and geometric concepts. The musical aspect of dance activities also provided opportunities for the children to explore measurement concepts relating to speed and sound. Nikki said “Good Morning” to each child and adult around the circle, and waited for their response, demonstrating one-to-one correspondence and sequencing. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Sound, Speed
Number:	One-To-One
Process:	Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Arrivals, Group Times, Routines
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Social Skills
Curriculum:	Music

Example 7.4 *Dancing at Group Time: 5LDC-0130*

Group times at the 5LDC were also an opportunity to read the children a story. *Story Time: 5LDC-0130* , shown in Example 7.5, was one of many stories captured during fieldwork. The book being read to the children in this episode was a non-fiction book about recycling, and included examples of classifying the garbage by the material it was made of, as well as measurement concepts such as volume, mass, size, and number. As mentioned previously in the 3YOK and 4YOK vignettes, reading stories also provides an awareness of sequencing as stories have a start, a middle, and an end. Nikki placed this image in the *No Mathematics* pile.

Category	Codes
Measurement:	Mass, Quantity, Size, Volume
Number:	--
Process:	Classification, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Group Times
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Literacy, Science

Example 7.5 *Story Time: 5LDC-0130*

Following this story, Nikki spoke to the children about recycling in *Exploring Recyclables: 5LDC-0130* , shown in Example 7.6. After asking the children to choose a box, Nikki asked, “Who has a big box and who has a small one?” providing the children with an opportunity to compare and classify their boxes by size. However, Nikki mentioned during the PEI, that there were many mathematical opportunities she had not explored in this episode. “You know we could have compared sizes of the boxes [pause]. We could have measured, we could have filled the boxes up with things [pause] umm, we could have weighed the boxes, there are lots that we could have done, but I think again, I would have asked the children what they would like to do with the boxes”. These other activities would have provided learning opportunities in measurement of volume and mass, geometric, and navigational awareness, and further opportunities to classify the boxes using other criteria. Nikki placed this image in the *No Mathematics* pile.

Category	Codes
Measurement:	Mass, Size, Volume
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Group Times
Pedagogy:	Educator Initiated
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Science

Example 7.6 *Exploring Recyclables: 5LDC-0130*

Another regular feature of the morning meeting was a discussion using the *Days of the Week Poster: 5LDC-0219* , shown in Example 7.7. This notice board also included a place for the *Letter* and *Number of the Week*. During this discussion each day, Nikki would ask the children “What day is it today?”, “What day was yesterday?”, and “What day will tomorrow be?” providing practice for the children’s sequencing skills. They would then reinforce the order of the days by singing the *Days of the Week* song. Nikki placed this image in the *Not So Obvious Mathematics* pile.

Category	Codes
Measurement:	Time
Number:	Order, Ordinal
Process:	Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Times
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	Cognitive, School Readiness
Curriculum:	Literacy

Example 7.7 *Days of the Week Poster: 5LDC-0219*

The 5LDC had a stuffed dog named Ralph that went home with a child for a few days as a way of connecting with families. The families were encouraged to take photos and write about Ralph's visit in a visual diary. During *Show and Tell: 5LDC-0011* , shown in Example 7.8, Nikki was sharing the visual diary that Oran had returned with photos of his weekend with Ralph. This interaction allowed children the opportunity to explore sequencing and time by discussing what Ralph had done at Oran's house and when; using terminology, such as *in the morning, after lunch,* and *at bed time*, when mentioning times of day. The ongoing nature of this visual diary also promoted discussion as they compared these activities with the dog's previous trips home with other children. Nikki placed this image in the *Not So Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Time
Number:	--
Process:	Comparison
Spatial:	Navigation
Mode of Use:	Language
Situation:	Group Times, Individual
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Cognitive, School Readiness, Social Skills
Curriculum:	Literacy

Example 7.8 *Show and Tell: 5LDC-0011*

7.2.4 Meals in the 5LDC

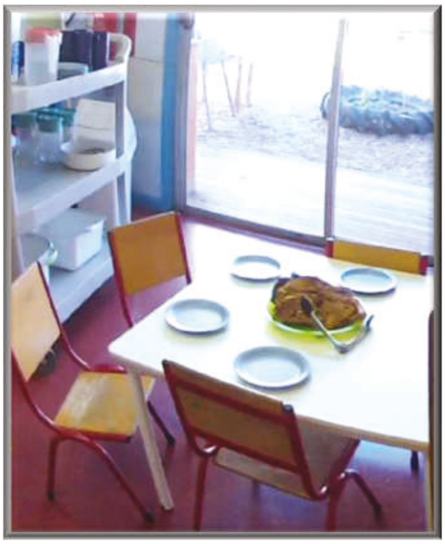
Unlike the 3YOK and the 4YOK centres, the meals in the 5LDC were fully catered by the centre and the children were provided with breakfast, morning tea, lunch, and afternoon tea as required. Prior to most meal times, the educators would gather the children together for a short group time, and the children would move to the tables after washing their hands in the bathroom. This routine was another example of a sequencing activity in which the children engaged, and the educators would often encourage the children to repeat the sequence they needed to follow: "Wash your hands, dry your hands, and find a seat at the table" (5LDC Field Notes, 2012).

Morning tea was regularly served at the tables in the 5LDC. However, at times the educators would choose to take the children outside for a picnic on rugs in the playground, as they did in *Outside Snack Time: 5LDC-0021* , shown in Example 7.9. The children ate in small groups of four to six, and were provided with a variety of fruit slices served on shared plates. For this special morning tea, the educators chose not to supply tongs and individual plates, but instructed the children to take only one piece at a time and to make sure they shared with their friends. Nikki was heard using terminology such as *half* and *full* to describe the plates of fruit. This provided the children with the opportunity to gain an awareness of one-to-one correspondence, quantity, fractions, and comparisons.

Category	Codes
Measurement:	Quantity, Size, Volume
Number:	Fraction, One-To-One
Process:	Classification, Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating, Outside, Routines, Small Group
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Social
Development:	Social Skills
Curriculum:	--

Example 7.9 *Outside Snack Time: 5LDC-0021*

In *Lunch Helpers: 5LDC-0000* , shown in Example 7.10, Nikki assigned the helper role to two or three children each day, to help with the set-up of lunch. This role came with a special apron, and involved wiping down and setting the tables. As the children wiped over the whole table surface, they were gaining a physical awareness of the area of the table top, and the educators were overheard asking the children to make sure they wiped the whole table "right to the edges and all across the middle" providing terminology for spatial skills in both navigation and geometry. Additionally, the children were exploring counting, one-to-one correspondence, and quantity as they counted the number of chairs required, and placed one plate or bowl, one fork, one spoon, and one cup next to each chair, as well as exploring volume as they filled the water jugs for each table.



Category	Codes
Measurement:	Area, Quantity, Volume
Number:	Counting, One-To-One, Subitize
Process:	Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Eating
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Fine Motor, Social Skills
Curriculum:	--

Example 7.10 *Lunch Helpers: 5LDC-0000*

The lunch supplied by the 5LDC changed daily to provide a variety of healthy meals over the week. Supplying these new foods provided Alice, the assistant educator, an opportunity to explore classification in *Pasta for Lunch: 5LDC-0096* , shown in Example 7.11. She asked the children if they thought the different coloured pasta pieces tasted different, like she did. Jackson agreed with Alice, and commented to his friend, Keith, "The green bits taste different, don't they?" Nikki placed this image in the *Not So Obvious Mathematics* pile during the PEI, but after further consideration also mentioned that during lunch "we can do size [pause] volume [pause] Umm [pause] and fractions".

Category	Codes
Measurement:	Mass, Volume
Number:	Fraction
Process:	Classification, Comparison, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating, Routines, Small Group, Table Play
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Fine Motor, Social Skills
Curriculum:	--

Example 7.11 *Pasta for Lunch: 5LDC-0096*

In a separate lunch episode, *Soup for Lunch: 5LDC-0017* , shown in Example 7.12, the children were having an active discussion as they ate their soup. Matea and Rachelle used descriptive language and quantitative gestures to describe the amount of food they had eaten to their friend Abigail. At the end of lunch and other meals, there was a routine in place to help with the clean-up, which was included in this episode. When the children had finished eating all, or most, of their main meal, they scraped the scraps into the compost bin, placed their bowl or plate in the white tub, shown in the top right of the image, and added their cutlery to the bowl of water to soak. They repeated this sequence after their dessert, and then washed their hands before returning to play or getting ready for rest. This routine also included classification, as the children needed to sort the scraps, bowls, and cutlery into three groups.

Example 7.12 *Soup for Lunch: 5LDC-0017*

Category	Codes
Measurement:	Mass, Volume
Number:	Fraction
Process:	Classification, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Eating, Small Group, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Social Skills
Curriculum:	--

7.2.5 Inside Free-Play Activities at the 5LDC

Music and dancing also occurred during free-play activities such as *Show Me Your Dance Moves: 5LDC-0090* , shown in Example 7.13. This episode included similar mathematics to *Dancing at Group Time: 5LDC-0130* (p. 238). In this episode, the children were forming small groups of two or three and dancing around in circles and additionally, through the educator's modelling of the dance movements, the children were also gaining experience with one-to-one correspondence, patterns, and sequencing. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Sound, Speed
Number:	One-To-One
Process:	Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Group Times
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Gross Motor, Social Skills
Curriculum:	Music

Example 7.13 *Show Me Your Dance Moves: 5LDC-0090*

Matea, the young girl in white in *Einee Meenee Minee Moe: 5LDC-0020* , shown in Example 7.14, had just asked her friends a question about the dramatic play in which they were engaging. In response, they all raised their hands so, after reciting the children's counting rhyme, *Einee Meenee Minee Moe*, Matea chose Rachelle to be the *mother* in their game. Counting games such as this provide opportunities for children to engage in counting, one-to-one correspondence, and pattern making as they pointed from one child to the next with each word.

Category	Codes
Measurement:	Length
Number:	Counting, One-To-One
Process:	Classification, Pattern, Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Routine, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Social Skills
Curriculum:	Drama

Example 7.14 *Einee Meenee Minee Moe: 5LDC-0020*

Matea also asked her friends “Who is going to be the ‘baby’?” Once the role of baby was assigned to Raeanna, she was required by the rules of the game to only act like a baby does. This involved being fed by the *mother* and only saying “goo, goo, ga, ga”. This dramatic play provided the children with an opportunity to explore the criteria of each role. There was great debate at one point during the play, when Rachelle, playing the role of *mother*, decided she wanted to lie down in the *baby’s* bed. The other two children were quick to tell her that *mothers* do not have a day time sleep, demonstrating their ability to understand these rules of classification.

Similarly, Madison and Amanda were using the play dough to cook cookies in *Play Dough Table: 5LDC-0124* , shown in Example 7.15. As mentioned for *Play Dough Table: 3YOK-0096* (p. 109) this material provides children with opportunities to explore measurement, fractions, comparisons, shapes, counting, and one-to-one correspondence.

Category	Codes
Measurement:	Length, Mass, Quantity, Size, Time, Temperature, Volume
Number:	Counting, Fraction, One-To-One
Process:	Comparison
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Small Group, Table
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Fine Motor
Curriculum:	Drama

Example 7.15 *Play Dough Table: 5LDC-0124*

In *Geometric Magnets: 5LDC-0167* , shown in Example 7.16, Bernard was also exploring the magnetic shapes. His exploration included picking up pieces and rotating them around in his hands; he inserted a small silver insert into the centre of a square, removed it, and reinserted it. Playing with the shapes this way provided geometric and navigational practice, as well as one-to-one correspondence and measurement of size and area. He then searched through the basket for another square and attempted to fit another insert in the centre. Bernard was engaging in individual play, however he was also watching the two young girls who also came to play with the shapes, and appeared to be learning from their play. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Length, Size
Number:	One-To-One
Process:	Classification, Comparison, Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Individual, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Art, Mathematics

Example 7.16 *Geometric Magnets: 5LDC-0167*

In a similar episode, *Madison and Ian and Magnet Shapes: 5LDC-0001* , shown in Example 7.17, the siblings Madison and Ian, were playing with the magnetic shapes and forming two- and three-dimensional objects. This episode included many of the same mathematical opportunities as *Geometric Magnets: 5LDC-0167* . Nikki also placed this image in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Area, Length, Size
Number:	One-To-One
Process:	Classification, Comparison, Pattern, Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Small Group, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Cognitive, Fine Motor
Curriculum:	Art, Mathematics

Example 7.17 *Madison and Ian and Magnet Shapes: 5LDC-0001*

Thanks to a family's donation, this centre had some large calculators for the children to play with. During this first episode, *Calculator Play: 5LDC-0002* , shown in Example 7.18, Oran was engaging in symbolic play using sequencing and one-to-one correspondence as he said and pressed each number in order, then checked the numbers on the display. The field notes show that Oran returned to the calculators numerous times while they were available. During one of these nonvideoed episodes, he also did a simple calculation of "1 + 1 = 2" and shared this with a peer (5LDC Field Notes, 2012).

Category	Codes
Measurement:	--
Number:	One-To-One, Order, Ordinal
Process:	Calculation, Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Individual, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

Example 7.18 *Calculator Play: 5LDC-0002*

During the second episode with calculators, *Office Play: 5LDC-0004* , shown in Example 7.19, Amanda and Alicia were transferring the numerals from the calculator display into a notebook and developing their one-to-one correspondence and symbolic mathematical understanding. Amanda was telling Alicia which numerals to write, then returning to type in more numbers and then tell her another numeral to write.

Category	Codes
Measurement:	--
Number:	Counting, Number Names, One-To-One, Order
Process:	Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	Drama, Mathematics

Example 7.19 *Office Play: 5LDC-0004*

The third episode, *Reading Numerals: 5LDC-0126* , shown in Example 7.20, shows twin sisters, Michaela and Amberley, writing and reading the numerals in the notebook. Amberley asked if I could film her reading the numbers she had written. She used one-to-one correspondence to point to each numeral she had written, some of which were mirror-reversed, and then demonstrated her symbolic knowledge as she read each numeral. After she read “7” she paused as she realised she had not written “8”, showing her growing understanding of the order of the numbers. *Reading Numerals: 5LDC-0126* was placed in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	--
Number:	Counting, One-To-One, Order
Process:	Sequence
Spatial:	--
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive
Curriculum:	Mathematics

Example 7.20 *Reading Numerals: 5LDC-0126*

In *Puzzles: 5LDC-0128* , shown in Example 7.21, Raeanna and Rachelle were working together on a multi-layer jigsaw puzzle. It appeared that this was a puzzle Raeanna had completed many times before as she placed the lowest centre piece correctly and quickly placed the second layer centre piece on top. Raeanna was explaining to Rachelle how to find the correct pieces for the lowest level by looking for those that had a “1” written on the back, this interaction provided practice in reading symbols, and comparing and classifying to find the pieces for each level. Completing the edge of a puzzle before attempting the centre, also provided the children with an awareness of area and navigation as they constructed the perimeter of the puzzle. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area
Number:	Number Names
Process:	Classification, Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Small Group, Table Play
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Fine Motor
Curriculum:	

Example 7.21 *Puzzles: 5LDC-0128*

Madison and Amanda were working side by side at the table in *Colouring with Pencils: 5LDC-0162* , shown in Example 7.22. Madison was drawing a picture of a helicopter, and at one point stated, “I used the yellow for my middle”. This interaction included classification, as she recognised that there were different areas within her drawing and was able to sort them by the criteria of colour. Her use of the word *middle* also shows a beginning awareness of measurement and fractions. Madison was also drawing outlines of each section and then colouring them in, potentially building an awareness of the object’s perimeter and area.

Category	Codes
Measurement:	Area, Length
Number:	Fraction
Process:	Classification
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Individual, Table Play
Pedagogy:	Child Initiated
Environment:	--
Development:	Fine Motor
Curriculum:	Art

Example 7.22 *Colouring with Pencils: 5LDC-0162*

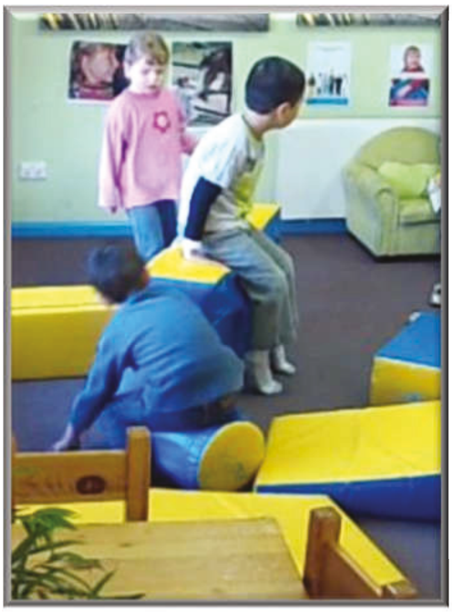
Alice, the assistant, was asked by Amanda and Madison for some paper for drawing in *What Size Paper?: 5LDC-0156* , shown in Example 7.23. She engaged in a short discussion with the children about the size of the paper they required. By explaining to the children that others may require larger or smaller sheets of paper, she was encouraging them to use classification to determine the criteria for the paper they required. Starting with a sheet of A3 paper, she offered the children the whole sheet, then folded it in half and offered that size, providing them with an awareness of fractions and measurement concepts. Nikki placed this interaction in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Size
Number:	Fraction
Process:	Classification, Problem Solving
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Small Group
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	--
Development:	Cognitive
Curriculum:	Art

Example 7.23 *What Size Paper?: 5LDC-0156*

The 5LDC provided blocks in a variety of sizes and shapes. Some provided completely open-ended play, and other blocks included instructions that could increase the learning potential of various mathematical concepts. The following eight episodes will explore some of the block play episodes that occurred during the fieldwork.

Keith was playing in *Large Soft Blocks: 5LDC-0003* , shown in Example 7.24. He stood the blocks on their side and lay on them. Indianna and Jackson joined him and he explained the rules about no shoes on the blocks, showing an awareness of the criteria for the rules in this situation. They tried various shaped blocks in various positions and, during this play, they were exploring comparisons, measurement concepts such as size, number, and area, as well as geometric and navigational awareness.



Category	Codes
Measurement:	Area, Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Gross Motor
Curriculum:	Drama

Example 7.24 *Large Soft Blocks: 5LDC-0003*

These large blocks were also used in *Building the Pirate Ship: 5LDC-0084* , shown in Example 7.25, where Paul was building with Indianna and Melissa, and insisting "I will be the Captain, 'cause I'm the oldest". Indianna challenged this stating, "I'm the oldest too!" and when he asked her how old she was, she held up four fingers, and he replied, "I'm already 5!" holding up his five fingers. This short interaction provided an opportunity for these children to explore amounts using both language and symbolic gestures, as well as classification by stating the criteria for who would be Captain. Nikki placed *Building the Pirate Ship: 5LDC-0084* in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Quantity, Size
Number:	--
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Gross Motor
Curriculum:	Drama

Example 7.25 *Building the Pirate Ship: 5LDC-0084*

Similarly, Amberley was pushing a train to the top of the triangular block and allowing it to roll to the bottom, exploring measurement concepts such as length and speed, and spatial concepts relating to geometry and navigation in *Train on a Slope: 5LDC-0154* , shown in Example 7.26. Nikki placed this image in the *Not So Obvious Mathematics* pile during the interview, later returning to this image to identify “Well there's measurement length, and geometric, and navigation, and ordinal, and patterns”.

Category	Codes
Measurement:	Length, Speed
Number:	Ordinal
Process:	Pattern
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Individual
Pedagogy:	Child Initiated
Environment:	--
Development:	Fine Motor
Curriculum:	Drama

Example 7.26 *Train on a Slope: 5LDC-0154*

Alicia used one of the large, soft triangular blocks as a base in *Somersault Time: 5LDC-0155* , shown in Example 7.27. Using the sloped block like this allowed her to gain an awareness of the height of the block, and she was being careful to stay on the block, expanding her navigation skills. Nikki placed this image in the *Obvious Mathematics* pile, also noting that it built navigation skills.

Category	Codes
Measurement:	Length
Number:	--
Process:	--
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Individual
Pedagogy:	Child Initiated
Environment:	--
Development:	Gross Motor
Curriculum:	Sport

Example 7.27 *Somersault Time: 5LDC-0155*

Blocks were available as part of table play as well. Working side-by-side in *Blocks on a Stick: 5LDC-0163* , shown in Example 7.28, were twins, Amberley and Michaela. Amberley, on the left, was following the suggested sequence displayed on the supplied cards, and building her geometric and pattern skills as she compared the blocks with the card and used criteria such as shape, size, or colour to choose the correct block. Her sister, Michaela, was exploring the blocks also. However, she did not follow the suggested card. This image was placed in the *Obvious Mathematics* pile by Nikki during the PEI.

Category	Codes
Measurement:	Size
Number:	One-To-One
Process:	Classification, Pattern, Sequence
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Symbolic
Situation:	Individual, Table Play
Pedagogy:	Child Initiated
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

Example 7.28 *Blocks on a Stick: 5LDC-0163*

Small blocks were also used in *Small Magnetic Block Play: 5LDC-0012* , shown in Example 7.29, where Indianna and Ian were exploring the magnetic blocks. With the inclusion of magnets, these blocks were able to be formed into a car and a helicopter by the children. As they played with this equipment, they required an awareness of mass to determine the number of blocks that would be held together by the magnets before falling off. Indianna was also lining the cube blocks into two long lines, an example of both one-to-one correspondence, and spatial navigation and geometric concepts. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Area, Length, Mass, Quantity
Number:	One-To-One
Process:	Classification, Pattern, Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Cognitive, Fine Motor
Curriculum:	Mathematics

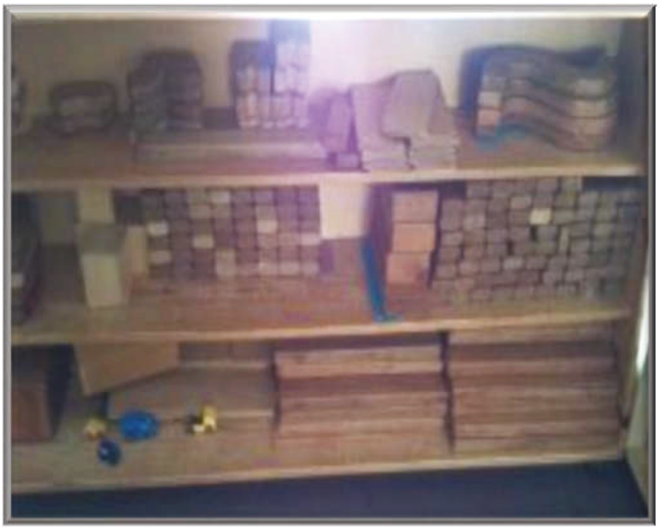
Example 7.29 *Small Magnetic Block Play: 5LDC-0012*

Similarly, medium sized blocks were also used in *Building with Blocks: 5LDC-0005* , shown in Example 7.30. Oran and Indianna worked together to build a structure with the blocks. They placed long thin blocks around the perimeter of the larger blocks, rotating some sideways as they attempted to complete the square. Indianna suggested they needed a roof and chose the thin blocks to use for it. This interaction provided opportunities to explore area and size, and to use problem solving, classification, and navigation skills as they selected and placed the blocks.

Category	Codes
Measurement:	Area, Length, Size
Number:	One-To-One
Process:	Calculation, Classification, Pattern, Problem Solving
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Language
Situation:	Floor Games, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Social
Development:	Fine Motor
Curriculum:	--

Example 7.30 *Building with Blocks: 5LDC-0005*

These medium-sized blocks were stored on the *Block Shelves: 5LDC-0185* , shown in Example 7.31, and provided the children with an opportunity to explore symbolic and geometric concepts as they matched the blocks with the blue shape outlines on the shelf. Nikki placed this image in the *Obvious Mathematics* pile during the PEI, stating “because (we) are looking at different shapes, sizes, weight”, adding mass to the concepts already identified in the analysis.



Category	Codes
Measurement:	Length, Mass, Size
Number:	One-To-One
Process:	Classification, Comparison
Spatial:	Geometric, Navigation
Mode of Use:	Concrete, Symbolic
Situation:	Floor Games, Individual, Routines, Small Group
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	--
Curriculum:	--

Example 7.31 *Block Shelves: 5LDC-0185*

7.2.6 Outside Free-Play Activities at the 5LDC

Block play was not confined to indoors at the 5LDC. There was an episode outside, *Sorting Blocks: 5LDC-0025* , shown in Example 7.32, where an assistant educator, Terri, was able to provide the children with an opportunity to use their classification skills to sort the blocks that had been left out overnight. She encouraged them to compare the size of the blocks, and to count them using one-to-one correspondence to work out the number of blocks that were joined together. In addition to these concepts she also led the children in a discussion about when it had been raining, providing them an opportunity to explore time measurement. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Length, Quantity, Size, Time
Number:	Counting, One-To-One
Process:	Classification, Comparison
Spatial:	Geometric
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded, Educator Scaffolded
Environment:	--
Development:	Cognitive, Gross Motor
Curriculum:	--

Example 7.32 *Sorting Blocks: 5LDC-0025*

The playground at the 5LDC had enough space for the children to engage in a variety of activities aimed at developing gross motor and sporting skills. Nikki enjoyed getting out and playing with the children in activities such as *Ball Skills: 5LDC-0137* , shown in Example 7.33, where she was teaching Alicia how to kick a football. As Nikki explained how hard and far to kick the ball and in which direction Alicia should aim, this short game provided Alicia with an opportunity to build concepts such as navigation, and measurement of length, and speed. Additionally, there was sequencing as they took turns kicking the ball. Nikki placed this image in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Area, Length, Speed
Number:	--
Process:	Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 7.33 *Ball Skills: 5LDC-0137*

The children also played outside in *Skipping Rope: 5LDC-0141* , shown in Example 7.34. This game included experiencing measurement concepts relating to length and speed, spatial concept of navigation, and practice in one-to-one correspondence as they jumped for each swing of the rope. The children waiting for their turn also gained experience in sequencing. After the children had been spinning the rope for each other, the educators came and scaffolded the play by spinning the rope and helping the children with the timing of when to enter and jump. Nikki placed this image in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Length, Speed, Time
Number:	One-To-One
Process:	Sequence
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded, Educator Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 7.34 *Skipping Rope: 5LDC-0141*

The sandpit adjacent to where the children were skipping was where the children collected the *ingredients* for their cooking, and was a busy feature of the 5LDC yard. Aside from the cooking experiences, in every session children were engaged in digging, making sandcastles, and jumping into the sand. For example, Abigail was playing beside Kelsie and Oran in *Burying the Dinosaur: 5LDC-0131* , shown in Example 7.35. During this short episode, Abigail needed to be able to dig a hole large enough to completely cover the dinosaur, giving her practice in visualising the length and depth required for the dinosaur she was burying. Nikki first placed this image in the *Not So Obvious Mathematics* pile and then moved it to the *Obvious Mathematics* pile after reading the title.

Category	Codes
Measurement:	Length, Size
Number:	--
Process:	Problem Solving
Spatial:	--
Mode of Use:	Concrete
Situation:	Individual, Outside
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	--

Example 7.35 *Burying the Dinosaur: 5LDC-0131*

Several children at the 5LDC had decided to do some cooking and moved some of the cooking equipment into the cubby house for *Cooking in the Cubby House: 5LDC-0133* , shown in Example 7.36. This pretend cooking experience shared the inherent mathematical concepts found with other cooking experiences such as counting, measurement, fractions, and sequencing. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Mass, Quantity, Size, Time, Temperature, Volume
Number:	Counting, Fraction
Process:	Classification, Sequence
Spatial:	--
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Fine Motor
Curriculum:	Drama, Science

Example 7.36 *Cooking in the Cubby House: 5LDC-0133*

Active, imaginative play was evident as Keith and Reyne were climbing on the A-frames with the dinosaur toys, in *Climbing Dinosaurs: 5LDC-0030* , shown in Example 7.37. This play provided the opportunity for the boys to explore length and navigation as they climbed over, under and through the A-frame and repeated their actions with the dinosaurs. Their conversation included terminology such as *upside down* and *on top*.

Category	Codes
Measurement:	Length, Size
Number:	--
Process:	--
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical
Development:	Gross Motor
Curriculum:	Drama

Example 7.37 *Climbing Dinosaurs: 5LDC-0030*

Nikki had attached a tape measure to the verandah post in *Measuring Heights: 5LDC-0140* , shown in Example 7.38. Keith and Kelsie were comparing their heights by standing next to the tape measure and reading out the number that was closest to their height. Unfortunately, the tape measure had been attached to the pole with the “0” at the top. This confused the children as they could not understand why Kelsie had a larger number then Keith, even though he was obviously taller.

They asked Alice if she could explain this and she helped them turn the tape measure around. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Length, Size
Number:	Counting, One-To-One
Process:	Comparison, Problem Solving
Spatial:	Navigation
Mode of Use:	Concrete, Language, Symbolic
Situation:	Outside, Small Group
Pedagogy:	Child Scaffolded, Educator Initiated, Educator Scaffolded
Environment:	Physical
Development:	Cognitive
Curriculum:	Mathematics

Example 7.38 *Measuring Heights: 5LDC-0140*

During *On the Swings: 5LDC-0132* , shown in Example 7.39, Amberley and Michaela were enjoying the swings. They were playing beside each other and taking turns on the swing and the monkey bar. Amberley was not tall enough to reach the monkey bar so she brought a block over to stand on. At one point in their play, Michaela asks Amberley to push her on the swing, providing an opportunity to also explore pressure and speed. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Length, Speed
Number:	
Process:	Comparison
Spatial:	Navigation
Mode of Use:	Concrete
Situation:	Outside, Small Group
Pedagogy:	Child Initiated
Environment:	Physical
Development:	Gross Motor
Curriculum:	Sport

Example 7.39 *On the Swings: 5LDC-0132*

The outdoor yard also contained a large climbing structure with two tunnels, a slide, telescope, steps, and a wobbly bridge. Outdoor play at the 5LDC was rarely organised as whole group activities. However, at times, the children themselves would decide they all wanted to play the same game or activity. This is what occurred in *Down the Slide: 5LDC-0153* , shown in Example 7.40 when the educators made the decision to allow the children to go down the slide head first rather than feet first as was the usual rule. This interaction provided the children with opportunities to build their navigational awareness, and helped build an awareness of distance and speed. Additionally, taking turns helped build sequencing skills and counting as the children noted where they were in the line, and counted who was in front of them. Nikki placed this image in the *Obvious Mathematics* pile.

Category	Codes
Measurement:	Length, Speed
Number:	Counting, Order, Ordinal
Process:	--
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Educator Scaffolded
Environment:	Physical, Social
Development:	Gross Motor
Curriculum:	Sport

Example 7.40 *Down the Slide: 5LDC-0153*

7.2.7 Special Projects at the 5LDC

Whilst I was observing the children at this centre, the Olympic Games were being held and the children were incorporating this into their play. During *Long Jump: 5LDC-0134* , shown in Example 7.41, the children decided to see how far they were able to jump into the sandpit, using their developing skills in measuring lengths. Through their discussions, they were also comparing the distances each child was able to jump. Nikki placed this image in the *Obvious Mathematics* pile during the PEI.

Category	Codes
Measurement:	Area, Length
Number:	--
Process:	Comparison
Spatial:	Navigation
Mode of Use:	Concrete, Language
Situation:	Outside, Small Group
Pedagogy:	Child Initiated, Child Scaffolded
Environment:	Physical, Social
Development:	Cognitive, Gross Motor
Curriculum:	Sport

Example 7.41 *Long Jump: 5LDC-0134*

The Olympic Games were also the prompt for a whole group cooking activity. The children were cooking with the educators in the episode labelled *Olympic Rings Cooking: 5LDC-0115* , shown in Example 7.42. They were making the Olympic Rings with salt dough. The pretend cooking experiences mentioned previously (see *Cooking in the Sandpit: 3YOK-0040* , p. 120; *Cooking in the Cubby House: 5LDC-0133* , p. 265) share the inherent mathematical concepts found with other cooking experiences, such as opportunities to explore as mass, amount, volume, sequencing, fractions, classification and calculations. In addition to these mathematical concepts, the educators in this episode provided a pictorial recipe, which presented a real-world example of symbolic mathematics, and required an understanding of sequencing and ordinal number concepts.

As a whole group experience, the educators measured out the ingredients and the children were required to take turns mixing the salt dough, providing additional opportunities for the educator to model ordinal and sequential terminology, and discuss the speed the children needed to mix the dough, as well as the time and temperature at which it would be cooked. Nikki sorted this image into *Obvious*

Mathematics pile in the PEI. However, she mentioned that, looking back, she was quite embarrassed at how this interaction was undertaken as a whole group. When she cooks with the children now, she ensures “they will measure everything themselves using various [pause] you know, measuring cups, if they want to use a bucket they'll use a bucket. We use a lot of different [pause] tools”.

Category	Codes
Measurement:	Mass, Quantity, Size, Speed, Time, Temperature, Volume
Number:	Counting, Fraction, One-To-One, Ordinal
Process:	Calculation, Classification, Sequence
Spatial:	Geometric
Mode of Use:	Concrete, Language, Symbolic
Situation:	Group Time, Table Play
Pedagogy:	Educator Initiated, Educator Scaffolded
Environment:	--
Development:	Cognitive, Fine Motor
Curriculum:	Science

Example 7.42 *Olympic Rings Cooking: 5LDC-0115*

7.2.8 End of the 5LDC Session

As the children in the 5LDC left at varying times during the afternoon, there was no whole group time as there was in the 3YOK and 4YOK settings. However, the children who were last to leave were encouraged to help with packing up the room before moving back into family grouping.

Packing up the room involved returning toys and equipment to the places they belonged, requiring skills in classification to sort the items and navigation to find their correct place. This was especially apparent in the block area where the educators encouraged the children to sort the blocks before placing them on the block shelf, and they provided symbolic outlines to assist them with this, as shown previously in *Block Shelves: 5LDC-0185* (p. 261).

7.3 Summary of the 5LDC Episodes

Each of the vignettes discussed in this chapter, together with their codes, are shown in Table 7.2. Following this, in Section 7.4, the details from the PEI with Nikki are presented. Details on the themes that emerged from these episodes, and those in the following two case study chapters, will be explored in Chapter 8.

Table 7.2
The 5LDC Episodes and Their Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Ball Skills: 5LDC-0137	(p. 263)	X	X					X																X		X	X	X							X		X		X			X	X				X									X
Block Shelves: 5LDC-0185	(p. 261)		X	X		X								X						X	X				X	X	X		X			X		X		X	X		X	X	X	X														
Blocks on a Stick: 5LDC-0163	(p. 258)					X								X						X		X		X	X	X	X		X					X				X	X						X	X							X			
Building the Pirate Ship: 5LDC-0084	(p. 256)				X	X														X	X				X	X	X	X	X			X					X		X	X			X	X	X		X				X					
Building with Blocks: 5LDC-0005	(p. 269)	X	X			X								X					X	X		X	X		X	X	X	X				X					X		X	X				X		X										
Burying the Dinosaur: 5LDC-0131	(p. 265)		X			X																	X				X							X	X				X				X				X									
Calculator Play: 5LDC-0002	(p. 250)													X	X	X			X					X			X	X	X					X				X	X	X				X	X	X							X			
Climbing Dinosaurs: 5LDC-0030	(p. 266)		X			X																				X	X	X							X		X		X	X			X				X				X					
Colouring with Pencils: 5LDC-0162	(p. 254)	X	X										X							X						X	X	X						X				X	X							X				X						
Coming to the Mat: 3YOK-0070	(p. 102)													X						X				X		X	X	X		X			X			X				X	X	X	X	X				X	X			X				
Cooking in the Cubby House: 5LDC-0133	(p. 265)			X	X	X			X	X	X	X	X							X				X			X	X							X		X		X	X			X	X		X					X				X	
Dancing at Group Time: 5LDC-0130	(p. 238)						X	X						X								X		X	X	X	X	X		X			X			X				X	X	X	X	X					X					X		
Days of the Week Poster: 5LDC-0219	(p. 240)									X					X	X								X			X	X	X				X								X	X		X	X			X				X				
Discussion on Bikes: 3YOK-0041	(p. 104)				X	X						X						X		X	X						X	X	X				X							X	X	X	X	X	X				X							
Down the Slide: 5LDC-0153	(p. 269)		X					X				X			X	X										X	X	X							X		X		X			X	X	X			X									X
Einee Meenee Minee Moe: 5LDC-0020	(p. 246)		X									X		X						X		X		X		X	X	X								X	X		X	X				X					X		X					
Exploring Recyclables: 5LDC-0130	(p. 240)			X		X					X									X	X				X		X	X					X								X		X	X	X										X	
Face Sorting Set-Up: 5LDC-0170	(p. 236)													X						X	X						X							X			X	X			X		X		X	X							X			
Geo Blocks: 5LDC-0038	(p. 235)	X	X		X	X							X	X						X		X			X	X	X							X			X	X			X		X		X	X				X			X			
Geometric Magnets: 5LDC-0167	(p. 248)	X	X			X								X						X	X	X			X	X	X							X				X	X	X			X		X	X				X			X			
Large Soft Blocks: 5LDC-0003	(p. 255)	X			X	X														X	X				X	X	X	X				X					X		X	X			X	X			X				X					
Long Jump: 5LDC-0134	(p. 270)	X	X																		X					X	X	X							X		X		X	X			X	X	X		X									X
Lunch Helpers: 5LDC-0000	(p. 243)	X			X						X	X		X				X					X		X	X	X	X			X										X	X	X	X		X			X							
Madison and Ian and Magnet Shapes: 5LDC-0001	(p. 249)	X	X			X								X						X	X	X	X		X	X	X	X									X	X	X	X			X		X	X				X			X			
Measuring Heights: 5LDC-0140	(p. 267)		X			X						X		X							X		X			X	X	X	X						X		X			X	X	X	X		X								X			
Office Play: 5LDC-0004	(p. 251)											X		X	X		X							X			X	X	X								X	X	X	X			X	X	X	X					X		X			

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Olympic Rings Cooking: 5LDC-0115	(p. 271)			X	X	X		X	X	X	X	X	X	X		X			X	X				X	X		X	X	X				X					X			X	X			X	X									X	
On the Swings: 5LDC-0132	(p. 268)		X					X													X					X	X								X		X		X				X				X									X
Outside Snack Time: 5LDC-0021	(p. 242)				X	X					X		X	X						X	X			X			X	X			X				X	X	X				X	X		X					X							
Pasta for Lunch: 5LDC-0096	(p. 244)			X							X		X							X	X			X			X	X			X					X	X	X		X	X	X	X	X		X			X							
Personal Tubs: 5LDC-0206	(p. 237)													X						X				X			X	X	X	X				X		X				X	X		X	X				X				X				
Play Dough Table: 5LDC-0124	(p. 247)		X	X	X	X			X	X	X	X	X	X							X				X		X	X									X	X	X	X			X			X					X					
Puzzles: 5LDC-0128	(p. 253)	X															X			X			X			X	X	X	X								X	X	X	X			X	X	X	X										
Reading Numerals: 5LDC-0126	(p. 252)											X		X	X									X			X	X	X								X	X	X	X			X	X	X								X			
Room Set-Up: 3YOK-0089	(p. 99)	X																		X						X	X	X	X			X		X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X			
Running on the Path: 3YOK-0033	(p. 101)		X					X													X					X	X	X						X	X		X		X	X			X				X									X
Show and Tell: 5LDC-0011	(p. 241)									X											X					X		X					X	X							X	X	X	X	X			X	X			X				
Show Me Your Dance Moves: 5LDC-0090	(p. 246)						X	X						X								X		X	X	X	X	X					X							X	X	X	X	X			X		X					X		
Skipping Rope: 5LDC-0141	(p. 264)		X					X		X				X										X		X	X	X							X		X		X	X		X	X				X									X
Small Magnetic Block Play: 5LDC-0012	(p. 259)	X	X	X	X									X						X		X	X		X	X	X					X					X		X	X				X	X	X							X			
Somersault Time: 5LDC-0155	(p. 257)		X																						X	X	X					X		X					X								X									X
Sorting Blocks: 5LDC-0025	(p. 262)		X		X	X				X		X		X						X	X				X		X	X							X		X		X	X		X			X		X									
Soup for Lunch: 5LDC-0017	(p. 245)			X							X		X							X				X			X	X			X						X	X	X	X			X	X					X							
Story Time: 5LDC-0130	(p. 239)			X	X	X					X									X				X			X	X					X								X	X	X	X	X							X			X	
Train on a Slope: 5LDC-0154	(p. 257)		X					X								X						X			X	X	X					X		X					X							X					X					
What Size Paper?: 5LDC-0156	(p. 254)	X				X							X							X			X		X		X	X									X		X			X			X					X						
Who is Here Today?: 3YOK-0041	(p. 103)											X		X				X	X	X			X				X	X	X				X							X	X	X	X	X				X	X							

7.4 Interview Data for the 5LDC

The PEI with Nikki was undertaken in October, 2013, and lasted approximately one hour and twenty minutes. This interview took place in a meeting room at Deakin University. The PEI followed the interview protocol (see Appendix D, p. 390) and Nikki's responses are presented in the following sections.

7.4.1 Nikki's Pedagogical Beliefs and Practices

Nikki's educational background, previously outlined in Section 7.1.1 (p. 230), showed she had a degree in Early Childhood Education and, at the time of the study, was enrolled in a Master of Education course. Nikki described her educational pedagogy as including her belief in a

> play-based curriculum, where children are able to, umm, express themselves and learn through play with the guidance and support from educators. I think, umm, I believe [pause] in connecting with families, and always having their involvement as well in the programs.

She continued on to explain that the centre followed a Reggio Emilia approach with activities set up daily that the children were encouraged to choose from. These activities were "to support obviously, science, maths, literacy. All those learning areas".

Before Nikki would intentionally teach mathematics or "even start thinking about school learning", she wanted "them to be confident". When asked about the specific mathematical skills she felt were important for this age group, she repeated the importance of confidence, stating

> I think obviously, as I said, it's confidence. And I think that they, I think many skills are important, and I think they are always

> acquiring those skills as they go along. … Things I see the children doing this age for example, are things like [pause]. They are constantly, you know, doing measurement, classification, umm.

Nikki admitted that, since being a participant in the study, her awareness of the mathematics the children were engaging in has changed dramatically.

> Everything that they do I find now is mathematical. I find everything that they do, there is maths somewhere. Whereas before, I didn't used to see that, I used, used to always see maths, and say “okay it's more of the flash card kind of thing, and we are doing numbers, and we doing counting, and we are [pause] doing adult directed[pause]”. Whereas now, umm, in the 18 months since you first came to us [pause], I think now I just see that maths everywhere. I think children are just constantly, engaged in maths. You know in nearly every conversation they have, I can now hear maths occurring.

Her response to whether mathematics should be included in early childhood was a strong “absolutely”; yet, the ability to identify the maths was the “really important part for early childhood educators. We need to be able to identify where the maths is occurring”.

She clarified these thought by stressing

> It’s how we include it, I don't think that it has to be specifically [pause] maths, well we have counting frame, and we have, you know, flash cards, or there are numbers on the wall, or things like that. It's how we are teaching the children maths, and how they are teaching each other as well.

Nikki placed the role of the educator as one of a “more a bystander, support, guide, and to role model mathematical language” and felt that it was important for the children to do the “thinking and learning” ensuring that they felt they were “in control of it, it’s their activity. It’s guided and directed by them, and I think educators, we are there to support them, to encourage them, and, you know, assist them with language”.

When asked about the specific mathematical concepts that she felt she would try to teach, Nikki thought it was “quite a broad range”; she felt that she now tried to “look at a whole lot of different areas” stressing the importance of observing the children’s play and working from that. However, she also felt there were times when “we want to give the children ideas as well, and just make things available”. Stressing again the importance of “small group play, one-on-one interaction, just children playing, I think is when, is really when they are learning best … That’s when I see the maths, and that’s when I hear the maths, and the interest”.

Nikki mentioned her confidence levels were a lot higher than before the study

> I wasn't really confident, I couldn't have even really told you what maths was. Obviously, you know, I'd read books and had posters and things that would tell me what maths is, but how to sort of, umm, teach that to the children or incorporated into the program that way, I had no idea. Whereas now, I'm a lot more confident.

At the time of the data collection, Nikki planned her program by observing the children’s interests, reflecting on these during her planning time, and building on these through the addition of new activities. As far as mathematics was concerned

> If I did see that their interests were in maths in some way, it might be that I could see they were interested in counting, or interested in, umm, you know, building blocks and measuring. Then I would provide activities like, it might be more counting beads or similar activities like that.

However, with the changes in Nikki's pedagogical practices in the time between data collection and the PEI, she felt that now she would build on to the existing activities whilst the child was still engaged in the activity.

> The way that I do it differently now is, that I've got their interests, and sort of learn it together and do it together as a group, it doesn't necessarily have to be a "sit down" activity … It's an activity that can be enjoyable, you know, a really positive experience that we can do it together. And they learn [from each] other, and the conversations I hear them having. When we plan for activities like this, it's fantastic. It's very spontaneous.

When scaffolding these activities, Nikki stressed the importance of using questions such as "What else could we do?" or "What other things could we measure?" as this ensured the children's "involvement in everything we do".

Nikki restated her goal of building confidence in the children and added that, for the later part of the year, she also included school readiness activities and interactions for those children who were interested. However, she felt her "planning is quite general, there is no particular way that I do things, it's just in a very [pause] child-initiated sort of way. Through lots of just conversations and interactions with the children".

When asked about specific goals, Nikki indicated that while she did not have written specific goals for the whole group, she did place importance on children being "confident. I want them to be engaged in experiences that they want to be involved in, I want them to be, you know, if we are having a group time, that all the children want to be involved".

Referring to the Australian Frameworks (DEEWR, 2009; DEECD, 2009) Nikki also felt it was important that educators "help [children] get their sense of identity".

Nikki worked in partnership with Alice, her assistant, for the program planning. They split the programming so that Nikki was primarily observing and planning for the older children, and Alice with the younger children. However, she was clear that there were a lot of discussions and they were “definitely working together as a team”.

Due to the nature of the long-day care environment, the kindergarten program itself only ran for around six hours a day. The additional four hours a day, plus the times that Nikki and Alice were on break, meant there were times when the room was run by floating staff members. Nikki admitted that at these times “things aren’t necessarily followed on the program”.

Moving on to questions about the mathematics the children may be experiencing within their family environment, Nikki hesitated; mentioning that it was something she would discuss with families during orientation, but could not recall any particular concepts for the group I had observed. However, she did note that her current group had more “older siblings … and I found that’s made a big difference” as they were bringing ideas into the room in reaction to their siblings homework; activities such as measuring and “writing in books, where they are doing numbers”.

Nikki was asked about the parental expectations for the mathematics. For the older children, Nikki mentioned parents had an expectation for “counting, it’s a really popular one that they want them to be able to count to 30 before they go to Prep … to be able to write them as well. And that’s also literacy”. Nikki mentioned parent’s also wanted the children “to be doing worksheets” which she felt was a direction that early childhood curriculum was moving away from. She dealt with these expectations by “generally try and talk about all the maths that is happening in the room”.

Nikki mentioned here that parents were

> often quite fascinated by the fact that their child has, you know,

> talked about the sides of the triangle or [pause] that there are three sides. And that is where the maths is, it's all beginning maths. And yeah, there isn't a need then to sit down and actually connect the dots if it's not their interest.

This information was also available to the parents in the program evaluations and through conversations but not "necessarily in newsletters".

7.4.2 Sorting the 5LDC Images

Following these background questions, Nikki was handed selected images (with the text written on the back) which were prepared for the interview as discussed in Section 4.3.3 (p. 70). I asked Nikki to sort the images into three piles: those that she could identify as containing (*Obvious Mathematics*), those that contained *Not So Obvious Mathematics* , and those in which she could see *No Mathematics* . Despite the nervousness of feeling "it's like a test", Nikki was able to easily identify the first image, *Block Shelves: 5LDC-0185* , as *Obvious Mathematics* , identifying "shapes, sizes, weight". Over the next seven minutes, Nikki sorted the images as shown in Table 7.3.

Table 7.3
Nikk's Sorting of the 5LDC Images

Image	Pile
Ball Skills: 5LDC-0137 (p. 263)	*Obvious Mathematics*
Block Shelves: 5LDC-0185 (p. 261)	*Obvious Mathematics*
Blocks on a Stick: 5LDC-0163 (p. 258)	*Obvious Mathematics*
Building the Pirate Ship: 5LDC-0084 (p. 256)	*Obvious Mathematics*
Burying the Dinosaur: 5LDC-0131 (p. 265)	*Obvious Mathematics*
Cooking in the Cubby House: 5LDC-0133 (p. 265)	*Obvious Mathematics*
Dancing at Group Time: 5LDC-0130 (p. 238)	*Obvious Mathematics*
Down the Slide: 5LDC-0153 (p. 269)	*Obvious Mathematics*
Geo Blocks: 5LDC-0038 (p. 235)	*Obvious Mathematics*
Madison and Ian and Magnet Shapes: 5LDC-0001 (p. 249)	*Obvious Mathematics*
Geometric Magnets: 5LDC-0167 (p. 248)	*Obvious Mathematics*
Long Jump: 5LDC-0134 (p. 270)	*Obvious Mathematics*
Measuring Heights: 5LDC-0140 (p. 267)	*Obvious Mathematics*

Olympic Rings Cooking: 5LDC-0115 (p. 271)	*Obvious Mathematics*
On the Swings: 5LDC-0132 (p. 268)	*Obvious Mathematics*
Play Dough Table: 5LDC-0124 (p. 247)	*Obvious Mathematics*
Puzzles: 5LDC-0128 (p. 253)	*Obvious Mathematics*
Reading Numerals: 5LDC-0126 (p. 252)	*Obvious Mathematics*
Show Me Your Dance Moves: 5LDC-0090 (p. 246)	*Obvious Mathematics*
Skipping Rope: 5LDC-0141 (p. 264)	*Obvious Mathematics*
Small Magnetic Block Play: 5LDC-0012 (p. 259)	*Obvious Mathematics*
Somersault Time: 5LDC-0155 (p. 257)	*Obvious Mathematics*
Sorting Blocks: 5LDC-0025 (p. 262)	*Obvious Mathematics*
What Size Paper?: 5LDC-0156 (p. 254)	*Obvious Mathematics*
Colouring with Pencils: 5LDC-0162 (p. 254)	*Not So Obvious Mathematics*
Days of the Week Poster: 5LDC-0219 (p. 240)	*Not So Obvious Mathematics*
Face Sorting Set-Up: 5LDC-0170 (p. 236)	*Not So Obvious Mathematics*
Pasta for Lunch: 5LDC-0096 (p. 244)	*Not So Obvious Mathematics*
Train on a Slope: 5LDC-0154 (p. 257)	*Not So Obvious Mathematics*
Exploring Recyclables: 5LDC-0130 (p. 240)	*No Mathematics*
Show and Tell: 5LDC-0011 (p. 241)	*No Mathematics*
Story Time: 5LDC-0130 (p. 239)	*No Mathematics*

As she sorted the photos, Nikki sorted some images into the piles confidently, while others took more consideration. For example, while Nikki placed *Olympic Rings Cooking: 5LDC-0115* into the *Obvious Mathematics* pile, she also stated how embarrassed she was looking back at “the maths I missed in this video that I can see now”.

She also admitted “even though I can see lots of maths happening at certain times and I put them down, it doesn’t necessarily mean that off the top of my head, I can think exactly what all the maths is. That is something I still struggle with”. She referred to a list given to her by a practicum student that highlighted mathematics in common preschool objects, stating “something like this has been really helpful”.

Following the sorting, I asked Nikki to choose an image from the *Obvious Mathematics* pile to discuss in greater detail and she chose *Dancing at Group Time: 5LDC-0130* . Nikki mentioned that from memory, the children were no longer engaged in the group time and she chose to turn on the music because “they were getting bored, and it all started to get a little bit noisy and silly, as you do when you are three to five".

Dancing was an activity Nikki often engaged in with the children, playing musical statues and "musical shapes, where the kids have to [pause]. We stop the music and they have to get into a shape". While Nikki could identify that the children were learning spatial awareness, she admitted that "back then I wasn't planning a maths activity, it was just [pause] dance, and not actually thinking about how much maths was included". She was "just trying to let them release some energy and have fun while they're doing it".

Nikki explained that the idea for Musical Shapes came from a child who said she could "make a triangle shape" and the educators built on from this. When asked if there were other mathematical concepts she could connect to this, she felt it would really depend on the children's interests, and she "would have to wait and see what the children are doing or saying". Although she also mentioned that she might suggest to the children "let's see if we can make a line, and see if we can make a straight line, and let's make a, you know, zig-zag line". However, she was also clear that this would not happen "until the experience happens, and until I hear what the children are saying".

The second image from the *Obvious Mathematics* pile was *Olympic Rings Cooking: 5LDC-0115* . Measurement was the only concept Nikki was able to remember discussing with the children in this experience.

> There's a lot of measurement happening, umm, I think we talked about measurement, I don't recall [pause] using any sort of other words that I can remember, apart from measurement. "We're measuring!" But talk about volume, and the differences in size between … And I think that's all I can remember.

As Nikki had previously mentioned, her pedagogical practices now included fewer whole group activities. Therefore, the cooking experiences she now plans for children include more child engagement. "The children now basically do everything themselves. So they will measure everything themselves using various, you know, measuring cups".

When looking at the *Not So Obvious Mathematics* pile, Nikki chose to first look at *Face Sorting Set-Up: 5LDC-0170* and reflected

> So this activity of the, umm, faces, I would never have thought of as a maths activity. It's just not something I would have thought of [pause]. I put it [pause] back then I remember putting it more as just a social emotional activity, I didn't think about the maths. Obviously, you know, we're matching, umm, and sorting and comparing, making comparisons, and that's [pause] I just I didn't think of it. In that sense. It's silly I know, but I didn't (shakes head).

When asked how Nikki would have scaffolded this activity, she mentioned that she would most likely have left the activity for the children to engage in without educator interactions. Whereas, she could now imagine herself "sitting with the children and just having a conversation about it, and asking them what they think about where the faces should go, 'what is the difference between these two faces?', and, you know, 'how many can we find?'"

She then chose to reflect on *Days of the Week Poster: 5LDC-0219* which had also been placed on the *Not So Obvious Mathematics* pile. Nikki's first comment on seeing this image as she was sorting the photos was "Did you notice that's gone now?" This was an activity that Nikki felt she had been engaging in specifically for the parents that she would engage in daily with the children.

> Well obviously I can see the number…when you see a number, you obviously think maths. Umm, but yeah I think that's all I could sort

> of see. Just the number of the week [pause] just that sort of thing. And yes, I can see maths in that now talking about yesterday and today and tomorrow, marking those differences. We would (also) sing our days of the week song, umm, and we would use our fingers to count the days of the week.

When asked to reflect on the images she had placed in the *No Mathematics* pile, Nikki first chose *Exploring Recyclables: 5LDC-0130* . This activity was planned as the children had been talking about recycling. Nikki recognized that "looking at that, we could have made comparisons in size" and when I confirmed that she had in fact asked the children to compare sizes, she appeared surprised. She mentioned that she could also

> have measured, we could have filled the boxes up with things, umm, we could have weighed the boxes. There are lots that we could have done, but I think again, I would have asked the children what they would like to do with the boxes.

Her second choice to reflect on from this pile was *Show and Tell: 5LDC-0011* . Sending Ralph home was an activity that she still engages in with the children. However, she now does this as a small group activity. This goal of this activity for Nikki was "just looking at the community, and connecting with the families". When asked if she could identify any mathematical concepts, she hesitantly mentioned, "we have shapes on the, umm, folder, that I didn't notice before? Umm, no, I can't? What am I missing?"

Interestingly, the remaining image Nikki had placed in the *No Mathematics* pile was *Story Time: 5LDC-0130* , a similar image to the above two.

7.4.3 Exploring the List of Mathematical Concepts with Nikki

When Nikki was handed the *Mathematical Concepts List for PEI* (see Appendix E, p. 393) she commented that a list like this was “exactly what we need”. Pointing to the previously mentioned list from the practicum student, Nikki continued, “And this is why I said, why I looked [pause] constantly looking at things [like this], as I just don’t have the maths brain”.

Reading through the list, Nikki admitted that one-to-one correspondence was a concept that always “confused” her. After reading out the description on the list, which stated, “One-to-One Correspondence: the matching of one object with another object or with a number, often used when counting and pointing to objects” (Appendix E, p. 393). She added, “Yeah I didn't, I didn't know that was what it was called”.

After reading through the list of mathematical concepts, Nikki was asked to re-look at some of the images she had previously placed in each pile, and attach prepared stickers to indicate if each concept was identifiable in the image (as discussed in Section 4.2.4, p. 61).

Starting with the images she had sorted into the *Obvious Mathematics* pile, Nikki chose *Block Shelves: 5LDC-0185* and attached *Size, Length, Area, Mass, Order, Pattern, Rational Counting,* and *Subitizing.*

She contemplated the concept of measuring Sound , as she looked at *Show Me Your Dance Moves: 5LDC-0090* , which prompted me to explain that the children may “tell you whether it’s loud or soft … whether it’s high or low”. She then agreed, and placed stickers for Navigation and Sound on to this image.

Nikki placed *Geometric, Order, One-to-One, Size,* and *Pattern* on to image *Geometric Magnets: 5LDC-0167* and then questioned the terminology of *non-comparative* used in the description of *Object* classification. An explanation of the difference between *Object* classification and *Order* helped to clarify these.

Geometric and *Pattern* stickers were then placed on the image for *Blocks on a Stick: 5LDC-0163* , and the *What Size Paper?: 5LDC-0156* image received a *Size* sticker.

Nikki hesitated as she reviewed the list of concepts for stickers to place on *Somersault Time: 5LDC-0155* and when asked if there was a concept she was looking for that was not there, she replied, "No, I'm kind of just looking [pause] there are so many different, umm, areas (??) that I haven't thought of before". She then placed a *Navigation* sticker on this image.

"For going down the slide, (Down the Slide: 5LDC-0153), there's *Navigation*, and taking turns". When asked where she would put taking turns, she hesitantly said "Would I put *ordinal*?"

Although I attempted not to lead any of the educators in the interviews, I decided that an example of *Order* and *Ordinal Numbers* were required to ensure Nikki understood the terminology. I explained that I would have put *Order* or *Pattern* "because the children are placing themselves in order, or they're putting themselves into patterns like your turn, my turn" and that *Ordinal Numbers* was "more using the words". She then placed *Order* and *Pattern* onto this image as well.

Looking at the image of *Skipping Rope: 5LDC-0141* , Nikki found herself getting confused

> I think I'm starting to think Science [pause]. It's a bit of the maths and science, but when I think of things like force, it a bit of the science going. I think that happens a lot as well, with a lot of the activities that we do. I know that science and maths obviously very much go together, but sometimes I think it's the more science terms that I think of.

She returned to the image, stating, "You can do *length* for skipping, and *navigation* [pause] and *geometric* (??)" When I mentioned it looked as if she was now questioning herself, she replied "I am seeing the transformation or rotation of objects, that's certainly rotating. Umm, and yeah*, Order"*. This image ended up with stickers for *Length, Navigation, Geometric,* and *Order*.

Moving on to the *Not So Obvious Mathematics* , Nikki chose the image of *Pasta for Lunch: 5LDC-0096* reflecting, "Eating lunch, for that one we can do Size , Volume , umm, and Fractions ". She then confidently placed stickers for *Length* , *Geometric* , *Navigation* , *Ordinal Numbers* , and *Pattern* . Nikki glanced over appearing to check if she was correct, however, she explained, "I was more looking to see if you're laughing".

When she picked up the *Colouring with Pencils: 5LDC-0162* image she stated, "Drawing with a colour pencil and trying to choose the right colour, hmmm, hmmm. We can do *Length, Size, Navigation, Pattern*, hmmm".

For Days of the Week Poster: 5LDC-0219 , Nikki placed stickers for *Ordinal Numbers , Reciting Numbers , Rational Counting , Role , Order ,* and *Pattern* .

Nikki was then asked if she could provide an example of where she would scaffold each of the mathematical concepts in the provided list.

Starting with *Size* , Nikki felt it could be scaffolded "when we talk about, umm. For example, where we were measuring feet. We talked about the size of our feet and we use those words, such as big, small, think, thin".

For *Length,* she thought "a different example, just [pause]. We might talk about the length of the room. When we measure the room".

Nikki needed to re-read the definition of *Area*, appearing to confuse it with *Volume* when she stated

> What I would talk about, like say, the area of box, we'd talk about the area of the box [pause], umm. But, in an activity? "Can you put [pause]. Can you put everything [pause]? Can you put all of these blocks inside the box?" Yep … Is my take on that.

For *Volume* she was able to confidently identify “a cooking experience. Looking at the volume of a measuring cup”. *Mass* , she felt, could be experienced by “weighing something in the sandpit”, while *Time* could be scaffolded through “Talking about today is Monday, tomorrow is Tuesday”.

Sound was a concept that Nikki thought would be “obviously the music. Be like a music experience and we might, you know, dance down low if it’s really soft and the music gets louder we dance up high”.

Spatial Awareness *Geometric* to Nikki was “Geometry is shapes. So any activity that involves shape is where I see geometry”. Dancing was again mentioned in relation to *Navigation* , where Nikki described “Obviously if we’re dancing. Or trying to get into a circle. All hold hands in a circle. Trying to navigate where we all need to stand”.

Object again confused Nikki due to the use of the word *Non-comparative* in the description, but she was able to talk it through by herself, “It’s just classification, just grouping? … Would that be like if you’re grouping colours? If you were to group all the red together, all the yellow together”.

Role classification also confused Nikki, “Don't really understand that one. Well I do because I obviously I took that (a sticker) away. I think I took that as? [pause]”. I reminded her that she had used the missing sticker on *Face Sorting Set-Up: 5LDC-0170* , and she continued to say, “Yes, well, just the fact that they’re classifying different kinds of emotions. And faces … is how I took that one”. (Note, due in part to this confusion by the educators, Role and Object Classification codes were combined in the final analysis).

Order, Nikki felt was “obviously just ordering. … I did for that one [*Face Sorting Set-Up: 5LDC-0170*], we could put the faces in a particular order, we could put all the boys [pause] first, and the girls [pause]”.

She continued down the list. “Umm, one for Pattern could be just creating patterns with, umm, the geometric shapes that we’ve got”.

When she reflected on *One-to-One* correspondence, she re-read the description aloud, and pondered, “What did I do for that one? Interesting”. I reminded her she had used the sticker on *Geometric Magnets: 5LDC-0167* and asked if she knew why she had chosen it. Her response was given with a smile, “I think I chose it for that one [pause]. That's a good question, Kathy. [The description says] The matching of one object with another object [pause]. Well just the matching two squares together, or two triangles together”.

The description of *Reciting Numbers* included the example of singing and Nikki agreed with that example, continuing on to add, “especially when we are singing or umm, doing the Days of the Week song. Counting the days of the week or month. Or one, two, three, four, five, once I caught a fish alive”.

Rational Counting Nikki felt “obviously is seen throughout all aspects of the day. Even to just get children’s attention. It might be just ‘1, 2, 3. Look at me’. You know we’re always counting anything we can”.

Nikki found *Subitizing* “difficult” and when I expanded on the definition, although she replied, that it was “interesting, it’s the language” she did not give an example of how she would identify or scaffold this concept.

Nikki was able to clearly identify that Fractions could easily be explored at lunch time, “like cutting up an apple, chopping an apple in two or four pieces”.

7.4.4 Additional Thoughts from Nikki

The final question in the PEI was asking if Nikki could identify any additional mathematical concepts or had any additional thoughts. The only concept Nikki thought was possibly missing was the measurement of Speed, which I added to the coding list in response to this. She mentioned it “in terms of [pause] the skipping rope and maybe going down the slide”.

She then said that she couldn’t think of anything more to add and the interview was concluded. After the recording stopped, Nikki and I chatted about the mathematics she was observing in her current group, and the changes she had made to the programming to incorporate the mathematics she was now aware of.

8 Discussion

Thematic analysis, as discussed in Section 3.3 (p. 46), was the framework used in the analysis of the coded data. The previous three chapters included 130 vignettes which provided details of the mathematical and non-mathematical coding used during the analysis. Coding the data was “the basis for ‘lifting’ to a more abstract theme statement or other interpretive presentation” (Ely et al., 1997, p. 162). This chapter will use a thematic framework to examine the coded data “in order to reveal their full value” (Bazeley, 2009, p. 8) and help to answer the research questions in Chapter 9.

During all stages of the research project, I kept notes on the potential themes emerging, and identified the following themes as significant in answering the research questions:

- Mathematics in the Set-Up of the Physical Environment
- Mathematics Embedded in Equipment
- Identifying the Mathematical Concepts
- Acknowledging Mathematics Within Other Curriculum Areas
- Mathematics in Social Rules and Expectations

The following five sections explore each of these themes individually, while Section 8.6 provides a summary and discussion of the educators’ role. Chapter 9 will then draw the themes together to answer the research questions and conclude the thesis.

8.1 Mathematics in the Set-Up of the Physical Environment

A theme that emerged very early in the design phase, and that I kept returning to during this study, centred on the set up of the physical environment by the educators for their groups. When defining the physical environment set-up, I included such things as the way the educators sectioned off the room or playground into smaller areas for various purposes, the number of chairs provided at a table, the shape of rugs for group time, and furniture used as dividers and in the storage of equipment. Although the set-up of early childhood environments also includes the addition of smaller items and equipment within these areas, the focus for this theme was the use of furniture and large equipment. This theme has been divided into two sections*: Set-Up of Specific Play Spaces* and *Set-Up of Activities*.

8.1.1 Set-Up of Specific Play Spaces

In early childhood settings, both Australian and international, educators regularly divide their areas into specific play spaces, often as a way to help with classroom management or to increase the variety of learning activities (Curtis & Carter, 2003; Rosback & Coulson, 2012). However, when first visiting the centres and exploring potential places for positioning the video cameras, I became aware of the potential for mathematical learning that these areas also provide.

Within the rooms, these areas tended to be separated by furniture or through the use of different flooring materials; outside, their boundaries were defined by garden beds, benches, paths, or a change in ground coverings. All of the episodes within the study occurred within these play spaces, yet in a selection of episodes there were specific play spaces that were identified as significant in their potential to provide mathematical learning. These episodes and the descriptive names used for these areas by the educators and children are listed in Table 8.1, together with their mathematical codes.

Table 8.1
Episodes in Specific Play Spaces and Their Mathematical Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation
Art Area																										
Box Construction: 4YOK-0128	p. 173		X	X	X	X				X				X						X	X		X		X	X
Play Dough Table: 3YOK-0096	p. 109	X		X	X	X						X	X	X	X						X				X	
Bike Area																										

Tricycles: 3YOK-0022	p. 125	X	X					X													X	X			X	X
Block Area																										
Block Shelves: 5LDC-0185	p. 261		X	X		X								X						X	X				X	X
Room Set-Up: 3YOK-0089	p. 99	X																		X						X
Gardens																										
Are the Strawberries Ripe?: 3YOK-0030	p. 127					X				X										X	X			X		
Eating Carrots: 3YOK-0034	p. 129																			X	X					
Flowers You Can Pick: 3YOK-0040	p. 128																			X	X					
Hide and Seek: 3YOK-0002	p. 126		X																							X
Parts of a Carrot: 3YOK-0037	p. 128																			X	X					
Vegetable Garden: 3YOK-0031	p. 129				X	X						X		X						X						
Home Corner																										
Home Corner: 4YOK-0025	p. 178			X	X				X	X	X		X	X						X				X		
Mat Area																										
Coming to the Mat: 3YOK-0070	p. 102													X						X				X		X
Dancing at Group Time: 5LDC-0130	p. 238						X	X						X								X		X	X	X
Hands Up if You Can Swim: 4YOK-0002	p. 158				X							X								X	X					X
Watching Eggs Hatch: 4YOK-0145	p. 195	X																					X			X
Witch Story Group Time: 4YOK-0024	p. 160		X	X	X	X		X				X	X	X						X	X	X		X		X
Playground																										
Boy Climbing Over Tunnel: 4YOK-0013	p. 189	X	X			X																			X	X
Down the Slide: 5LDC-0153	p. 269		X					X				X			X	X										X
Long Jump: 5LDC-0134	p. 270	X	X																		X					X
On the Swings: 5LDC-0132	p. 268		X					X													X					X
Running on the Path: 3YOK-0033	p. 101		X					X													X					X
Swing Set #1: 3YOK-0023	p. 124		X		X							X									X					X
Tomiko on the Monkey Bars: 4YOK-0023	p. 193	X	X					X		X		X			X								X		X	X

These specific play spaces provided the children with an opportunity to physically experience the concept of area as they became aware of these boundaries. At times, the area in these spaces was clearly defined by the educators for safety reasons. For example, the educators were heard reminding the children to keep back so they were safe in the episodes that took place in the swing and slide areas: *Tomiko on the Monkey Bars: 4YOK-0023* , *Swing Set #1: 3YOK-0023* , *On the Swings: 5LDC-0132 ,* and *Down the Slide: 5LDC-0153* .

The labelling of these play spaces also provided the children with opportunities to build classification skills and navigational terminology; the educators scaffolded this learning through discussions with the children about where they may find equipment, or when they directed the children to a particular area to play. These labels also provided an opportunity for the children to practise classifying when the educators encouraged them to use or return equipment to the area it belonged.

This labelling is an example of what Vygotsky called “cultural tools and symbols” and assisted children in understanding their culture and community, allowing them to become full participants in their own society (Vygotsky, 1978b). While Serena preferred the children to keep the specific equipment within the designated area, Samantha and Nikki encouraged the children to gather equipment from other areas if it could enhance their play; reminding the children to return the equipment when they were finished playing. While these two approaches were different, both pedagogical practices provided opportunities for the children to classify, as the children were observed in all centres discussing where equipment belonged and reminding their peers to follow these rules (3YOK Field Notes, 2012; 4YOK Field Notes, 2012; 5LDC Field Notes, 2012).

Furthermore, the size and shape of the play spaces provided opportunities for mathematical discussions. In *Watching Eggs Hatch: 4YOK-0145* , the educators worked with the children to identify where they could all sit and still be able to see the eggs hatch. In smaller areas, such as the block area or home corner, the educators encouraged the children to make sure that there was an appropriate number of children in the area, to allow room for everyone to play safely, and the children were observed discussing these limitations and counting the number of children in the area (3YOK Field Notes, 2012; 4YOK Field Notes, 2012; 5LDC Field Notes, 2012).

8.1.2 Set-Up of Activities

The physical set-up of regular and planned activities within the specific play spaces was also identified as supporting children’s awareness of a variety of mathematical concepts. While mathematical learning was not usually the focus of the educators, the set-up of these smaller activities also provided opportunities for the children to learn mathematics incidentally. These opportunities, which were identified in a selection of episodes through the choice or arrangement of furniture or equipment, are listed in Table 8.2, together with their mathematical codes and sorted by the description of the set-up feature used. The following four sections then discusses each of these features.

Table 8.2
Episodes With Mathematics in the Set-Up of Activities and Their Mathematical Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation
Table and Chairs																										
Four Children at the Clay Table: 4YOK-0028	p. 176		X	X	X	X				X			X							X	X	X		X	X	X
Lunch Helpers: 5LDC-0000	p. 243	X			X						X	X		X				X					X		X	X
Lunch Table: 4YOK-0121	p. 188				X	X				X		X	X					X	X	X	X			X		X
Moving Chairs: 4YOK-0038	p. 196	X				X								X									X			X
Office Play: 5LDC-0004	p. 251											X		X	X		X							X		
Pasta for Lunch: 5LDC-0096	p. 244			X							X		X							X	X			X		
Play Dough Table: 3YOK-0096	p. 109	X		X	X	X						X	X	X	X						X				X	
Play Dough Table: 5LDC-0124	p. 247		X	X	X	X			X	X	X	X	X	X							X				X	
Snack Time: 3YOK-0004	p. 106				X					X		X		X					X	X	X		X			
Soup for Lunch: 5LDC-0017	p. 245			X							X		X							X				X		
Line for Waiting																										
Down the Slide: 5LDC-0153	p. 269		X					X				X			X	X										X
Swing Set #1: 3YOK-0023	p. 124		X		X							X									X					X
Tomiko on the Monkey Bars: 4YOK-0023	p. 193	X	X					X		X		X			X								X		X	X
Group Time Mats																										
Coming to the Mat: 3YOK-0070	p. 102													X						X				X		X
Dancing at Group Time: 5LDC-0130	p. 238						X	X						X								X		X	X	X
Hands Up if You Can Swim: 4YOK-0002	p. 158				X							X								X	X					X
Storage of Materials																										
Block Shelves: 5LDC-0185	p. 261		X	X		X								X						X	X				X	X
Box Construction and Collage: 3YOK-0024	p. 108	X			X	X														X		X	X	X	X	X
Box Construction Supplies: 4YOK-0046	p. 174		X		X	X														X	X		X		X	
Box Construction: 4YOK-0128	p. 173		X	X	X	X				X				X						X	X		X		X	X
Drawing Materials: 3YOK-0019	p. 115					X								X						X					X	X
Photo Wall: 4YOK-0131	p. 155				X															X						X
Storage of Loose Materials: 4YOK-0144	p. 175		X		X	X														X	X				X	X
Trucks on a Shelf: 4YOK-0036	p. 189	X	X		X									X						X						X

Table and Chairs

The set-up of table activities provided the opportunity for children to experience one-to-one correspondence. This happened when the educators set up small group activities for a particular number of children, for example when they set up four chairs and four places in *Four Children at the Clay Table: 4YOK-0028* .

While the set-up at each centre provided such opportunities, only Serena clearly acknowledged that the placement of chairs provided “a kind of inbuilt one-to-one correspondence in having to match one child to one chair” (Serena - Interview with 3YOK Educator). Similarly, her use of individual cushions at group time in the 3YOK also provided the opportunity for children to practise one-to-one correspondence. Samantha noted how the number of chairs at a table can be a deliberate move by the educator and a reflection of their pedagogical practices.

> There are always a certain number of chairs at the tables, which sort of indicate the number of people that generally are invited to that experience. So you know you got to work out if you’re flexible with that, or with some experiences there is no flexibility, because there is only a certain number of things at the table. Where [for] other experiences, it doesn't matter if six people pull chairs up to the table of four because you just share, share the experience out if you can (Samantha - Interview with 4YOK Educator).

The way these tables and chairs were set up provided opportunities to explore other mathematical concepts as well. For example, in *Snack Time: 3YOK-0004* , this set-up also provided a child with an opportunity to engage in counting, calculation, and problem solving when he chatted with Serena about what he should do when there were no seats left at the table. In *Lunch Table: 4YOK-0121* the children were engaged in a conversation about where other children were sitting in relation to themselves, building navigational understanding.

The table set-up in each of the early childhood centres provided similar opportunities for these mathematically-rich interactions to have occurred in any of the episodes situated at the tables and chairs, whether they were initiated by a child as above, or initiated and scaffolded by the educators asking simple questions.

Line for Waiting

I also observed a few isolated interactions where the educators encouraged the children to form a "straight line" while they were waiting for a turn on the swings, slide, or other equipment, such as *Tomiko on the Monkey Bars: 4YOK-0023* and in *Down the Slide: 5LDC-0153* . These included opportunities to explore length, order, and geometric and navigational spatial skills. Additionally, if the educators chose to count the children in the line, the children could explore counting, one-to-one correspondence, and ordinal numbers.

Group Time Mats

All three centres had large rectangular mats, yet, in most of the episodes, the children were asked or encouraged to sit in a circle or semi-circle, building geometric and navigational awareness. The three educators used differing pedagogical practices in these interactions; each appropriate for the children with whom they were working. Serena, working with the youngest group, created a semi-circle on her group time mat with small cushions for the children to sit on in *Coming to the Mat: 3YOK-0070* ; Nikki, working with a mixed group, helped the children form a circle shape in *Dancing at Group Time: 5LDC-0130* by asking them to hold hands with their friend and move backwards; while Samantha and her assistant, working with the older group, just encouraged the children to form a big circle on the mat as they entered the room in *Hands Up if You Can Swim: 4YOK-0002* .

Storage of Materials

The shelving and containers in which equipment and loose items were stored was also included in this theme. The way in which the equipment was stored also provided children with opportunities to explore classification. The children were encouraged to return equipment to not only the *Specific Play Space* where it belonged, as discussed above, but also to a specific place within that area, for example as in *Trucks on a Shelf: 4YOK-0036* and *Drawing Materials: 3YOK-0019* . Taking this a step further, *Block Shelves: 5LDC-0185* also provided opportunities for increasing children's symbolic awareness through the use of images showing where each block belonged. Although they were not captured in any of the episodes, similar images were used by the 3YOK and 4YOK educators on their block shelves.

Other storage solutions, such as those found in *Box Construction and Collage: 3YOK-0024 , Box Construction Supplies: 4YOK-0046 , Box Construction: 4YOK-0128 , Storage of Loose Materials: 4YOK-0144 ,* and *Photo Wall: 4YOK-0131* encouraged the children to make choices based on their needs and the materials available, providing opportunities to compare, measure and classify.

8.2 Mathematics Embedded in Equipment

As an early childhood educator, I was aware prior to this study, that equipment and materials traditionally found in early childhood centres, could, by their very design, provide opportunities for mathematically-rich interactions. Therefore, I kept notes for this theme from the very beginning; adding more during the fieldwork, through the analysis of the video data, and when listening to the educators as they sorted the images in the photo-elicitation interview [PEI].

During the data collection and analysis stages, it was very easy at times to identify equipment that afforded these incidental mathematical opportunities. For example, blocks of various shapes and sizes, puzzles, calculators, Lego, and the toy tape measures were all easily recognised as mathematical equipment. During the PEIs, all three educators placed photos of these in the *Obvious Mathematics* pile with very little hesitation. However, there was also mathematics embedded in less obvious equipment. For example, cars and trains, collections of animals, collage materials, doll house, climbing equipment, and the basketball hoop.

The episodes in which equipment was identified as having mathematics embedded in them were sorted into groups and are presented in Table 8.3, together with their mathematical codes. The following seven sections look at the opportunities for mathematical development embedded in this equipment.

Table 8.3
Episodes Identified as Having Mathematics Embedded in the Equipment and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Blocks, Boxes, and Geometric Shapes																										
Block Shelves: 5LDC-0185	p. 261		X	X		X								X						X	X				X	X
Blocks on a Stick: 5LDC-0163	p. 258					X								X						X		X		X	X	X
Box Construction and Collage: 3YOK-0024	p. 108	X			X	X														X		X	X	X	X	X
Box Construction: 4YOK-0128	p. 173		X	X	X	X				X				X						X	X		X		X	X
Boys and Lego Roads: 4YOK-0083	p. 179	X	X			X								X						X	X		X	X	X	X
Building the Pirate Ship: 5LDC-0084	p. 256				X	X														X	X				X	X
Building with Blocks: 5LDC-0005	p. 269	X	X			X								X					X	X		X	X		X	X
Geo Blocks: 5LDC-0038	p. 235	X	X		X	X							X	X						X		X			X	X
Geometric Magnets: 5LDC-0167	p. 248	X	X			X								X						X	X	X			X	X
Group Time with Flower Petals: 3YOK-0014	p. 117				X						X			X						X		X				X
Large Soft Blocks: 5LDC-0003	p. 255	X			X	X														X	X				X	X
Lego Baddies: 4YOK-0029	p. 179		X		X	X		X						X						X	X				X	X
Madison and Ian and Magnet Shapes: 5LDC-0001	p. 249	X	X			X								X						X	X	X	X		X	X
Small Magnetic Block Play: 5LDC-0012	p. 259	X	X	X	X									X						X		X	X		X	X
Small Play Set Up: 4YOK-0047	p. 154	X	X		X	X					X		X	X						X	X	X		X	X	X
Somersault Time: 5LDC-0155	p. 257		X																						X	X
Sorting Blocks: 5LDC-0025	p. 262		X		X	X				X		X		X						X	X				X	
Train on a Slope: 5LDC-0154	p. 257		X					X								X						X			X	X
Two Boys and Blocks: 3YOK-0020	p. 113	X	X			X						X		X					X	X	X	X	X	X	X	X
Sets and Collections																										
Checking the Speed of Trains: 4YOK-0019	p. 183		X					X		X				X						X	X		X			X
Doll House Activity: 4YOK-0042	p. 153	X				X				X				X						X				X		X
Emergency Vehicles: 4YOK-0009	p. 182	X	X		X	X														X	X				X	X
Four Children with Cars: 4YOK-0006	p. 181	X	X		X	X														X	X				X	X
Stones and Spoon Activity: 4YOK-0044	p. 154	X										X								X		X			X	X
Two Girls with Animals: 4YOK-0060	p. 184	X				X								X						X	X					X
Play Dough and Clay																										
Four Children at the Clay Table: 4YOK-0028	p. 176		X	X	X	X				X			X							X	X	X		X	X	X
Play Dough Table: 3YOK-0096	p. 109	X		X	X	X						X	X	X	X						X				X	
Play Dough Table: 5LDC-0124	p. 247		X	X	X	X			X	X	X	X	X	X							X				X	
Two Children at the Clay Table: 4YOK-0093	p. 177		X			X							X							X				X		
Puzzles																										
Ben at the Puzzle Table: 4YOK-0125	p. 167					X														X	X				X	X
Christie Jack and Imogen at the Puzzle Table: 4YOK-0125	p. 167	X																		X	X	X		X	X	X
Educator at the Puzzle Table: 3YOK-0021	p. 111	X	X			X														X	X	X		X	X	X
Finishing the Puzzles Together: 3YOK-0005	p. 112	X	X			X														X	X			X	X	X
Puzzle with Educator's Help: 4YOK-0027	p. 166	X																		X	X			X	X	X
Puzzles: 5LDC-0128	p. 253	X															X			X			X			X
Containers																										
Cooking in the Cubby House: 5LDC-0133	p. 265			X	X	X			X	X	X	X	X							X				X		
Cooking in the Sandpit: 3YOK-0040	p. 120			X	X				X	X	X		X						X					X		X

Filling Containers: 4YOK-0075	p. 192	X		X	X	X					X		X							X	X					X
Home Corner: 4YOK-0025	p. 178			X	X				X	X	X		X	X						X				X		
Outdoor Kitchen and Sandpit: 4YOK-0048	p. 191	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X
Playground Equipment																										
Boy Climbing Over Tunnel: 4YOK-0013	p. 189	X	X			X																			X	X
Climbing Bridge: 3YOK-0027	p. 122		X											X										X		X
Climbing Dinosaurs: 5LDC-0030	p. 266		X			X																				X
Climbing Frame: 3YOK-0036	p. 123		X																					X		X
Down the Slide: 5LDC-0153	p. 269		X					X				X			X	X										X
Obstacle Course: 3YOK-0042	p. 121		X			X		X								X					X			X		X
On the Swings: 5LDC-0132	p. 268		X					X													X					X
See Saw: 3YOK-0028	p. 123		X					X													X			X		X
Swing Set #1: 3YOK-0023	p. 124		X		X							X									X					X
Swing Speeds: 3YOK-0026	p. 125							X												X	X					X
Tomiko on the Monkey Bars: 4YOK-0023	p. 193	X	X					X		X		X			X								X		X	X
Other Equipment																										
Calculator Play: 5LDC-0002	p. 250													X	X	X			X					X		
Explaining the Tape Measure: 3YOK-0090	p. 110		X			X						X							X	X	X					X
Face Sorting Set-Up: 5LDC-0170	p. 236													X						X	X					
Marble Run Construction: 4YOK-0083	p. 184		X			X		X						X						X			X	X	X	X
Measuring Heights: 5LDC-0140	p. 267		X			X						X		X							X		X			X
Office Play: 5LDC-0004	p. 251											X		X	X		X							X		
Reading Numerals: 5LDC-0126	p. 252											X		X	X									X		

8.2.1 Blocks, Boxes, and Geometric Shapes

All three centres included a variety of blocks and boxes with which the children could engage. These included small pattern blocks, regular timber blocks, large plastic outdoor blocks, soft climbing blocks, magnetic blocks, blocks as part of activities, and cardboard boxes for the construction table. There is a substantial body of research on the mathematical concepts that can be developed with blocks (see, for example, Amundsen, 2006; Eberly & Golbeck, 2004; Moss, 2013; Sarama & Clements, 2009; van Nes & van Eerde, 2010) and, not surprisingly, potential opportunities for children to build a range of mathematical concepts were identified in the episodes where children were playing with blocks.

Interestingly, where twin sisters Amberley and Michaela were playing in *Blocks on a Stick: 5LDC-0163* , I noted how easily the equipment can provide opportunities for children to engage with different mathematical concepts. Michaela was placing blocks on the stick, which provided practice in geometric and navigational awareness. However, Amberley was using the supplied pattern cards with the blocks and, while also gaining practice in the concepts her sister was exploring, her interaction with the blocks also included classification, sequencing, size, pattern, and one-to-one correspondence.

While Lego blocks were included in this theme with the other blocks, it is important to note that, at the 4YOK, the Lego provided opportunities to explore the changing criteria used in classification, due to the large variety within the set. This was especially clear in *Lego Baddies: 4YOK-0029* where Phil provided me with a very detailed narrative of the features of his Lego vehicle, and the particular blocks he needed to complete it, describing these by using criteria such as size, shape, colour, and function. Samantha easily identified the mathematics embedded in the Lego, identifying the planning and spatial awareness skills children are developing as they are “working out where things go, how you are going to go about doing it. How much [pause]. How many pieces of Lego do you need, this and that” (Samantha - Interview with 4YOK Educator).

The two other educators were also clearly aware of the mathematics that can be developed through block play. Nikki mentioned the “different shapes, sizes, [and] weight” that children are exploring when she was looking at the *Block Shelves: 5LDC-0185* image, and later identified the opportunity for the children to explore the mathematical concepts relating to size, length, area, mass, order, patterns, counting, subitizing in this image. Serena also mentioned the teak box of blocks in *Two Boys and Blocks: 3YOK-0020* and *Group Time with Block Tray: 3YOK-0014* specifically because they had “mathematical properties” (Serena - Interview with 3YOK Educator).

The two episodes at the 5LDC with geometric magnets are also included in this section, as the children were forming three-dimensional shapes with the geometric magnets and therefore gaining similar opportunities for mathematical development.

The blocks were available in a variety of sizes and materials for the children – ranging from small timber blocks, such as those in *Two Boys and Blocks: 3YOK-0020*

, through to the large soft blocks in *Building the Pirate Ship: 5LDC-0084* . The children were observed using the blocks in different ways in different areas of the preschool to explore similar mathematical concepts. This variety of opportunities allowed them to transfer their mathematical knowledge from one activity to another.

Due to the overlap of episodes within multiple themes and to avoid repetition, the mathematics in episodes with blocks can also be linked to the following sections: Storage of Materials (Section 8.1.2, p. 297), Sets and Collections (Section 8.2.2, p. 302), and Sport and Gross Motor (Section 8.4.6, p. 321).

8.2.2 Sets and Collections

The animals that Emily and Jodie were playing with in *Two Girls with Animals: 4YOK-0060* were a typical example of a set or collection of toy animals that can be found in most early childhood centres. These sets will often include a variety of realistic parent and baby animals, or the very popular set of bears that includes small, medium, and large bears in three colours. Mathematically, these sets provide opportunities for children to explore classification and build their awareness that objects can be sorted using differing criteria. Samantha mentioned that she also provided opportunities for the children to sort “zoo animals as opposed to farm animals or African animals” as an example of the criteria the children can use when sorting (Samantha - Interview with 4YOK Educator).

While I did not capture any episodes that included these types of sets at the 3YOK, Serena mentioned in the PEI that, she felt “a lot of materials that are developed for early childhood are actually about classification, we get the kids to do a lot of sorting” (Serena - Interview with 3YOK Educator). Possibly due to her background in linguistics, Serena appeared to have a strong focus on literacy and language skills, and she believed that for three-year-old children, with regard to sorting and categorising, “it's really not possible to distinguish between learning that is part of a new language, and learning that is part of mathematics” (Serena - Interview with 3YOK Educator).

Other more eclectic collections were also noted, including such things as cars, trains, home corner supplies, stones, collage materials, and as noted above, blocks and Lego. These collections all provided opportunities for classification, however the criteria chosen can be more flexible and therefore potentially more difficult for children to articulate. For example, in Four Children with Cars: 4YOK-0006 (p. 181), the children used criteria such as colour, length, overall size, and number of wheels to sort the cars into their favourites.

The sharing of these sets or collections between small groups also provided opportunities for the children to engage with problem solving, calculation, measurement, one-to-one correspondence, comparison, and fractions. This was also apparent in the episodes with play dough or clay that children were sharing.

8.2.3 Play Dough and Clay

Samantha and Nikki both placed images showing play dough or clay into the *Obvious Mathematics* piles. Samantha identified mathematics in the interactions where the children were sharing. When she was looking at the *Two Children at the Clay Table: 4YOK-0093* , she mentioned “If one child had taken all the clay then we could work out how we could make it nice and fair” by encouraging the children to divide it equally (Samantha - Interview with 4YOK Educator).

Serena placed the *Play Dough Table: 3YOK-0096* image into the *No Mathematics* pile. Yet, interestingly, she was observed in this episode showing children how to make small balls and modelling one-to-one correspondence with the children as she counted the balls. Serena also reminded the children to share the play dough. Off camera, she also mentioned that she had laminated cards for placemats, which provided opportunity for the children to build an awareness of area.

In addition to the sharing of play dough and clay, these materials provided opportunities for the children to build their spatial awareness of as they made shapes, mainly spheres and cylinders, which were often flattened to make circles. As could be seen by the way Jack stepped on the clay in *Four Children at the Clay Table: 4YOK-0028* , clay could also be used to explore patterns.

8.2.4 Puzzles

Puzzles were a regular activity in all three centres, with children working with peers, individually, and with educators, as reported in each of the case study chapters. All three educators were able to clearly identify the puzzles as mathematical, and noted that they provided opportunities for the children to build spatial awareness as they rotated, flipped, and moved the pieces around to find the correct place.

The potential was also there for children to build their awareness of classification, sequencing, order, and area, as they sorted the edge pieces to make the perimeter first, and then filled in the centre pieces. In addition to these mathematical concepts, the educators' choice of puzzles provided additional concepts to explore. For example, one of the puzzles used in *Educator at the Puzzle Table: 3YOK-0021* contained a variety of geometric shapes that could be used to build geometric terminology, and also to create patterns while filling the puzzle tray. Some of the puzzles used in the 4YOK and 5LDC were multi-layered puzzles that provided additional opportunities to sort the pieces by layer.

8.2.5 Containers

Containers such as buckets, bowls, and jugs were used in a variety of episodes, including in the sandpit, digging patch, and with cooking activities. The three educators were all aware of measuring volume. Nikki felt that, at the time of data collection, she would have been more likely to have just said, "We're measuring" whereas now, she would be more likely to provide the children with more specific terminology in these types of interactions (Nikki - Interview with 5LDC Educator).

Conversations in the sandpit episodes, where the children commented on how full their buckets were, or how much of an ingredient they needed for cooking, provided opportunities for them to share fraction terminology such as *half*, *full*, and *quarter*. These words can easily be included by the educators in any interactions where the children are using containers, making these incidental opportunities a perfect way to include this terminology into the everyday vocabulary of the children.

8.2.6 Playground Equipment

The physical movement of the children across, over, and under these pieces of equipment, provided them with the opportunity to build an understanding of where their body was in space, thus building their navigational awareness. These activities also provide opportunities to explore comparison of length as children determine how far they have to move. The movable playground equipment, such as the pieces in *Obstacle Course: 3YOK-0042* , could also offer educators an opportunity to further scaffold these mathematical concepts if they chose to encourage the children to design and set up the obstacle course themselves.

Additionally, most of these pieces of playground equipment, especially the slide in the 5LDC, were used by groups of children. This provided them with practice in sequencing and order as they took turns using the equipment.

8.2.7 Other Equipment

Other equipment that was also identified as having mathematical concepts embedded included measuring tapes, marble run in the 4YOK, the calculators and telephones in the 5LDC, and matching games such as *Face Sorting Set-Up: 5LDC-0170* . The design of each of these pieces of equipment provided opportunities for the children to build mathematical concepts as they played.

During the PEIs, most of the images containing these other pieces of equipment were placed in the *Obvious Mathematics* piles by the educators. Serena and Nikki did not hesitate as they easily identified the symbols and measurement concepts in the tape measures, and Nikki responded in the same way to the symbols on the calculators and telephones. Samantha similarly identified the sequencing and measurement concepts in the pieces for the marble run.

However, Nikki placed the *Face Sorting Set-Up: 5LDC-0170* image into the *Not So Obvious Mathematics* pile, stating, “I would never have thought of [this activity] as a maths activity”, mentioning she was unable to identify anything other than the activity’s social and emotional benefits. However, when asked to look at the image again, later in the PEI, she acknowledged that, “Obviously you know, we're matching, and sorting, and comparing, making comparisons, and that's [pause] I just I didn't think of it” (Nikki - Interview with 5LDC Educator).

8.3 Identifying the Mathematical Concepts

While the three educators all felt it was important to include mathematics in an early childhood program, they also confirmed that they did not usually plan for specific curriculum areas such as mathematics. Nikki explained “It’s how we include it, I don't think that it has to be specifically [pause] maths” (Nikki - Interview with 5LDC Educator). Samantha expressed a similar view “Educators need to be aware of HOW they incorporate maths or how it is incorporated, but I don't … I don't necessarily know whether it needs to be a separate subject” (Samantha - Interview with 4YOK Educator).

Serena also agreed, stating, “I think maths is inevitably included in early childhood education because maths is in the world. And it's also very deeply embedded in our culture, and so that even without intending to, we include a lot of maths”. She explained that, “It would be good if we were more conscious of the maths that we are teaching and be able to make more intentional selections" (Serena - Interview with 3YOK Educator).

This ability to be "more conscious of the maths" was explored during the PEIs when the educators were asked to sort the supplied images into three piles that reflected the level of mathematics they were able to identify in the activity. All three appeared to find the sorting of images challenging, questioning their own ability to carry out this task. Nikki, for example, stated that she felt "It's like a test … they're probably all obvious mathematics, but not to me" (Nikki - Interview with 5LDC Educator) and all three needed to be reassured that there were no right or wrong answers.

Samantha and Nikki believed the majority of the images from their centres contained *Obvious Mathematics* , with only a small percentage having *Not So Obvious Mathematics* or *No Mathematics* . While Serena had more even piles of images, with the largest number of images being placed in the *Not So Obvious Mathematics* pile. A summary of the number of images placed in each pile is shown in Table 8.4; the full details of how each educator sorted the images was presented in Sections 5.4.2, 6.4.2, and 7.4.2.

Table 8.4
Summary of Image Sorting During the PEI

Sorting Pile	Serena 3YOK	Samantha 4YOK	Nikki 5LDC
Obvious Mathematics	10 (32%)	26 (81%)	24 (75%)
Not So Obvious Mathematics	14 (45%)	4 (13%)	5 (16%)
No Mathematics	7 (23%)	2 (6%)	3 (9%)
Total	31	32	32

A few of the images from each initial pile were discussed in depth by the educators during the PEIs. They were asked to explain the mathematics they were able to identify in the image or, for the images they had placed in the *No Mathematics* pile, other learning goals they could identify. During these in-depth examinations of the images, the educators were able to identify more mathematics then they were expecting, especially in the images from the *No Mathematics* and the *Not So Obvious Mathematics* piles.

For example, images from two of the group time episodes in the 5LDC were placed in the *No Mathematics* pile and the *Not So Obvious Mathematics* pile by Nikki – *Exploring Recyclables: 5LDC-0130* (p. 240) and *Story Time: 5LDC-0130* (p. 239) respectively. As shown in the vignettes, these included a variety of mathematical concepts. During the PEI, Nikki identified ways in which she could have potentially scaffolded the children's mathematical development during these episodes. For the first image, she mentioned, "Now looking at that [the boxes], we could have made comparisons in sizes" and reflected that, with a different group, "We could have measured, we could have filled the boxes up with things. Umm, we could have weighed the boxes". For the second image, she was less confident, but was able to identify the geometric shapes in the folder as a potential topic to discuss with the children.

Serena placed Snack Time: 3YOK-0004 (p. 106) in the Not So Obvious Mathematics pile. She explained that for snack time, "There are a limited number of places at the table … We have a rule [pause] there has to be a place free at the table, which means that they had to observe, umm [pause] empty and taken", identifying that there was an "inbuilt one-to-one correspondence in having to match one child to one chair". She also placed Hide and Seek: 3YOK-0002 (p. 126) in the No Mathematics pile and later reflected that "This is a hiding game. Which is about object permanence [pause] which is really important cognitive stage, but not particularly [pause] I mean it's necessary for mathematics" (Serena - Interview with 3YOK Educator).

Samantha had placed Self Portraits: 4YOK-0132 (p. 171) in the No Mathematics pile but upon reflection, she realised

> I could count the people. People's fingers, people's feet. They could sort out which ones are the girls and boys. I could try and identify which ones are their friends. I can see they don't really have the names on them really. Most of them don't. So could be a bit of a guessing game “This one’s got really curly hair, who do you think might be?” Yeah that's maths (Samantha - Interview with 4YOK Educator).

Samantha also looked again at Small Play Set Up: 4YOK-0047 (p. 154) which she had previously placed in the *Not So Obvious Mathematics* pile, and discussed some of the ways she could scaffold this activity to help develop the mathematical concepts.

> It is a bit of a sorting activity which we might put the shells in one, and stones in the other, pinecones in the other, and so on and so forth. In that the children could then, you know, if there were more of the snakes, they could have divided them by colour, or bits and pieces to create more of a mathematical kind of experience (Samantha - Interview with 4YOK Educator).

Later in the PEIs, the educators were asked to use the *Mathematical Concepts List for PEI* (see Appendix E, p. 393) as a guide when looking at the images for a third time, to identify the mathematical concepts they could have scaffolded in each image. This list contained 19 mathematical concepts and their definitions; changes were made to the coding list after the PEIs which, as noted in Section 4.4.3 (p. 82) resulted in 25 mathematical concepts in the final list. Due to time constraints, this section of the interview was omitted with Serena.

During this section, Samantha commented again on the two images discussed above, stating that, for the *Small Play Set Up: 4YOK-0047* , she could also include *Object Classification, Navigation,* and *Geometric* awareness. As she talked further about the image, she added

> Count, I suppose I can do that … Yep that one, fractions “Half of them are here, half of them are there”, I guess we could go first, middle, last, (ordinal), one-to-one correspondence [nods], we could create patterns - you could go “rock, pine cone, rock, pine cone”. Order, and eventually sequencing yes, we put them in order and things like that. Umm, yes we could do shapes. Is it Time if they say “Yesterday I did this and I did such and such with it?” okay. Then mass, definitely. “Yes I filled that one right up” so yes (volume). “There we are too small”, yes, I guess. Length “This one is bigger, that one is shorter, wider”. And size so, yes (Samantha - Interview with 4YOK Educator).

When she returned to the *Self Portraits: 4YOK-0132 i*mage, near the end of the PEI, she laughed and stated, “Well we already discovered that there's all the maths in that didn't we? My non-maths activity!” (Samantha - Interview with 4YOK Educator).

Nikki did not reflect further on the two group times mentioned above, but she did look at two images she had placed in *Not So Obvious Mathematics* pile: *Pasta for Lunch: 5LDC-0096* (p. 244) and *Train on a Slope: 5LDC-0154* (p. 257) stating, “Eating lunch. For that one we can do size, volume, umm, and fractions” and “Pulling Lego train across the floor and up the cushion. Okay, well there's measurement length, and geometric, and navigation, and ordinal, and patterns” (Nikki - Interview with 5LDC Educator).

At the completion of the PEIs, all three educators reflected on the ease with which they were able to identify individual mathematical concepts when referring to the *Mathematical Concepts List for PEI*. Samantha stated she was fascinated by how easy it was to identify the mathematical concepts with the list in front of her.

A comment by Serena during the PEI, further demonstrated the value of providing educators with the list of mathematical concepts. She reflected that, while she felt confident that she "did things that are valuable", she also wondered, "if there are things I'm missing out on because I don't know that they exist?" (Serena - Interview with 3YOK Educator).

Nikki also mentioned a handout that she had been given by a practicum student that identified the mathematics in common preschool objects. She noted during the PEI that this had been "really helpful" and reflected that she also wanted to "make poster things around the walls, just to help with that language" (Nikki - Interview with 5LDC Educator).

8.4 Acknowledging Mathematics Within Other Curriculum Areas

A prominent theme in my analysis of the data was how educators were including or acknowledging the mathematics within their existing practices. I had noted in my field notes and reflective journal that Samantha and her team appeared to have a strong focus on art. However, the importance of this to my research did not became clear until I was filming a young girl, Emma, as she painted at the easel in *Giraffe Painting: 4YOK-0144* (p. 169). I realised that Samantha's focus on Art was potentially reducing her acknowledgement of the mathematics that the children were exploring during activities she felt were art activities.

As mentioned in the vignette, the *Giraffe Painting: 4YOK-0144* was an oil painting for the annual art exhibition, and the one-on-one interaction between Samantha and Emma lasted approximately 25 minutes before Emma was finally happy with her painting and wandered off to play. I turned off the camera and was busy writing field notes. I was fascinated and excited with the number and variety of mathematical concepts I had observed in this interaction and I could not wait to start the analysis. Then Samantha left me speechless as she turned toward me and commented, "Oh, I forgot you were filming, I would have tried to put some maths into it. I guess we did talk about the size of the spots on the giraffe and how many legs there should be" (4YOK Field Notes, 2012).

My surprise obviously showed on my face, as she asked was there other mathematics she had missed. While I had normally refrained from discussing the mathematics I was observing, I could not help but explain what I had seen. I too, had observed the counting of legs, and the measurement of spots but, as mentioned in the vignette, measurement was also apparent in their discussion on the height of the tree the giraffe was eating, the length of the grass, the size of a giraffe's neck and ears, and the distance to the trees in the back ground, as well as the height of the giraffe depending on where it was placed on the canvas – in the fore-ground, middle-ground, or back-ground.

As well as these concepts, this episode also included classification, fractions, one-to-one correspondence, subitizing, calculation, comparison, sequence, and geometric and navigational awareness. After I listed and explained to Samantha how she had scaffolded all of these concepts, she laughingly said she was going to ask for a pay rise, as she was obviously smarter than she thought.

Reflecting at the end of the day, I found myself contemplating how Samantha appeared to be looking through an art-focused lens during this interaction. Her pedagogical content knowledge for Art was well developed, she was very aware of using techniques and terminology that related to art, but she was very surprised that she had actually covered so much mathematics as well.

I reflected in my journal that this may be occurring with other curriculum areas and developmental domains, and I decided to explore further the potential connections between the areas for which educators plan, and the mathematical concepts that these may also contain. This was the prompt for adding the Curriculum and Developmental categories to the coding tree (Section 4.4.3, p. 82). The following six sections discuss the episodes which were assigned these codes, and the ways in which mathematical concepts can be acknowledged within these areas.

8.4.1 Art

The episodes that were coded as Art are shown in Table 8.5, together with their mathematical codes. These episodes provided numerous opportunities for the children to build on almost all of the mathematical concepts.

Table 8.5
Art Activity Episodes and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
A Long Long Long Tail: 4YOK-0003	p. 171		X									X								X	X					X
Box Construction and Collage: 3YOK-0024	p. 108	X			X	X														X		X	X	X	X	X
Box Construction Supplies: 4YOK-0046	p. 174		X		X	X														X	X		X		X	
Box Construction: 4YOK-0128	p. 173		X	X	X	X				X				X						X	X		X		X	X
Colouring with Pencils: 5LDC-0162	p. 254	X	X										X							X						X
Drawing Materials: 3YOK-0019	p. 115					X								X						X					X	X
Easel for Chicken Drawings: 4YOK-0040	p. 168	X	X		X	X								X						X	X				X	X
Easel Stamping: 3YOK-0015	p. 116	X																			X				X	X
Four Children at the Clay Table: 4YOK-0028	p. 176		X	X	X	X				X			X							X	X	X		X	X	X
Geo Blocks: 5LDC-0038	p. 235	X	X		X	X							X	X						X		X			X	X
Geometric Magnets: 5LDC-0167	p. 248	X	X			X								X						X	X	X			X	X
Giraffe Painting: 4YOK-0144	p. 169	X	X		X	X						X	X	X				X	X	X	X			X	X	X
Group Time with Flower Petals: 3YOK-0014	p. 117				X						X			X						X		X				X
How to Make a Book: 4YOK-0053	p. 165		X		X	X							X							X				X	X	X
Jack's Homemade Book: 4YOK-0002	p. 162																			X	X		X	X		
Kyle's How To Make a Book: 4YOK-0049	p. 163				X	X							X							X				X		X
Madison and Ian and Magnet Shapes: 5LDC-0001	p. 249	X	X			X								X						X	X	X	X		X	X
Picture of the Tooth Fairy: 4YOK-0027	p. 172		X																		X				X	X
Play Dough Table: 3YOK-0096	p. 109	X		X	X	X						X	X	X	X						X				X	
Self Portraits: 4YOK-0132	p. 171		X		X	X														X	X					
Separating Petals: 3YOK-0018	p. 118										X		X	X						X						
Stones and Spoon Activity: 4YOK-0044	p. 154	X										X								X		X			X	X
Storage of Loose Materials: 4YOK-0144	p. 175		X		X	X														X	X				X	X
Two Children at the Clay Table: 4YOK-0093	p. 177		X			X							X							X				X		
What Size Paper?: 5LDC-0156	p. 254	X				X							X							X			X		X	

In many of these Art episodes, concepts such as classification, comparison, measurement, and geometric and navigational awareness were explored as the child decided on the colour, texture, size, shape, or placement of the items they were using or were drawing. As clearly demonstrated in the box construction and drawing episodes, these concepts were developing when children were looking for materials that matched their criteria. These criteria, at times, were clearly articulated – as demonstrated when Kyle was searching for a “strong enough box” for the base of the drum kit in *Box Construction: 4YOK-0128* . At other times, they were not articulated at all – as demonstrated in *Colouring with Pencils: 5LDC-0162* where Madison was choosing the colours for her helicopter drawing without discussing her choices. In art activities such as these, educators can scaffold these concepts simply by asking the child to describe what they are drawing or the materials they require.

During the PEI, Samantha acknowledged that mathematics can be explored through the interactions in which children engage when discussing their art with the educator or a peer. She mentioned “There can always be maths associated with drawing. The children will draw things often and then count them or talk about them” (Samantha - Interview with 4YOK Educator).

Art activities also often provide an inherent opportunity for children to create a pattern, as was clearly demonstrated in free-play activities such as the *Stones and Spoon Activity: 4YOK-0044* and the episodes with geo blocks, as well as during intentional planned activities such as the episodes with flower petals in the 3YOK.

8.4.2 Literacy and Fine Motor

The research on literacy in early childhood is vast (see, for example, Raban & Scull, 2013; Watson & Wildy, 2014) as is that on the importance of including fine motor activities to help build hand strength for use in writing (see, for example, Bhatia, Davis, & Shamas-Brandt, 2015; C. Brown, 2010; Lust & Donica, 2011; Roebers & Jäger, 2014). Due to the connection between Fine Motor skills and Literacy in this age group, this section has included some of the episodes coded as Fine Motor into the analysis in this section. The episodes that were identified as significant within these codes are shown in Table 8.6, together with their mathematical codes.

Table 8.6
Literacy and Fine Motor Activity Episodes and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
A Long Long Long Tail: 4YOK-0003	p. 171		X									X								X	X					X
Box Construction and Collage: 3YOK-0024	p. 108	X			X	X														X		X	X	X	X	X
Colouring with Pencils: 5LDC-0162	p. 254	X	X										X							X						X
Coming to the Mat: 3YOK-0070	p. 102													X						X				X		X
Days of the Week Poster: 5LDC-0219	p. 240									X					X	X								X		
Drawing Materials: 3YOK-0019	p. 115					X								X						X					X	X
Easel for Chicken Drawings: 4YOK-0040	p. 168	X	X		X	X								X						X	X				X	X
Easel Stamping: 3YOK-0015	p. 116	X																			X				X	X
Exploring Recyclables: 5LDC-0130	p. 240			X		X					X									X	X				X	
Giraffe Painting: 4YOK-0144	p. 169	X	X		X	X						X	X	X				X	X	X	X			X	X	X
Googling Chickens: 4YOK-0001	p. 195		X	X		X														X	X					
How to Make a Book: 4YOK-0053	p. 165		X		X	X							X							X				X	X	X
Jack's Homemade Book: 4YOK-0002	p. 162																			X	X		X	X		
Kyle's How To Make a Book: 4YOK-0049	p. 163				X	X							X							X				X		X
Office Play: 5LDC-0004	p. 251											X		X	X		X							X		
Olympic Rings Cooking: 5LDC-0115	p. 271			X	X	X		X	X	X	X	X	X	X		X			X	X				X	X	
Personal Tubs: 5LDC-0206	p. 237													X						X				X		
Picture of the Tooth Fairy: 4YOK-0027	p. 172		X																		X				X	X
Reading in Group Time: 3YOK-0101	p. 130					X				X										X				X		
Reading Numerals: 5LDC-0126	p. 252											X		X	X									X		
Room Set-Up: 3YOK-0089	p. 99	X																		X						X
Rules for the Mat: 4YOK-0133	p. 159				X											X	X			X				X		X
Samantha Reads to Jane: 4YOK-0052	p. 185				X									X						X		X		X		
Show and Tell: 5LDC-0011	p. 241									X											X					X
Story Time: 5LDC-0130	p. 239			X	X	X					X									X				X		
There Was an Old Lady Story: 4YOK-0129	p. 198					X						X			X						X			X		
Witch Story Group Time: 4YOK-0024	p. 160		X	X	X	X		X				X	X	X						X	X	X		X		X

One of the many activities that educators regularly include in their programming is reading stories. As discussed in the vignettes, whether they are whole group, small group, or one-on-one interactions, reading a story offers many opportunities to engage in mathematically-rich interaction. The content of the story (see, for example, *Story Time: 5LDC-0130*) may provide opportunities to discuss all manner of mathematical concepts, such as measurement, comparison, and patterns, while pointing to objects in the illustrations can include one-to-one correspondence and counting, as well as geometric and navigational awareness.

Educators can also introduce the concept of sequencing as the story progresses, by asking the children to retell the story, or to think about what might come next (see, for example, *There Was an Old Lady Story: 4YOK-0129* or *Witch Story Group Time:*

4YOK-0024 160). Sequencing was also apparent when following the recipe in *Olympic Rings Cooking: 5LDC-0115* .

Interestingly, while Samantha placed both images showing stories (*Samantha Reads to Jane: 4YOK-0052* and *There Was an Old Lady Story: 4YOK-0129*) into the *Obvious Mathematics* pile, Nikki chose the *No Mathematics* pile for the two images of stories (*Exploring Recyclables: 5LDC-0130* and *Story Time: 5LDC-0130*) from her centre.

Samantha also scaffolded the children's learning through opportunities for the children to make their own books. These activities provided further practice in counting, sequencing, classifying, and measuring, as well as building symbolic, geometric, and navigational awareness as the children discussed the materials required for the book and how to go about making them.

Due to the overlap of episodes within multiple themes and to avoid repetition, the discussion of the mathematics in the other Literacy and Fine Motor episodes can be found in the following sections: blocks, (Section 8.2.1, p. 300), play dough and clay (Section 8.2.3, p. 303), puzzles (Section 8.2.4, p. 304), and art activities (Section 8.4.1, p. 313).

8.4.3 Music

The three musical interactions included opportunities to explore very similar mathematical concepts with the children. Musical activities were evident in two of the three centres, and the episodes that were coded as Music are shown in Table 8.7, together with their mathematical codes.

Table 8.7
Music Activity Episodes and Their Mathematical Codes

Episodes	Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation

Dancing at Group Time: 5LDC-0130	p. 238	X	X		X		X	X	X	X
Pass it to Your Neighbour: 4YOK-0049	p. 161	X	X	X		X	X	X	X	X
Show Me Your Dance Moves: 5LDC-0090	p. 246	X	X		X		X	X	X	X

Two of these three episodes included dancing. When educators repeat a set of dance moves they model patterns and sequencing, additionally when they dance and move their bodies to the beat of the music, getting faster or slower, they model speed measurement concepts. During the PEI when Nikki was discussing *Dancing at Group Time: 5LDC-0130* , she explained that music was a good way to explore geometric and navigational concepts, although she admitted that often music was played to help children "get some energy out" and that she was "not actually thinking about how much mathematics was included in dancing … [Now] I can see, that they're learning spatial awareness, umm, but back then I wasn't planning a maths activity" (Nikki - Interview with 5LDC Educator).

The third Music episode, *Pass it to Your Neighbour: 4YOK-0049* , was a whole-group activity that was included many mathematical concepts. Educators have opportunities with these types of activities to explicitly scaffold the children's mathematical learning through discussions of musical terminology – for example, by explaining to the children that *Beat* is the speed at which music is played, and then encouraging the children to clap to the beat.

Clapping can also be used to explore patterns. While, surprisingly, there were no musical activities observed at the 3YOK, Serena mentioned in the PEI that she would often explore patterns with the children through music, explaining, "In that group…, there had been quite a strong thread of our [pause] clapping and copying clapping patterns" (Serena - Interview with 3YOK Educator).

8.4.4 Science

Science is also identified in education literature as an important topic for early childhood (see, for example, Campbell & Jobling, 2012; Doyle, 2011; Fleer &

Ridgway, 2007; Hong & Diamond, 2011). Three common threads in the Science code were gardening, animals, and cooking. The episodes that were coded as Science are shown in Table 8.8, together with their mathematical codes.

Table 8.8
Science Activity Episodes and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Cooking Episodes																										
Cooking in the Cubby House: 5LDC-0133	p. 265			X	X	X			X	X	X	X	X							X				X		
Cooking in the Sandpit: 3YOK-0040	p. 120			X	X				X	X	X		X						X					X		X
Olympic Rings Cooking: 5LDC-0115	p. 271			X	X	X		X	X	X	X	X	X	X		X			X	X				X	X	
Outdoor Kitchen and Sandpit: 4YOK-0048	p. 191	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X
Gardening Episodes																										
Are the Strawberries Ripe?: 3YOK-0030	p. 127					X				X										X	X			X		
Eating Carrots: 3YOK-0034	p. 129																			X	X					
Filling Containers: 4YOK-0075	p. 192	X		X	X	X					X		X							X	X					X
Flowers You Can Pick: 3YOK-0040	p. 128																			X	X					
Group Time with Flower Petals: 3YOK-0014	p. 117				X						X			X						X		X				X
Parts of a Carrot: 3YOK-0037	p. 128																			X	X					
Separating Petals: 3YOK-0018	p. 118										X		X	X						X						
Two Girls with Animals: 4YOK-0060	p. 184	X				X								X						X	X					X
Animal Episodes																										
Chickens and Temperature: 4YOK-0020	p. 194				X	X			X				X					X		X	X					
Chickens and Temperature: 4YOK-0020	p. 194				X	X			X				X					X		X	X					
Googling Chickens: 4YOK-0001	p. 195		X	X		X														X	X					
Watching Eggs Hatch: 4YOK-0145	p. 195	X																					X			X
Other Episodes																										
Checking the Speed of Trains: 4YOK-0019	p. 183		X					X		X				X						X	X		X			X
Exploring Recyclables: 5LDC-0130	p. 240			X		X					X									X	X				X	
Marble Run Construction: 4YOK-0083	p. 184		X			X		X						X						X			X	X	X	X
Story Time: 5LDC-0130	p. 239			X	X	X					X									X				X		

Most of the images that were used in the PEIs that were also identified as Science were placed in the *Obvious Mathematics* piles. However, Serena placed *Eating Carrots: 3YOK-0034* in the *No Mathematics* pile, and commented that, “Looking at the carrot and which parts of that you can eat, I would interpret more as a scientific sort of activity” (Serena - Interview with 3YOK Educator). This episode included both classification and comparison, and with a little scaffolding by the educator, it would be easy to include sequencing, geometric shapes, and sizes as they discussed how carrots grow. Serena's comment was a clear example of the inability educators may have with acknowledging the connections between mathematics and science.

Cooking was popular across all three centres and the educators were aware that cooking, whether real or pretend, provided numerous mathematical concepts to explore. Serena noted the potential for children to have explored some of these concepts outside of the preschool, when she stated, "I think parents, particularly the ones who involve the children in cooking, do quite a lot of measurement and talk about quantity".

Nikki placed the *Olympic Rings Cooking: 5LDC-0115* image in the *Obvious Mathematics* pile, stating, "I remember that experience and I just cringe about it if I saw that video now. I just remember it perfectly and I remember, I just remember the [pause] I guess, the maths I missed in this video that I can see now" (Nikki - Interview with 5LDC Educator). During the PEI, she was able to identify measurement concepts relating to amount, size, and volume in this image.

The other Science activities included a story and discussion on recycling in the 5LDC: *Exploring Recyclables: 5LDC-0130* and *Story Time: 5LDC-0130* . Nikki placed both images in the *No Mathematics* pile during the PEI, yet they were coded with seven mathematical concepts during the analysis. During the PEI, Nikki forgot she had discussed the size of the boxes with the children and reflected that she could "have measured, we could have filled the boxes up with things, umm, we could have weighed the boxes".

Due to the overlap of episodes within multiple themes and to avoid repetition, the discussion on the mathematics in Science can also be linked with the following: Containers, (Section 8.2.5, p. 304) and Trains and Marble Run (Section 8.2.7, p. 305).

8.4.5 Dramatic Play

Dramatic play episodes provided opportunities for the children to explore social roles and through this, gain an understanding of classification as they discussed and explored the criteria for each role. The episodes that were coded as Dramatic Play are shown in Table 8.9, together with their mathematical codes.

Table 8.9
Dramatic Play Activity Episodes and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Boys and Lego Roads: 4YOK-0083	p. 179	X	X			X								X						X	X		X	X	X	X
Building the Pirate Ship: 5LDC-0084	p. 256				X	X														X	X				X	X
Checking the Speed of Trains: 4YOK-0019	p. 183		X					X		X				X						X	X		X			X
Climbing Dinosaurs: 5LDC-0030	p. 266		X			X																				X
Cooking in the Cubby House: 5LDC-0133	p. 265			X	X	X			X	X	X	X	X							X				X		
Cooking in the Sandpit: 3YOK-0040	p. 120			X	X				X	X	X		X						X					X		X
Doll House Activity: 4YOK-0042	p. 153	X				X				X				X						X				X		X
Einee Meenee Minee Moe: 5LDC-0020	p. 246		X									X		X						X		X		X		X
Emergency Vehicles: 4YOK-0009	p. 182	X	X		X	X														X	X				X	X
Four Children with Cars: 4YOK-0006	p. 181	X	X		X	X														X	X				X	X
Home Corner: 4YOK-0025	p. 178			X	X				X	X	X		X	X						X				X		
Large Soft Blocks: 5LDC-0003	p. 255	X			X	X														X	X				X	X
Lego Baddies: 4YOK-0029	p. 179		X		X	X		X						X						X	X				X	X
Office Play: 5LDC-0004	p. 251											X		X	X		X							X		
Outdoor Kitchen and Sandpit: 4YOK-0048	p. 191	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X
Play Dough Table: 5LDC-0124	p. 247		X	X	X	X			X	X	X	X	X	X							X				X	
Room Set-Up: 3YOK-0089	p. 99	X																		X						X
Sandpit: 3YOK-0001	p. 119			X		X					X	X	X	X							X	X				X
Small Play Set Up: 4YOK-0047	p. 154	X	X		X	X					X		X	X						X	X	X		X	X	X
Train on a Slope: 5LDC-0154	p. 257		X					X								X						X			X	X
Two Girls with Animals: 4YOK-0060	p. 184	X				X								X						X	X					X

A clear example of classification in dramatic play was observed in *Einee Meenee Minee Moe: 5LDC-0020* . In their play, the children's ability to understand the rules of classification were demonstrated. Rachelle was the mother and Raeanna was the baby, and it was important for the game that each stayed in character. Matea and Raeanna were explaining to Rachelle that mothers do not have day-time sleeps, only babies do. Educators have many opportunities to scaffold dramatic play such as this, and to explore with the children the different categories in which their role play personas can belong.

Additionally, these episodes also provided opportunities for the children to explore the mathematics that they may engage with in real life, when dealing with topics such as money, animals, building, travel, cooking, and gardening, and not-so-real life topics such as dinosaurs and fairies.

8.4.6 Sport and Gross Motor

The episodes that were coded as Sport and Gross Motor were also shown to overlap, and therefore are also drawn together for discussion under this theme. The episodes identified with these codes are shown in Table 8.10, together with their mathematical codes.

Table 8.10
Sport and Gross Motor Episodes and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Ball Skills: 5LDC-0137	p. 263	X	X					X																X		X
Boy Climbing Over Tunnel: 4YOK-0013	p. 189	X	X			X																			X	X
Building the Pirate Ship: 5LDC-0084	p. 256				X	X														X	X				X	X
Burying the Dinosaur: 5LDC-0131	p. 265		X			X																	X			
Climbing Bridge: 3YOK-0027	p. 122		X											X										X		X
Climbing Dinosaurs: 5LDC-0030	p. 266		X			X																				X
Climbing Frame: 3YOK-0036	p. 123		X																					X		X
Cooking in the Sandpit: 3YOK-0040	p. 120			X	X				X	X	X		X						X					X		X
Dancing at Group Time: 5LDC-0130	p. 238						X	X						X								X		X	X	X
Down the Slide: 5LDC-0153	p. 269		X					X				X			X	X										X
Emergency Vehicles: 4YOK-0009	p. 182	X	X		X	X														X	X				X	X
Filling Containers: 4YOK-0075	p. 192	X		X	X	X					X		X							X	X					X
Four Children with Cars: 4YOK-0006	p. 181	X	X		X	X														X	X				X	X
Heavy Bucket: 3YOK-0003	p. 119			X							X		X						X		X		X			
Hide and Seek: 3YOK-0002	p. 126		X																							X
Hula Hoop Basketball: 4YOK-0071	p. 190		X	X	X	X						X							X	X	X		X			X
Large Soft Blocks: 5LDC-0003	p. 255	X			X	X														X	X				X	X
Long Jump: 5LDC-0134	p. 270	X	X																		X					X
Obstacle Course: 3YOK-0042	p. 121		X			X		X								X					X			X		X
On the Swings: 5LDC-0132	p. 268		X					X													X					X
Outdoor Kitchen and Sandpit: 4YOK-0048	p. 191	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X
Patterns with a Rake: 3YOK-0040	p. 121	X	X																			X			X	X
Running on the Path: 3YOK-0033	p. 101		X					X													X					X
Sandpit: 3YOK-0001	p. 119			X		X					X	X	X	X							X	X				X
See Saw: 3YOK-0028	p. 123		X					X													X			X		X
Show Me Your Dance Moves: 5LDC-0090	p. 246						X	X						X								X		X	X	X
Skipping Rope: 5LDC-0141	p. 264		X					X		X				X										X		X
Somersault Time: 5LDC-0155	p. 257		X																						X	X
Sorting Blocks: 5LDC-0025	p. 262		X		X	X				X		X		X						X	X				X	
Swing Set #1: 3YOK-0023	p. 124		X		X							X									X					X
Swing Speeds: 3YOK-0026	p. 125							X												X	X					X
Tomiko on the Monkey Bars: 4YOK-0023	p. 193	X	X					X		X		X			X								X		X	X

Tricycles: 3YOK-0022	p. 125	X	X					X													X	X			X	X
Trucks on a Shelf: 4YOK-0036	p. 189	X	X		X									X						X						X

An example of educator's inability to acknowledge potential mathematical concepts gross motor activities can be found in Serena's discussion of *Tricycles: 3YOK-0022* . She was unable to identify any mathematical opportunities in this activitiy, and felt this activity was for "gross motor skill development and social play" and therefore placed this image in the *No Mathematics* pile. Interestingly, Serena later noted how the children will often explore spatial concepts through "a lot of vehicle play, so kids are into wheels which rotate" (Serena - Interview with 3YOK Educator), yet she did not make the connection with the larger tricycle wheels.

The *Hula Hoop Basketball: 4YOK-0071 , Ball Skills: 5LDC-0137 ,* and *Skipping Rope: 5LDC-0141* episodes were three examples of games children played in their outside areas. While the hula hoop episode was not included in the PEI with Samantha, Nikki placed the other two images in the *Obvious Mathematics* pile and, with the help of the *Mathematical Concepts List for PEI* identified length, navigation, geometric, and order, as the mathematics that could be scaffolded in an activity such as the *Skipping Rope: 5LDC-0141* .

Due to the overlap of episodes within multiple themes and to avoid repetition, the discussion on the mathematics in Sport and Gross Motor curriculum can also be linked with the following sections: Blocks (Section 8.2.1, p. 300), Playground Equipment, (Section 8.2.6, p. 305), Music (Section 8.4.3, p 316), and Dramatic Play (Section 8.4.5, p. 320).

8.5 Mathematics in Social Rules and Expectations

There were some minor differences in the rules and expectations in the three centres. These rules and expectations form part of the social norms for each centre. While the norms of any classroom are usually implemented by the educators, they are also co-constructed and maintained by the participants (Blumer, 1986; Cobb & Yackel, 1996; Vygotsky, 1994).

The behavioural expectations placed on the children by the educators included the expectation that children keep the environment tidy, the expectation to try their best, the expectation to make choices during free-play, and the development of independence and autonomy. The episodes that provided clear examples of these expectations are shown in Table 8.11, together with their mathematical codes.

Table 8.11
Episodes with Behavioural Expectations and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Box Construction and Collage: 3YOK-0024	p. 108	X			X	X														X		X	X	X	X	X
Coming to the Mat: 3YOK-0070	p. 102													X						X				X		X
Cushion Hat and Play: 3YOK-0041	p. 105														X	X								X		X
Discussion on Bikes: 3YOK-0041	p. 104				X	X						X						X		X	X					
Easel for Chicken Drawings: 4YOK-0040	p. 168	X	X		X	X								X						X	X				X	X
Einee Meenee Minee Moe: 5LDC-0020	p. 246		X									X		X						X		X		X		X
Finishing the Puzzles Together: 3YOK-0005	p. 112	X	X			X														X	X			X	X	X
Group Reflection: 4YOK-0129	p. 199				X					X		X	X							X						
Group Time with Block Tray: 3YOK-0014	p. 114	X	X		X					X		X		X			X		X	X	X	X	X	X	X	X
Group Time with Flower Petals: 3YOK-0014	p. 117				X						X			X						X		X				X
Hands Up if You Can Swim: 4YOK-0002	p. 158				X							X								X	X					X
How to Make a Book: 4YOK-0053	p. 165		X		X	X							X							X				X	X	X
Hula Hoop Basketball: 4YOK-0071	p. 190		X	X	X	X						X							X	X	X		X			X
Jack's Homemade Book: 4YOK-0002	p. 162																			X	X		X	X		
Kyle's How To Make a Book: 4YOK-0049	p. 163				X	X							X							X				X		X
Lunch Helpers: 5LDC-0000	p. 243	X			X						X	X		X				X					X		X	X
Lunch Table: 4YOK-0121	p. 188				X	X				X		X	X					X	X	X	X			X		X
On the Swings: 5LDC-0132	p. 268		X					X													X					X
Outdoor Kitchen and Sandpit: 4YOK-0048	p. 191	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X
Outside Snack Time: 5LDC-0021	p. 242				X	X					X		X	X						X	X			X		
Pasta for Lunch: 5LDC-0096	p. 244			X							X		X							X	X			X		
Personal Tubs: 5LDC-0206	p. 237													X						X				X		
Photo Wall: 4YOK-0131	p. 155				X															X						X
Pictures and Hooks: 4YOK-0037	p. 156													X						X				X		X
Play Dough Table: 3YOK-0096	p. 109	X		X	X	X						X	X	X	X						X				X	
Reading in Group Time: 3YOK-0101	p. 130					X				X										X				X		
Room Set-Up: 3YOK-0089	p. 99	X																		X						X
Rules for the Mat: 4YOK-0133	p. 159				X											X	X			X				X		X
Self Portraits: 4YOK-0132	p. 171		X		X	X														X	X					
Show and Tell: 5LDC-0011	p. 241									X											X					X
Show Me Your Dance Moves: 5LDC-0090	p. 246						X	X						X								X		X	X	X
Snack Time: 3YOK-0004	p. 106				X					X		X		X					X	X	X		X			
Soup for Lunch: 5LDC-0017	p. 245			X							X		X							X				X		
Story Time: 5LDC-0130	p. 239			X	X	X					X									X				X		
Swing Set #1: 3YOK-0023	p. 124		X		X							X									X					X
Swing Speeds: 3YOK-0026	p. 125							X												X	X					X
There Was an Old Lady Story: 4YOK-0129	p. 198					X						X			X						X			X		

Tomiko on the Monkey Bars: 4YOK-0023	p. 193	X	X					X		X		X			X								X		X	X
Watching Eggs Hatch: 4YOK-0145	p. 195	X																					X			X
Who is Here Today?: 3YOK-0041	p. 103											*X*		*X*				*X*	*X*	*X*			*X*			
Witch Story Group Time: 4YOK-0024	p. 160		X	X	X	X		X				X	X	X						X	X	X		X		X

There were numerous routines in these episodes that the educators had in place to assist the children with the behavioural expectations. These, often small, routines were identified in such things as arrivals and departures, meal times, completing art works, or packing up. As established in the vignettes, some of these routines, such as those in *Coming to the Mat: 3YOK-0070* and *Soup for Lunch: 5LDC-0017* , were explicitly stated. Other routines, such as those in *Easel Stamping: 3YOK-0015* and *Box Construction and Collage: 3YOK-0024* , were more vague, implicit, and flexible. These routines and expectations provided opportunities for many mathematical concepts to be explored, with sequencing and classification often scaffolded by other children, as well as the educators.

The way in which the educators would move the children from one activity to another also included routines that provided opportunities to develop sequencing. In the 4YOK and 5LDC, there were times that the children were asked to line up and be counted as a way of moving from one area to another (4YOK Field Notes, 2012; 5LDC Field Notes, 2012). While these movements were not included in any of the episodes analysed, lining up was observed in *Tomiko on the Monkey Bars: 4YOK-0023* and *Down the Slide: 5LDC-0153* where the educators encouraged the children to form a straight line while they waited for their turn. While these practices may have been used for safety and class management, they also provided opportunities for children to build their geometric and navigational awareness as they formed a line, and to practise their counting and sequencing as they discussed who was next in line.

Serena placed great importance on what children did with their completed artworks; I have numerous field notes of her reminding children, "When you are finished, write your name in the top right corner and place it on the drying rack" which, as noted in *Easel Stamping: 3YOK-0015* and *Box Construction and Collage: 3YOK-0024* provided practice in sequencing and navigation. The 4YOK and 5LDC had similar expectations. While these were in place to build children's self-help skills, to ensure children's artwork was valued, and to keep the room tidy and organised, they also provided the children with sequencing and navigation practice.

Due to the importance the educators placed on the children's social and emotional development, many of these routines and expectations were also in place in order to build autonomy and independence. Social and emotional development has traditionally been a focus in early childhood environments (Berk, 2006) and both Samantha and Nikki identified these domains specifically as important in their planning for children's development.

Serena also worked on building communication skills. She mentioned in the PEI, that she preferred to use descriptive positional language to help children find objects within her room, as opposed to finding things for them, using terms such as *under, above, next to, beside, near,* and *over there* (3YOK Field Notes, 2012). While she stated in the PEI, that she did this to build children's independence, this pedagogical choice also provided the children with a rich mathematical vocabulary.

The educators were also encouraging the children to gain an understanding of fairness and the ability to share. As mentioned previously when discussing clay and play dough (Section 8.2.3), the sharing of materials provided the children with the opportunity to gain an awareness of fractions and calculation, as well as to practise comparison.

Although Nikki and Samantha both allowed children extra time to finish an activity, there was an expectation at these three centres that all children come together for the group times. The educators used classification terminology such as *all the children* and *everyone* in these interactions. Group times, which occurred two or three times a day in these centres, provided many opportunities for group discussions that included mathematical concepts. These discussions included concepts such as counting, sequencing, classification, and geometric and navigational awareness. Each centre also had clear expectation for behaviour within the group times, although the 4YOK was the only one that had written rules to follow, which, as noted in *Rules for the Mat: 4YOK-0133* , were often discussed by both the educator and the children.

As mentioned in Section 8.1.1 (p. 292), there was an expectation in the 3YOK that the toys and equipment were used in the specific play space set up for that equipment. However, the expectations in the 4YOK and the 5LDC centres were different; these children were allowed to move toys and equipment from one area to another. At times the educators were seen to encourage this, and in the 4YOK, the inclusion of the *Photo Wall: 4YOK-0131* and the *Storage of Loose Materials: 4YOK-0144* also clearly supported this. The *Mathematics in the Set-Up of the Physical Environment* theme explained how, although opposite, both of these expectations were able to provide opportunities to build classification skills.

Although, it was not mentioned in any episodes, the educators had different rules depending on whether the children were inside or outside. These were mostly concerning the speed at which the children should move and the level of noise permitted; there are numerous times in the field notes where I observed the educators, and at times the children, reminding each other of these rules. The terms often used in these interactions were “Inside feet” or “Inside voices” and specifying this criterion of *inside* provided the children with further practice in classification.

The educators’ aims for the children to build autonomy and independence were also apparent in the way the educators encouraged the children to work or play in small groups. During these episodes, the children had opportunities to share their mathematical knowledge and language with each other. There were numerous examples of children interacting with their peers throughout the case study chapters. The episodes identified as significant are listed in Table 8.12, together with their mathematical codes.

Table 8.12
Episodes Where Children are Learning Through Peer Interactions and Their Mathematical Codes

Episodes		Area	Length	Mass	Amount	Size	Sound	Speed	Temperature	Time	Volume	Rational Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Problem Solving	Pattern	Sequence	Geometric	Navigation
Ben at the Puzzle Table: 4YOK-0125	p. 167					X														X	X				X	X
Blocks on a Stick: 5LDC-0163	p. 258					X								X						X		X		X	X	X
Box Construction: 4YOK-0128	p. 173		X	X	X	X				X				X						X	X		X		X	X
Building the Pirate Ship: 5LDC-0084	p. 256				X	X														X	X				X	X
Drawing Materials: 3YOK-0019	p. 115					X								X						X					X	X
Einee Meenee Minee Moe: 5LDC-0020	p. 246		X									X		X						X		X		X		X
Emergency Vehicles: 4YOK-0009	p. 182	X	X		X	X														X	X				X	X
Finishing the Puzzles Together: 3YOK-	p. 112	X	X			X														X	X			X	X	X
How to Make a Book: 4YOK-0053	p. 165		X		X	X							X							X				X	X	X
Jack's Homemade Book: 4YOK-0002	p. 162																			X	X		X	X		
Kyle's How To Make a Book: 4YOK-0049	p. 163				X	X							X							X				X		X
Lego Baddies: 4YOK-0029	p. 179		X		X	X		X						X						X	X				X	X
Madison and Ian and Magnet Shapes:	p. 249	X	X			X								X						X	X	X	X		X	X
Marble Run Construction: 4YOK-0083	p. 184		X			X		X						X						X			X	X	X	X
Measuring Heights: 5LDC-0140	p. 267		X			X						X		X							X		X			X
Obstacle Course: 3YOK-0042	p. 121		X			X		X								X					X			X		X
Puzzle with Educator's Help: 4YOK-0027	p. 166	X																		X	X			X	X	X
Puzzles: 5LDC-0128	p. 253	X															X			X			X			X
Reading Numerals: 5LDC-0126	p. 252											X		X	X									X		
Rules for the Mat: 4YOK-0133	p. 159				X											X	X			X				X		X
Small Magnetic Block Play: 5LDC-0012	p. 259	X	X	X	X									X						X		X	X		X	X
Two Boys and Blocks: 3YOK-0020	p. 113	X	X			X						X		X					X	X	X	X	X	X	X	X

At times, the mathematical learning in these episodes was highly structured and almost formal in nature. At other times, the opportunity to learn came from simply observing other children’s play. This form of structured peer-to-peer learning was evident in three episodes involving making books in the 4YOK: *Kyle's How To Make a Book: 4YOK-0049* , *Phil’s Idea: 4YOK-0050* , and *How to Make a Book: 4YOK-0053* . These episodes demonstrated the importance Samantha placed on children working together and learning from each other.

There were also examples of both these structured and observational learning opportunities in the puzzle episodes, where children of different abilities were playing together or beside each other. One example included Ben who was observed in *Puzzle with Educator's Help: 4YOK-0027* struggling to complete a puzzle, but later in the week, immediately after observing *Christie Jack and Imogen at the Puzzle Table: 4YOK-0125* , he attempted and was able to complete this more complex puzzle during *Ben at the Puzzle Table: 4YOK-0125* . While the scaffolding provided by the educator certainly helped, Ben's completion of this second puzzle provided a good example of how children also learn by observing other children.

As mentioned in the *Mathematics Embedded in Equipment* theme, the equipment in *Blocks on a Stick: 5LDC-0163* was inherently mathematical, however, this episode, also demonstrated the way in which children can learn from each other, as Amberley worked beside her sister. Similarly, in *Building with Blocks: 5LDC-0005* , Oran was building a structure with Indianna and leading the play, however, later in *Small Magnetic Block Play: 5LDC-0012* , Indianna took more of a lead role, scaffolding Ian as they worked to build a helicopter.

In *Box Construction: 4YOK-0128* , Kyle was looked upon by his peers as an expert in this area, and was asked numerous times for his help or suggestions for their problems. As previously discussed, the cooking episodes also demonstrated the learning through observation, as the children engaged in both real and pretend cooking (see Section 8.4.4, p. 317).

8.6 Summary of Chapter 8

Throughout this thematic discussion, the role of the educator was a strong thread tying these five themes together. The *Mathematics in the Set-Up of the Physical Environment* theme demonstrated that the ways in which educators divided the room into smaller play spaces and arranged the furniture within these spaces, can create mathematical opportunities for children. Samantha mentioned during the PEI, as she looked at *Moving Chairs: 4YOK-0038* , how she often provided opportunities for children to estimate area and quantity in the smaller areas. Although this was not observed, Samantha explained how she would often encourage the children to estimate the number of children an activity was suitable for, and to support symbolic awareness ask them to draw a representation of this, stating

> When we put out a new activity sometimes they are just specifically for a couple of children. So we might talk about it with them on the mat and say "Look we have pulled out the tent today and you can see the tent is over there. How many children do you think it would be reasonable to allow in the tent at any one time?" And the children would go "five", "two", "one" and we would say "Two, I think two was a good idea". So then we make them draw a picture of two people and stick that on the tent so that the children know that's a reasonable number (Samantha - Interview with 4YOK Educator).

Importantly, while each of the educators, and their assistants, took an active role and pride in the setting-up of the early childhood centres, it was clear in the PEIs that their motivation and aims were more focused on providing an engaging environment and on the management of children's behaviour, rather than providing opportunities for mathematical development, as discussed in the PEIs. However, Serena felt strongly that the environment in which children were engaging would often provide opportunities for the children to construct their own learning, even if, at times, this learning was not part of the educator's aims.

The *Mathematics Embedded in Equipment* theme highlighted the mathematical potential embedded in early childhood equipment. Serena commented during her PEI, that equipment with "a lot of embedded mathematics … provides self-directed learning and also opportunities for staff to draw mathematical concepts out in relation to those materials" (Serena - Interview with 3YOK Educator).

However, it is important to highlight a significant issue with educators' practices within this theme. During the data collection and analysis stages, I noted that perhaps *because* preschool manipulatives are often regarded as inherently mathematical, educators may become complacent, and assume they do not need to draw out the mathematics; that they can just allow the children to play and gain mathematics incidentally.

This idea was confirmed in Serena's PEI when she noted that she believed educators were "doing" more than they realise by relying on "the other expert people who have just had input into designing the materials that are popular in kindergartens, that have those mathematical properties" and that, "the area where teachers need most support is in learning to recognise the mathematical environment and the mathematical activities that they are already doing" (Serena - Interview with 3YOK Educator).

Samantha made a similar comment, "I don't look around my room and think, oh I need to put a maths activity out, because there's probably maths incorporated in half of the activities or more that are out". She stressed that the important factor was "that educators need to be aware of HOW they incorporate maths or how it is incorporated" (Samantha - Interview with 4YOK Educator).

This highlighted the importance of ensuring educators are able to find ways to recognise mathematics in children's play and, once recognised, that they have the content knowledge to use these observations as a prompt for further planning and scaffolding of the children's mathematical development. The *Identifying the Mathematical Concepts* theme highlighted that while there was an initial hesitancy in identifying mathematical concepts in activities in which the children were engaging, the educators were clearly able to identify mathematics in these interactions when asked to reflect on the relevant image.

The use of the *Mathematical Concepts List for PEI* was an effective tool in getting the educators to think about mathematical content, with all three educators able to connect multiple mathematical concepts to images they had previously identified as containing *No Mathematics* or *Not So Obvious Mathematics* . All three were also able to provide additional examples of activities or interactions that could be used in the teaching of these mathematical concepts.

Incorporating the mathematics requires Pedagogical Content Knowledge (PCK). The *Acknowledging Mathematics Within Other Curriculum Areas* theme discussed the gap in the acknowledgement and support of mathematical development in activities which educators identify as being part of other curriculum areas. The activities and interactions I observed were clearly well thought out and planned to help children reach the goals set by the educators. However, the ability of the educators to also acknowledge the mathematical concepts the children were building was often absent. This theme discussed the mathematical content that can be found in other curriculum areas and ways such content can be scaffolded by the educators to build children's mathematical content knowledge.

Of course, the opportunity to extend mathematical awareness cannot always be taken. For example, in *Picture of the Tooth Fairy: 4YOK-0027* , Imogen included clear geometric aspects in her drawing which were not acknowledged by the relief educator, Nicole. Perhaps this was due to Nicole's knowledge of Imogen's interests and needs, or due to the length of interaction which lasted only 21 seconds. But during the PEI, Samantha was able to identify how she could bring all of the mathematical concepts into this interaction through simple sentences, such as "The tooth fairy, look the fairy is really big. The tooth fairy is taller then you in the picture" (Samantha - Interview with 4YOK Educator).

Another way educators can support mathematical development was highlighted in the *Mathematics in Social Rules and Expectations* theme. Simple discussions and reminders to follow the routines and behavioural expectations of the centre provided many implicit opportunities to explore mathematical concepts. While some routines and expectations were different across the centres, and potentially different from the children's home environments, building the children's understanding of these social norms supported their classification skills, as they gained an understanding of acceptable and non-acceptable behaviours within different areas and environments.

The opportunity to explore mathematics in the rules and expectations of each centre were further strengthened as the children were also discussing and re-enacting some of these routines in dramatic play. For example, in *Einee Meenee Minee Moe: 5LDC-0020* , Matea and her friends were pretending to be a family and their play included feeding and sleeping routines similar to the centre.

This theme also demonstrated the ways in which the children were learning mathematics from each other. While at times the children may not have been aware of the learning other children were gaining from observing them, the episodes in this theme demonstrated how this was occurring. These episodes also provided evidence of how the children were able to explicitly teach each other.

9 Conclusion

This study examined the mathematically-rich interactions occurring in early childhood centres. It was undertaken in three centres in Victoria, Australia, with participants including children from three to five years of age and their educators. The centres were two sessional kindergartens and one long-day care centre as these are the most common early childhood settings for Victorian children in the year prior to starting school (Department of Education and Early Childhood Development [DEECD], 2011).

To re-cap, the research questions posed in Section 2.5 (p. 32) were:

RQ1: What constitutes a mathematically-rich interaction in early childhood centres?

RQ2: How do early childhood educators plan and scaffold for mathematically-rich interactions?

RQ3: What roles do the physical and social environments play in mathematically-rich interactions?

RQ4: What role do children play in scaffolding mathematically-rich interactions?

Five themes were identified and discussed in Chapter 8 – Mathematics in the Set-Up of the Physical Environment (Section 8.1), Mathematics Embedded in Equipment (Section 8.2), Identifying the Mathematical Concepts (Section 8.3), Acknowledging Mathematics Within Other Curriculum Areas (Section 8.4), and Mathematics in Social Rules and Expectations (Section 8.5). While simply discussing these themes individually may have provided answers to the research questions, there is, as Bazeley (2009) states, “a problem also in being purely descriptive, presenting each theme in sequence. … Themes only attain full significance when they are linked to form a coordinated picture or an explanatory model” (p. 9).

It is the interpretation of these themes, within the larger context, that is required to fully understand the data and to answer the Research Questions. The following four sections address each of research questions in turn. The recommendations resulting from this study are then presented in Section 9.5. This is followed by Section 9.6, a discussion of the strengths and limitations of this study, and suggestions for further research. Section 9.7 provides the researcher's final remarks, and concludes the thesis.

9.1 Mathematically-Rich Interactions

The aim of the first research question (RQ1) was to gain an understanding of what mathematically-rich interactions look like within early childhood centres. As noted in the Literature Review (p. 10), educators are not always able to identify the mathematics in the activities in which children are engaging. In Section 4.3.1 (p. 67) the working definition I put forward for *Mathematically-Rich Interactions* was *children talking to or doing things with others, or with objects in their environment, to explore mathematical concepts and use mathematical language.*

Throughout the analysis it became clear that, while there were opportunities to explore mathematical concepts and use mathematical language in the 130 vignettes presented in the case study chapters, this potential was not always acknowledged or supported by the educators. As noted in the *Identifying the Mathematical Concepts* theme (p. 306) and the *Acknowledging Mathematics Within Other Curriculum Areas* theme (p. 311) the educators were not always able to identify the mathematics present in some of the interactions in which the children were engaged, particularly in those that are traditionally thought of as belonging to other curriculum areas.

For example, all of the educators were able to identify opportunities for the children to explore mathematics in episodes that took place in the sandpit in each centre. However, when presented with the images shown in Figure 9.1, Serena was only to identify the mathematics found in cooking, not the potential for developing children's measurement and other mathematical concepts when they used the equipment as shown in the other two images.

Cooking in the Sandpit: 3YOK-0040 (p. 120)

Sandpit: 3YOK-0001 (p. 119)

Heavy Bucket: 3YOK-0003 (p. 119)

Figure 9.1 Mathematically-Rich Interactions in the 3YOK Sandpit

While most of the cooking episodes observed were pretend cooking interactions between small groups of children, the opportunity exists for educators to engage the children in mathematically-rich interactions during both real and pretend cooking activities. Simple statements such as “Next, you add half a cup of flour” explore sequencing, volume and fraction. Turning the statement around to ask, “What are you going to add next?” and responding with, “How much/many do you need?” or “Why are you adding sugar?” encourages the child to discuss measurement and describe the characteristics of the ingredients they are adding.

While the conversations during meals at the three centres (see Figure 9.2) varied greatly they were frequently mathematically-rich and provided opportunities for the children to share their mathematical knowledge. Some children were using navigational terminology such as *opposite, next to* and *across from* as they chatted about where they were sitting in relation to the each other, while others used descriptive mathematical language to describe the amount of food they had eaten, and one child demonstrated his calculation skills when he stated, “There are two on that side and two on this side, so there is four people”. Both Serena and Nikki chose the *Not So Obvious Mathematics* pile for the meal time interactions from their centres.

Lunch Table: 4YOK-0121 (p. 188)

Soup for Lunch: 5LDC-0017 (p. 245)

Soup for Lunch: 5LDC-0017 (p. 106)

Figure 9.2 Mathematically-Rich Interactions During Meals

In some episodes, it was the equipment used by the children that educators identified as mathematical. For example, there were four episodes discussed in the PEIs that related to puzzles (see Figure 9.3). All of these were placed in the *Obvious Mathematics* pile, with the educators identifying mathematical concepts such as, area, length, and size measurements, classification, comparison, sequence, and geometric and navigational awareness, as evident in the images. However, only two of the episodes included one-on-one scaffolding with an educator, while the other two included peer scaffolding.

Finishing the Puzzles Together: 3YOK-0005 (p. 112)

Educator at the Puzzle Table: 3YOK-0021 (p. 111)

Puzzle with Educator's Help: 4YOK-0027 (p. 166)

Puzzles: 5LDC-0128 (p. 253)

Figure 9.3 Puzzle Episodes

As the researcher in this study, I was able to identify the potential to explore mathematics in all of the 130 vignettes. However, while the educators were more hesitant in identifying mathematics at the start of the PEIs, they were all able to identify opportunities to engage children in mathematically-rich interactions when discussing individual images or providing examples from their pedagogical practices. This is discussed further in answering RQ2 below.

9.2 Planning and Scaffolding for Mathematics by Early Childhood Educators

The aim of the second research question (RQ2) was to look at how educators plan for and scaffold children's mathematical development. There was a clear indication during the PEIs that these educators all believed that mathematical education was important in the early childhood programs. However, when directly asked how they planned for mathematics, they all indicated that mathematics was rarely, if ever, planned for as a specific topic. For example, Samantha stated, "I don't [pause] plan specifically the mathematics. I don't look around my room and think, 'Oh, I need to put a maths activity out', because there's probably maths incorporated in half of the activities or more that are out anyhow" (Samantha - Interview with 4YOK Educator, 2013). The fact that all these educators believed they did not need to plan for mathematics may be due to the fact that they all used an emergent, play-based style of programming, rather than focussing on individual topics.

During the interviews, the educators clearly indicated that they were likely to teach mathematical content through discussions; providing mathematical language and content as they scaffolded children's play. For example, Samantha explained that with activities such as *Marble Run Construction: 4YOK-0083* (p. 184), which she had identified as containing *Obvious Mathematics* , she would engage the children in a conversation, "If it wasn't working I'd say 'well if you have a look at the height of this one and if you have a look at that, you know, it needs to travel downhill' and talk to them about that" (Samantha - Interview with 4YOK Educator, 2013).

Similarly, when Nikki was reflecting on *Face Sorting Set-Up: 5LDC-0170* , which she had identified as having *Not So Obvious Mathematics* , she realised that she could draw out the mathematics easily, by simply “sitting with the children and just having a conversation about it, and asking them what they think. About where the faces should go, what is the difference between these two faces, and, you know, how many can we find” (Nikki - Interview with 5LDC Educator).

These mathematical conversations were also noted in the way educators managed children’s behaviour, such as when children were reminded about where equipment belonged, how many children were able to play in activities, or the rules for group times. These social interactions were explored in greater depth in the *Mathematics in Social Rules and Expectations* theme (p. 322) and are discussed further in answering RQ3.

Despite this lack of formal planning, the educators’ pedagogical practices were still instrumental in providing opportunities for mathematical development, even if, at times, they were unaware of the depth of this potential. For example, through the set-up of the centres, the educators created an environment that provided opportunities for children to be surrounded by mathematics as they play. The way educators divided the room into specific play spaces provided opportunities for exploring area and classification, and the set-up of table activities provided opportunities for exploring one-to-one correspondence, counting, and building navigational awareness. Further mathematical opportunities were highlighted in the *Mathematics in the Set-Up of the Physical Environment* theme (p. 291) and these practices are also discussed below in answering RQ3 in Section 9.3.

The choices educators made in the selection and purchase of equipment also affected the potential for mathematical learning. As discussed in the *Mathematics Embedded in Equipment* theme (p. 298), this study found that some equipment – for example the blocks, puzzles, and tape measures – included embedded mathematical concepts. Playing with this equipment provided opportunities for the children to develop a variety of mathematical concepts and, as mentioned in the *Mathematics in Social Rules and Expectations* theme, the children were often observed playing together, which allowed them to share and scaffold each other's mathematical development.

However, educators may assume that, because some preschool equipment is inherently mathematical, they do not need to draw out the mathematics in activities that include this equipment; but can just allow the children to play with the equipment and gain mathematical knowledge incidentally. This was observed with the Lego equipment in the 4YOK, when Samantha identified the equipment as mathematical during the interview. Yet, during the two weeks of observations, while the children were engaged and exploring mathematical concepts such as classification and measurement, and building their navigational awareness in these episodes, Samantha was not observed discussing any mathematical ideas or using any mathematical language with the children at the Lego tables.

Similarly, in her interview, Serena specifically identified the box of blocks two boys were using as having been purchased for its mathematical properties, but did not interact with the children. However, in this case, she did engage with the children in a later group time to explore some of these mathematical.

Even though the three educators confirmed they did not plan for specific curriculum areas, there were activities they set up that they appeared to think of as traditionally belonging to other curriculum areas or developmental domains, such as Literacy, Science, Art, Gross Motor, or Fine Motor; these episodes were shown in the case study to be mathematically-rich. However, at times, the educators had difficulty acknowledging the mathematics in these activities. Samantha's surprise at the depth of the mathematics in *Giraffe Painting: 4YOK-0144* (p. 169) was a strong example of this. This episode and other examples are discussed in the *Acknowledging Mathematics Within Other Curriculum Areas* theme (p. 311).

Therefore, this study has found that the educator's planning and scaffolding included creating a mathematically-rich environment, the purchase and inclusion of equipment to support mathematical development, and through individual or group conversations providing children with the mathematical language to discuss and understand these concepts.

9.3 The Role of the Physical and Social Environment

The aim of the third research question (RQ3) was to investigate the role the physical and social environment of early childhood centres played in the mathematically-rich interactions that were occurring in the centres.

The physical environment included specific play spaces and the way the activities were set up by the educators. This study found that children can learn mathematics through their movement within the early childhood centres. As the children played in specific areas, moved to new activities, or found and returned equipment, their interactions with others provided opportunities for explicit and incidental mathematical learning. For example, as the children came together for group times, the shape and size of the mat provided opportunities for the children to build navigational and geometric spatial awareness, and gain an understanding of area. As the children moved from group time, they were often asked in which area they would like to play, and the labelling of these specific play spaces as, for example, *Block Area, Box Construction, Home Corner,* or *Playground,* assisted the children with learning to classify as they learnt where equipment belonged.

The way in which the table activities were set up for a specific number of children was also built counting and one-to-one correspondence skills and increased the children's spatial awareness. Often this learning was incidental, but at times these interactions were also scaffolded by the educators. For example, in *Snack Time: 3YOK-0004* (p. 106) Serena had a short discussion with James about the number of chairs at the snack table, addressing the mathematical concepts relating to counting, one-to-one correspondence, comparison, problem solving, and calculation.

The second part of this question relates to the role of the social environment in children's mathematical development. Children's interactions with educators were often observed to be connected with the routines and social rules of the centre. For example, the routines to join and leave the group times discussed above were also identified as social. There were expectations during these group times about where the children would sit (in a circle or semi-circle) and the rules they would follow. Samantha's regular reference during group times to the stick figures in *Rules for the Mat: 4YOK-0133* (p. 159) is an example of how these social rules can also build symbolic mathematical awareness. At each centre, as the children left the mat, they would choose where they would play and, as shown in *Cushion Hat and Play: 3YOK-0041* (p. 105), this required them to take into account the number of children at an activity, and where equipment could be used or taken.

Sequencing was also clearly identified in numerous small routines – such as those relating to arrivals or cleaning up – that occurred in all three centres. As discussed in the *Mathematics in Social Rules and Expectations* theme (p. 322), the social norms of each centre provided opportunities within these small daily interactions for children to develop their understandings of a variety of mathematical concepts. Children's interactions with their peers were also affected by the social rules of the centres, with educators encouraging the children to work together. This is discussed further in the next section.

9.4 The Role of Children in Scaffolding Mathematically-Rich Interactions

The aim of the fourth research question (RQ4) was to explore the ways in which children were scaffolding each other's learning as they engaged in mathematically-rich interactions.

As noted in Section 3.1 (p. 35) this study drew on Vygotsky's socio-cultural theory (Vygotsky, 1966, 1978a, 1978b) and this question looks at the way in which children can be identified as the "more capable peers" in Vygotsky's theory of the *Zone of Proximal Development* (ZPD) (1978a, p. 86).

Many of the interactions where children were scaffolding each other's learning took place due to the set-up of the environment and the social norms of the centre. The vignettes in the case study chapters provided many examples of how the children were engaged in mathematically-rich interactions as they were co-constructing the social rules, and following the behavioural expectations of the educators within the various play spaces in each centre, as noted in response to RQ3.

The children in this study were learning mathematics from observing each other, as shown in *Ben at the Puzzle Table: 4YOK-0125* (p. 167), and, at times, explicitly teaching each other a variety of mathematical concepts, as shown in *Kyle's How To Make a Book: 4YOK-0049* (p. 163) where he was explaining to a peer about the size of the paper, and included both fractions and sequencing in his explanation. As noted in the *Mathematics in Social Rules and Expectations* theme, once the children start to develop these mathematical concepts, and have the language to talk about them, they can share this knowledge with their peers.

There are strong links here with RQ2, as when educators are not aware of, or do not acknowledge, the mathematical interactions in which the children are engaged, the educators are unlikely to include the relevant mathematical concepts in the language and interactions they share with the children. The children then have reduced opportunities to gain an awareness of the mathematical concepts, and therefore reduced opportunities to scaffold each other's mathematical play.

9.5 Recommendations from this Study

While this research was conducted in three early childhood centres in Victoria, Australia, there are implications from the findings of this study that make this research useful for a much broader audience. I have identified two major areas in educator training where this study could benefit the field of early childhood education. The recommendations for early childhood educator training, both pre-service and practising educators is generalizable internationally and suitable for multiple modes of delivery. Educator training that builds mathematical pedagogical content knowledge will have flow-on benefits for the children these educators are teaching.

9.5.1 Recommendations for Pre-Service Educator Training

In this research, it was evident that the actions of the educator are very important in providing opportunities for children's mathematical development. Yet, the identification and acknowledgement of mathematical concepts in activities that educators see as belonging to other curriculum areas – such as Art, Drama, Literacy, Music, Science, and Sport – were not always present.

To address this gap, it is important that opportunities for pre-service educators to make the connections with other curriculum areas are available within the Mathematics unit of an Early Childhood Degree. This can be achieved by providing pre-service educators opportunities to discuss short vignettes, such as those in the case study chapters that focus on these other curriculum areas. Assessment could then focus on their ability to identify mathematical concepts and plan ways in which they could scaffold the children in their interactions to build these concepts.

Alternatively, this can be addressed within the teaching of the other curriculum areas, with examples of how mathematical content can add value to these areas. Science units could highlight mathematical concepts within the content they include, such as measuring plant growth, classifying objects, or graphing results. Art units may provide geometric terminology for the non-regular shapes children may draw such as *nonagons* or *heptagons*, or more precise names and an understanding of regular shapes, such as *equilateral triangle*, *ellipse,* or *parallelogram*. Music units may encourage pre-service educators to count the beat when singing with children, or clap a rhythmic pattern.

Supplying the pre-service educators with a resource, such as the *Mathematical Concepts List for PEI*, greatly increased the educator's ability to identify a greater variety of mathematical concepts in the images supplied. Activities that assess the pre-service educator's ability to connect this list to supplied images, or images taken from their practicum, may see an increase in their ability to identify mathematical content and understand the pedagogical practices required to include this content.

9.5.2 Recommendations for Practising Educators

One of the challenges in this study was determining how much information I should give to the educators, while I was observing in their centres or conducting the PEI. There were numerous occasions when I was asked questions such as, "What am I missing here?" or "What maths can you see?" As the research design was observational, rather than participatory, I generally gave little feedback. Although, I generally chose to observe rather than participate when collecting observational data, all three educators believed their pedagogical practices and mathematical content knowledge had changed as a result of participating in the study.

For example, during her interview, Nikki mentioned the value of having real-time feedback on the mathematics I was able to identify in the children's play. She reflected, "I remember when you came to us and started pointing out and showing me where maths was occurring … it made me, obviously, see things completely differently now" (Nikki - Interview with 5LDC Educator). Serena also felt her pedagogical practices had changed and believed there was a need for educators to build "their own mathematical understanding, and their understanding of mathematical teaching", suggesting this was best addressed with scaffolding by a mentor who could say “What you are doing here is mathematical and this is what we mean by this kind of concept” (Serena - Interview with 3YOK Educator, 2013).

Therefore, the relevance of professional development opportunities, where a mentor, with strong pedagogical content knowledge (PCK) in mathematics, is able to provide information to the educator whilst they are observing the children together, is clearly supported by this research.

However, as one-on-one professional development opportunities can be expensive and difficult to obtain, there are other options. This study clearly demonstrated a marked improvement in the educators’ ability to identify mathematics in their own practices when using the *Mathematical Concepts List for PEI* as a prompt. During the PEIs, the educators were able to identify a larger range of mathematical concepts in every image when they went back to look at the images with the supplied list of mathematical concepts. The list, which helped build the educators’ mathematical PCK, could also be supplemented through the creation of easy to read posters or literature that also describe mathematical concepts.

The educators themselves confirmed the value of a list such as this during the PEIs when all three asked for a copy of the list as they felt it would be a valuable resource for the teaching staff at their centre. To further enhance the value of this list, I recommend the educators personalise the provided list by adding examples from their own practice, as this would help place the mathematical concepts into context.

One way to identify these examples would be to encourage educators to utilize existing portfolio pages and observational records to undertake their own version of a photo-elicitation interview; this could be in private reflection or jointly with their peers during planning time. Sharing these reflections in parent-teacher interviews would be a valuable way to educate families about how the educators are teaching their children mathematical concepts, and provide potential ways for the parents to also build their child’s mathematical development. As children are often interested in looking at photos of themselves and their friends playing, engaging in conversations with the children about the mathematical concepts identified in the portfolio images would also be a valuable way to assess what the children have learnt and uncover any misconceptions they may have.

9.6 Strengths and Limitations of This study

There are, of course, strengths and limitations within every study. It was not feasible for this study to undertake fieldwork in a large number of early childhood centres given the limitation of being a single researcher. However, by focusing closely on three environments, it is argued that the case study approach has allowed an in-depth investigation of this topic, rather than a larger overview (Stake, 1978; Yin, 1981a).

I decided against collecting data through small group or individual interviews with the children participating in the study, due to time limitations and the desire to use observational rather than participatory action research. However, it is important to note that the inclusion of children as research partners can provide rich data including data on their opinions and interpretations of their own play (Cremin & Slatter, 2004; Danby, Ewing, & Thorpe, 2011). This has the potential to inform a deeper level of understanding of the mathematically-rich interactions that are occurring in the settings from their viewpoint.

As previously mentioned in Section 4.3.1, as a lone researcher it is impossible to completely remove one's own preconceptions, biases, and prior understanding of the subject one is studying (Schreier, 2012). As noted by Cousin (2010) "All researchers into human activities brought their own subjectivity to the research table"(p. 9), therefore, there was an importance in acknowledging my own background as a preschool educator and as a person who enjoyed mathematics. Furthermore, I believe that my background in early childhood education may allow other educators to have trust in my analysis.

However, to further help circumvent any issues of bias, I discussed the coding tree with my supervisory team during the design and analysis stages, and with the educators during the PEIs. As mentioned in Section 4.2.4, the use of photographs within the PEI's also provided opportunities to discuss the individual episodes in the study with the educators and therefore provided reliability and validity to the analysis (Kotsopoulos, 2010; Mavrou et al., 2007). Additionally, by articulating the theories and assumptions that underpin this research, it is argued that any potential biases have been made known to the readers allowing their own interpretations or generalisations to be fully informed.

While this study included 25 mathematical concepts in the analysis of the episodes, there were others that could have been included but were not observed. For example, both Samantha and Serena mentioned they had previously explored graphing with the children, yet this study found no instances of graphing in any of the three centres. Symmetry was another potential mathematical concept which is often explored in early childhood settings through the traditional folded paint-blot butterfly activity and can often be seen in children's block structures.

9.6.1 Further Studies

Gender issues were not the focus in this study, however mathematics is an area where differences may be a factor in later learning (D. Cross, 2009; Palmer, 2009). There was an instance in the block area of the 4YOK in *Emergency Vehicles: 4YOK-0009* (p. 182), where a young girl was attempting to get her friend to come to another area, and was quite vocal that blocks and cars were for boys, that "Girls don't play with cars!" Further studies comparing the different areas, interactions, and activities where children are playing, may identify differences in the potential opportunities that boys and girls have to explore mathematical concepts as they are playing and provide new knowledge.

While the participants in this study included at least five children who had been identified as having additional needs, this was not my focus. However, a study that looks at how mathematically-rich interactions may support the mathematical learning of children with additional needs may provide educators with opportunities to further improve their pedagogical practices.

A similar study on mathematically-rich interactions could also be undertaken in other early childhood educational environments such as the younger rooms in long-day care centres, occasional-care centres, or family day care.

The sharing of mathematical information with the families, may also increase children's opportunities to engage in mathematically-rich interactions. Although I did not collect data on the families of the children in this study, the routines set up by the staff for arrival and departure are worth noting, as these routines created opportunities for families to engage in and scaffold many mathematical concepts with their children.

Additionally, research has shown the importance of strong connections between early childhood centres and families, with evidence that educators who connect well with families and parental influences can be an important factor in children's mathematical development. Therefore, there is scope for a similar study to this one, focusing on the mathematical understandings of families or how educators share their knowledge of children's mathematics with families.

9.7 Final Remarks

Early childhood educators play an important role in young children's mathematical development. As the educators in this study found, when they reflected and actively looked for it, mathematics could be found or included in almost all of the interactions they have with the children in their settings. It is my hope that this research provides real world examples to demonstrate that mathematically-rich interactions can happen all the time and in all areas of early childhood centres.

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Appendix A **Glossary**

Belonging, Being and Becoming – Early Years Learning Framework [EYLF]

Planning documents for the Early Childhood Profession created in 2009 by the Australian Federal Government (DEEWR, 2009).

Culture

"The meanings and practices produced, sustained, and altered through interaction, … as used by particular people, in particular places, at particular times" (Van Maanen, 2011, p. 221).

Curriculum

"All the interactions, experiences, activities, routines and events, planned and unplanned, that occur in an environment designed to foster children's learning and development" (DEEWR 2009, p. 45).

Early Childhood Centre

For the purpose of this research, this includes all formal environments where children are cared for and educated, including, but not exclusive to, long-day care centres, sessional kindergartens, and occasional-care centres.

Educators

Adults who are caring and educating the child within the early childhood centre. As stated in the EYLF (DEEWR, 2009) and the VEYLDF (DEECD, 2009), this term may encompass people with a variety of backgrounds including: three- or four-year bachelor degrees, diploma qualifications, certificate III, untrained assistants, and parental volunteers working in the centre.

Episode

For the purposes of this research study, the term "Episode" is used to indicate any selection of the data that has been identified as a separate activity or interaction for analysis.

Family Grouping

In long-day care centres, where children of various age groups are grouped together at the beginning and end of the day because of the smaller number of children in the centre.

Floating Staff Member

An educator who moves between the rooms in a long-day care centre to ensure adult to child ratios are covered whilst other educators are taking meal or programming breaks.

Frameworks

The set of educational guidelines written by government. For the purpose of this research, the term “Frameworks” is used to indicate the EYLF and the VEYLDF (See: Belonging, Being and Becoming – The Early Years Learning Framework for Australia [EYLF]; Victorian Early Years Learning and Development Framework [VEYLDF].)

Indoor/Outdoor free-play

Opportunities for children to choose to play indoor or outdoor during free-play times.

Interactions

Interaction is defined as “the act of talking or doing things with other people” (Interaction, n.d.).

Kindergarten

For the purpose of this research, the term ‘kindergarten’ describes the year or two prior to formal schooling, as is the case in Victoria.

Multimodal Discourse Analysis

“The study of language in combination with other resources, such as images, scientific symbolism, gesture, action, music and sound” (O'Halloran, 2011, p. 120).

Numeracy

“Numeracy is the capacity, confidence and disposition to use mathematics in daily life” (DEEWR, 2009, p. 38).

Outcomes

Defined in the EYLF as “a skill, knowledge or disposition that educators can actively promote in early childhood settings, in collaboration with children and families” (DEEWR 2009, p. 8).

Pedagogical Content Knowledge (PCK)

“the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction” (Shulman, 1987, p. 8).

Pedagogical Practices

The strategies used by the educators in the teaching of children, and these are complex and multifaceted.

Pedagogy

The art or science of teaching children.

Room Set-up

Early childhood settings are arranged and made ready for each day according to the educators program. The room set-up may be fluid with new items or activities added or removed as the day progress.

Victorian Early Years Learning and Development Framework [VEYLDF]

Planning documents for the Early Childhood Profession created in 2009 by the Victorian Government (DEECD, 2009).

Zone of Proximal Development [ZPD]

The ZPD "is the difference between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978a, p. 86).

Appendix B **Ethics Approval**

Human Research Ethics

DEAKIN UNIVERSITY AUSTRALIA

Deakin Research Integrity
70 Elgar Road Burwood Victoria
Postal: 221 Burwood Highway
Burwood Victoria 3125 Australia
Telephone 03 9251 7123 Facsimile 03 9244 6581
research-ethics@deakin.edu.au

Memorandum

To: A/Prof Susan Groves
School of Education

B

cc: Mrs Kathy Ann Swinkels

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 27 March, 2012

Subject: 2012-049

Mathematically-Rich Interactions in Early Childhood Centres

Please quote this project number in all future communications

The application for this project was considered at the DU-HREC meeting held on 26/03/2012.

Approval has been given for Mrs Kathy Ann Swinkels, under the supervision of A/Prof Susan Groves,School of Education, to undertake this project from 26/03/2012 to 26/03/2016.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:

- Serious or unexpected adverse effects on the participants
- Any proposed changes in the protocol, including extensions of time.
- Any events which might affect the continuing ethical acceptability of the project.
- The project is discontinued before the expected date of completion.
- Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123

Department of Education and Early Childhood Development

Strategy and Review Group

2 Treasury Place
East Melbourne, Victoria 3002
Telephone: +61 3 9637 2000
DX [illegible]
GPO Box 4367
Melbourne, Victoria 3001

2012_001492

Mrs Kathy Swinkels
Faculty of Arts and Education
Deakin University
221 Burwood Highway
BURWOOD 3125

Dear Mrs Swinkels

Thank you for your application of 27 March 2012 in which you request permission to conduct research in Victorian government schools and/or early childhood settings titled *Mathematically-Rich Interactions in Early Childhood Centres.*

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Early Childhood Development.

2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the DEECD approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.

3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Early Childhood Development for its consideration before you proceed.

4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.

5. You acknowledge the support of the Department of Education and Early Childhood Development in any publications arising from the research.

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.

7. If DEECD has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Kathleen Nolan, Research Officer, Research and Evaluation Branch, by telephone on (03) 9637 3244 or by email at nolan.kathleen.j@edumail.vic.gov.au.

Yours sincerely

Signature Redacted by Library

Dr Elizabeth Hartnell-Young
Director
Research and Evaluation Branch

24/04/2012

Appendix C Plain Language Statement and Consent Forms

DEAKIN UNIVERSITY AUSTRALIA

Plain Language Statement and Consent Forms
for Early Childhood Director

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

Introduction:

My name is Kathy Swinkels and I am currently a PhD candidate at Deakin University. My background includes a Bachelor of Early Childhood Education (Hons) and nine years of working in various early childhood environments in both Australia and the United States.

The importance of mathematics education has been well established over the years with many studies highlighting the relationship between a child's early mathematical development and their later confidence and ability with mathematical concepts. The value of parents providing a mathematically-rich home environment is well established. However, with large numbers of children spending their days in long day care or sessional kindergartens, a joint responsibility for supplying these mathematically-rich interactions now falls to the educators. Therefore the objective of this research is to investigate the mathematically-rich interactions occurring in early childhood centres and analyse the role of the educators, and the social and physical environments.

Your Participation:

Participation in any research project is voluntary. As the director of an Early Childhood Centre (ECC), you are invited to take part in this research by allowing me access to your centre and providing copies of your policies and philosophy.

With your consent, and the consent of the educators in the room, the families and the children, two digital video cameras will be used to capture interactions that are occurring naturally in and ECC. These interactions will be analysed with the collected documents and an interview with the educator to explore the following four research questions:

- *What constitutes a mathematically-rich interaction in the early childhood centre?*
- *How do early childhood educators plan and scaffold for mathematically-rich interactions?*
- *What role does the physical and socio-cultural environment play in mathematically-rich interactions?*
- *What role do children play in scaffolding each other's mathematically-rich interactions?*

The potential benefits of participating in this research may include opportunities for your educators to reflect on the mathematics available to children in their environment, leading to stronger mathematical opportunities within your centre. There are no anticipated risks expected to arise from this research. There will be no monetary payments to any participants taking part in this research.

If the parent or guardian of a child, or the child themselves, does not wish to participate there is no adverse consequences to the child or their family. The educator and I will avoid recording when the child is in the field of the camera, and delete any video taken if the child runs through the field. To ensure children are comfortable, I propose attending your centre for a few days prior to collecting the data to allow the educators and children a chance to get to know me and feel comfortable with the cameras. All videos taken during this trial will be given to the centre to use as per your policies.

To protect participant's privacy and confidentiality all transcripts will include first names only and your centre will not be named.

A summary of results will be made available to you, your educators and families. The results of this research will be used in my PhD thesis. Results may also be reported in peer-reviewed journals, presented at national and international conferences, and used for educator training purposes. This includes the video data if consent from all participants appearing is given.

All data collected will be stored on a password protected computer at Deakin University, with the backups kept on a password protected hard drive and stored with any paper copies in a locked filing cabinet. As I am a student at Deakin University, my research will be monitored by my supervisory team to ensure it complies with ethical guidelines.

This research is partially funded through the Glendon Lean Memorial Scholarship and the School of Education at Deakin University. There are no other parties who may claim a financial or other interest in this research.

Participation is voluntary:

Participation in any research project is voluntary. I will be available to answer any questions you have about the research project and you may ask for any information you require. Please only sign the attached Consent Form after you have had a chance to ask your questions and have received satisfactory answers.

If you decide to provide consent and later change your mind, you are free to withdraw your centre from the project at any stage. Any data collected from you will not be used and will be destroyed. Your decision whether or not to take part, or to take part and then withdraw, will not affect your relationship with Deakin University. If you decide to withdraw from this project, please notify a member of the research team and complete and return the Revocation of Consent Form attached.

Contact details of the researcher:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

Complaints

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, please quote project number 2012-049 and contact:

The Manager,
Office of Research Integrity,
Deakin University,
221 Burwood Highway,
Burwood Victoria 3125,

phone: 9251 7129,
fax: 9244 6581;
email: research-ethics@deakin.edu.au

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UNIVERSITY AUSTRALIA

Early Childhood Director Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I have read and I understand the attached Plain Language Statement and I give my permission for staff members, families and children of:

____ (Centre name)

____ (Centre Address), to

participate in this project according to the conditions in the Plain Language Statement, a copy of which I have been given to keep.

I agree that …

- *our centre WILL NOT be named in research publications or other publicity.*
- *we DO / DO NOT require an opportunity to check the factual accuracy of the research findings related to our institution/organisation.*
- *we EXPECT to receive a summary of the research findings or publications that we may share with our families.*
- *We CONSENT to the use of selected video clips for presentations at national and international conferences, and used for educator training purposes by the researcher, Mrs Kathy Swinkels, **only** provided consent is granted by all participants appearing in the footage.*

Name (please print) ……………………………………………………………………………

Role/Position at organization ……………………………………………………………

Signature ……………………………………………………… Date:……………………………

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

DEAKIN UNIVERSITY AUSTRALIA

Early Childhood Director Revocation of Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I hereby wish to **WITHDRAW** the consent for staff members, families and children of:

____ (Centre name)

____ (Centre Address) to

participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University.

Name (please print) ....

Role/Position at organization ....

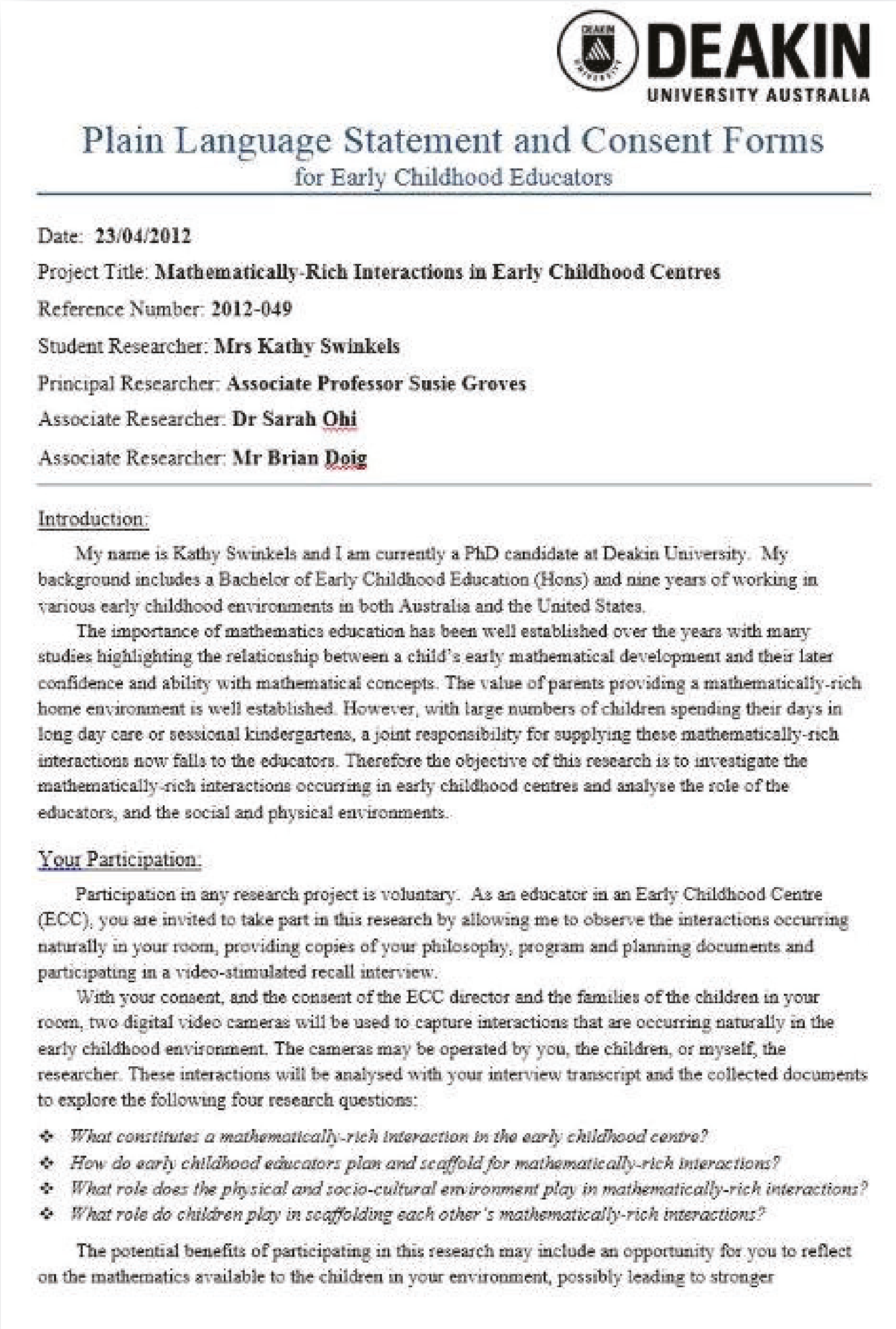
Signature .... Date:.......................................

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels School of Education Deakin University 221 Burwood Highway, Burwood VIC	phone: email: kasw@deakin.edu.au

Or

The Manager, Office of Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125,	phone: 9251 7129, fax: 9244 6581; email: research-ethics@deakin.edu.au



Plain Language Statement and Consent Forms

for Early Childhood Educators

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

Introduction:

My name is Kathy Swinkels and I am currently a PhD candidate at Deakin University. My background includes a Bachelor of Early Childhood Education (Hons) and nine years of working in various early childhood environments in both Australia and the United States.

The importance of mathematics education has been well established over the years with many studies highlighting the relationship between a child's early mathematical development and their later confidence and ability with mathematical concepts. The value of parents providing a mathematically-rich home environment is well established. However, with large numbers of children spending their days in long day care or sessional kindergartens, a joint responsibility for supplying these mathematically-rich interactions now falls to the educators. Therefore the objective of this research is to investigate the mathematically-rich interactions occurring in early childhood centres and analyse the role of the educators, and the social and physical environments.

Your Participation:

Participation in any research project is voluntary. As an educator in an Early Childhood Centre (ECC), you are invited to take part in this research by allowing me to observe the interactions occurring naturally in your room, providing copies of your philosophy, program and planning documents and participating in a video-stimulated recall interview.

With your consent, and the consent of the ECC director and the families of the children in your room, two digital video cameras will be used to capture interactions that are occurring naturally in the early childhood environment. The cameras may be operated by you, the children, or myself, the researcher. These interactions will be analysed with your interview transcript and the collected documents to explore the following four research questions:

- *What constitutes a mathematically-rich interaction in the early childhood centre?*
- *How do early childhood educators plan and scaffold for mathematically-rich interactions?*
- *What role does the physical and socio-cultural environment play in mathematically-rich interactions?*
- *What role do children play in scaffolding each other's mathematically-rich interactions?*

The potential benefits of participating in this research may include an opportunity for you to reflect on the mathematics available to the children in your environment, possibly leading to stronger mathematical opportunities within your centre. There are no anticipated risks expected to arise from this research. There will be no monetary payments to any participants taking part in this research.

If the parent or guardian of a child, or the child themselves, does not wish to participate there will be no adverse consequences to the child or their family. There will be the need to avoid recording when these children are in the field of the camera, and I will delete any video taken if the child runs through the field. To ensure children are comfortable, I propose attending your centre for a few days prior to collecting the data to allow you and children a chance to get to know me and feel comfortable with the cameras. All videos taken during this trial will be given to the centre to use as per their policies.

To protect participant's privacy and confidentiality all transcripts will include first names only and your ECC will not be named. A summary of results will be made available to you, your centre and families and it the results of this research will be used in my PhD thesis. Results may also be used in peer-reviewed journals, presented at national and international conferences, and used for educator training purposes. This includes the video data if consent from all participants appearing is given.

All data collected will be stored on a password protected computer at Deakin University, with the backups kept on a password protected hard drive and stored with any paper copies in a locked filing cabinet. As I am a student at Deakin University, my research will be monitored by my supervisory team to ensure it complies with ethical guidelines. This research is partially funded through the Glendon Lean Memorial Scholarship and the School of Education at Deakin University. There are no other parties who may claim a financial or other interest in this research.

Participation is voluntary:

Participation in any research project is voluntary. I will be available to answer any questions you have about the research project and you may ask for any information you require. Please only sign the attached Consent Form after you have had a chance to ask your questions and have received satisfactory answers.

If you decide to provide consent and later change your mind, you are free to withdraw from the project at any stage. Any data collected from your centre will not be used and will be destroyed. Your decision on whether to or not to take part, or to take part and then withdraw, will not affect your relationship with Deakin University. If you decide to withdraw from this project, please notify a member of the research team and complete and return the Revocation of Consent Form attached.

Contact details of the researcher:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone
email: kasw@deakin.edu.au

Complaints

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, please quote project number 2012-049 and contact:

The Manager,
Office of Research Integrity,
Deakin University,
221 Burwood Highway,
Burwood Victoria 3125,

phone: 9251 7129,
fax: 9244 6581;
email: research-ethics@deakin.edu.au

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UNIVERSITY AUSTRALIA

Educators' Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I have read and I understand the attached Plain Language Statement and

I, ______________________________ (Participant's name),

teaching at ______________________________ (Centre Name)

agree to participate in this project according to the conditions in the Plain Language Statement, a copy of which I have been given to keep.

I agree that ...

- *I WILL participate in this study,*
- *I CONSENT to participate in an interview of approximately ninety minutes to discuss the interactions filmed on the video and how I plan and scaffold for mathematically-rich interactions in my early childhood environment.*
- *I WILL discuss with the children in my care issues such as care of the cameras, how to film or interview their classmates, and the need to stop recording if a friend says stop.*
- *I CONSENT for the use of selected video clips I appear in for presentations at national and international conferences, and to be used for educator training purposes provided consent is granted by all participants appearing.*

The researcher has agreed not to reveal my identity or personal details, if information about this project is published, or presented in any public forum.

Signature .... Date: ....

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

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UNIVERSITY AUSTRALIA

Educators' Revocation of Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I, ______________________________ (Participant's name),

teaching at ______________________________ (Centre Name) hereby wish to

WITHDRAW my consent to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University.

Signature .... Date:..

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

Or

The Manager,
Office of Research Integrity,
Deakin University,
221 Burwood Highway,
Burwood Victoria 3125,

phone: 9251 7129,
fax: 9244 6581;
email: research-ethics@deakin.edu.au

DEAKIN
UNIVERSITY AUSTRALIA

Plain Language Statement and Consent Forms
for Parents and Guardians

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

Introduction:

My name is Kathy Swinkels and I am currently a PhD candidate at Deakin University. My background includes a Bachelor of Early Childhood Education (Hons) and nine years of working in various early childhood environments in both Australia and the United States.

The importance of mathematics education has been well established over the years with many studies highlighting the relationship between a child's early mathematical development and their later confidence and ability with mathematical concept±ts. The value of parents providing a mathematically-rich home environment is well established. However, with large numbers of children spending their days in long day care or sessional kindergartens, a joint responsibility for supplying these mathematically-rich interactions now falls to the educators. Therefore the objective of this research is to investigate the mathematically-rich interactions occurring in early childhood centres and analyse the role of the educators, and the social and physical environments.

Your Participation:

Participation in any research project is voluntary. As the parent or guardian of a child attending this Early Childhood Centre (ECC), you are invited provide consent for your child to be a part of this research.

With your consent, and the consent of the director and the educators in the room, two digital video cameras will be used to capture interactions that are occurring naturally in the ECC. These interactions will be analysed with the collected documents and an interview with the educator to explore the following four research questions:

- *What constitutes a mathematically-rich interaction in the early childhood centre?*
- *How do early childhood educators plan and scaffold for mathematically-rich interactions?*
- *What role does the physical and socio-cultural environment play in mathematically-rich interactions?*
- *What role do children play in scaffolding each other's mathematically-rich interactions?*

The potential benefits of participating in this research may include opportunities for your child's educators to reflect on the mathematics available to children in their environment, leading to stronger mathematical opportunities within your centre. There are no anticipated risks expected to arise from this research. There will be no monetary payments to any participants taking part in this research.

If you, as a parent or guardian of a child, or the child themselves, does not wish to participate there is no adverse consequences to your child or family. The educator and I will avoid recording when your child is in the field of the camera, and delete any video taken if the child runs through the field. To ensure children are comfortable, I propose attending the centre for a few days prior to collecting the data to allow the educators and children a chance to get to know me and feel comfortable with the cameras. All videos taken during this trial will be given to the centre to use as per their policies.

To protect participant's privacy and confidentiality all transcripts will include first names only and your centre will not be named.

A summary of results will be made available to you, the director and the educators and the results of this research will be used in my PhD thesis. Results may also be used in peer-reviewed journals, presented at national and international conferences, and used for educator training purposes. This includes the video data if consent from all participants appearing is given.

All data collected will be stored on a password protected computer at Deakin University, with the backups kept on a password protected hard drive and stored with any paper copies in a locked filing cabinet. As I am a student at Deakin University, my research will be monitored by my supervisory team to ensure it complies with ethical guidelines.

This research is partially funded through the Glendon Lean Memorial Scholarship and the School of Education at Deakin University. There are no other parties who may claim a financial or other interest in this research.

Participation is voluntary:

Participation in any research project is voluntary. I will be available to answer any questions you have about the research project and you may ask for any information you require. Please only sign the attached Consent Form after you have had a chance to ask your questions and have received satisfactory answers.

If you decide to provide consent and later change your mind, you are free to withdraw your child from the project at any stage. Any data collected on your child will not be used and will be destroyed. Your decision on whether to or not to take part, or to take part and then withdraw, will not affect your relationship with Deakin University or your child's early childhood centre. If you decide to withdraw from this project, please notify a member of the research team and complete and return the Revocation of Consent Form attached.

Contact details of the researcher:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

Complaints

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, please quote project number 2012-049 and contact:

The Manager,
Office of Research Integrity,
Deakin University,
221 Burwood Highway,
Burwood Victoria 3125,

phone: 9251 7129,
fax: 9244 6581;
email: research-ethics@deakin.edu.au

DEAKIN UNIVERSITY AUSTRALIA

Parental/ Guardian Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I have read and I understand the attached Plain Language Statement and

I, ______________________________ (Participant's name),

parent or guardian of ______________________________ (Child's Name)
agree to their participation in this project according to the conditions in the Plain Language Statement, a copy of which I have been given to keep.

I agree that ...

- *my child MAY participate in this study,*
- *I <u>DO / DO NOT</u> give consent for the use of selected video clips my child appears in for presentations at national and international conferences, and to be used for educator training purposes by the researcher, Mrs Kathy Swinkels.*

The researcher has agreed not to reveal my child's identity or personal details, if information about this project is published, or presented in any public forum.

Signature .... Date: ....

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

DEAKIN
UNIVERSITY AUSTRALIA

Parental/ Guardian Revocation of Consent Form

Date: **23/04/2012**

Project Title: **Mathematically-Rich Interactions in Early Childhood Centres**

Reference Number: **2012-049**

Student Researcher: **Mrs Kathy Swinkels**

Principal Researcher: **Associate Professor Susie Groves**

Associate Researcher: **Dr Sarah Ohi**

Associate Researcher: **Mr Brian Doig**

I hereby wish to **WITHDRAW** the consent for my child.

____(Child's Name),
to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with their early childhood centre or Deakin University.

Name (please print) ....

Signature .... Date:...

This form will be collected from the early childhood centre or may be returned to:

Mrs Kathy Swinkels
School of Education
Deakin University
221 Burwood Highway,
Burwood VIC

phone:
email: kasw@deakin.edu.au

Or

The Manager,
Office of Research Integrity,
Deakin University,
221 Burwood Highway,
Burwood, VIC, 3125

phone: 9251 7129,
fax: 9244 6581;
email: research-ethics@deakin.edu.au

Appendix D **Interview Protocol**

After thanking the educator for making time for the interview, remind them the video camera and voice recorder will be recording the interview, and turn them on.

This interview with ___________________ from the 3YOK / 4YOK / 5LDC is being conducted on __________________ 2013 at ______ am/pm by Kathy Swinkels.

As you are aware, my PhD research is looking at the mathematically-rich interactions that occur in early childhood settings. During this interview, I would like to discuss the maths you are aware of, program for and scaffold in your setting. While I do have permission for each of the children in the photos, I do need to remind you to keep any personal information confidential, but you are free to mention anecdotal stories that do not disclose any identifiable information.

Background Information.

Initially, I would like to start with a short section on your background:

Q1) How long have you been working in ECE?
- *a) How long with this age group?*
- *b) How long have you been working at this centre?*
- *c) Do you hold, or have held, any other roles in ECE?*

Q2) What qualifications do you have?
- *a) What mathematics was included in your training?*
- *b) Have you undertaken any PD focusing on early childhood mathematics?*

Q3) Can you tell me a little about your educational philosophy?
- *a) How do children learn?*
- *b) Do you follow Reggio/Piaget/Vygotsky/Montessori/DAP etc.?*

Q4) What maths skills do you think are important for children of this age group?
- *a) Do you think maths should be included in early childhood education?*
- *b) What do you think is the role of the early childhood educator?*
- *c) Are there any specific mathematical skills or concepts you would teach?*
- *d) How confident are you with teaching mathematics in early childhood? Why do you think this is?*

Q5) Everyone does planning differently; can you explain how you plan for mathematics?
- *a) Do you have any particular focus? (school readiness, social skills, creativity, etc.).*
- *b) Do you set specific goals for your whole group?*
- *c) How much input do the other staff members have in the program/planning?*
- *d) How close to your programming do you stay?*
- *e) How does the team you are working with change what happens in the room?*
- *f) With the activities that are always available, how are these chosen? Do they appear on your program/plan?*

Q6) What mathematics do you think the children are exploring at home?
- *a) What were the families' views on mathematics in early childhood for this group?*
- *b) Were there any mathematical skills the families expected you to include?*

c) *How does this affect your planning?*

Q7) Do you have anything other information that you feel would be relevant?

The next section will discuss some of the data I collected when I did the fieldwork at your centre. I have printed out a selection of screenshots taken from the video data which show a variety of the interactions and activities that occurred whilst I was there (Spread photos out). I understand that maths is not always the focus when you are interacting with the children, however, since today we have an opportunity to focus in on the maths, I am really interested in what you can identify, and how you would plan and scaffold this development.

So looking at these photos, can I get you to sort them into three piles – a pile of photos in which you find the maths very obvious, a second pile where the maths is not so obvious but you could scaffold the children in some mathematical learning, and a third pile of photos in which you are unable to identify any opportunities for mathematical learning.

Q8) So taking this first pile of obvious mathematical interactions/activities, can you choose a photo and explain what mathematics you can see?

a) *Did you plan for this activity?*
b) *Was this an activity the children engage in often?*
c) *What would the goals for this type of interaction/ activity normally be?*
d) *How would you normally scaffold this interaction/activity?*
    - *Mathematically or otherwise.*
e) *Would you do this differently with a different group of children?*
    - *How and Why?*
f) *Is there any other mathematics you could connect to this?*
g) *Can you identify any other mathematics you would be able to connect to this?*
h) *Can you identify any other activities that do contain mathematical learning that you would be able to connect to this?*

Q9) So taking this second pile of not so obvious mathematical interactions/activities, can you choose a photo and explain what mathematics you can identify?

a) *Did you plan for this activity?*
b) *Was this an activity the children engage in often?*
c) *What would the goals for this type of interaction/ activity normally be?*
d) *How would you normally scaffold this interaction/activity?*
e) *Mathematically or otherwise.*
f) *Would you do this differently with a different group of children?*
g) *How and Why?*
h) *Can you identify any other mathematics you would be able to connect to this?*
i) *Can you identify any other activities that do contain mathematical learning that you would be able to connect to this?*

Q10) So taking this third pile which you have identified as not having any mathematical learning, can you choose a photo and explain other learning you can identify?

a) *Did you plan for this activity?*
b) *Was this an activity the children engage in often?*
c) *What would the goals for this type of interaction/ activity normally be?*
d) *How would you normally scaffold this interaction/activity?*
e) *Mathematically or otherwise.*

f) *Would you do this differently with a different group of children?*
g) *How and Why?*
h) *Can you identify any other mathematics you would be able to connect to this?*
i) *Can you identify any other activities that do contain mathematical learning that you would be able to connect to this?*

Repeat 8, 9, and 10 if time permits.

Q11) *Can you think of any other activities or interactions that I have not captured in images that you would typically consider to be mathematically-rich?*

a) *Would this be an activity you would normally plan for?*
b) *Was this an activity the children engage in often?*
c) *What would the goals for this type of interaction/ activity normally be?*
d) *How would you normally scaffold this interaction/activity?*
   - *Mathematically or otherwise.*
e) *Would you do this differently with a different group of children?*
   - *How and Why?*
f) *Can you identify any other mathematics you would be able to connect to this?*
g) *Can you identify any other activities that do contain mathematical learning that you would be able to connect to this?*

Repeat this if time permits.

Q12) *Is there anything else you would like to add or comment on?*

For this third section, here is a list of the mathematical categories that I have identified from the literature and the video data.

Q13) *Looking at these definitions, can you indicate on each photo which activities could be used to support each of these mathematical skills? I have prepared a set of stickers that covers all of the concepts in this list (some photos will cover more than one codes).*

a) *Measurement?*
b) *Spatial Awareness?*
c) *Classification?*
d) *Number Concepts?*

Final words.
Additional Question Added for Serena and Nikki – Can you give me an example of somewhere you would scaffold each concept?

Q14) *Are there any other mathematical concepts that you can identify in addition to these?*

Q15) *Have any of your practices changed after being involved in this study?*

Q16) *Would you look for further professional development on mathematics in early childhood?*

Q17) *Where would you look for this?*

Q18) *And finally, do you have anything else you would like to add or comment on?*

Appendix E Mathematical Concepts List for PEI

Measurement

Measurement includes identifying the characteristics of objects so they may be quantified using informal or formal units to measure items, or compared to other objects.
The following seven sub-codes emerged from the date:

Size
The comparison or quantification of the general size of whole objects, including terminology such as “big”, “small”, “more” and “huge”.

Length
The comparison or quantification of the length of objects, including terminology such as “fatter”, “thinner”, “longer”, “shorter”, “tall, “little”, and “wide”.

Area
The comparison or quantification of the area of objects, including terminology such as “covers”, “inside”, “more” and “too small”.

Volume
The comparison or quantification of the volume of objects, including terminology such as “full”, “empty”, “more” and “half-way”.

Mass
The comparison or quantification of the mass of objects, including terminology such as “heavy” and “light”.

Time
The comparison or quantification of time, including terminology such as “earlier”, “later”, “now”, “yesterday”, “in two minutes” and “soon”.

Sound
The comparison or quantification of sound, including terminology such as “loud”, “soft”, “quiet”, “noisy”, “volume”, and “inside voices”.

Spatial Awareness

Spatial awareness activities involve an awareness of space, position, or shape. The following two sub-codes emerged from the data:

Geometric
An awareness of geometric shapes, or of their properties, including the transformation or rotation of objects.

Navigation
An awareness of direction, or positioning of themselves, or objects; where children were seen to be navigating within their environment, or directing others.

Classification

The matching or sorting of items (concrete and non-concrete) into groups or sets by chosen criteria or characteristic(s). Items may fit in various groups depending on the characteristics used. The following four sub-codes emerged from the data:

Object Classification
Non-comparative criteria used to group objects (including people).

Geometric
The classification of people or roles chosen by criteria.

Order
The placing of objects in order from one extreme to another. This is a combination of sub-codes that were originally "ordering", "seriation", and "sequencing", as these were found to be similar enough to combine.

Patterns
The observation, creation, or extension of patterns. Patterns can occur through sounds, objects or actions.

Number Concept

The concept of number includes an understanding that objects may be counted, measured, or compared with the use of symbolic representations. The following six sub-codes emerged from the data:

One-to-One Correspondence
The matching of one object with another object or was a number, often used when counting and pointing to objects.

Ordinal
Numbers used to indicate the position of objects, including terminology such as "first", "second", "before", "after", "last", "in the middle".

Reciting Number Names
Reciting the names of the numbers out loud without connecting them to any mathematical content such as counting or one-to-one correspondence. For example, singing.

Rational Counting
Using numbers to find the cardinality of a group.

Subitizing
Demonstrating a mental knowledge of the cardinality of a group by looking at the group.

Fractions
Indications of fractions including terminology such as "half", "quarter", "full", "equal", "all", "some" and "most".

Appendix F Complete Episodes with Their Codes

Table F.0.1
Complete Episodes with Codes

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
A Long Long Long Tail: 4YOK-0003	(p. 171)		X									X								X	X					X	X	X									X	X	X	X					X	X				X						
Are the Strawberries Ripe?: 3YOK-0030	(p. 127)					X				X										X	X			X			X	X							X		X		X			X	X	X	X										X	
Ball Skills: 5LDC-0137	(p. 263)	X	X					X																X		X	X	X							X		X		X			X	X				X									X
Ben at the Puzzle Table: 4YOK-0125	(p. 167)					X														X	X				X	X	X	X						X				X	X	X				X	X	X										
Block Shelves: 5LDC-0185	(p. 261)		X	X		X								X						X	X				X	X	X		X			X		X		X	X		X	X	X	X														
Blocks on a Stick: 5LDC-0163	(p. 258)					X								X						X		X		X	X	X	X		X					X				X	X						X	X							X			
Box Construction and Collage: 3YOK-0024	(p. 108)	X			X	X														X		X	X	X	X	X	X	X						X		X		X	X		X		X	X		X				X		X				
Box Construction Supplies: 4YOK-0046	(p. 174)		X		X	X														X	X		X		X		X	X						X			X	X	X	X	X		X			X				X						
Box Construction: 4YOK-0128	(p. 173)		X	X	X	X				X				X						X	X		X		X	X	X	X						X			X	X	X	X			X	X	X	X				X						
Boy Climbing Over Tunnel: 4YOK-0013	(p. 189)	X	X			X																			X	X	X							X	X				X				X				X									X
Boys and Lego Roads: 4YOK-0083	(p. 179)	X	X			X								X						X	X		X	X	X	X	X	X	X								X	X	X	X					X	X					X		X			
Building the Pirate Ship: 5LDC-0084	(p. 256)				X	X														X	X				X	X	X	X	X			X					X		X	X			X	X	X		X				X					
Building with Blocks: 5LDC-0005	(p. 269)	X	X			X								X					X	X		X	X		X	X	X	X				X					X		X	X				X		X										
Burying the Dinosaur: 5LDC-0131	(p. 265)		X			X																	X				X							X	X				X				X				X									
Calculator Play: 5LDC-0002	(p. 250)													X	X	X			X					X			X	X	X					X				X	X	X				X	X	X							X			
Checking the Speed of Trains: 4YOK-0019	(p. 183)		X					X		X				X						X	X		X			X	X	X				X					X		X	X			X		X	X					X				X	
Chickens and Temperature: 4YOK-0020	(p. 194)				X	X			X				X					X		X	X						X	X	X				X								X	X	X	X	X										X	
Christie Jack and Imogen at the Puzzle Table: 4YOK-0125	(p. 167)	X																		X	X	X		X	X	X	X	X									X	X	X	X				X	X	X										
Climbing Bridge: 3YOK-0027	(p. 122)		X											X										X		X	X	X						X	X				X				X				X									X
Climbing Dinosaurs: 5LDC-0030	(p. 266)		X			X																				X	X	X							X		X		X	X			X				X				X					
Climbing Frame: 3YOK-0036	(p. 123)		X																					X		X	X	X							X		X		X	X			X				X									X
Colouring with Pencils: 5LDC-0162	(p. 254)	X	X										X							X						X	X	X						X				X	X							X				X						
Coming to the Mat: 3YOK-0070	(p. 102)													X						X				X		X	X	X		X			X			X				X	X	X	X	X				X	X			X				
Cooking in the Cubby House: 5LDC-0133	(p. 265)			X	X	X			X	X	X	X	X							X				X			X	X							X		X		X	X			X	X		X					X				X	
Cooking in the Sandpit: 3YOK-0040	(p. 120)			X	X				X	X	X		X						X					X		X	X	X						X	X		X		X	X			X				X				X				X	
Cushion Hat and Play: 3YOK-0041	(p. 105)														X	X								X		X		X					X			X					X	X	X	X				X	X							

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Dancing at Group Time: 5LDC-0130	(p. 238)						X	X						X								X		X	X	X	X	X		X			X			X				X	X	X	X	X					X					X		
Days of the Week Poster: 5LDC-0219	(p. 240)									X					X	X								X			X	X	X				X								X	X		X	X			X				X				
Discussion on Bikes: 3YOK-0041	(p. 104)				X	X						X						X		X	X						X	X	X				X							X	X	X	X	X	X				X							
Doll House Activity: 4YOK-0042	(p. 153)	X				X				X				X						X				X		X	X	X						X			X	X			X		X	X		X			X		X					
Down the Slide: 5LDC-0153	(p. 269)		X					X				X			X	X										X	X	X							X		X		X			X	X	X			X									X
Drawing Materials: 3YOK-0019	(p. 115)					X								X						X					X	X	X	X						X			X	X	X	X			X	X		X		X		X		X				
Easel for Chicken Drawings: 4YOK-0040	(p. 168)	X	X		X	X								X						X	X				X	X	X							X							X		X	X		X				X						
Easel Stamping: 3YOK-0015	(p. 116)	X																			X				X	X	X							X					X							X				X						
Eating Carrots: 3YOK-0034	(p. 129)																			X	X						X							X	X				X						X										X	
Educator at the Puzzle Table: 3YOK-0021	(p. 111)	X	X			X														X	X	X		X	X	X	X	X						X			X	X		X	X	X	X	X	X	X										
Einee Meenee Minee Moe: 5LDC-0020	(p. 246)		X									X		X						X		X		X		X	X	X								X	X		X	X				X					X		X					
Emergency Vehicles: 4YOK-0009	(p. 182)	X	X		X	X														X	X				X	X	X					X					X		X	X			X		X		X				X					
Explaining the Tape Measure: 3YOK-0090	(p. 110)		X			X						X							X	X	X					X	X	X	X					X					X			X			X	X							X			
Exploring Recyclables: 5LDC-0130	(p. 240)			X		X					X									X	X				X		X	X					X								X		X	X	X										X	
Face Sorting Set-Up: 5LDC-0170	(p. 236)													X						X	X						X							X			X	X			X		X		X	X							X			
Filling Containers: 4YOK-0075	(p. 192)	X		X	X	X					X		X							X	X					X	X	X							X		X		X	X			X				X								X	
Finding your Lunch Box: 4YOK-0080	(p. 187)																			X	X			X			X	X			X										X		X	X				X								
Finishing the Puzzles Together: 3YOK-0005	(p. 112)	X	X			X														X	X			X	X	X	X	X									X	X		X	X		X	X	X	X			X							
Flowers You Can Pick: 3YOK-0040	(p. 128)																			X	X						X							X	X				X				X	X	X										X	
Four Children at the Clay Table: 4YOK-0028	(p. 176)		X	X	X	X				X			X							X	X	X		X	X	X	X	X						X			X	X	X	X			X	X	X	X				X						
Four Children with Cars: 4YOK-0006	(p. 181)	X	X		X	X														X	X				X	X	X	X				X					X		X	X						X	X				X					
Geo Blocks: 5LDC-0038	(p. 235)	X	X		X	X							X	X						X		X			X	X	X							X			X	X			X		X		X	X				X			X			
Geometric Magnets: 5LDC-0167	(p. 248)	X	X			X								X						X	X	X			X	X	X							X				X	X	X			X		X	X				X			X			
Giraffe Painting: 4YOK-0144	(p. 169)	X	X		X	X						X	X	X				X	X	X	X			X	X	X	X	X						X							X	X	X		X	X				X						
Googling Chickens: 4YOK-0001	(p. 195)		X	X		X														X	X						X	X									X			X	X	X			X							X			X	
Group Reflection: 4YOK-0129	(p. 199)				X					X		X	X							X							X	X					X								X	X		X	X			X								
Group Time with Block Tray: 3YOK-0014	(p. 114)	X	X		X					X		X		X			X		X	X	X	X	X	X	X	X	X	X	X				X							X	X	X	X	X	X								X			
Group Time with Flower Petals: 3YOK-0014	(p. 117)				X						X			X						X		X				X	X	X					X								X	X	X	X		X				X					X	
Hands Up if You Can Swim: 4YOK-0002	(p. 158)				X							X								X	X					X	X	X		X			X						X			X	X	X	X				X							
Harrison's Assessment: 4YOK-0007	(p. 197)		X			X						X			X	X				X	X	X	X	X	X	X	X	X	X												X	X		X	X			X					X			
Heavy Bucket: 3YOK-0003	(p. 119)			X							X		X						X		X		X				X	X							X		X		X	X			X				X						X			
Hide and Seek: 3YOK-0002	(p. 126)		X																							X									X		X		X				X				X									

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic
Home Corner: 4YOK-0025	(p. 178)			X	X				X	X	X		X	X						X				X			X	X	
How to Make a Book: 4YOK-0053	(p. 165)		X		X	X							X							X				X	X	X	X	X	X
Hula Hoop Basketball: 4YOK-0071	(p. 190)		X	X	X	X						X							X	X	X		X			X	X	X	X
Jack's Homemade Book: 4YOK-0002	(p. 162)																			X	X		X	X			X	X	X
Kyle's How To Make a Book: 4YOK-0049	(p. 163)				X	X							X							X				X		X	X	X	X
Large Soft Blocks: 5LDC-0003	(p. 255)	X			X	X														X	X				X	X	X	X	
Lego Baddies: 4YOK-0029	(p. 179)		X		X	X		X						X						X	X				X	X	X	X	
Long Jump: 5LDC-0134	(p. 270)	X	X																		X					X	X	X	
Lunch Helpers: 5LDC-0000	(p. 243)	X			X						X	X		X				X					X		X	X	X	X	
Lunch Table: 4YOK-0121	(p. 188)				X	X				X		X	X					X	X	X	X			X		X	X	X	
Madison and Ian and Magnet Shapes: 5LDC-0001	(p. 249)	X	X			X								X						X	X	X	X		X	X	X	X	
Marble Run Construction: 4YOK-0083	(p. 184)		X			X		X						X						X			X	X	X	X	X		
Measuring Heights: 5LDC-0140	(p. 267)		X			X						X		X							X		X			X	X	X	X
Morning Snack Time: 4YOK-0000	(p. 186)				X	X				X		X	X					X		X	X			X			X	X	
Moving Chairs: 4YOK-0038	(p. 196)	X				X								X									X			X	X		
Obstacle Course: 3YOK-0042	(p. 121)		X			X		X								X					X			X		X	X	X	
Office Play: 5LDC-0004	(p. 251)											X		X	X		X							X			X	X	X
Olympic Rings Cooking: 5LDC-0115	(p. 271)			X	X	X		X	X	X	X	X	X	X		X			X	X				X	X		X	X	X
On the Swings: 5LDC-0132	(p. 268)		X					X													X					X	X		
Outdoor Kitchen and Sandpit: 4YOK-0048	(p. 191)	X	X	X	X				X	X	X	X	X	X					X	X	X			X	X	X	X	X	X
Outside Snack Time: 5LDC-0021	(p. 242)				X	X					X		X	X						X	X			X			X	X	
Parts of a Carrot: 3YOK-0037	(p. 128)																			X	X						X		
Pass it to Your Neighbour: 4YOK-0049	(p. 161)						X	X				X					X					X		X	X	X	X	X	X
Pasta for Lunch: 5LDC-0096	(p. 244)			X							X		X							X	X			X			X	X	
Patterns with a Rake: 3YOK-0040	(p. 121)	X	X																			X			X	X	X		
Paul's Assessment: 4YOK-0012	(p. 197)		X			X						X			X	X				X	X	X	X	X	X	X	X	X	X
Personal Tubs: 5LDC-0206	(p. 237)													X						X				X			X	X	X
Phil's Idea: 4YOK-0050	(p. 164)	X	X		X	X							X							X	X		X	X	X	X	X	X	
Photo Wall: 4YOK-0131	(p. 155)				X															X						X		X	
Picture of the Tooth Fairy: 4YOK-0027	(p. 172)		X																		X				X	X	X	X	
Pictures and Hooks: 4YOK-0037	(p. 156)													X						X				X		X	X	X	X
Play Dough Table: 3YOK-0096	(p. 109)	X		X	X	X						X	X	X	X						X				X		X	X	

Episodes		Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Home Corner: 4YOK-0025	(p. 178)								X		X	X			X								X					
How to Make a Book: 4YOK-0053	(p. 165)								X	X	X	X				X	X	X		X	X	X		X				
Hula Hoop Basketball: 4YOK-0071	(p. 190)						X		X		X	X			X				X		X							X
Jack's Homemade Book: 4YOK-0002	(p. 162)				X							X	X	X	X	X	X	X		X	X	X		X				
Kyle's How To Make a Book: 4YOK-0049	(p. 163)				X						X		X	X	X	X	X	X		X	X	X		X				
Large Soft Blocks: 5LDC-0003	(p. 255)			X					X		X	X			X	X			X				X					
Lego Baddies: 4YOK-0029	(p. 179)			X		X			X		X	X			X		X	X					X		X			
Long Jump: 5LDC-0134	(p. 270)						X		X		X	X			X	X	X		X									X
Lunch Helpers: 5LDC-0000	(p. 243)		X										X	X	X	X		X			X							
Lunch Table: 4YOK-0121	(p. 188)		X						X	X	X	X					X				X							
Madison and Ian and Magnet Shapes: 5LDC-0001	(p. 249)								X	X	X	X			X		X	X				X			X			
Marble Run Construction: 4YOK-0083	(p. 184)			X		X					X	X					X	X									X	
Measuring Heights: 5LDC-0140	(p. 267)						X		X			X	X	X	X		X								X			
Morning Snack Time: 4YOK-0000	(p. 186)		X						X		X				X	X				X								
Moving Chairs: 4YOK-0038	(p. 196)								X		X	X			X													
Obstacle Course: 3YOK-0042	(p. 121)						X		X		X	X			X				X									X
Office Play: 5LDC-0004	(p. 251)								X	X	X	X			X	X	X	X					X		X			
Olympic Rings Cooking: 5LDC-0115	(p. 271)				X					X			X	X			X	X									X	
On the Swings: 5LDC-0132	(p. 268)						X		X		X				X				X									X
Outdoor Kitchen and Sandpit: 4YOK-0048	(p. 191)					X	X		X		X	X	X		X			X	X		X		X				X	
Outside Snack Time: 5LDC-0021	(p. 242)		X				X	X	X				X	X		X					X							
Parts of a Carrot: 3YOK-0037	(p. 128)					X	X				X						X										X	
Pass it to Your Neighbour: 4YOK-0049	(p. 161)			X	X							X	X	X	X	X		X								X		
Pasta for Lunch: 5LDC-0096	(p. 244)		X					X	X	X		X	X	X	X	X		X			X							
Patterns with a Rake: 3YOK-0040	(p. 121)					X	X				X				X				X									
Paul's Assessment: 4YOK-0012	(p. 197)												X	X			X			X					X			
Personal Tubs: 5LDC-0206	(p. 237)	X				X		X				X	X		X	X				X				X				
Phil's Idea: 4YOK-0050	(p. 164)								X	X	X	X		X	X	X	X											
Photo Wall: 4YOK-0131	(p. 155)					X					X			X	X	X	X				X							
Picture of the Tooth Fairy: 4YOK-0027	(p. 172)					X				X	X			X				X				X						
Pictures and Hooks: 4YOK-0037	(p. 156)	X				X		X					X		X	X				X	X							
Play Dough Table: 3YOK-0096	(p. 109)					X			X	X		X	X	X	X	X		X			X	X			X			

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize	Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play	Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Play Dough Table: 5LDC-0124	(p. 247)		X	X	X	X			X	X	X	X	X	X									X				X		X	X											X	X	X	X			X			X						X					
Puzzle with Educator's Help: 4YOK-0027	(p. 166)	X																			X	X			X	X	X	X	X							X				X	X			X		X	X	X										
Puzzles: 5LDC-0128	(p. 253)	X															X			X			X			X	X	X	X								X	X	X	X			X	X	X	X											
Reading in Group Time: 3YOK-0101	(p. 130)					X				X									X				X			X					X								X	X	X	X	X			X	X			X				
Reading Numerals: 5LDC-0126	(p. 252)											X		X	X									X			X	X	X								X	X	X	X			X	X	X									X			
Room Set-Up: 3YOK-0089	(p. 99)	X																		X							X	X	X	X			X		X		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X			
Rules for the Mat: 4YOK-0133	(p. 159)				X											X	X			X				X		X	X	X	X				X								X	X	X		X				X	X			X				
Running on the Path: 3YOK-0033	(p. 101)		X					X													X						X	X	X						X	X		X		X	X			X				X									X
Samantha Reads to Jane: 4YOK-0052	(p. 185)				X									X						X		X		X			X	X	X								X		X			X			X			X			X					
Sandpit: 3YOK-0001	(p. 119)			X		X					X	X	X	X								X	X				X	X	X							X		X		X	X			X				X				X		X			
See Saw: 3YOK-0028	(p. 123)		X					X												X			X		X	X							X		X		X	X			X				X									X
Self Portraits: 4YOK-0132	(p. 171)		X		X	X														X	X							X	X												X		X			X	X	X				X						
Separating Petals: 3YOK-0018	(p. 118)										X		X	X						X									X	X							X				X			X	X				X					X						X	
Show and Tell: 5LDC-0011	(p. 241)									X										X					X		X					X	X							X	X	X	X	X			X	X			X				
Show Me Your Dance Moves: 5LDC-0090	(p. 246)						X	X					X									X		X	X	X	X	X				X							X	X	X	X	X			X		X				X		
Skipping Rope: 5LDC-0141	(p. 264)		X					X		X					X									X		X	X	X							X		X		X	X		X	X			X				X									X
Small Magnetic Block Play: 5LDC-0012	(p. 259)	X	X	X	X									X							X		X	X		X	X	X			X					X		X	X				X	X	X							X			
Small Play Set Up: 4YOK-0047	(p. 154)	X	X		X	X					X		X	X							X	X	X		X	X	X	X					X				X			X		X	X		X						X					
Snack Time: 3YOK-0004	(p. 106)				X					X		X		X					X	X	X		X					X	X		X			X		X	X	X	X	X	X	X	X	X				X	X							
Somersault Time: 5LDC-0155	(p. 257)		X																								X	X	X				X		X					X									X									X
Sorting Blocks: 5LDC-0025	(p. 262)		X		X	X				X		X		X							X	X				X		X	X						X		X		X	X		X			X		X									
Soup for Lunch: 5LDC-0017	(p. 245)			X							X		X								X				X				X	X		X						X	X	X	X			X	X					X							
Stones and Spoon Activity: 4YOK-0044	(p. 154)	X										X								X		X			X	X	X						X				X			X		X			X					X			X			
Storage of Loose Materials: 4YOK-0144	(p. 175)		X		X	X													X	X				X	X	X	X	X						X					X	X	X		X	X						X						
Story Time: 5LDC-0130	(p. 239)			X	X	X					X									X				X			X	X						X							X	X	X	X	X						X			X	
Swing Set #1: 3YOK-0023	(p. 124)		X		X							X									X					X	X	X	X							X		X		X	X			X	X			X									X
Swing Speeds: 3YOK-0026	(p. 125)							X													X	X					X	X	X								X		X		X	X					X		X				X			X
There Was an Old Lady Story: 4YOK-0129	(p. 198)					X						X			X								X			X			X	X	X			X	X									X				X				X		X				
Tomiko on the Monkey Bars: 4YOK-0023	(p. 193)	X	X					X		X		X			X								X		X	X	X	X	X						X		X		X	X		X	X	X			X		X							X
Train on a Slope: 5LDC-0154	(p. 257)		X					X									X						X			X	X	X				X		X					X							X						X					
Tricycles: 3YOK-0022	(p. 125)	X	X					X												X	X			X	X	X								X		X		X	X			X	X			X									X
Trucks on a Shelf: 4YOK-0036	(p. 189)	X	X		X										X							X						X	X									X					X			X			X										

Episodes		Area	Length	Mass	Quantity	Size	Sound	Speed	Temperature	Time	Volume	Counting	Fraction	One-to-One	Order	Ordinal	Reciting Numbers	Subitize
Two Boys and Blocks: 3YOK-0020	(p. 113)	X	X			X						X		X				
Two Children at the Clay Table: 4YOK-0093	(p. 177)		X			X							X					
Two Girls with Animals: 4YOK-0060	(p. 184)	X				X								X				
Vegetable Garden: 3YOK-0031	(p. 129)				X	X						X		X				
Watching Eggs Hatch: 4YOK-0145	(p. 195)	X																
What Size Paper?: 5LDC-0156	(p. 254)	X				X							X					
Who is Here Today?: 3YOK-0041	(p. 103)											X		X				X
Witch Story Group Time: 4YOK-0024	(p. 160)		X	X	X	X		X				X	X	X				

Episodes		Calculation	Classification	Comparison	Pattern	Problem Solving	Sequence	Geometric	Navigation	Concrete	Language	Symbolic	Arrivals	Eating	Floor Games	Group Times	Individual Play	Outside Play	Routines	Small Group Play	Table Play
Two Boys and Blocks: 3YOK-0020	(p. 113)	X	X	X	X	X	X	X	X	X					X		X			X	
Two Children at the Clay Table: 4YOK-0093	(p. 177)		X				X			X							X				X
Two Girls with Animals: 4YOK-0060	(p. 184)		X	X					X	X	X				X					X	
Vegetable Garden: 3YOK-0031	(p. 129)		X							X	X	X						X		X	
Watching Eggs Hatch: 4YOK-0145	(p. 195)					X			X	X						X					
What Size Paper?: 5LDC-0156	(p. 254)		X			X		X		X	X									X	
Who is Here Today?: 3YOK-0041	(p. 103)	X	X			X				X	X	X				X					
Witch Story Group Time: 4YOK-0024	(p. 160)		X	X	X		X		X	X	X	X				X					

Episodes		Child Initiated	Child Scaffolded	Educator Initiated	Educator Scaffolded	Physical	Social	Cognitive	Fine Motor	Gross Motor	School Readiness	Social Skills	Art	Dramatic Play	Literacy	Mathematics	Music	Science	Sport
Two Boys and Blocks: 3YOK-0020	(p. 113)	X	X					X	X							X			
Two Children at the Clay Table: 4YOK-0093	(p. 177)	X				X			X				X						
Two Girls with Animals: 4YOK-0060	(p. 184)	X	X			X			X					X				X	
Vegetable Garden: 3YOK-0031	(p. 129)	X	X			X	X	X										X	
Watching Eggs Hatch: 4YOK-0145	(p. 195)		X	X	X	X	X	X				X							
What Size Paper?: 5LDC-0156	(p. 254)	X			X			X					X						
Who is Here Today?: 3YOK-0041	(p. 103)		X	X	X	X	X				X	X							
Witch Story Group Time: 4YOK-0024	(p. 160)		X	X	X		X	X				X			X				