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Abstract: Using both child-guided and adult-guided learning, Intentional Teaching in the early years can be a powerful tool for enhancing young children's numeracy skills. As Epstein (2009) notes, this can include providing "opportunities for children to represent things by drawing, building and moving" (p. 47). This paper investigates how kindergarten (four-five year olds) children represented and demonstrated numeracy concepts through their drawings and explanations, completed for a research study that used arts-based strategies to enhance children's environmental understanding. This research study involved kindergarten children in Australia creating and exchanging postcards (drawings and explanations) of their local environments with their peers in Canada. Findings include that the kindergarten children, through creating postcards of their physical environments and explanations, demonstrated their growing understanding of numeracy concepts, such as spatial orientation, quantification and attributes of objects. The study argues for quality Intentional Teaching and the development of an 'early childhood numeracy progress monitoring framework' that maps and assesses children's mathematical development.

Introduction

The Victorian Early Years Learning and Development Framework and the Victorian Essential Learning Standards (2008) discussion paper suggest that a gradual shift in emphasis from 'free play' to 'structured learning' in the early years of formal education gives a strong rationale for alignment between learning in early years and the wider education system. This, in turn, helps children to achieve academically in their schooling in the first eight years of life.

The discussion paper further suggests that, while the notion of stages of development is now widely debated, general principles for teaching and learning are needed to orient early childhood educators and early childhood teacher educators towards commonly agreed-upon goals, strategies and modes of assessment related to changes in children's capacities and needs as they grow. However, discussions around exactly when 'structured learning' should be introduced, as well as how 'structured learning' and 'play-based learning' are (re)conceptualized remain contestable and can at times result in opposite positions with no 'middle ground'. Brown (n.d.) writes that:

> *When you enter the preschool search, you will want to consider what you value in your child's early education. Do you want a lot of free play or more structured*

> *activities? Do you want the teacher to direct the day or for your child to choose activities based on her interests? Are you interested in language immersion or a focus on music or the arts? Or maybe you want a little of everything?*

At one end are those who advocate for 'structured learning' and at the other end are those who advocate for 'free play' and child-directed learning only; seemingly viewing 'structured learning' as something like 'imprisonment of the mind'. Intentional Teaching in the early years seems to lie somewhere in the middle.

This paper looks at how Intentional Teaching - in this case using children's drawings and explanations of their local environments, supported the demonstration of numeracy concepts such as spatial orientation, quantification and attributes of objects.

Intentional Teaching in Early Childhood

Intentional Teaching is a pedagogical practice defined by Epstein (2007) as actions where "teachers act with specific outcomes or goals in mind for children's development and learning" (p. 1). Epstein argues that Intentional Teaching does not happen by chance, but is a thoughtful and purposeful framework. The intentional teacher supports both child-guided and adult-guided learning through provision of resources and experiences; systems of knowledge that children cannot create on their own; responses to requests for assistance; and the gathering of evidence to support further learning (Epstein, 2009). Similarly, Tucker (2011) articulates a practitioner-initiated approach, where "the practitioner suggests a mathematical task or idea for children to pursue with specific learning outcomes in mind, which the children may address during their activity" (p. 10). The Early Years Learning Framework (EYLF) (Department of Education, Employment, and Workplace Relations [DEEWR], 2009) conceptualizes Intentional Teaching as a "deliberate, purposeful and thoughtful" (p. 15) framework that teachers use in their actions and decisions with children to promote their learning and development. Intentional Teaching thus becomes not just a set of strategies for planning teaching and learning activities but a pedagogical approach that informs educators' practices.

Many early childhood educators suggest that it is impossible to disentangle children's play, learning and development. According to Shipley (2008), research and evidence all point to the role of play in children's development and learning across cultures. Play-based learning is described in the EYLF (2009) as "a context for learning through which children organise and make sense of their social worlds, as they actively engage with people, objects and representations" (p. 46). They note that "when children play with other children they create social groups, test out ideas, challenge each other's thinking and build new understandings" (Ibid, p. 15). The EYLF suggests that play-based learning is a complex form of natural enquiry that requires an experienced educator who knows each child's overall development, emerging strengths and interests (DEEWR, 2009). Barblett (2010) adds that play shapes the brain's structural design: "Play provides active exploration that assists in building and strengthening brain pathways" (p. 4).

Arthur, Beecher, Dockett, Death and Farmer (2015) highlight that, in keeping with considerations of how young children learn, the EYLF reflects a holistic approach to learning and development which is embedded within play-based environments and includes a broad range of learning outcomes. Further, within the outcome, "Children are confident and involved learners", a descriptor is: "Children develop dispositions for learning such as curiosity, cooperation, confidence, creativity, commitment, enthusiasm, persistence, imagination and reflexivity" (DEEWR, 2009, p. 3). Many of these attributes can be developed through the Arts.

The Arts feature in both Intentional Teaching pedagogy and play-based learning. Intentional Teaching can include providing “opportunities for children to represent things by drawing, building and moving” (Epstein, 2009, p. 47). The play-based learning approach “provides opportunities for children to learn as they discover, create, improvise and imagine” (DEEWR, 2009, p. 15).

Arthur and colleagues (2015) suggest that both the EYLF and the Australian Curriculum are relevant for early childhood educators. Further, Early Childhood Australia and the Australian Curriculum, Assessment and Reporting Authority (ACARA) published the 2011 paper, *Foundations for learning: Relationships between the Early Years Learning Framework and the Australian Curriculum,* explaining how the EYLF and the Australian Curriculum are linked. This paper confirms “that quality early childhood practice underpinned by the EYLF establishes solid foundations for students’ successful engagement with the Australian Curriculum” (p. 1).

The Australian Curriculum: Mathematics (ACARA, 2011) focuses on specific learning outcomes across a range of numeracy and mathematics content areas. These outcomes are associated with specific years of formal schooling. The premise of this paper is that Intentional Teaching in prior to school settings such as kindergarten, can integrate the EYLF with *The Australian Curriculum: Mathematics* (ACARA, 2011) to scaffold learning and produce numeracy and mathematics outcomes before children even reach the school years. Montague-Smith and Price (2012) argue that “it is appropriate to teach mathematics in early years settings so long as it is the right mathematics taught in the right way” (p. 11). Intentional Teaching in prior to school settings can encourage young children to play, explore and learn specific numeracy and mathematics concepts.

Numeracy and Mathematics

According to Sullivan (2011) the term, ‘numeracy’ is most commonly used in Australia to encapsulate the practical perspective; when mathematics is used in practice, while the term ‘mathematical literacy’ is used in this same way in many other countries and in international assessments. The State of Victoria ‘*Numeracy in Practice’* paper (2009) suggests that without a solid grounding in mathematical concepts and procedures, there can be no numeracy. On the other hand, knowledge of mathematical concepts and procedures alone is not enough to guarantee numeracy. This perspective implies that numeracy and mathematics are not the same; but as highlighted by the *Australian National Numeracy Review*, they are:

> *clearly interrelated. All numeracy is underpinned by some mathematics; hence school mathematics has an important role in the development of young people's numeracy (Commonwealth of Australia, 2008, p.11).*

Numeracy can be described as a key outcome of how mathematics is taught and learned and the variety of contexts in which it needs to be used in everyday life (National Curriculum Board, 2009).

The definition of ‘numeracy’ used in this paper is informed by *The Shape of the Australian Curriculum: Mathematics*, which defines ‘numeracy’ as: “the capacity, confidence and disposition to use mathematics to meet the demands of learning, school, home, work, community and civic life.” (National Curriculum Board, 2009, p. 5). In this paper, the definition of ‘mathematics’ is the study of numbers, data, space and shapes using a sophisticated and abstract system that involves mathematical processes, thinking, rules and symbols (Education Queensland, 2010).

Young Children Developing Numeracy Concepts

Young children's activities during play can enhance their numeracy skills and help them develop mathematical ideas. A number of studies have shown that young children who have a good start with numeracy and who engage with mathematical ideas in the early years make better progress in school mathematics (Aubrey & Godfrey, 2003; Aunio & Niemivirta, 2010). This does not mean that teachers should teach them 'school maths' early; according to Montague-Smith and Price (2012) this has negative effects on their learning later in school; but that enhancing their play activities through Intentional Teaching helps them to learn and apply mathematics ideas.

According to Geist (2009), Sarama & Clements (2009) and Montague-Smith & Price (2012), babies can distinguish between quantities and match numbers in small sets of objects, and at about two years of age children start to chant the counting words, though they may not be in the right order. Between two and half to three years children are more accurate in their counting when asked to count with no obvious purpose and will be aware that adults use number and counting to solve real world problems. By age of three years children subitize (recognize the number of items represented without counting); name up to three or four objects; and select correct numbers of objects. By about five years children have a secure understanding of cardinal numbers; can subitize to five; and may recognize patterns to 10, for example on dominoes (Geist, 2009; Sarama & Clements, 2009; Minetola et al, 2014).

Purpura and Lonigan (2015) argue specific early mathematics skills appear to develop in overlapping phases. This means that children develop at different rates and will not have the same level of mathematics and numeracy skills. Pianta and La Paro (2003, p.28) suggest that most early childhood classrooms feature instructional organization but lack "intentionality – directed, designed interactions between children and teachers in which teachers purposefully" challenge, scaffold and extend children's skills. Presser, Clements, Ginsburg and Ertle (2015) suggest that standard practice in the early childhood classroom does not reflect research findings. Research findings regarding 'Big Math for Little Kids' (BMLK), a mathematics curriculum designed to help teachers intentionally use play-based, developmentally appropriate mathematics instruction for four and five year-old children indicate that the BMLK curriculum has a positive impact on young children's development of mathematical knowledge (Presser et al, 2015).

Purpura and Lonigan (2015) constructed and validated 12 early numeracy tasks that measure the skills and concepts identified as key to early mathematics development by the National Council of Teachers of Mathematics (2006) and the National Mathematics Advisory Panel (2008)". They are also informed by the "critical developmental precursors to later mathematics skills noted in the Common Core State Standards (2010)" (p. 287). These measures include: one-to-one counting, cardinality, counting subsets, subitizing, number comparison, set comparison, number order, numeral identification, set-to-numerals, story problems, number combinations, and verbal counting. Purpura and Lonigan (2015) concluded that for teachers to identify individual instructional needs and measure progress, they need to be able to efficiently assess children's numeracy skills and the effects of intentional instruction on individual numeracy skills. They further suggest that early childhood numeracy progress monitoring tools can help early childhood educators to efficiently assess children's numeracy skills and effects of targeted instruction.

Early childhood educators also need to restate more clearly how young children develop numeracy skills and conditions that influence their learning. Montague-Smith and Price (2012) argue that educators "must learn to model actions, tools and language that will allow children access to the underlying mathematical concepts embedded in an activity" (p. 11). Demetriou, Spanoudis and Mouyi (2011) suggest that as young children grow they start to deal with increasingly more complex representations of their world, and that the emergence of language during their second year of life brings these representations into focus so that they can talk about, reflect upon and elaborate on these representations. DeLoache (2000) observes that at the age of three to four years, children start to differentiate these representations from each other and from the objects they represent. This means that kindergarten children at the age of three to four start to differentiate objects from their representations and develop ideas in various environment-oriented domains, and that this development is a continuous process from emergence to differentiation and integration of new representations.

When children make connections between existing and new representations, they can access powerful mathematical ideas relevant to their everyday lives. In referring to mathematical learning in Primary School, Van de Walle, Karp and Bay-Williams (2013) suggest that understanding mathematics is a measure of the quality and quantity of connections that a new mathematical idea has with existing ideas. Lesh, Cramer, Doerr, Post and Zawojewski (2003) outline five different ways to represent mathematical ideas: real-world situations, manipulative models, pictures, oral/written language, and written symbols. These representations play an important role in numeracy and mathematical activities and are increasingly seen as useful tools for building and communicating mathematical knowledge. Early childhood educators can engage these representations when young children explore numeracy and mathematical ideas. The EYLF (DEEWR, 2009) argues that, "spatial sense, structure and pattern, number, measurement, data argumentation, connections and exploring the world mathematically are the powerful mathematical ideas children need to become numerate" (p. 38).

Intentional Teaching can integrate and promote meaningful learning (Epstein, 2007). Montague-Smith and Price (2012) highlight that initially, the experience of numeracy is through physical interaction with the environment. Montague-Smith and Price highlight that in the first instance, this concrete level of representation involves action on an object or objects. Second, the experience is represented in an iconic form; an image that represents the object or objects. Finally the concept can be represented in spoken words or written symbols. Here the words or symbols call to mind the concept directly. As the representation process moves from the concrete to the abstract, it is no longer connected with a particular example, but becomes generalised. This development has been described by Kilpatrick, Swafford and Findell (2001) who suggest that when children progress from 'real-world' scenarios to pictorial, verbal and then symbolic representation, they are developing conceptual knowledge of mathematical ideas.

The Child as Learner: Social Constructivism & Sociocultural Perspective

Social constructivism helps our thinking about how a child internalises an idea, and a sociocultural perspective helps analyse influences of the social/cultural aspects within the learning environment (Van de Walle et al., 2013). Central to constructivism is the idea that children are creators of their own knowledge and apply prior knowledge to make sense of new knowledge. This approach positions children as active participants and decision-makers, who actively construct their own understandings and contribute to others' learning. According to Van de Walle and colleagues (2013), this can happen in two ways: assimilation and accommodation. Assimilation occurs when a new concept 'fits' with prior knowledge and the new information expands an existing network. Accommodation takes place when the new concept does not 'fit' with prior knowledge, so the brain revamps or replaces existing schema. Though learning is constructed within the self, the cultural environment contributes to learning while the child contributes to the cultural environment.

A sociocultural approach to learning emphasises the socially-negotiated and embedded nature of meaning-making and how children use the cognitive tools of their cultural community through participation in social activity (Murphy & Hall, 2008). Central to sociocultural perspectives is the notion that knowledge exists between and among individuals in social settings and learning occurs through interactions that are influenced by different cultural, multimodal representations (language, pictures, etc.) and the cultural environment. Children learn with understanding when they bring their diverse experiences, perspectives, expectations, knowledge and skills to their learning. The way in which this information is learned depends on the zone of proximal development (ZPD). The ZPD refers to a 'range' of knowledge that may be out of reach for a child on his or her own, but is accessible if the child has support from peers or more knowledgeable others (Vygotsky, 1978; Goos, 2004). The importance of language and other ways of conveying cultural practice, such as pictures and other action visuals exchanged between and among the group of children, plays a central role.

Methodology

A Qualitative research project, which took the form of Action Research within an early childhood learning environment, was conducted with kindergarten children (four-five year olds) in Australia and in Canada. As part of intentional teaching, its purpose was to utilize arts-based methods (drawings and explanations) to determine and enhance children's understandings of their local and global environment. Teachers and researchers guided children through the process of creating postcards. In the first instance, children illustrated the picture side of the postcard. After this was completed, they explained the story behind their illustration and this was scribed by the teachers or researchers. The purpose of this paper is to examine the representation of numeracy concepts as depicted in children's postcards, both the drawings and the text.

The research question focused on in this paper is: How do kindergarten (four-five year olds) children represent and develop numeracy ideas through their drawings and supporting text? As early as 1998, The Australian Association of Mathematics Teachers highlighted that the historic acceptance of 'arithmetic skills' as the limit of mathematical knowledge precluded other important aspects of numeracy such as: logical reasoning, spatial thinking and visual representations. This paper investigates these important aspects of numeracy and how they were represented through the children's postcards.

Following ethics approval, kindergarten children in Australia (N=22) and in Canada (N=19) and their teachers were recruited from a small regional city in northern Australia and a large metropolitan area in eastern Canada. Over a 10-week period, data were collected, including three sets of postcards from each group of children to the other group, often in response to a postcard received from the other group. This paper looks at the postcards - both the pictorial and written texts.

Data analysis of the written components of the postcards was through open coding; where texts were read and re-read, looking for patterns or themes. Wiersma and Jurs (2005) state that in qualitative research, "more commonly the specific categories emerge from the data" (p. 207). Drawings produced by the children were analysed by examining their content, interpretation and developmental appropriateness. Di Leo (1983) suggests that holistic approaches that include several methods provide better information about the item.

Findings that emerged from both the drawings and explanations included that these young children (aged 4 to 5 years) are already demonstrating substantial numeracy and mathematical concepts. The following section, 'Findings and Interpretation', describes the numeracy and mathematical concepts conveyed in the postcards, and their implications.

Findings and Interpretation

Teachers and researchers in both classrooms engaged an Intentional Teaching approach to scaffold children's environmental understanding. However, learning went beyond environmental understanding in a number of ways; most notably in numeracy. The research found that when kindergarten children created and shared postcards with their peers, they generated rich visual representations of their physical environments. Further, through their postcards, the children clearly demonstrated spatial orientation, or their position in relation to their physical environment. Further, they were able to quantify objects and describe the attributes of objects; which are important concepts in numeracy and mathematics. The study highlighted these concepts through postcards produced by the children. Each of these findings is described below.

Spatial Orientation

Children showed that they were able to draw and think about objects in various spatially-oriented ways. For example, in Figure 1 (below), V drew people and objects. The drawing shows images of three people, a ladder in a swimming pool and a tree near the swimming pool. V explained that it was her, along with her mum and dad, swimming in the swimming pool. In this drawing, V articulated important aspects of spatial orientation: (a) the capacity to identify and represent where she was in space at a particular time, (b) the ability to understand how objects (herself, mum, dad, the ladder and the tree) were arranged in space in relation to one another, and (c) the coordination of different spaces in relation to other spaces.

Figure 1

In Figure 1, V configured herself and her parents in a spatial formation and orientation in relation to the tree and the pool ladder. The tree and ladder are drawn in the vertical direction and perpendicular to the surface of the swimming pool, which is in the horizontal direction. Also, the surface of the swimming pool and its three human occupants are drawn on a horizontal plane. *The Australian Curriculum: Mathematics* (ACARA, 2011) states by the end of Year 2 (typically seven years old); students “Interpret simple maps of familiar locations and identify the relative positions of key features (ACMMG044)”. However, the drawing (Figure 1) suggests that V (four and half years old) was able to draw and represent objects in a three dimensional space, a spatial skill that involves thinking about objects in different spatially oriented ways.

Some students’ drawings did not articulate to the same level the important aspects of spatial orientation demonstrated in Figure 1. Students develop specific early mathematics and numeracy skills at different rates and, according to Purpura and Lonigan (2015), appear to develop these skills in overlapping phases. This means that it becomes important to enhance early childhood educators’ Intentional Teaching strategies with not only play-based activities, but with the development of an early childhood numeracy progress monitoring framework. This framework could be designed to efficiently assess children’s developing numeracy skills and to further develop intentional numeracy teaching strategies. As indicated in Figure 1 and discussion of other children's work, children seem to develop their mathematics and numeracy skills at different rates. A numeracy progress monitoring framework could enable early childhood classrooms to feature instructional organization that is intentionality – directed, with designed interactions between children and teachers in which teachers purposefully challenge, scaffold and extend children’s developing mathematics and numeracy skills (Pianta & La Paro, 2003).

Early childhood educators could employ Intentional Teaching strategies and an early childhood numeracy progress monitoring framework to specifically monitor children’s drawing and representational skills with numeracy concepts, such as objects in three dimensional spaces. DeLoache (2000) and Demetriou and colleagues (2011) suggestion that children’s language develops during the second year of life, and their differentiation of objects at around three to four years gives us the space and opportunity to develop mathematical language early. An early childhood numeracy framework could be used to develop Intentional Teaching strategies that progress young children’s concepts of space, encourage them to draw representations of those spaces, and to also use the language of mathematics (e.g. vertical, horizontal, plane, etc.) to describe those spaces to their peers.

Quantification of Objects

The children in this research expressed understanding of quantities of objects, including people and animals in their drawings, by pointing to and counting them. However, within the group, children’s achievement levels differed. For example, W’s drawing (Figure 2) was followed by the explanation: *There is a lot of sun in Australia…. We grow many vegetables at my place…. We pick cherries in our garden and we eat some of them* (counting the red round markings in the drawing)…. *We also have coconuts, mango trees and pawpaw trees* (pointing to the pictures of trees in the drawings). In this drawing W was able to articulate important aspects of quantification of objects including the act of counting and estimation (some, many, few, a lot) to determine a measure that indicates quantity or number of objects, an important milestone required in early numeration understandings (Cotton, 2010; Purpura & Lonigan, 2015).

Figure 2

The EYLF (DEEWR, 2009) suggests that young children should be demonstrating an increasing understanding and use of language to communicate thinking about quantities to describe attributes of objects and collections, and to explain mathematical ideas. *The Australian Curriculum: Mathematics* (ACARA, 2011) states that by the end of the Foundation year (typically five to six year olds), students should make connections between number names, numerals and quantities up to 10, and order small collections. In Figure 2, W (four years old) was able to represent objects in categories and sets. W was also able to appoint objects as members of sets, such as when she differentiates between groups of cherries, coconuts, mangoes and pawpaw's.

Early childhood educators, as the 'more knowledgeable others' (Vygotsky, 1978) could extend young children's zone of proximal development (ZPD) using Intentional Teaching accompanied by an early childhood numeracy framework could specifically progress young children's early number sense, as well as the language of mathematics; for example children's development and understanding of the one-to-one principle and the stable order principle. From this framework an early childhood numeracy progress monitoring tool could be developed to assess the 'one-to-one principle', which involves children knowing that they count each item once, and the 'stable order principle', which involves children knowing that the order of number names always stays the same (Cotton, 2010; Purpura & Lonigan, 2015).

Attributes of Objects

Children in this study were able to express and highlight attributes of objects in their drawings, such as that a parent was taller/bigger than them or that a younger sister or brother was shorter/smaller. In Figure 3 (below), for example, X shows the size of members of his family. He explained that his father is taller than his mother, and his mother is taller than him.

In Figure 3, X articulated important aspects of numeracy, including recognizing and describing an attribute (the height, which is a form of length) of objects of the same kind, and realizing that they can use that attribute to compare objects, as either taller or shorter than other objects.

Figure 3

The EYLF (DEEWR, 2009) suggests that young children should demonstrate an increasing understanding of measurement and number using vocabulary to describe length, volume and capacity. *The Australian Curriculum: Mathematics* (ACARA, 2011) states that by the end of the Foundation year, students group objects based on common characteristics and sort shapes and objects. In Figure 3, X (four years old) was able to put the images of his family members in order, from the shortest/smallest to the tallest/ biggest, articulating an important aspects of numeracy which involves ordering (or ranking) of a class of objects using an attribute of the objects.

An early childhood numeracy progress-monitoring framework could be used to assess the range of children's developing understanding of the attributes of length, volume and capacity. Again, this could lead to the development of Intentional Teaching strategies that specifically progress children's use of mathematical vocabulary for attributes or properties of objects, such as size, length, volume and capacity of objects. A framework such as this needs to be carefully and deliberately chosen and developed, so as to convey the right mathematical ideas taught in the right way for early years settings (Montague-Smith & Price, 2012).

Findings from this research seem to indicate that these children, at a much younger age than the *Australian Curriculum: Mathematics* states were able to demonstrate spatial orientation, quantification of objects and attributes of objects. It seems that the Intentional Teaching strategy of postcard making worked well to progress kindergarten children's numeracy and mathematical skills in their visual and descriptive representations. This supports Purpura and Lonigan's (2015) suggestion of the need to efficiently measure the mathematical progress of young children and the effects of Intentional Teaching on their developing numeracy.

Conclusions

This study concluded that through Intentional Teaching in an arts-based project about the environment, children's learning went beyond environmental understanding to demonstrate considerable numeracy learning. Children seemed to demonstrate the development of spatial orientation, quantification of objects and attributes of objects. It is felt that with further investigation, these young children could demonstrate "spatial sense, structure and pattern, number, measurement, data argumentation, connections and exploring the world mathematically," which are the powerful mathematical ideas children require to become numerate (DEEWR, 2009, p. 38). As Presser et al (2015) indicate, programs such as 'Big Math for Little Kids' could make a positive contribution to young children's mathematical development.

Beyond this, an early childhood numeracy progress monitoring framework could be developed and prove very useful for determining children's progressing numeracy and mathematical skills. This, accompanied by quality Intentional Teaching, could enhance numeracy and mathematics learning and teaching in the early childhood classroom.

We hope to encourage further dialogue among early childhood educators and early childhood teacher educators and to research and develop such an early childhood numeracy-monitoring framework. This could also include professional development for early childhood educators to help them to map children's development and progress in spatial sense, structure and pattern, number, measurement, data argumentation, connections and exploring the world mathematically (DEEWR,2009) from the emergent phase to the application of numeracy and mathematics ideas.

References

Arthur, L., Beecher, B., Death, E., Dockett, S. & Farmer, S. (2015). *Programming and planning in early childhood settings* (6th ed.). Melbourne: Cengage Learning.

Australian Association of Mathematics Teachers [AAMT]. (1998). *Policy on numeracy education in schools*. Adelaide: Author

Aubrey, C. & Godfrey, R. (2003). The Development of children's numeracy through Key Stage 1, *British Educational Research Journal*, 29(6), 821-840. http://dx.doi.org/10.1080/0141192032000137321

Aunio, P. & Niemivirta, M. (2010). Predicting children's mathematical performance in grade one by early numeracy, *Learning and Individual Differences*, 20, 427-435. http://dx.doi.org/10.1016/j.lindif.2010.06.003

Australian Curriculum and Reporting Authority: ACARA (2011): *Australian Curriculum: Mathematics*, Commonwealth of Australia, Canberra. www.australiancurriculum.edu.au/mathematics/mathematics-across-foundation-to-year-12

Barblett, L. (2010). Why play-based learning? *Every Child*, 16(3), 4 – 5.

Brown, L. L. (n.d.). Comparing Preschool Philosophies: Play-Based vs. Academic, PBS Parents. www.pbs.org/parents/education/going-to-school/choosing/comparing-preschool-philosophies/

Council of Australian Governments (2008), National numeracy review: final report, commissioned by the Human Capital Working Group, COAG, Commonwealth of Australia, Canberra. www.coag.gov.au/reports/index.cfm

Cotton, T. (2010). *Understanding and teaching primary mathematics*. London: Pearson Education Limited.

DeLoache, J. S. (2000). Dual representation and young children's use of scale models. *Child Development*, 71, 329–338. http://dx.doi.org/10.1111/1467-8624.00148

Demetriou, A., Spanoudis, G., & Mouyi, A. (2011). Educating the Developing Mind: Towards an Overarching Paradigm, *Educational Psychology Review*, 23, 601–663. http://dx.doi.org/10.1007/s10648-011-9178-3

Di Leo, J. H. (1983). *Interpreting Children's Drawings.* New York: Brunner-Routledge.

Driver, R., & Bell, B. (1986). Students' thinking and learning of science: A constructivist view. *School Science Review*, 67(240), 443-456.

Early Childhood Australia and the Australian Curriculum, Assessment and Reporting Authority. (2011). *Foundations for learning: Relationships between the Early Years Learning Framework and the Australian Curriculum.* www.acara.edu.au/.../ECA_ACARA_**Foundations**_Paper_FINAL.pdf
Epstein, A.S. (2009). Think before you (inter)act: What it means to be an intentional teacher. *The Intentional Teacher Exchange*, January/February, 45 – 49.
Epstein, A. S. (2007). *The Intentional Teacher: Choosing the Best Strategies for Young Children's Learning.* Washington, DC: National Association for the Education of Young Children.
Geist, E. (2009). *Children are Born Mathematicians: Supporting Mathematical Development, Birth to Age 8.* Upper Saddle River, NJ: Pearson.
Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal of Research in Mathematics Education*, 35(4), 258-291. http://dx.doi.org/10.2307/30034810
Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.
Lesh, R. A., Cramer, K., Doerr, H., Post, T., & Zawojewski, J. (2003). Model development sequences. In R. A. Lesh & H. Doerr (Eds.), *Beyond constructivism: A model and modelling perspective on mathematics teaching, learning, and problem solving* (pp. 35-58). Mahwah, NJ: Lawrence Erlbaum.
Minetola, J. R., Ziegenfuss, R. G. & Chrisman, J. K. (2014). *Teaching Young Children Mathematics*. New York: Routledge.
Montague-Smith, A. & Price, A. J. (2012). *Mathematics in Early Years Education* (3rd ed.). New York: Routledge.
Murphy, P. & Hall, K. (2008). *Learning and Practice: Agency and Identities*. London: Sage Publication.
Pianta, C. R. & La Paro, k. (2003). Improving early school success. *Educational Leadership*, 60, 24-29.
Presser, A. L., Clements, M., Ginsburg, H. & Ertle, B. (2015). Big Math for Little Kids: The Effectiveness of a Preschool and Kindergarten Mathematics Curriculum, *Early Education and Development*, 26(3), 399-426. http://dx.doi.org/10.1080/10409289.2015.994451
Purpura, D. J. & Lonigan, C. J. (2015). Early Numeracy Assessment: The Development of the Preschool Early Numeracy Scales, *Early Education and Development*, 26(2), 286-313. http://dx.doi.org/10.1080/10409289.2015.991084
Sarama, J. & Clements, D. H. (2009). *Early Childhood Mathematics Educational Research – Learning Trajectories for Young Children*. London: Routledge.
Shipley, D. (2008). *Empowering children. Play based curriculum for lifelong learning* (4th ed.). USA: Nelson Education.
State of Victoria (2009), Numeracy in practice: teaching, learning and using mathematics. Paper No. 18, June 2009, Education Policy and Research Division Office for Policy, Research and Innovation Department of Education and Early Childhood Development. www.eduweb.vic.gov.au/edulibrary/public/publ/research/nws/numeracy_in_practice_paper_no_18.pdf
Sullivan, P. (2011). Teaching mathematics: using research-informed strategies. http://research.acer.edu.au/aer/13
Tucker, K. (2011). *Mathematics Through Play in the Early Years* (2nd ed.). London: Sage Publication.

Van de Walle, J. A., Karp, K. S. & Bay-Williams, J. M. (2013). *Elementary and Middle School Mathematics: Teaching Developmentally* (8th Ed). Boston: Pearson.
Victorian Early Years Learning and Development Framework [VEYLDF] and the Victorian Essential Learning Standards [VELS] (2008). Victorian Curriculum and Assessment Authority. www.vcaa.vic.edu.au/Documents/earlyyears/veyldf_vels.pdf
Vygotsky, L. S. (1978). *Mind and Society*. Cambridge, MA: Harvard University Press.
Wiersma, W. and Jurs, S.G. (2005). *Research Methods in Education – an introduction* (8th ed.). USA: Pearson.