



Practitioner Researcher

Strategies for teachers developing strategies for mathematics in early childhood education

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This study emerged from a search for effective ways to incorporate mathematics/*pāngaru* into our Early Childhood Education (ECE) programme. Optimising mathematics learning outcomes in ECE requires using *Te Whāriki* as a curriculum base (Ministry of Education [MoE] 1996). While this delivers broad expectations that children will grow in familiarity with number and mathematics concepts, it doesn't prescribe actual teacher practice. Looking at the literature in New Zealand and internationally reveals a number of viewpoints on delivering positive mathematics outcomes. This paper will examine strategies for increasing mathematics learning in a holistic way include focusing on the teacher's role, the child, the environment and resources.

That young children are capable of mathematical thinking is well established (Baroody, Eiland & Thompson, 2009; Clements & Sarama, 2003). Many studies have shown that four year olds possess a considerable amount of knowledge regarding numbers and counting (Bobis, Clarke, Clarke, Thomas, Wright, Young-Loveridge & Gould, 2005) with findings showing a correlation between early childhood mathematics ability and achievement at school (Young-Loveridge, Carr & Peters, 1995).

School achievement in mathematics is seen as a contributor to a productive adult life (Walshaw & Anthony, 2008); consequently, there is more attention being paid to enhancing mathematics in ECE as a way to address inequities in achievement and maintaining children's enthusiasm about mathematics early on (Haynes, Cardno & Craw, 2007; Parks & Bridges-Rhoads, 2012).

Issues arise however when the child directed holistic curriculum *Te Whāriki* that sees mathematics integrated throughout the curriculum, is placed alongside the New Zealand school curriculum (Alcock & Haggerty, 2013). Preparing children for a standards' assessed system while staying true to *Te Whāriki's* emergent curriculum can be challenging for teachers. While the mathematics strand is implied, individual teachers need to be able to: "encourage skill in using the counting system and mathematical symbols and concepts ... for meaningful and increasingly complex purposes" - while allowing each child to learn at their own pace (MoE, 1996, p.78).

Strategies

Linder, Powers-Costello & Stegelin (2011) researched strategies in the USA for improving mathematics learning in early childhood education, specifically in



numeracy. They advocated for instructional methods of the Reggio Emilia approach based around meaningful activities for children, citing also intentional teaching to make up for the lack of mathematics content in the ECE curriculum. Clements & Sarama (2003) also consider mathematics as lacking in the ECE curriculum but that other methods exist besides direct instruction to help children become competent in mathematics early.

Contradicting this view, Gifford (2004) maintains that instruction is not part of the ECE teacher's role. Being instructive, they believe, puts pressure on the child and stifles enthusiasm (Peters & Rameka, 2010). Helping make connections, demonstrating, modelling and posing questions like, "what would happen if?" are recommended instead of direct teaching. Parks and Bridges-Rhoads (2012) argue that societal demands for increased achievement contribute to a more instructive teaching style. They suggest that extending children's thinking through meaningful relationships and innovative activities is far more preferable. Edens and Potter (2013), similarly focus on how communication between teachers and children helps mathematics competence. Their findings show the link between number talk and teachers' knowledge (Edens & Potter, 2013) demonstrates the need for increased professional development in mathematics.

Teaching early childhood mathematics as the subject of research is undervalued next to literacy (Linder et al, 2011). While numerous text books exist (Copley, 2010; Carruthers, E., & Worthington, M., 2006) detailing mathematics games and strategies, research into their use and effectiveness within New Zealand centres is an area for more research. Gifford (2004) refers to a lack of research into mathematics teaching in early childhood centres in England. Siraj-Blatchford (as cited in Gifford, 2004) suggests that despite the availability of number resources, only 5% of children's time is spent on mathematics. Edens and Potter (2012), identified another gap in research concerning "ways to provide opportunities to advance children's early mathematical skills development" (p. 237). Early childhood education in New Zealand doesn't advocate rote learning to meet mathematics standards, but if preschool predicts schooling outcomes, we need to consider how to promote mathematical learning in a holistic play based environment (Bobis et al, 2005).

As Baroody et al. (2009) found, the key is to make connections and extend what children already know. The teacher's role according to Linder et al. (2011) is to make a child's observations of mathematics in their natural world more obvious. In an attempt to use mathematical talk while avoiding being overly instructive, teachers sometimes mention number facts without adequately connecting them to a child's reality (Linder et al., 2011).

Rudd, Lambert, Satterwhite and Zaier (2008), show that teaching concepts like graphs, tallies and geometry are often viewed as direct teaching which is not popular. Table top mathematics activities need to be added in their view, with planned mathematical activities like group projects triggered by the children's interests unlike teaching that focuses on counting. They add that spatial and geometric skills are often better predictors of mathematical ability (Edens & Potter, 2013). If children are to become more familiar with numbers, which are seen by some as cultural tools (Vygotsky cited in Berk, 2003), then the mathematics of 'other' cultures should be more visible (Bailey & Taylor, 2010). A New Zealand study by Young-Loveridge et al. (1995) recommending resources



for outdoor mathematics, cited by Gifford (2004), advocates meaningful experiences in rich outdoor environments.

Teacher's role

Improving mathematical outcomes was the subject of a teaching and learning research initiative by Haynes et al. (2007), acknowledging that the teachers' subject knowledge and confidence have influence on the development of children's mathematical thinking. Anthony and Walshaw (2007) concur that teachers have a huge significance in how we perceive learning outcomes.

Teaching is complex and socially constructed (Peters & Rameka, 2010), so there isn't a set way to teach mathematics. In fact the search for prescribed, 'effective' ways to teach, can lead to narrow instructional methods. Parks and Bridges-Rhoads (2011) argue against a highly structured curriculum that allows children to achieve essential skills but diminishes their interest in the subject. Begg (1999) suggests observing and scaffolding in such a way that the child learns to focus their attention. This construction of meaning is supported by Wang (2009), who highlights the value of including social items such as time telling and money. Fostering learning dispositions such as curiosity and perseverance developed through play leads to the child making discoveries of number and mathematics concepts (Carr, 2001), a type of learning which should endure.

Teachers' confidence and knowledge is positively correlated with mathematical outcomes (Haynes et al., 2007; Baroody et al., 2009; Anthony & Walshaw, 2007). Teacher knowledge is also related to enthusiasm about mathematics and transfers to the child (Bobis et al, 2005). Children need encouragement and opportunities to practice with teachers who understand the mathematics children are doing is vital (Anthony & Walshaw, 2007; Clements & Sarama, 2003).

Recognising children's mathematical ability and supporting it by using opportunities purposefully is still an area for teacher development (Gifford, 2004). In addition, recognising that teaching mathematics might be construed as pressure on the child, other teachers or parents can deter teachers from initiating any sort of mathematical activity (Linder et al, 2011).

Rudd et al. (2008), when referring to teachers' mathematical language, advance a playful approach when guiding the child. Finding a balance between structured games activities and play based learning, they see this occurs when teachers facilitate mathematical activity that leads to better outcomes (Siraj-Blatchford, 2004). What researchers are in agreement on, is that spontaneous free-play is not enough on its own (Bobis et al, 2005; Edens & Potter, 2013). Being involved and engaged depends on prior knowledge so children who are not interested in mathematical play or talk need to be inspired (Anthony & Walshaw, 2007).

The teacher's role in learning according to Walshaw and Anthony,(2008) is in creating a sense of belonging and engagement in the classroom. While this research was on primary students, it also applies to ECE, in that students do better when knowledge is co-constructed, when children feel comfortable in a relationship with their teacher (Bobis et al, 2005). Gifford (2004) confirms the role of the teacher in discussing mathematical concepts with the child's interest.



Hooks and Duarte (2005) also say mathematics should come from the child's interest, a view elaborated on by theorists Rogoff and Vygotsky (cited in Anthony & Walshaw, 2007), who advocate shared learning or co-construction. Mathematics being part of holistic learning, recognised in the New Zealand curriculum, (MoE, 1996), fosters curiosity and extending interests through resources and incidental mathematical conversations (Clements & Sarama, 2003). These conversations are to be incorporated in an effective project approach (Hooks & Duarte, 2005), allowing mathematical concepts to be discussed and children to ask the questions while working on an activity.

Wang's (2009) research has shown that children benefit from activities relevant to daily life. Working in partnership with families, linking mathematics from home to centre being another effective strategy as learning is seen as a social process (Peters & Rameka, 2010). As number sense is foundational (Baroody et al, 2009) and predicts later skills (Edens & Potter, 2013), guiding the child to know and enjoy numbers is critical. Other research into the connection between body, mind and emotions (Alcock & Haggerty, 2013) points to mathematics strategies that are tactile, fun and shared. Peters and Rameka (2010) explain that as ECE teachers we need to be confident that practices and resources will foster learning and enjoyment, not simply temporary gains in particular skills.

Conclusion

In conclusion, children's mathematics ability should be nurtured and extended by capable and confident teachers who position the child at the centre of their learning. While much is known about the way mathematics develops and its importance throughout life, teachers need more strategies to inspire interest and enthusiasm for mathematics in children. Creative environments and resources that encourage natural curiosity and discovery in mathematics could also be further researched in an effort to address disparities in achievement that begin early.

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