International Perspectives on Early Years Mathematics

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In recent decades the development of mathematical proficiency has been recognised as a key issue for children and their education. The purpose of this paper is to identify key international perspectives that influence Australian mathematics education in the early years especially those that are in a similar state of technological development to Australia. There are four key trends deserving of discussion: (1) development in the early years, (2) mathematical proficiency in the early years, (3) mathematics policy and curriculum designed for young children, and (4) the existing research evidence-base.

In recent decades there has been universal interest in the benefits surrounding early childhood education and the crucial role early childhood development plays in societies economic and social growth has been internationally recognized and acknowledged (Dodge, 2004). This commitment to early childhood education and care is evident in the report *Starting strong: Early childhood education and care* (OECD, 2001, 2006). Policy-makers have "recognised that equitable access to quality early childhood education and care can strengthen the foundations of lifelong learning for all children" (OECD, 2001, p. 7). Correspondingly, the importance of mathematics in the lives of young children has been recognised (Ginsburg, Cannon, Eisenband, & Pappas, in press).

The past few decades have seen substantial changes in thinking about young children's ability to reason mathematically and their propensity to learn mathematical concepts and acquire associated skills (e.g., Baroody, 2000; Clements & Sarama, in press; Ginsburg, Balfanz, & Greenes, 2000). The development of mathematical proficiency has been recognised as a key issue for children and their education. In recent years it has also been acknowledged that the advances in technology have influenced the need for increased and enhanced numeracy practices. Steen (2001) credits the rise in the use of quantitative data, numbers, and information to the universal increase in the usage of technology, computer, and the internet. Our very young children are born into a world that is built on digital technology and a world where having competence and dispositions to use mathematics in context is essential. The importance of a numerate society in a technological age is recognized globally (Her Majesty's Inspectorate, 1998; National Council of Teachers of Mathematics (NCTM), 2000).

The coalescence of contemporary understandings (i.e., early learning, mathematical proficiency, technology) has created a juncture in the field of early childhood mathematics. The purpose of this paper is to identify key international influences on Australian mathematics education in the early years, especially those from countries that are in a similar state of technological development to Australia. There are currently four international trends guiding early childhood mathematics – the nature of early years development, the mathematical capabilities of young children, early childhood policy and curricula to inform practices, and the call for evidence-based research.

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The Early Years of Development

The internationally defined period of early childhood spans the years from birth to eight years (Bredekamp & Copple, 1997). These first eight years of life constitute two distinct learning periods: first, the development that occurs prior-to-school in informal learning situations, and second, the development that occurs in the first three years of schooling, which is often regarded as formal learning. High quality educational programs in the prior-to-school years facilitate the development of the child in all its dimensions and have considerable long-lasting effects on the child's life (OECD, 2001, 2006). Perry (2000) argues that during this period the growth of fine and gross motor skills, understanding and expression of emotional and social competence, cognitive changes, and the development of language are extensive. Contributing to the current perceptions of young children and their learning capabilities are the findings of neuroscience research.

Neuroscience research findings confirm the connection between young children's experiences and achievements later in life (Bruer, 1999). These studies have suggested that brain growth is highly dependent upon children's early experiences. Original research by Chugani (1998) provides evidence that "environmental enrichment" stimulates brain development. Worldwide, there has been excitement about the potential of the studies from neuroscience to inform early childhood education (e.g., Meade, 2000). Consequently, it has been widely accepted that early childhood development prior to school helps prepare young children to succeed in school (Bowman, 1999) and that long-term success in learning requires quality experiences during the "early years of promise" (Carnegie Corporation, 1998).

Mathematical Proficiency in the Early Years

International research provides evidence advocating the salient nature of early childhood development and mathematical growth. An increased recognition of the importance of mathematics (Kilpatrick, Swafford, & Findell, 2001) coupled with research findings has confirmed that mathematical development occurs in the early years and is critical to success and achievement in both school and life pursuits. Studies have shed light on the many general and specific mathematical skills, abilities, knowledge, and dispositions acquired by young children. For example, Hughes' (1986) research clearly showed that children exhibit knowledge of subtraction before attending school, while Carpenter and Moser (1984) noted children use informal knowledge to solve simple addition problems. Feeney and Stiles (1996) produced research findings that describe children's spatial ideas. Measurement, data, and probability have also been identified as features in early childhood learning (Perry & Docket, 2002). Other studies have reported on problem solving (Cobb et al., 1991), data sense (Jones, Langrall, Thornton, & Nisbet, 2002), numerical competence (Wynn, 1998), and counting (Sophian, 2004). Research findings on children's early mathematical growth together with the growing number of children who spend time in early childhood programs has created an impetus for the creation of policies and curricula that support the development of early years care and education. In the digital age with the vast majority of jobs requiring more sophisticated skills than in the past, mathematical proficiency has become as important a gatekeeper as literacy (Baroody, Lai, & Mix, in press).

Mathematics Position Statements and Curriculum in the Early Years

Position statements and curricula advocating mathematics education in the early years recognises young children's mathematical potential. A position statement developed by the National Association for the Education of Young Children (NAEYC, 2002), and NCTM (2002) have affirmed that high-quality, challenging, and accessible mathematics education for 3- 6-year-old children is a vital foundation for future mathematics learning. Besides advocating a robust mathematical base for these young members of society, the position statement acknowledges that higher levels of mathematical proficiency are required in the 21st century (NAEYC, 2002; NCTM, 2002). However, none of the ten research-based recommendations designed to guide classroom practice discusses the role of technology on young children's mathematical development.

Curriculum documents create the foundation for much that happens in compulsory and pre-compulsory settings. The NCTM (2000) proposes that mathematics is a way of thinking about relationships, quantity, and pattern via the processes of modelling, inference, analysis, symbolism, and abstraction (NCTM, 2000). They stipulate that, "the foundation for children's mathematical development is established in the earliest years" (p. 73) and have created principles and standards that promote this viewpoint. American researchers involved in early childhood mathematics have made a concerted effort to foster curriculum reform informed by the mathematics standards. Clements, Sarama, and Di Biase (2003) have compiled a list of assumptions, themes, and recommendations that evolved from the conference on *Standards for Pre-Kindergarten and Kindergarten Mathematics Education* (NCTM, 2000). Clements et al. (2003) emphasise that the guidelines for developing standards and curricula should be based on available research and inform practice.

Evidence-based Practice

The belief that mathematical capabilities and competencies of young children are extensive and impressive (Clements & Sarama, in press) is validated by contemporary research findings. Yet a dearth of research on early childhood mathematics especially in the years prior-to-school has been reported (Perry, 2000). Hiebert (1999) cautions that an adequate evidence base is essential to inform teachers who are trying to improve children's achievement in mathematics. In a recent study, I reviewed 208 articles on early childhood mathematics education sourced from the ERIC database that were published between 2000 and 2005 in order to determine the adequacy of the literature. Overall, this study revealed: (1) a lack of peer-reviewed articles that discuss, investigate, examine, or debate early childhood mathematics; (2) a limited emphasis in the prior-to-school years; and (3) a paucity of literature on technology and problem solving. Traditional mathematical topics are represented in the research, such as mathematical concepts and instruction, but the literature was limited in other significant ways. For example, scant research on technology use by young children was reported. When considering the mathematical proficiency to be developed by young children to function effectively in everyday life, technology plays an important role.

A further consideration in the adequacy of the literature base is the rigour of the research. The requirement for evidence-based policy and curricula in the USA has drawn attention to the quality of the research base from which policy and curricula are developed in other countries. In the United States landmark legislation titled, *No Child Left Behind* (NCLB) (U.S. Department of Education, 2001) aims to improve the performance of school students by increasing the standards of accountability as well as providing parents more flexibility in choosing which schools their children will attend. This act specifically calls for scientifically-based research to inform education policy and practice and that decisions regarding policy and practice be evidence-based. Thus, not only is there a need for more early childhood research on contemporary topics such as technology, but there is a corresponding need for this research to be rigorous.

Conclusion

Four international trends influence contemporary early childhood mathematics: (1) world wide beliefs about the salient nature of early years' development, (2) the mathematical capabilities of young children, (3) the development of position statements and curricula to inform early childhood practices, and (4) the evidence base. However, some essential areas remain under-researched. For example, the influence of technology on human life in the new millennium has created a world characterized by diverse and energetic communication, vast amounts of information, rapid change, and high levels of numeracy. Technology affects the daily lives of every person, directly or indirectly (Williams, 2002) yet currently it is featuring little in the early childhood mathematics research literature. The research base providing evidence of the salient nature of prior-to-school years and mathematical development is also lacking. These first years of life should not be overlooked due to their important role in brain development, lifelong learning, and life chances.

This paper has identified some of the international perspectives influencing early childhood mathematics education and some of the areas in need of research. These international perspectives contribute to the research agendas and directions in Australian early childhood.

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