July, 2009

Mathematical thinking of young children through the eyes of preschool practitioners

Robert Hunting, *La Trobe University*
Catherine Pearn, *University of Melbourne*

Mathematical Thinking of Young Children Through the Eyes of Preschool Practitioners

Robert Hunting
La Trobe University
<hunting@latrobe.edu.au>

Catherine Pearn
The University of Melbourne
<cpearn@unimelb.edu.au>

This paper reports on interview responses to 3 questions seeking preschool practitioners' perceptions of mathematical thinking in very young children. Generally, the interviewees were found to have a good sense of mathematical concepts relevant to babies and toddlers, and they cited evidence of young children's mathematical development. It is concluded that this practical knowledge provides a strong foundation for further professional development.

Mathematics is a core component of cognition, and "robust mathematical learning by all young children is a necessary base for later learning" (Clements, Sarama, & DiBiase, 2003, p. 105). Many researchers have recognised that children bring to school powerful mathematical knowledge, skills and dispositions (e.g., Baroody, 2000; Clarke, Clarke, & Cheeseman, 2006; Ginsburg, Balfanz, & Greenes, 2000), but it is important that people who care for young children and design their activities are also aware of this. It is vital that they can identify moments with potential to lift the level of children's thinking through scaffolding (Siraj-Blatchford & Sylva, 2004).

This paper presents results from three interview questions designed to elicit views of preschool practitioners on mathematical thinking in the earliest years.

- At what age do you start to see children thinking mathematically?
- Can you give an example of mathematics learning that you have observed in your Centre recently? Was this planned or incidental?
- Think of a child who has a good grasp of mathematical knowledge. Describe some of the mathematical things that this child does.

Such questions are important because awareness of mathematical thinking is likely to lead to the provision of activities and opportunities and interactions that encourage development of relevant mathematical processes, concepts, and language. It is also vital to know where to start when planning professional development.

When Children Begin to Think Mathematically

Responses were grouped into three broad categories: those who thought children start to think mathematically at less than 12 months, between 12 and 24 months, and older than 2 years. In the <12 month category (n=30), 6 practitioners believed mathematical thinking began from birth, and 13 believed preschool children's mathematical thinking is evident in babies. A practitioner said:

> I am in the nursery so I see them problem solving, as in if something falls over, or how do I pick it up, and how will that sort of work. Yeah, I think from when they are born, they are solving problems and that sort of thing. (Peninsula-Gippsland, Vic)

In the 12-24 month category (n=18), 10 practitioners believed mathematical thinking was present in children aged 12-18 months. Reasons offered included:

> Children like to start counting when you put their socks on and you say one and two and they try and copy that, or going down a couple of steps and counting each one as you go. One of our mums was just telling me about her one year old the other day that the little girl has learnt to go "one more,

In R. Hunter, B. Bicknell, & T. Burgess (Eds.), *Crossing divides: Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 1). Palmerston North, NZ: MERGA.

one more", and she goes like this so you know that is something that she has picked up on her own—and at one year old (Tamworth, NSW).

In the >24 months category (n=18), 7 said mathematical thinking begins by age 3, 5 thought it to be about aged 4, and the others at school age.

We don't have mathematics as such. They learn to recognise numbers but counting and sums are for the school. (Toowoomba, Qld)

Overall, a total of the 58 practitioners (88%) thought that mathematical thinking starts before the age of 3, and many identified mathematical activity in babies and toddlers. Such a finding is surprising, considering that evidence of infant and toddler mathematical thinking is not incorporated in the preparation of certified practitioners or the meagre in-service opportunities available in Australia. Hopefully, the task of providing a theoretical rationale for the mathematical development of preschool children would be made easier by the fund of personal experience and observations early childhood practitioners draw on.

Examples of Recently Observed Mathematics Learning

Responses of recently observed mathematics learning were classified into five broad categories, based on the *Principles and Standards for School Mathematics*' (National Council of Teachers of Mathematics, 2000) content strands (see Table 1). The Number category included responses relating to counting, basic operations, fractions, numeral recognition, ratio and proportion and sharing. The Algebra category included classifying, ordering, matching, patterns, grouping. Geometry included responses that focused on shape recognition, block building, 2D shapes and 3D objects, and location. The responses for Measurement included volume, length, weight, comparing, ordering, and estimation. Graphing was included in Data Analysis. Maths Activities on the computer and Problem Solving were included in an "Other" category.

Table 1.
Observations Related to 5 Content Strands in Mathematical Learning

Categories	Frequency	Example
Number	40 (32%)	… he will count how many steps. He can count by twos, too.
Algebra	25 (20%)	I said, "You have blue, blue, red, red, blue, blue. What's next?" She said "Red, red".
Geometry	23 (18%)	… we have been asking … where they want to put their hand-printed leaf—whether they want to put it up high, down low, or in the middle.
Measurement	33 (26%)	Children will often measure themselves and each other and within a little group they'll sort of work out who is the smallest and who is the tallest.
Data Analysis	1 (1%)	We have been talking about what pets we have … children to stand up if they had a certain pet … and then they're counted and then put that up.
Other	4 (3%)	We have an apple tree board and the number at the bottom of the trunk can change. If I put a number 5 in and then I change it to a 7, a lot of the children are picking up that they don't have to remove all of the pegs—they can just add 2 more and so they are counting on from 5, and counting "6 and 7".

Practitioners interviewed were able to provide examples of both incidental and planned mathematical activities across the breadth of the 5 major content strands, even though they were talking about children well under school age. Their practical experience fits well with the findings of researchers who have examined young children's mathematical thinking and learning (e.g., Ginsburg, Cannon, Eisenband, & Pappas, 2006). This knowledge would provide a strong foundation for development of more formal understandings of early child development in terms of mathematical knowledge, skills and language—through in-service education, further study, or professional reading distributed by relevant bodies.

Activities of Children Demonstrating "A Good Grasp of Mathematical Knowledge"

Responses here were categorized as content oriented or process oriented. Table 2 shows the variety of content related categories, and Table 3 shows the types of process related categories mentioned. The content related categories included Number, Algebra, Geometry, Measurement and Other. The Number responses recorded in Table 2 included the mathematical topics of counting, addition, and identification of numbers. The category of Algebra included topics such as making patterns, sorting and classifying, ordering and matching. The Geometry category included block building, completing puzzles, recognising shapes, representing shapes, arranging shapes, while Measurement included measuring, reading digital time, volume and weighing.

Table 2.
Content-related Activities of Children with "A Good Grasp of Mathematics"

Category	Number	Algebra	Geometry	Measurement	Other
Frequency	47 (48%)	23 (24%)	19 (20%)	7 (7%)	1 (1%)

Table 3.
Process-related Activities of Children with "A Good Grasp of Mathematics"

Category	Frequency	Example
Problem solving skills	5	She is exceptional at doing puzzles … figuring out where things go and trial and error and all that sort of thing.
Persistence	2	…. and they keep going and stay on the task … instead of losing interest they will actually keep going.
Explaining	1	…. with Sam doing the numbers he was showing the kids the counting, explaining to the others how to count.
Noticing	1	… would notice the difference and say "That is bigger than there" or "That won't fit in there", so they are thinking about it before it is happening, during and after.
Interpreting	1	Talking about the graph: circles representing family members, lines connecting members who love each other.
Trial and error	1	A lot of is that—basically, they do a lot of trial and error.
Well-developed vocabulary	1	A lot of language is involved with those children. They can explain things, describe things to you. They have the language, the mathematical language, when talking.

These practitioners generally demonstrated a creditable awareness of children who seemed to have a good grasp of mathematics from a content perspective. They seemed less

aware that mathematical proclivity could be demonstrated by means of processes children use as they engage in mathematical activity, so this is an area to focus on for professional development. While these processes will improve with opportunities in kindergarten and school and as their language develops, they also learn at a young age from carer's expectations, modelling and feedback when they show signs of these characteristics. Such characteristics can be developed in the right environment (Perry, Dockett, & Harley, 2007; VanDerHeyden, Broussard, & Cooley, 2006). It is important to support this development in young children because approaches to learning demonstrate positive relationships with later growth in mathematical skills (DiPerna, Lei, & Reid, 2007).

In relation to early childhood practitioners' views of young children's mathematical thinking, the project *Mathematical Thinking of Preschool Children in Rural and Regional Australia: Research and Practice* has provided evidence that there is a general awareness that such thinking starts at a very early age. Many practitioners responsible for childcare were able to identify a wide range of mathematical concepts and skills, and were able to give examples of occasions when these had been observed. Some were able to give evidence of individual children who seemed to be developing strengths in this area, although such evidence was more content-related than process-related. It is clear that there is a good foundation for further professional development in the field, and such activity is important because good mathematics curricula and teaching in the earliest years can close equity gaps (Clements, Sarama, & DiBiase, 2003).

References

Baroody, A. J. (2000). Does mathematics instruction for three-to-five year olds really make sense? *Young Children, 4*, 61–67.

Clarke, B., Clarke, D., & Cheeseman, J. (2006). The mathematical knowledge and understanding young children bring to school. *Mathematics Education Research Journal, 18*(1), 78–102.

Clements, D. H., Sarama, J. & DiBiase, A. M. (Eds.) (2003). *Engaging young children in mathematics: Standards for early childhood mathematics education*. Mahwah, NJ: Lawrence Erlbaum.

DiPerna, J. C., Lei, P-W., & Reid, E. (2007). Kindergarten predictors of mathematical growth in the primary grades: An investigation using the early childhood longitudinal study-Kindergarten cohort. *Journal of Educational Psychology, 99*(2), 369–379.

Ginsburg, H. P., Balfanz, R. & Greenes, C. (2000). Challenging mathematics for all young children. In A. L. Costa, (Ed.), *Teaching for intelligence: A collection of articles* (pp. 245–258). Arlington Heights, IL: Corwin Press.

Ginsburg, H. P., Cannon, J., Eisenband, J., & Pappas, S. (2006). Mathematical thinking and learning. In K. McCartney & D. Philips (Eds.), *Blackwell handbook of early child development* (pp. 208–229). Malden, MA: Blackwell Publishing.

National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Perry, B., Dockett, S., & Harley, E. (2007). Preschool educators' sustained professional development in young children's mathematics learning. *Mathematics Teacher Education and Development, 8*, 117–13.

Siraj-Blatchford, I., & Sylva, K. (2004). Researching pedagogy in English preschools. *British Educational Research Journal, 30*(5), 713–730.

VanDerHeyden, A. M., Broussard, C., & Cooley, A. (2006). Further development of measures of early math performance for preschoolers. *Journal of School Psychology, 44*, 533–553.