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DG 17: Current problems and challenges in pre-school mathematics education

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Aims and focus

With participants from Australia, Canada, England, Sweden, Norway, and the United States in attendance, the group availed itself of this opportunity to build global perspectives on early childhood mathematics education. The central purpose of DG 17 was to support productive dialogue about important current problems, issues and challenges relevant to young children's mathematical development. Research of the last few decades has made important steps to clarify how young children think, behave, communicate, construct their worlds and reason differently than adults or even older children do. Further, the range of contexts in which younger children build ideas and learn, and the variety of adults and older peers who interact with them across these contexts, present important special features of their own. To make the most of the particular qualities, strengths and challenges that contribute to pre-school mathematics learning, the DG 17 organizing team drew from data and analyses that emphasize listening to and observing young children closely in everyday practice. Through this discussion group process, the group aimed to co-construct what such research might tell us about young learners' mathematical development, and what such research might imply for policy and practice. In particular, discussion was expected to be strengthened by the diversity of conceptual approaches being taken, across a wide variety of settings, with the potential to bring wider substantive and methodological issues to the foreground. In essence, the group set out to examine what we might know (or still need to know) about the focus questions, "where", "how", "who", "when", "what", and "why" of young children's mathematical engagement.

Session 1

Session 1 was opened with two striking instances to stimulate discussion on the first three focus questions. Carol Aubrey shared some examples of child-solitary math related speech and joint dialogue with a parent, focusing on the eighteen-month to three-year period. This related to recent work examining the contexts, early pedagogical strategies and linguistic inputs that pave the way for later mathematical development as well as foster expectations and attitudes to future learning (Aubrey, Bottle and Godfrey, 2003). Ann Anderson showed a video excerpt in which a three-year-old boy, using 7 flat sticks (i.e. sidewalk), constructed several different outlines of parking spaces while his mother supported his actions with general discussion of parking lots they had visited. This episode was one of many captured in a longitudinal study of supportive environments for mathematics learning in the home (Anderson, 2003). Once these two researchers had shared parts of their work, participants broke into small groups to reflect.

Where: the settings or contexts where pre-school children might think mathematically. For instance, when we speak of mathematics education of young children, it



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seemed best not to restrict attention automatically to young children's activities and communication in formal settings such as pre-school classrooms or day care centres. It also seems important to learn more about young children cared for in less formal environments, including such non-school settings as at home, or outside the home in museums, science centres, outdoor activities – in all situations where mathematical concepts can be an issue.

How: the ways in which pre-school children learn/engage with mathematics. For instance, mathematical or mathematics-related thinking can emerge for young children in everyday events (in play, through social interaction, informally, embedded) where children and adults may reason mathematically, yet not necessarily call such thinking mathematical. In the early years, play is central to how children live in and understand their world. But how much do we know, or still need to know about playful or informal mathematics? In particular, we might enquire more systematically about the influence of people around the youngsters, and about how such people can help children see mathematics in the world around them. One aspect of learning is actually attending to something, for example by drawing a child's attention to a potentially productive issue by a question or through an aspect of structure in a game or activity, without directly teaching. How important might this aspect be, and what might be its contribution?

Who: the important others (adults, siblings, peers or friends) with whom young children interact. How might better understanding of significant adults (including parents and a wide variety of caregivers and teachers) help us to support or assist young children most effectively? It seems helpful to learn more, in detail, about their mathematical education, knowledge and capacity, and about their understanding of young children's intellectual development. It may also help to understand, through comparative studies, more clearly in what ways might mathematics educators' access (or lack of access) to such adults affect the quality and strength of pre-school children's mathematical learning. Such research might clarify to what extent we have the capacity (including needed understanding) to educate adults more broadly, and suggest potential forms that such education might take. For example, could information disseminated by health care centres (such as the Swedish National Centre for Mathematics Education (NCM) project "Mathematics from the Beginning") be helpful?

As this session came to a close some commentary on the parking lot episode that arose in the small groups was debriefed. For example, there were several comments on the parent-child dyad that (i) emphasized the mother's capability to hold back and encourage her child's activity without directing it in any particular fashion; (ii) focused on the spatial understanding that the child demonstrated as the task unfolded and he parked cars both between, to the side of, and at the end of "sidewalks" so that formations divided space in multiple ways; and (iii) indicated that the boy also seemed to engage in goal-directed critical rethinking, which his mother seemed to welcome. Such comments seem especially important here because they emphasize the need to step outside the usual school and daycare settings, to consider the strengths that other caregivers, such as parents, might bring to helping children learn. Further, they suggest a power and richness in young children's thinking that may be greater than has been widely believed.



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Session 2

Session 2 was opened with two striking instances to provoke discussion on the next three focus questions. Ingvill Stedøy shared experiences of her team at the Norwegian Centre for Mathematics Education, as they developed math clubs for five year olds. Two masters students have studied how the children developed their communicative competences about mathematical issues. They also pointed out the importance of letting the children's own thoughts and questions lead the communication. The aim for the clubs has been to help them discover mathematics in their own play, games and daily lives, to give them a view of mathematics that is different from the picture they may get from parents and older brothers and sisters. In this way it is likely that they will be more open for a variety of ways and places to learn mathematics. They will also think of mathematics as fun and natural, not scary or hard. Marj Horne shared interview footage of a young girl, age 5, counting a collection of over twenty small teddy bears. She clearly demonstrated the one-to-one correspondence aspect of counting and the idea of cardinality, but made an error in the rhyme, skipping the number fifteen. Over 1000 five year old children were interviewed on beginning school and over 40% of them counted a collection of over twenty teddy bears successfully. It would help to learn more about what kinds of past experience contribute to such knowledge, and about the related understanding of number that has developed in such children. Similarly it would help to learn more about other kinds of knowledge that they bring with them to school, and about the impact of such past experience on children's subsequent mathematical development in formal school. Such episodes as these reminded us of the diversity in children's strengths and of their confidence in solving interesting problems. Again, small groups discussed these striking instances in light of the focus questions provided for this session.

When: The time frames or age ranges that delineate young children's mathematics. When we speak of mathematics education for pre-school children, are we implicitly envisioning children who are 4 and 5 years old? Perhaps the answer varies across countries. In some places there are pre-schools attached to schools, and in other places not. If we include still younger children, including both non-verbal (birth through one year or so) and early verbal years (through, say age three) it would surely help to locate relevant special opportunities and challenges that might arise. For example, how might the choice of stimulating games and focus of communication help children prepare for later mathematical challenges before or in school? Responses to such questions may not depend just on place, but also on the different ways that programs for young children may be focused.

What: the nature of the mathematics in young children's own emerging worlds. We need to understand more clearly the nature of the mathematics (such as the implicit vs. explicit presence of quantity and space in everyday activities) that young children can introduce, work with, and explore in problem situations. In particular, how might we best conceptualize the particular strengths we find in younger children's successful mathematical activity? It seems quite unlikely that such mathematics (or perhaps emerging mathematics) will be limited simply to counting or pre-number tasks, as we often see suggested in the media. Considering the verbal and social skills of younger children (including potential opportunities, as well as challenges, presented by linguistic and cultural diversity) we recognize a need to understand more systematically the obstacles or opportunities that the current emphasis on talk in mathematics pose for children in

this age group, and for adults who work with them, and to explore alternative perspectives that may be more helpful for young learners and adults who work with them.

Why: questions of motivation and engagement, both for young learners to engage with mathematics deeply, and for important others to see such mathematical engagement as important. Here we sensed a need to see more studies that seek, in a variety of settings, to clarify what significant, highly motivated mathematical activity by young children looks and feels like. What motivating factors (including the design of tasks or situations with which young learners engage) can be shown to support young children's rich, extended mathematical activity or exploration? What attitudes and beliefs do young children have about their mathematical learning, and how do adults and older children who work and interact with them regard such learning? In what ways do important others (whether age-mates, older children, or a variety of adults) contribute (or perhaps not contribute) to young children's growing mathematical engagement? It could be equally important to address how some adults and other children do not contribute to or do not stimulate young children's mathematical engagement.

To bring this session to a close, a representative from each small group shared highlights of their discussions. In essence, the following points were made. Interestingly, discussants found themselves posing further questions rather than proposing answers. For instance, in response to "what maths?" one group wondered "should we emphasize the structure? If so, how much should we do? Who should introduce the structure? When should we do this?" As they reflected on "Why bother with maths?" this same group offered "because the kids are interested; because it helps them organize their world." A second group began their discussions around "when to do maths?" and responded with "2-3-4-or 5. It depends on the child's current knowledge and the child's interest. Pre-schools without a formal "curriculum" have the opportunity to "do" the appropriate maths." A final reflection for this group was characterized as "big problem: How do we support pre-school teachers to do maths?". A third group responded to "when?" with ages and the philosophical stance, "birth to three and three to six curriculum should include mathematics; intertwining and progression – of tasks, of children, of mathematics, in different dimensions." As for "what opportunities and challenges?" this group simply (and profoundly) said "who knows ... what and where to challenge". With respect to "why", they felt that "young children have an endless drive, energy and curiosity to explore with joy," and their "teachers' positive attitudes and beliefs confirm why we should bother with math." A final group posed two further questions that evolved from their discussions, namely "how do we draw mathematics out of authentic activities? And, what are authentic activities?" as well as "what can we learn from different cultures according to how children are viewed?" As the group debriefed further, participants were asked to visit the posters display to view the Swedish NCM project *A pilot project in pre-school: math for teachers and children aged 1-5* as examples of this project teams' experiences were arising in the discussions.

Session 3

The final session was opened with two striking instances to provoke discussion on our final focus question and two sub-questions. To what extent is it desirable to expose preschool children to structured or institutionalized mathematics teaching? What aspects of mathematics should be taken as significant for very young children? What ways other than formal curricula are there to organize thinking, practice and research to support



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young children's mathematical engagement? Herbert Ginsburg shared video excerpts of pre-school classroom episodes where *Big Math for Little Kids* activities (Belfanz, Ginsburg, & Greenes, 2003; Greenes, Ginsburg, & Belfanz, 2004) were in progress. He showed an excerpt in which a pre-school teacher engages her 4 and 5 year old children in counting from 1 to 100 during circle time. The method is to pause each time the children have reached a number ending in 9 (like 19, 39), and to encourage them to learn the subsequent decade number (20,40 in the example cited) and then to construct the next 9 spoken numbers by applying the rule "add 1,2,3, ... 9 to the decade number". The teacher also encourages the children to relate each spoken number to the corresponding written number in a large hundreds chart in which each row ends with a number ending in 9. Ginsburg claimed that children learn from this activity that the spoken words are rule-governed in important and mathematically significant ways. Robert Speiser shared a project in which five year olds had been encouraged and supported to photograph patterns and shapes that they found interesting, using disposable cameras. Once these two examples had been shared, participants engaged with the presenters on them. For instance, looking at a selection of the children's photographs, participants commented on what they saw as a powerful geometric emphasis in many pictures, especially quite striking perspective effects. Again participants noted the richness of young children's spatial and perceptual experience. To bring some sense of closure to the discussions, the whole group attended to this session's focus questions: *Given the recent development of formal curricula for pre-school mathematics education in some countries, and given what we now might know about how young children think and learn, to what extent is it desirable to expose pre-school children to structured or institutionalized mathematics teaching?* This question is critical. Many adults who work with young children do not see many things as mathematical that we view as mathematical activity. *What aspects of mathematics should be taken as significant for very young children? Are there further ways, other than formal curricula, to organize thinking and practice to support young children's mathematical engagement?* Interestingly, group members found themselves, as a collective, rather dissatisfied with the wording of the first question, "To what extent is it desirable to expose preschool children to structured or institutionalized mathematics teaching?" and wrestled with its rewording. The group was happier with, "Is it desirable for teachers (caregivers) to help expose pre-school children to a range of activities for children to develop and interact with focused mathematical ideas?" The organizing team for DG 17 welcomes the enthusiasm participants exhibited about the possibilities and strengths that young mathematics learners offer us as educators. Although no consensus was sought (if even such a thing were possible!) the discussions seemed likely to inform participants' future steps individually and collectively, not simply as researchers and practitioners but also as policy developers, whose decisions might support young children's mathematics education significantly at local, national, or even international levels.

References

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One paper submission was distributed to participants in DG 17:

Anderson, J., Anderson, A., Moffat, L., Shapiro, J. (2004) *Co-constructing understanding of literacy and mathematics: An analysis of parent-child discourse while playing a board game*. (University of British Columbia)

This report was written by Bob Speiser and Ann Anderson who will be happy to be contacted at speiser@byu.edu and anders@interchange.ubc.ca for further information on the work of this DG.

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