

## **Left to their own devices: Student-led inquiry into mathematical ideas in kindergarten**

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### **Abstract**

In this workshop, participants engaged with and reflected on authentic artifacts from student inquiry into measurement (4 years old) and data (5 years old). Participants analyzed and reflected on these authentic examples in order to discuss the children's learning processes that arose and what were the respective roles of the classroom environment and teachers in affording the students' self-directed inquiry. Participants were also invited to reflect on the radical implications of this for curriculum development and mathematics learning in school, even at the pre-primary level, as well as implications for teacher development.

### **Student-led Inquiry with Young Children**

The mathematics education community is still engaged in a lively debate about the nature of mathematics, what it means to do mathematics, and how to best help students to become doers of mathematics in school. Many educators still believe that such a view applies only to older students who have already "mastered the basics" in order to move on to higher-level mathematical activity. The examples we explored in this workshop put the spotlight on how very young children might come to do mathematics and actively, purposefully and appropriately use it as a tool for learning on their own, without direct instruction from a teacher and well before having "mastered the basics."

Very recent studies in educational psychology by Bonawitz, et al. (in press) and Buchsbaum et al. (2011) have called into question the appropriateness of direct instruction for young children and also the role the teacher should have in the learning process. It turns out the very young children are capable of engaging more fully and fruitfully in authentic inquiry and exploration on their own than with explicit guidance from a teacher. Their work suggests that a more appropriate role for the teacher is to be a learner side by side with the children, a more implicit role as a learning partner in a process of inquiry. The Primary Years Program of the International Baccalaureate, if practiced as the documentation of it envisions, provides a potentially ideal programmatic school setting in which to explore these notions in practice because of the emphasis on student-led inquiry.

Indeed, the students in the present examples were able to pursue logical lines of inquiry on their own with little explicit teacher intervention. The children were working in the context of a pre-primary program housed within a larger international school in Lebanon that follows the International Baccalaureate Primary Years Program with some significant features of the Reggio Emilia educational approach. The program, if practiced as the documentation of it envisions, provides a potentially ideal programmatic school setting in which to explore these notions in practice because of the emphasis on student-led inquiry.

The four-year old students' inquiry into measurement began with noticing something placed in the environment by the teacher, namely a measuring tape posted vertically on the wall (the kind often used to keep track of changes in children's height). One student noticed it and began trying to make sense of it. He then called over other

students until eventually several students were standing next to the measuring tape, comparing themselves to the lines drawn making the units, and comparing themselves to one another. The teacher stayed at a distance only taking photos and noting down what children were doing and saying. Later the same day there was an opportunity for students to recount what they had done and discovered. The teacher then elicited questions from the students about what they thought they should do next to find out more. Eventually this led to the students exploring the use of non-standard units for measuring length and making some connections about the concept of a measuring unit that we often think of as beyond their capability, such as discovering the idea of iteration of a unit and the relation between the unit size and the measure of the attribute. Student engagement in such an inquiry process constitutes significant learning and can be viewed as an essential foundation for students conceptual development in mathematics (Gravemeijer, 1999).

In the second set of examples, five-year old students engaged in a variety of authentic data collection and data analysis activities in order to pursue their own questions and to make sense of things in their environment. It is often hard for teachers to imagine how they can use data modeling (Lehrer & Schauble, 2002) with young children given all the traditional constraints and the tendency to view younger children as unable to deal with complex reasoning and problem solving. In our program, we have found that working with data is essential and comes very naturally for young children if they are truly engaged in trying to make sense of phenomena and understand how the world works, thus developing a better sense of the nature of mathematics and science and their role in our lives.

### **Implications for Curriculum and Teacher Development**

Allowing children from such an early age to engage in more self-directed learning implies a radical shift in thinking about what mathematics learning should look like in school. The idea of engaging students in inquiry processes or in an inquiry cycle in school is aligned well with reform-oriented approaches to mathematics education as advocated for the past 20 years is not very radical by itself. However, I believe that taking it a step further and thinking about inquiry not as an instructional method, but as a *stance* toward mathematics curriculum (Short, 2009) represents a radical shift. Another aspect of the shift is from thinking of mathematics as a school subject toward thinking of it as a tool for learning about oneself, the human condition, and about the world in general. Such a shift has great implications for the design of school learning environments and materials, as well as for teacher education and ongoing development.

First, with respect to curriculum development, it is important to realize that inquiry is not just a way to make learning more fun; it is the embodiment of doing mathematics and science and the way children naturally learn and make sense of things. Any earnest attempt to engage children with authentic inquiry highlights the obvious tension between thinking of mathematics in school as a body of content knowledge that needs to be acquired by the child vs. mathematics as a tool for systematically understanding how the world works and imagining/inventing ways to improve upon it. This tension raises all the questions about the utility and role of textbooks as resources (and for whom should they be a resource) and what children “should” learn and how that should be determined and what really are “the basics” when it comes to mathematics in the 21<sup>st</sup> Century.

Second with respect to teacher development, the major challenge is helping teachers to get in touch with their own deep-seated beliefs about what mathematics is and why it is important to worry about whether children learn it and their beliefs about what children are capable of. Children do not know that they cannot direct their own learning and pursue their own ideas until they learn that through the schooling process—an assumption worth questioning. Teachers first need to believe it is possible for themselves and their students to generate legitimate questions that can lead to fruitful investigations and learning without always being told what the questions should be. Professional development programs need to address this explicitly and to engage teachers in authentic problem solving and inquiry processes as learners. Professional development experiences must be contextualized in teachers' practice as much as possible in order to impact on their practice (Smith, 2001) and it is further helpful if teachers actually come to view teaching as an important inquiry in and of itself. In other words, adopting inquiry as a stance toward curriculum implies a need to also adopt an inquiry stance toward one's teaching practice.

#### References

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