

What do they know? Assessing Mathematical Thinking in Kindergarten

By Carole Fullerton and Sandra Ball

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Kindergarten is a time for exploring – for play and talk and investigation. Motivated by what’s important to them, our youngest learners come to understand key concepts through their play. This is true in mathematics more than other areas; little children spontaneously explore mathematical concepts through the activities they themselves choose. Kindergarten teachers know that their students quite naturally count and sort, order and compare, pattern and predict while at play in their classrooms.

We see so much capacity in our learners when we know what to look and listen for! Capturing and synthesizing this information in order to make instructional decisions is the fine art of teaching.

So what exactly is important to know – mathematically speaking – in kindergarten? What key skills and understandings are predictors of success in numeracy? And what tools – authentic, whole class and embedded in play-fullness – can we use to assess them?

This last question is harder to answer than one might assume. There are few quality numeracy assessments available for kindergarten-aged students, with the notable exception of the BC Early Numeracy Project Assessment. The Early Numeracy Project (ENP) was a collaboration between respected UBC teacher educators Dr. Heather Kelleher and Dr. Cynthia Nicol and teams of primary teachers throughout the province. Modeled on the Australian Early Numeracy Research Project and

supported by its developer, Dr. Doug Clarke, the BC ENP is made up of an assessment and instructional component for K and K/1 classrooms. The assessment tool itself is rich and varied, and explores ideas within and well beyond the current K math curriculum, since it is developmentally framed, rather than tied to a curriculum. The downside to this formal research-based assessment tool is that it must be administered one-on-one, which makes it cumbersome to use with an entire class.

Looking for a tool that was less formal and more embedded in classroom practice, Sandra Ball and I came together in May of this year to design our own early numeracy assessment. Drawing on the ENP, we sought to create a tool that could be done in small groups or with the whole class; a tool that could be used to gather information in the fall and again in the spring; and a tool that might help to promote student-centered numeracy programs in early primary. A tall order!

An Overview of the Assessment

We started with a premise: that in order to be successful at the end of kindergarten, students needed to demonstrate capacity in the following areas of numeracy:

- **Subitizing**
 - The instant recognition of a quantity
- **Partitioning or decomposition**
 - The ability to break apart a number and put it back together again
- **Patterning**
 - The ability to recognize, represent and describe repeating patterns with different attributes

Much of the above list is explicit in the prescribed learning outcomes in the K and grade 1 curricula. Likewise, the research we have read and the wise teachings of John Van de Walle, Marian Small and the ENP developers all support our choice of these three predictors of numeracy success.

After all, we know that the capacity to **subitize** is important. When children can “see” quantities at a glance without counting, they understand that 5-ness has a shape – or rather a series of shapes. Regardless of its arrangement, though, 5 is still five, and young learners who have grasped this

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concept are more likely to be able to “count on” from a set, to “hold” a set in their mind, and to think more flexibly around number.

Subitizing is connected to the mathematical idea of **partitioning**. When students know that there are many ways to break up a set of 6 objects – into 5 and 1, 3 and 3, 4 and 2, etc – and that these smaller groupings still make 6 when they are put back together, they are demonstrating an understanding of partitioning. The ability to partition is critical to developing conceptual understanding of the operations: addition and subtraction as well as division and multiplication.



A child’s ability to **pattern** lays the foundation for algebraic reasoning – being able to predict what will come next (or even “before”) in a pattern is an essential skill. The more complex the pattern, the better! Students who can develop and extend a pattern with a complex core truly understand what a pattern is – and can generalize their learning to more challenging contexts.

Having identified these three predictors of success, Sandra and I set out to design tasks to match each one. Ultimately we created a set of assessment tasks for the fall and another set of parallel tasks for the spring. The tasks themselves are very much like what a kindergarten teacher would do naturally in her classroom. This was important for Sandra and I to incorporate into the assessment. In fact, to make the assessment more classroom based, we included the use of a storybook for both the fall and spring assessments. Even the name for the assessment was consciously chosen. We call it the “What Do They Know?” numeracy assessment, since it focuses on students’ capacity, and how to build it...

The Tool at a Glance

Teachers begin by asking their students to perform some subitizing activities and making notes about their comfort level and flexibility in “seeing” number. Next, the teacher reads a story aloud to the class and poses an open-ended story problem of the children, who are then invited to model and solve the problem independently. Lastly, students create patterns to match characters on the stories and tell about what they have created.



The spring task mirrors the fall task exactly, but includes more complex numbers and pattern cores.

From the description, above, it is clear that these tasks are informal – or rather they are structured like regular classroom lessons, with intentional prompts and focused observations. The assessment forms allow teachers to focus their observations on the key concepts, and to note interesting extensions or comments on the part of the children.

The “What Do They Know?” assessment package includes all the instructions, the line masters for data gathering and all necessary lesson props in full colour for both the fall and spring assessments. A rubric for use in the fall and spring is appended to the end of each term’s assessment; instructions on how to analyze and consolidate the observational data into the rubric are also included. To complement the assessment and to address the results, an instructional resource is included with suggestions for subitizing, partitioning and patterning lessons. The WDTK assessment also includes adaptations for grade 1, so that K/1 teachers can administer the assessment to all of their students.

The intention is that teachers assess their students in small groups or as a whole class in the fall, use the sample lessons included in the resource (among others) and assess again in the spring to judge the level of growth over time. Like with a “school-wide write”, we recommend that teachers use one rubric per child for both the fall and spring assessments, changing the colour of highlighter to show growth. This could ultimately be used for reporting to parents, should a teacher want to include the results in their more formal evaluation of students’ learning.

Initial Feedback

Sandra field-tested the “What Do They Know?” assessment items in the Surrey school district this June. The students enjoyed the stories and seemed comfortable with the tasks they were asked to complete. Sandra reported that she and the classroom teachers were able to learn a great deal about

the students – and were even surprised at what some children knew and could do mathematically.



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Feedback from the teachers has been overwhelmingly positive. They see both the value of the assessment and its fit within a play-full numeracy program at the Kindergarten level.

Future Plans – Where to From Here?

Teachers in the Surrey school district will have the opportunity to explore the WDTK Assessment in the fall of 2011. Each school will be provided with a copy of the assessment, the teaching props and a copy of the storybooks used. In Richmond, after school sessions will be offered in the fall of 2011, with participating K and K/1 teachers receiving professional development, the tool and a copy of each of the stories. In both districts, the participating teachers will have the chance to use the materials and then come together again to discuss what they are learning about their children – and together make plans for instruction based on the results.

Kindergarten is a time of joy – in learning, in play and in making sense of the world around. As early primary teachers we have the opportunity to experience that joy first hand – and to support our youngest learners along their path. The “What Do They Know?” assessment seeks to find out – in an authentic and classroom-familiar way – just what sense students are making out of their mathematical explorations, and to conscientiously build upon those understandings.

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