Kindergarten Education: Theory, Research, and Practice
Vol. 2, No. 1, Spring 1997 - pp. 32-41

Exploring Math Concepts with Children's Books

BELLE AKERS

The purpose of this article is to discuss and demonstrate how children's literature is an important resource in mathematics instruction for young children. Books concerning the following concepts are discussed: numbers, one to ten; counting by 2's and odd and even numbers; groups or number patterns; large numbers, and the 100th Day of School. The successful use of the recommended books with kindergarten and first grade children is described.

Recent research (Hong, 1996; Jennings, Jennings, Richey, and Dixon-Krauss, 1992) reveals significant effects of the instructional use of children's literature on kindergartners' achievement in mathematics. The storybook content created children's interest in mathematics and increased their understanding and retention of mathematical concepts. Children's books also serve as a viable math resource in primary classrooms (Akers, 1996).

The purpose of this article is to discuss and demonstrate using this resource in mathematics instruction for young children. Books recommended here have been used successfully with kindergarten and first grade students.

As books are integrated with math curriculum, it is important to remember that students still need many opportunities to explore with manipulatives to build their knowledge of mathematical concepts and logical reasoning skills. Through hands-on activities with a variety of manipulative materials, children develop their understanding of new concepts and relate these to what they have already learned (Burns, 1988).

Integrating books with the math curriculum has several benefits, including cross-curricular connections in science, social studies and art (Akers, 1996), and literacy development through oral language, rhymes, and cumulative text. Books with cumulative text such as *Deep Down Underground* by Dunrea (1989) are wonderful for student participation as children chime in following the introduction of each new number. By the end of the book, students have not only practiced sequential counting but also practiced counting backwards as they count down from "ten red ants march and stamp when they hear"...to "1 wee moudiewort digging, digging deep down underground" (p. 15).

Math concept books provide an enjoyable format for children to develop their understanding of mathematical concepts. Pleasurable experiences with concept books help children develop and expand their familiarity with math vocabulary. The repetition or cumulative text found in math books can produce positive feelings and build self-confidence that have been found to be critical in shaping "an individual's disposition to learn and to use knowledge" (Baroody, 1992). Baroody noted:

> Affective factors such as needs, feelings, and interests energize or motivate action and thus exert a tremendous influence on learning.... Affective factors such as drive, which involves interest, self-confidence,

BELLE AKERS is a first grade teacher at Convent of the Sacred Heart Elementary School, San Francisco, CA.

> and perserverance, are important for problem-solving success.... (p. 153)

Children's books that explore math concepts can be used for reinforcing concepts from simple counting to large numbers as found in *Count!* by Fleming (1992), *One Potato* by Pomeroy (1996) and *One is a Family* by Ryan (1996). More complex math concepts such as addition and building number combinations are found in *Domino Addition* by Long (1996), *12 Ways to Get to Eleven* by Miriam (1993) and *Splash!* by Jonas (1995). Numerical equations are clearly written out in *Domino Addition*, while vocabulary words (one, two, three, ...) are used to build number combinations in *12 Ways to Get to Eleven.* Through a story format of children at a pond, *Splash!* involves counting the combination of animals in or out of the pond as stated in the text. Since answers are not given, students have opportunities to filter information read aloud, look for animals and then count the total number of animals. Vivid, colorful artwork by Jonas keeps the focus on finding animals easily against the background of the blue pond.

NUMBERS, ONE TO TEN

Counting provides an essential base for mathematical understanding. Stressing the importance of counting, Baroody (1992) stated:

> Teachers should be particularly alert for children who do not have basic counting skills when they begin kindergarten. Such children should be given ample, supervised, and purposeful counting experiences. Moreover kindergarten should extend the counting skills (foster, for example, counting backwards and counting by counting by 2s and 5s) of all children so that they have a strong informal basis for arithmetic. (pp. 167-168)

The books and related activities recommended here and in the next section will help teachers provide that important base.

Ten Black Dots by Crews (1992) is an excellent selection for counting one to ten. Bold and colorful artwork show the one-to-one correspondence for each number. Children enjoy counting the black dots that are cleverly used in creative arrangements. Counting the different arrangements develops strategies for keeping track of what has and has not been counted (Baroody, 1992; Ginsburg, 1989). As a follow-up activity, children make their own "Dot Books" using one inch colored, adhesive dots. For kindergarten students, dictation may be taken for each number, while older students may use invented spellings to describe their artwork.

An extension activity for *Ten Black Dots* fulfilled several functions in my first grade class. While its main focus is that of counting, *Ten Black Dots* is also a great read-aloud for a "Colors" theme. Students were given a story booklet with sentence frames for one through five:

1 One ___(color)___ dot can make _____.

2 Two ___(color)___ dots can make _____.

3 Three ___(color)___ dots can make _____.

4 Four ___(color) ___ dots can make _____.

5 Five ___(color)___ dots can make _____.

First, students arranged the corresponding number of dots on each page and completed artwork. Next, they

filled in color words and sounded out names for illustrated objects. After practicing and reading together with a teacher, students read their books with partners. From the completed Five Dots booklets, informal observations were made about a student's writing progress as well as number recognition and sequence counting, one to five (or ten, if desired). Students' independent spellings included:

"Two blue dots can make *clas* (clouds)."
"Four yellow dots can make a *lamminteer* (a lemon tree)."
"Three red dots can make *is gem* (ice cream)." (Artwork shows a triple scoop cone.)
"Four yellow dots can make *potavgod* (pot of gold)."
"Two red dots can make *srobe* (strawberries)."

Text and illustrations from *Deep Down Underground* by Dunrea (1989) and *Over in the Meadow* by Keats (1971) show animals from one through ten. These books develop the principle of cardinal number and that of the last number counted establishing the number of the set as a whole (Gelmon & Gallistel, 1978; Gelman & Meck, 1986). These books also can easily be integrated with science themes related to animals or habitats. A set of animal cards (for either book) are made by having students illustrate the number of animals in the story on 4" x 6" or larger index cards. Additional math activities using student-illustrated animal card sets include sorting, graphing and practicing mathematical concepts such as *more than/less than* and *even* or *odd*.

Math graphs (or sorting) can show animal movement (walk, crawl, fly), number of legs (2, 4, 6, 8 or more), body covering (fur, scales, feathers, skin) and scientific classification (mammal, insect, bird, fish, reptile). Sorting and representational graphs with animal card sets can be done on the floor or in pocket charts with individual categories written on sentence strips. One advantage of making index card sets is that they are versatile and reusable over a period of several days. Once math activities have been completed, cards may be glued on a permanent class-selected graph.

Animal picture card sets were also used to engage students in mathematical reasoning through comparison and contrast about even-odd distributions and *more than* and *less than*. The teacher wrote the words *even* and *odd* on two separate index cards, and these concept cards were used as column headings on the pocket chart. For even/odd number practice, students took turns finding an animal card to place under the correct column. After sorting all the animal cards for even/odd numbers, first graders insisted on putting the cards in numerical order. When this task was completed by volunteers, the whole class recited each column, even numbers: 2,4,6,8,10 and odd numbers: 1,3,5,7,9.

Animal cards were also used for identifying number values for *more than* and *less than* concepts. The *more than* and *less than* relationships require children to make a numerical comparison. Baroody (1992) stressed the need for providing such comparative experiences in kindergarten. He stated: "Unfortunately, this important skill is often overlooked or not adequately empha-

sized in the evaluation and the teaching of kindergartners" (p. 159).

Once again, each concept is printed on individual index cards. Working with one concept at a time, *more than* or *less than*, student volunteers were asked to find and place appropriate animal cards in front of and after the concept card. Then students "read" their math statement to the class. For example: "eight lizards are *more than* two fish," "five honey bees are *more than* four muskrats." After each turn animal cards were removed until all cards had been used in making combinations. Examples for less than included: "one turtle is *less than* seven crickets, six crows are *less than* ten fireflies".

Since card sets are kept on the math shelf, they are handy to use during transitions while students gather together or clean up for the next period. These cards are an excellent resource for providing whole class, small group and individual practice of number values.

MATHEMATICAL CONCEPTS

The books discussed in this section will provide the extension of counting skills urged by Baroody (1992). Children count by 2s as they learn about even and odd numbers. *Even Steven Odd Todd* by Cristaldi (1995) and *Crayon Counting Book* by Ryan and Pallotta (1996) develop students' understanding of even and odd numbers. *Even Steven Odd Todd* , from the Hello Math Reader series by Scholastic Inc. expands on the concept of even and odd numbers through a read-aloud story. Readers are introduced to Even Steven who likes things in even numbers, such as six cats, ten goldfish, twelve pancakes, and Odd Todd who Todd who likes odd numbered things, such as rubbing his stomach 13 times, eating three pancakes and a triple scoop of ice cream. Following an initial reading, my students chimed in on counting even numbered objects for Steven and odd numbered objects for Todd as objects were pointed out on appropriate pages.

An extension activity provides students with an opportunity to illustrate objects (from the story) that match a corresponding number. A recording sheet is divided in two columns, one for Even Steven and one for Odd Todd. Each column lists numbers and objects for each boy. In the blank space, students illustrate objects, as listed. For Steven illustrate: 2 loaves of bread, 4 books, 8 stamps and 4 slices of pizza. For Todd: write in the numbers for knocks at the door (3,5,7) and illustrate: 3 suitcases, 3 pancakes, and 9 gummy worms (on his pizza).

The Crayon Counting Book challenges students to count even and odd numbers, one through twenty-four. The colorful arrangements of crayons on each page makes counting aloud by even or odd numbers a successful experience. Students participate in counting aloud even numbers for the first half and odd numbers in the second half of the book.

One, Two, One Pair! by McMillan (1991) explores the concept of pairs, and *What Comes in 2's, 3's, & 4's?* by Aker (1990) expands on higher number sets of objects. Both selections develop the concept of finding groups of objects to explore number values, such as two items for pairs or four same items on an object (car has four wheels, table has four legs, square has four corners, etc.). After reading *One, Two, One Pair!* , students

were given a homework assignment to find things at home that came in pairs. The next day, homework drawings were shared in class. Commonly found pairs of objects included: shoes, boots, socks, mittens, earrings, curtains

(from a bedroom and living room). Some students also named body parts such as eyes, ears and hands.

For an extension activity, students selected one pair of objects to illustrate for a class book, "One, Two, One Pair". The repetitive text on each page: One, two, I see a pair of _____ provided for subsequent, successful independent reading experiences. Artwork by kindergartners can be drawn with markers, and first graders can cut out a pair of objects. To reinforce the concept of a pair, provide folded construction paper for students to draw on. When they cut out on the folded paper, it results in two of the same shapes - one pair.

GROUPS OR NUMBER PATTERNS

Ginsburg (1989) noted the importance of children developing grouping strategies and recognition of mathematical patterns. The books and activities presented in this section advance that development. *The Doorbell Rang* by Hutchins (1986) and *Stay in Line* by Slater (1996) explore grouping as a mathematical strategy to organize a dozen cookies and a dozen children, respectively. In *Stay in Line*, at various stops during a field trip at the zoo, twelve children are shown in arrangements of ones, twos and threes. *The Doorbell Rang* shows how one dozen cookies are shared by friends who come to visit Victoria and Sam. They are joined in subsequent sequent pages by groups of friends, until there are a dozen children seated at the kitchen table. Both books show groups that result in an even distribution.

After reading *The Doorbell Rang*, we brainstormed what kinds of cookies

might be favorites among the students. Our list included: chocolate chip, oatmeal, cookies with sprinkles, butter cookies, raisin, shortbread and gingerbread. After the children revealed their favorite cookies, we compared the actual selections with the brainstormed list. We found that gingerbread, chocolate chip and shortbread cookies were favorites and on the list. Surprisingly, Oreos had not been named on the original list, but Oreos were a favorite cookie of three students.

In class, students illustrated their favorite kind of cookie on 4" x 6" index cards, in a format similar to the animal card sets. The cookie cards were used for a variety of sorting and graphing activities, both on the floor and in two pocket charts, placed side by side. We sorted the cookies by shapes: round, oval, rectangle and other. Graph activities included looking at color (brown, yellow, tan, black, two colors) and identifying the kind of cookie (Oreos, chocolate chip, gingerbread, lemon snap, shortbread, butter cookie).

Stay in Line and *The Doorbell Rang* show the even distribution of groups. *A Remainder of One* (Pinczes, 1995) explores the uneven distribution of groups for the number 25. In this book Joe and the 25th squadron of ants practice marching in patterns that will please the queen who likes "things tidy". When marching in twos, Joe is asked by Sergeant Steven "to

geant Steven "to stand aside, so the troop will be even" (p. 10). The next two days, marching in rows of threes and fours, the troops passed by the queen only to discover that once again, there is an uneven arrangement and Joe continues to be "a remainder of one" (p. 11). Finally on the next try, marching

by fives, the queen observes "the neatest, best troops...five in each row... - and that's counting Joe" (p. 27).

I often chuckle when I recall how two of my first graders solved the problem of an uneven number. One year, during 100th Day activities, a pair of students were making groups of threes with bear counters. After one hundred bears had been grouped, they were ready to count aloud the total number of sets. They counted very accurately in sequence and arrived at a total of 33 sets (of three). Knowing that there would be one left over, I explained that 33 sets of three equaled 99. I asked them if there had been an extra bear when they made the groups of three. Nodding affirmatively, they pointed out the set that contained four bears. My students expected their groups to come out even, very much like the queen ant in *A Remainder of One*.

LARGE NUMBERS & 100TH DAY OF SCHOOL

Several books and 100th Day of School activities engage children with large numbers and extend counting skills with numerical knowledge. *One Watermelon Seed* by Lottridge (1986) and *One Hundred is a Family* by Ryan (1994) begin simply with numbers one through ten but then present the challenge of counting in tens. In *One Watermelon Seed* two children plant a garden with seeds and plants. The resulting harvest is counted by tens: 10 watermelons, 20 pumpkins, 30 eggplants, 40 yellow peppers, 50 tomatoes, ... until they have picked 100 ears of corn. *One Hundred is a Family* introduces one through ten and then continues by tens, through one hundred showing families in a variety of activities such as ten is a family cheering at a baseball game, forty is a family bringing in the harvest, sixty is a family sharing a neighborhood, and one hundred is a family caring for the fragile universe.

Whole class participation in counting by tens to one hundred is reinforced by circling or coloring in decade numbers on a laminated chart or one placed under plastic film. When introducing the concept of counting by tens on a chart, I follow (or sweep my hand) across each row of numbers until I reach the tens number. This develops the concept that a group of ten repeats each time until the sequential tens number is reached. Later, this concept will contribute to learning about place value.

Other literature selections that develop counting by tens through fifty are: *One Potato* by Pomeroy (1996), *Ocean Parade* by MacCarthy (1990) and *Count!* by Fleming (1992). *One Potato* introduces numbers one through ten, ten through fifty (ten cherries, twenty radishes, thirty blueberries, forty grapes and fifty blackberries), and ends with one hundred sunflower seeds. *Ocean Parade* introduces number one through twenty, twenty through fifty (twenty green seahorses, thirty little purple fish, forty golden fish, fifty pink-and-green spotted fish), and then concludes with one hun-

one hundred silver fish. Colorful batik paintings illustrated in two-page spreads invite counting aloud by children. Illustrated in a similar fashion to *Ocean Parade, Count!* explores counting by tens with animals. Brightly colored two-page spreads engage children in counting aloud for ten lizards, twenty butterflies, thirty snails, forty frogs and fifty bees.

In preparation for the 100th Day of School, I present warm-up activities a few days before and explore further with large number activities after the 100th day. Each year we brainstorm "Ways to Count a Large Number of Objects". First graders respond with these ideas:

"You can divide the group in half, then count."
"You can find another person to help you count."
"Count by 10's."
"Count by 2's."
"Count by 5's."
"You keep adding on numbers until you get to the end."
"You can count by 1's. It's the longest way."
"You can count by 3's. This would be hard. You have to know what number comes next."

Student responses give me an indication of the mathematical strategies they already have about making groups or using number patterns. I always encourage students to explain their ideas and even physically show them, if possible with manipulatives, on a number chart, chalkboard or paper. Students are also adept at helping each other out when a classmate becomes stuck and cannot find the words to explain an idea.

After trying out various groups (or patterns), most first graders agreed that counting by tens was the easiest and quickest. We discovered counting by ones and twos took a longer time to reach one hundred because "you count more numbers". Counting by threes and fours were the most challenging because "you have to count all the numbers each time" before the next one in the pattern, i.e. 1,2,3,**4**, 5,6,7,**8**, 9,10,11,**12**.

One Hundred Hungry Ants (Pinczes, 1994) is a "must" for teachers who celebrate the 100th Day of School! Follow along as one hundred ants make their way to a picnic site by breaking up into groups. First they arrange themselves in twos. Then threes, fours and fives when progress is not being made fast enough. Finally they arrange themselves in tens. However, by the time they arrive, there isn't any food left in sight.

During our 100th Day of School celebration, first graders engage in math activities using number patterns (or groups) that have previously been found in book selections. Using manipulatives, such as bear counters, colored links, pattern blocks and Linker Cubes (a Mathland material), students worked in teams to explore number patterns, such as 2, 4, 5, 10, with 100 objects placed on an 11" x 17" 100's chart. They count aloud their number patterns to the teacher. Each child then fills in his or her own number chart to take home. It is helpful to set a limit of two different colors of bears for the number patterns of 2, 4, 5, or 10 so that the colored patterns are easy to recognize in a diagonal orientation, as well as in vertical columns.

Linker Cubes are small, plastic squares that can be snapped together for three dimensional building projects. These are available from Creative Publications in sets of 100 to 500 cubes. Linker cubes are more versatile than unifix cubes which only snap in one direction for linear activities. Students working with Linker Cubes were challenged to find out how much space (or area) 100 Linker cubes take up, using number patterns of 4, 5 and 10 in a row and, then, to record that information. This activity contributed to understanding of spatial relations as well as number patterns.

The completed Linker Cube projects provided a geometry review for two shapes. Using grid paper, the same size as Linker Cubes, students outlined, colored in and cut out the shape of their projects. The paper shapes, one square and two rectangles, were glued onto chart paper or 18" x 24" construction paper for display and a class discussion. Students were encouraged to share their own observations about the chart. If needed, teachers can give prompts or ask questions to help direct students' mathematical thinking.

Students easily recognized that the ten rows of ten cubes made a square. A comparison of the two rectangles showed that the one made by fours was thinner and longer than the one made from fives. Linker cubes connected in rows of four created a tall, thin rectangle, 4 cubes across by 25 rows. Linker cubes connected in 5 cubes across by 20 rows created a medium width rectangle.

MATHEMATICAL AWARENESS

A recent classroom experience shows the level of understanding first graders have developed in mathematical concepts and logical reasoning skills since September. After reading The Doorbell Rang (Hutchins, 1986) we played a game of Fair Share with a dozen cookies. Students worked together with a partner for Fair Share. Each pair of students shared one dozen paper cookies, bear counters and a recording sheet for how many cookies 2, 3, 4, and 6 bears would get. In Fair Share, the cookies are distributed one at a time to each bear. While students recorded information individually, I filled in data on a large size chart: Column 1 - number of bears (1-12), Column 2 - cookies and Column 3 - any left over?

After completing the data for numbers 2,3,4 and 6, we continued Fair Share (with bear counters) to complete the rest of the chart. As we recorded data on the chart, first graders started sharing observations about what was occurring. Someone noticed that the "number of left over cookies are getting smaller". Another student noticed that the numbers (in the left over column) were "going in backwards order". Using this observation we predicted what number of left over cookies would come up next, for 10 bears. Indeed, after each bear got one cookie, two were left over. The final prediction was made that there would be one left over after the next turn. Everyone cheered and clapped when there was one left over.

As we progressed in the Fair Share game, many smaller conversations were occurring between partners. Math phrases were overheard: "It's going to be a[sic] even number," "There's going to be some left over," "We need two more,"

"Now they only get one cookie each time," etc. These bits of information told me how much learning had occurred since September. The success of the Fair Share game was due in large part to the children's work with manipulatives and their application of concepts they had learned previously. I love being interrupted by students calling out: "Ms. Belle, I see a pattern!" "I noticed something." "Can I share an observation?"

The preceding math activity and discussion supports a developmental approach that give students opportunities to apply mathematical knowledge. In relation to this point, Baroody (1992) stated:

> They [teachers] should give children the opportunity to use their existing knowledge to puzzle through a problem or question. Teachers should listen carefully to children as they explain their ideas and solutions.... Even confused or incorrect answers can be informative because these reflect a child's current level of understanding". (p.156)

The math books, in this article, have provided a concrete source for students to see, hear and learn about mathematical concepts. The positive experiences from classroom use of math books not only fostered students' interest in learning math concepts but also engaged them in practical application of mathematical thinking through related classroom activities.

REFERENCES

Aker, S. (1990). *What comes in 2's, 3's, & 4's?* New York: Simon and Schuster.

Akers, B. (1996). Books you can count on! *TAKE FIVE* The CKA Newsletter, pp. 2-3, Fall 1996.

Akers, B. (1996). Mathematics across the curriculum. *CMC ComMuniCator*, pp. 20-21, Vol. 21, No. 1, Sept. 1996.

Baroody, A. (1992). Fostering the mathematical learning of young children. In B. Spodek (Ed.), *Handbook of research on the education of young children* (pp. 151-175). New York: Macmillan.

Burns, M. (1988). *A collection of math lessons.* New York: Cuisenaire Co.

Crews, D. (1986). *Ten black dots.* New York: Greenwillow.

Cristaldi, K. (1995). *Even steven odd todd.* New York: Scholastic Inc.

Dunrea, O. (1989). *Deep down underground.* New York: Macmillan.

Fleming, D. (1992). *Count!* New York: Henry Holt.

Gelman, R. & Gallistel, C.R. (1978). *The child's understanding of number.* Cambridge, MA: Harvard University Press.

Gelman, R. & Meck, E. (1986). The notion of principle: The case of counting. In J. Hiebert (Ed.), *Conceptual and procedural knowledge:*

The case of mathematics (pg. 29). Hillsdale, NJ: Lawrence Erlbaum.

Ginsburg, H. (1989). *Children's arithmetic How they learn it and how you teach it.* Austin, TX: Pro-Ed.

Hutchins, P. (1986). *The doorbell rang.* New York: Greenwillow.

Hong, H. (1996). Effects of mathematics learning through children's literature of math achievement and dispositional outcomes. *Early Childhood Research Quarterly, 11* (4) 477-494.

Jennings, C., Jennings, J., Richey, J. & Dixon-Krauss, L. (1992). Increasing interest and achievement in mathematics through children's literature. *Early Childhood Research Quarterly, 7* (2) 263-276.

Jonas, A. (1995). *Splash!* New York: Greenwillow.

Keats, E. (1971). *Over in the meadow.* New York: Scholastic Inc.

Long, L.(1996). *Domino addition.* Watertown, MA: Charlesbridge.

Lottridge, C. (1986). *One watermelon seed.* Toronto: Oxford University Press.

MacCarthy, P. (1990). *Ocean parade.* New York: Dial Books.

Miriam, E. (1993). *12 ways to count to eleven.* New York: Simon & Schuster.

Pinczes, E. (1994). *One hundred hungry ants.* New York: Houghton Mifflin.

Pinczes, E. (1995). *A remainder of one.* New York: Houghton Mifflin.

Pomeroy, D. (1996). *One potato.* San Diego: Harcourt Brace.

Ryan, P. (1994). *One hundred is a family.* New York: Hyperion.

Ryan, P. & Pallotta, J. (1996). *The crayon counting book.* Watertown, MA: Charlesbridge.

Slater, T. (1996). *Stay in line.* New York: Scholastic Inc.