Sharing Beans with Friends

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First graders in an urban public school actively engage with mathematics by using the story *Bean Thirteen* as a context for developing number sense.

By Clare V. Bell

Bean Thirteen (McElligott) was published in 2007, but I came across the picture book just two years ago at a local children's bookstore. What a treat to find a "new" book to encourage thinking about mathematics. At the beginning of the story, Ralph and Flora, two insects, are picking beans for dinner. Ralph, who is superstitious, does not want Flora to pick a thirteenth bean, but she does so anyway. When Ralph and Flora divide the beans into two piles for their dinner, Flora discovers that they have one extra—bean thirteen. Ralph refuses to accept the "unlucky number" bean, so Flora devises a plan. She will invite a guest to dinner.

Throughout the remainder of the story, Ralph and Flora invite additional dinner guests because they do not want anyone to end up with the "extra" bean. Friends are called, one at a time, and each time, Flora and Ralph divide the beans to create fair-share piles. By the time they realize that even with four friends joining them, they will still have an extra bean, the doorbell rings, indicating that guests have begun to arrive.

BEANS: LUISCAR/VEER

Rich social interaction and mathematical discourse are two classroom benefits to students and teachers alike when using children's literature to actively engage with math concepts.

Why we use children's literature

Teachers and researchers have known for decades that the use of storybooks can have a positive impact on students' experiences with mathematics (e.g., Baroody, Lai, and Mix 2006; Hong 1996; Keat and Wilburne 2009; Whitin 1994). Stories help teachers give students contexts for making sense of mathematical concepts. Additionally, practices that support learning to read and visual literacy—such as making sense of the text, predicting what will happen next in a story, and making sense of visual representations—add interest and meaning to learning mathematics.

Using children's literature supports active engagement with mathematical concepts in several ways, such as—

1. prompting children's movement through a sequence of problem-solving steps stimulated by character-posed problems, teacher-posed problems, and student-posed problems;

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As each character in the storybook *Bean Thirteen* (McElligottt 2007) is invited to a dinner party, first graders create equal shares by placing beans on the characters' name card.

2. encouraging imagination in children's mathematical thinking as they bring story characters' problems into mathematical activity and pretend play;
3. helping children to make mathematical connections to their learning and their own lives as they engage in creating representations and narrating their own stories inspired by the literature; and
4. providing opportunities for children to demonstrate enthusiasm and engagement (Keat and Wilburne 2009; see also Ducolon 2000; Hyson 2008).

An overarching benefit for students and teachers alike is the rich social interaction, specifically mathematical discourse, that can result from such engagement. Questions and expressions of mathematical thinking during classroom discourse help teachers understand students' mathematical development more deeply than is possible with strictly demonstrating and practicing procedures. Students' questions can lead to further mathematical inquiry. Furthermore, on the basis of observing and discussing one another's mathematical behaviors, students can expand their repertoire of strategic behavior.

Developing the activity

Last year, I worked with preservice elementary school teachers and two classes of first-grade and second-grade students in an after-school tutoring program at a local urban school. The first and second graders had little classroom experience with manipulating concrete objects as part of exploring mathematical concepts. During the first few after-school tutoring sessions, the preservice teachers and I found that most of the students could add single-digit numbers. Most of them needed to count objects when adding, and many had not yet developed strategies for addition, such as counting on. For example, all the first graders and some second-grade students started counting with "one" every time they added, even if they knew how many items were in each of the groups being combined. At the other end of the developmental spectrum, a few of the second-grade students were able to add and subtract two-digit numbers, and they understood the relationship between ten ones and one ten. The Sharing Beans with Friends activity was originally designed for students in the after-school tutoring program to address a wide range of developmental needs, from building on their counting skills to informally exploring the concept of whole-number division with remainders.

Engaging in the activity

This year, I implemented the Sharing Beans with Friends activity with a group of first graders from another urban public school district to create a video model for preservice teachers about interviewing and working with young elementary school students on number concepts. The model was intended to demonstrate methods for making students comfortable with being interviewed, activating their prior knowledge, providing a context for exploring mathematical ideas, and prompting students to extend their mathematical thinking. The classroom teacher selected four students to participate: Miguel,

Cierra, John, and Daniela. The activity objectives for the first-grade students included communicating about numbers and demonstrating understanding of decomposing numbers (into equal shares and remainders). Additional objectives related to communication included predicting story events (making mathematical conjectures) and representing mathematical concepts with concrete objects, drawings, verbal explanations, and written number sentences.

To begin the activity, we talked informally about what the students knew about number operations (adding, subtracting, and multiplying) and categorizing numbers (as even or odd). Because the mathematical activity would take place at various points within the story, students were asked to label 3 × 5-inch cards with the names of story characters before we began reading. They were each provided with thirteen lima beans and a blank recording sheet (see the **online appendix**) to keep track of their work when decomposing the number 13 as the dilemma posed by the characters. Students were encouraged to communicate their mathematical findings throughout the activity.

The first mathematical problem encountered in the story is to divide thirteen beans into two piles (for Ralph and Flora). Students used the cards and beans to create equal shares. They quickly recognized that they could not separate the beans into two piles with equal numbers—they had one extra bean, or "six plus six plus one." John volunteered that "six plus six is like two times six; it's multiplication." When pressed to explain what he meant, he added that his classroom teacher once said that multiplication is like repeated addition, "so if you have six and six, it's the same as two times six—there are two sixes."

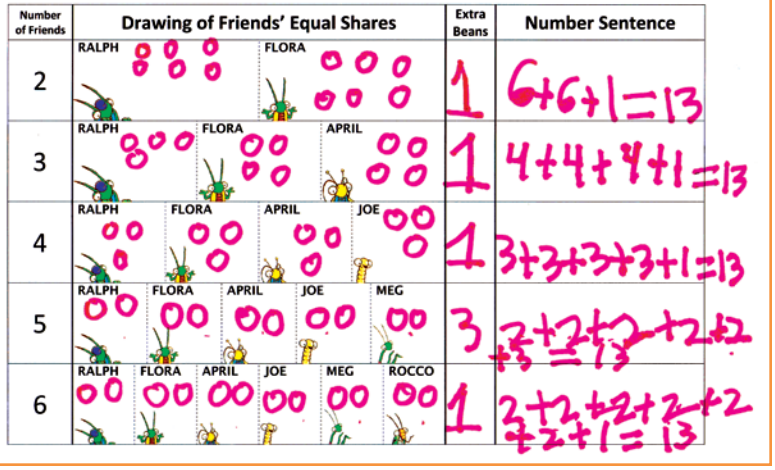
Using beans and cards, all four students demonstrated equal shares of six beans each for Ralph and Flora with one leftover bean.

In the story, to deal with the problem of the extra bean, Ralph and Flora invite additional friends to dinner, one at a time, hoping to separate thirteen beans into equal shares with no leftovers. As each additional story friend is invited, the first-grade students created equal shares by placing beans on the characters' name cards. Then, on the recording sheet, they drew a picture of the groups of beans and wrote a corresponding number sentence (see **fig. 1**). They found that with three characters sharing the beans (Ralph, Flora, and April), each got four beans, but they still had one extra. With four characters (Ralph, Flora, April, and Joe), each character got three, and they once again had an extra—to a student chorus of "Bean thirteen!" At this point in the activity, Daniela made a mathematical conjecture that they would "always [have] one leftover bean because thirteen is an odd number." She reasoned that she had just divided the beans among four friends; the extra bean is number 13, an odd number. John said that adding one more bean would make it even, because seven plus seven is fourteen. We continued with the story to find out what would happen next.

Solving the problem of including one more guest (Meg), for a total of five friends, presented a new challenge and an aha! moment of learning. The first graders had been using two different strategies for dividing the beans: either distributing them among the friends one at a time or starting with some small number for each character and then adjusting until each had the same number. When dividing the thirteen beans among five friends, regardless of the strategy used, the students experienced a higher degree of cognitive dissonance. Until he ran out of beans, John, who distributed the beans one by one, did not realize that he did not have enough beans for each character to have three. At that point, three of the storybook friends had three beans each, and two of the friends had only two. It was not obvious to John that he could have

FIGURE 1

A full-size, blank recording sheet accompanies the online article.



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Miguel explained to the class how he removed beans to make equal shares, but the other students doubted that the leftover beans could be a greater number than what was in an equal share.

more than one "extra" bean, so he tried rearranging the beans to make the groupings equal. Cierra, who had set random numbers of beans on the five cards, also tried rearranging them to make equal numbers. Miguel had distributed only twelve of the beans, because of his previous experience with having the leftover thirteenth bean. His process resulted in two groups of three beans and three groups of two beans; he held the thirteenth bean in his hand.

The students found that rearranging the beans on the cards was not facilitating in solving the problem. To help them move beyond the impasse, I suggested to Miguel that if each friend did not have the same number of beans, he could remove some. He removed a bean from each card that had three, which left him with two beans on each of the five cards. Miguel then had *three* extra beans in his hand. The act of removing and holding the "extra" beans helped him realize that the previous pattern could be broken—he would have three leftover beans this time. Even though Miguel explained to the rest of the group that he removed beans to make equal shares, the other students were skeptical of the idea that the number of leftover beans could be greater than the number in an equal share. They were convinced of Miguel's solution only after manipulating their own sets of beans, seeing two on each card, and holding the three remaining beans in their hands.

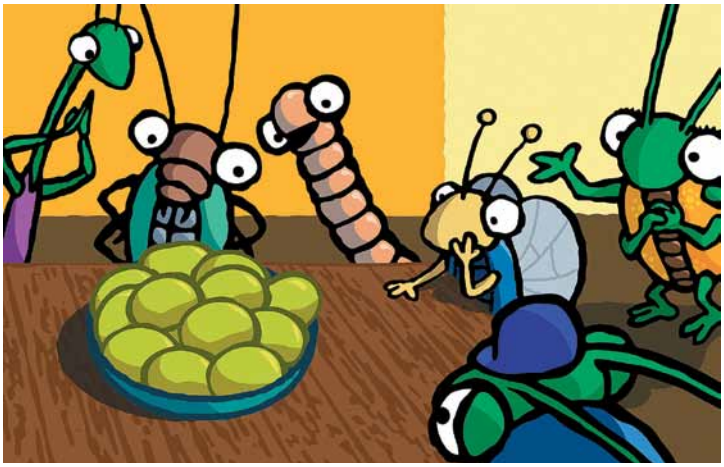
Using prior knowledge

During this phase of the activity (dividing thirteen beans among five friends), students realized they could apply their previous knowledge about counting strategies. Miguel decided to recheck his results by counting on his fingers, "two, plus two, plus two, plus two...," holding up two more fingers with each repetition; but he became confused about when to stop. Daniela asked him why he did not count by twos. Before Miguel could try it, John counted, "Two, four, six, eight, ten," as quickly as he could. Miguel got a big smile on his face when he realized that counting by twos is so much easier. This interaction illustrates the rich mathematical discourse that occurred throughout the first graders' collaborative problem solving.

After going through the process of making equal shares with the beans one more time, dividing the beans among Ralph, Flora, April, Joe, Meg, and Rocco, I prompted further discussion by asking what the students knew about the number 13. John said that it is an odd number. When asked what that means, he replied, "Well, you cannot split it in half, because it would be six and seven." Making a connection to his own life that the story had inspired, John also observed

FIGURE 2

The *Bean Thirteen* friends arrive for dinner.



that the word *thirteen* has *teen* in it and that his brother is thirteen years old. John's comment stimulated a student discussion of teen numbers. On the basis of the students' interest, I posed the problem of finding out how many tens are in thirteen. The students divided the beans into two mounds and confirmed that they could make thirteen with ten in one and three in the other.

While discussing other ways to "make thirteen," the first graders shared their number sentences from the activity. Because the discussion led to more student observations about repeated addition and multiplication, one of their classroom co-teachers, Ms. Bruns, guided students through writing out their number sentences to include multiplication, for example:

$$2 + 2 + 2 + 2 + 2 + 2 + 1 = 13$$
$$6 \times 2 = 12$$
$$12 + 1 = 13$$

We celebrated our exploration of the number 13 by sharing jellybeans:

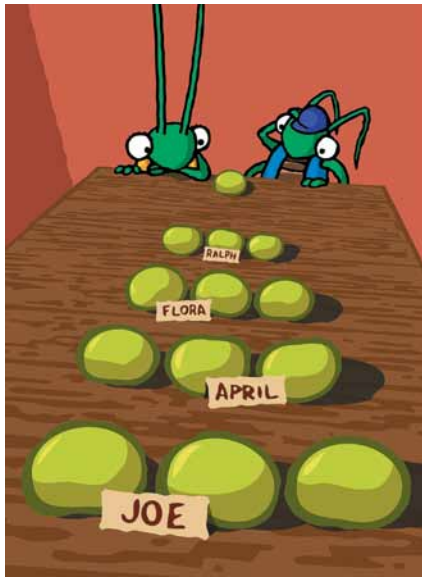
> Each student had thirteen jellybeans. There were four students. How many jellybeans did the students have altogether?

What literature can contribute

The National Council of Teachers of Mathematics (NCTM) emphasizes that students must have access to high-quality, engaging mathematics instruction, to "learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" (NCTM 2000, p. 20). Teachers can support learning mathematics with understanding by building on young students' natural curiosity and eagerness to make sense of the world around them. Although no single "right" way exists to teach mathematics, it is essential that teachers create classroom contexts for engaged mathematical activities that encourage students to think, ask questions, collaborate to solve problems, and discuss their ideas (NCTM 2000). Children's literature can help teachers furnish the contexts for engaging mathematical activity. Additionally, recording sheets, such as the one used in the Sharing Beans with Friends activity, can support students in expressing and recalling their thoughts, strategies, and solutions, which will facilitate communication and discussion of their mathematical ideas.

FIGURE 3

Ralph and Flora divide the beans.



The Sharing Beans with Friends activity demonstrated support for students' active engagement with mathematical concepts by prompting movement through a sequence of problem-solving steps, encouraging imagination in mathematical thinking, helping the children make mathematical connections, and providing opportunities to demonstrate enthusiasm (Keat and Wilburne 2009). In the activity, the *Bean Thirteen* story contributed to building a foundation for the development of a variety of number concepts. At the most basic level, the story of Ralph and Flora's bean dinner can reinforce that numbers are used to express characteristics of things in the world (e.g., how many in a set), that large sets of items can be broken into smaller sets (decomposition of numbers), and that there are relationships between numbers. *Bean Thirteen* can be used at first grade and at other grade levels as an entry point for investigating additional mathematical concepts, such as even and odd numbers, composite and prime numbers, and relationships between basic number operations.

Although this story was used to help students think about numbers and contribute to their development of number sense, teachers can

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To connect addition and multiplication, a co-teacher guides students in writing number sentences related to the story they are reading as a class.

find a wide range of children's literature available for supporting student engagement with a variety of mathematical concepts. In the process of using such literature, teachers may find that they too enjoy engaging in activities that add interest and meaning to learning mathematics.

Common Core Connections

1.OA.1	2.OA.1
1.OA.2	2.OA.3
1.OA.6	2.OA.4

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Download one of the free apps for your smartphone to access the full-size, blank recording sheet at **www.nctm.org/tcm049.**