Exploring Children's Literature in the Elementary Mathematics Classroom

Gregory Bryan and Ralph Mason

The project reported here involved the collaborative design and implementation of a "math-lit" approach to mathematics and language arts instruction in four classrooms from three school divisions. In literature-triggered mathematics, a teacher uses sets of children's trade books with mathematical elements to lead students into contextually rich, active and interactive mathematics activities. After appreciating each trade book as a literary experience, students engage with the mathematics in the story through various activities. The classrooms contained heterogeneous student groups from Grades 3 to 5 with widely varying mathematics and reading achievement levels. The purpose of the research was to explore the mathematical experiences of children engaged in literature-triggered mathematical activities.

The teachers in this project demonstrated a willingness to follow the leads of their students. They encouraged the creativity of the children, who participated in various activities for two months, working within the framework of the project. When given the freedom to respond to their reading and to the math in the books, some students selected traditional options like creating number sentences to reflect the math. Other students embraced the opportunity to demonstrate and enhance their learning with such diverse activities as literature-circle discussions, dramatic interpretations and performances of roles depicted in some of the picture books, (for example, a Grade 5 performance of *Minnie's Diner* [Dodds and Manders 2004], and a Grade 3 performance of *The Wolf's Chicken Stew* [Kasza 1987]) and the creation of reader's theatre scripts based on and inspired by the various books.

The teachers were pleased that the children approached their mathematics learning with excitement and enthusiasm. One teacher felt sure that she was on the right track when a Grade 5 student exclaimed, "This story is so cool. It has math in it!"

We, Ralph Mason and Greg Bryan, are the authors of this article. Mason is a professor of mathematics education, and Bryan is a professor of children's literature and literacy education. This study was a good marriage of our interests and expertise. We began the project by meeting with the teachers involved in the study. We shared our perspectives and discussed the possibilities that the project could bring to the classrooms. Above all else, we encouraged the teachers to use the books as they pleased—we wanted to see how they and the students would use them.

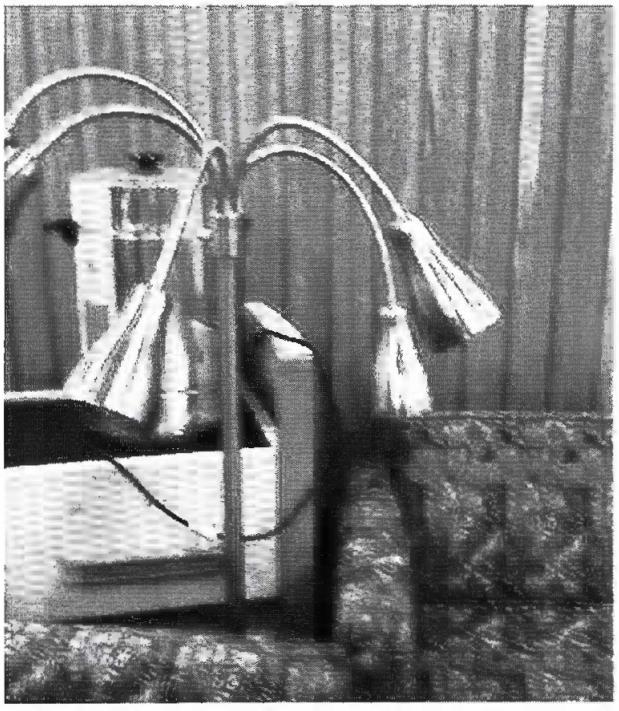
We assembled five or six sets of different picture books. In some of the books, the math was more explicit than in others. Some mathematical concepts in a story were less obvious and, seemingly, less deliberate. The text sets were arranged in particular mathematical themes: addition and subtraction, repeated doubling, and multiplying and dividing.

Introductory Activity

When the teachers took the math-lit books to their classrooms, the initial approach was to share with students what we had identified as suitable introductory texts: Stephen Johnson's (1998) *City by Numbers* and Scieszka and Smith's (1995) *Math Curse*. The teachers used these two books to raise awareness of the idea of math being all around us.

In *Math Curse* a teacher says to the class, "You know, you can think of almost everything as a math problem." This leads one child to realize how prevalent math is in the world. *City by Numbers* depicts city scenes where the shape of the urban environments portrays the shapes of numerals from 0 to 21. For instance, the twin smoke stacks of an old factory look like the numeral 11, a crumbling brick wall appears to contain a 15, while a bridge looks like a 4.

With Johnson's example of New York City scenes in mind, students dispersed across their schools to look for hidden numerals. In one classroom, students took digital photographs depicting the numerical shapes they found embedded in their school. For instance, the following photographs illustrate the location of a 6 that appeared in the teachers' lounge when an electrical cord blended with a light stand.



Through the students' interactions with the books and teacher-guided actions with the books' ideas, students' feelings about mathematics and their visual creativity became legitimate elements of their engagement with mathematics.

Addition and Subtraction Text Set

One book in the addition and subtraction set was a counting book entitled *My Little Sister Ate One Hare* (Grossman and Hawkes 1996). The book begins:

My little sister ate 1 hare.
We thought she'd throw up then and there.
But she didn't.

The little sister then eats two snakes and one hare. Then she eats three ants, two snakes and one hare. After the little sister is depicted eating a series of items, the book ends:

My little sister ate 10 peas.
But eating healthy foods like these
Makes my sister sick, I guess.
Oh, my goodness! What a mess!

This book can be an important addition to mathematics classrooms because it can add fun to the math experience. It also serves as a starting point for various mathematical explorations. Of all the things the little sister ate, the students were asked what they would most like and dislike. They wrote their names on Post-it notes and voted by adding their names to bar graphs depicting the most and least popular items. In that particular class, eating nine lizards was the most resisted meal, while, fortunately, eating the 10 peas was preferred to eating worms, mice and bats.

One Grade 4 group created a readers' theatre script inspired by this same book. In the student-created script, a mother asked her children to clean their bedrooms, so they proceeded to eat the mess in their rooms: one spider, two books, three dirty socks and so on. Keeping to the pattern of the original text, eventually the children vomited everything. When the mother came to the bedrooms to check on the progress, she said, "Oh, my goodness! What a mess!"

A necessary step to understanding arithmetic as sensible is seeing addition as an extension of counting. When children's literature enables students to fold back again, to look at their prior counting experiences in the light of addition and subtractions, the students can form links between the arithmetic they are studying and the acts of counting up and down. The arithmetic they are learning can be a sensible extension of the counting they understand, literally, backward and forward.

Repeated Doubling Text Set

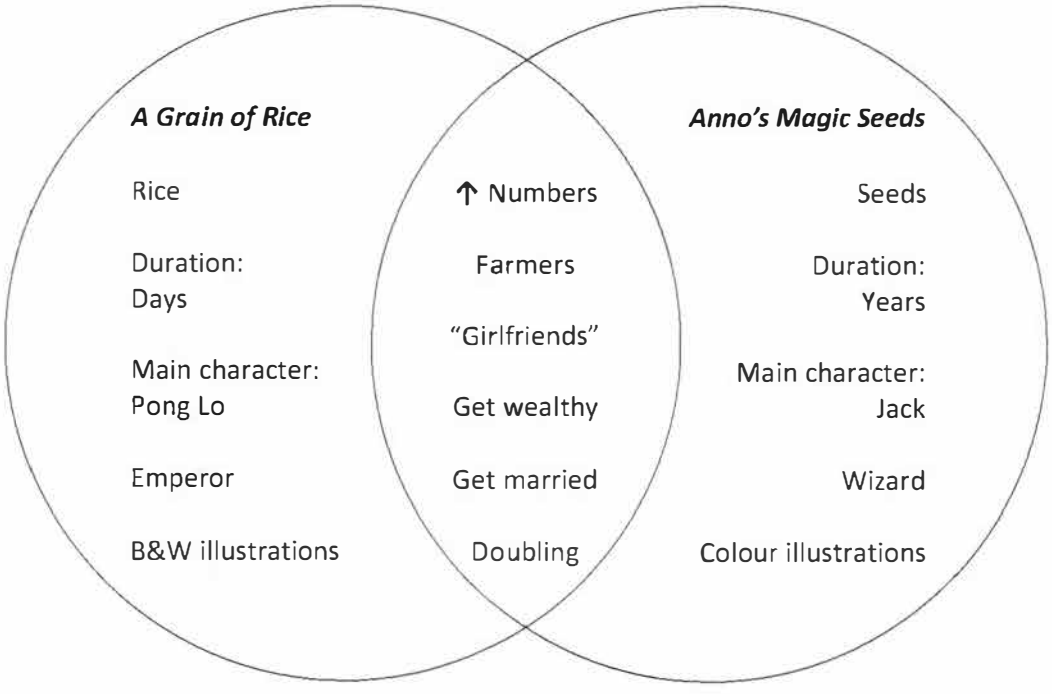
One text set included books that involved the repeated doubling of quantities. This set deliberately included several different versions of the same folk tale of a ruler and his rice. In Birch and Grebu's (1988) version of this story, *The King's Chessboard*, a wise man helps an Indian king. Not wanting to be indebted to anyone, the king wishes to repay the debt.

> The wise man replies, "I wish no other reward than to serve you."
>
> After some pressure from the king, the wise man eventually says:
>
> I only ask this: Tomorrow, for the first square of your chessboard, give me one grain of rice; the next day, for the second square, two grains of rice; the next day after that, four grains of rice; then, the following day, eight grains for the next square.

The king sees this as an odd but easily satisfied request so he agrees. The teachers had their students use manipulatives to represent the mathematics within the story. Because the numbers got large quickly, students needed to use different manipulatives to represent place value units. Although they started with individual grains of rice, the grains were soon spilling beyond the edges of the chessboard squares with which they worked. Therefore the children began representing tens, hundreds and thousands of grains with coins and bottle caps. Just as with the king in the story, the children were amazed to see the amounts owed each day. Within just two weeks, the number of grains of rice owed for that 14th day had grown to 8,192. Through the process of doubling, by the end of four weeks, the number of grains of rice owed for the 28th day was 134,217,728. It was a surprising discovery for the children, just as it had been for the teachers when first demonstrated by Ralph during the planning meetings.

In the repeated doubling text set, there were five different versions of the same multiplying rice story: *The Rajah's Rice* (Barry and Perrone 1994), *The King's Chessboard* (Birch and Grebu 1988), *One Grain of Rice* (Demi 1997), *The Token Gift* (McKibbon and Cameron 1996) and *A Grain of Rice* (Pittman 1999). Although illustrated in black and white, Pittman's book is a short novel and differs in appearance and format from the other books. The different versions of the same story allowed the teachers and students to explore the notion of critical reading, comparing and contrasting the books. Students identified their favourite version of the story. This led to discussions of preferences and reasons for those preferences. In turn, these reading discussions led to exploration of the mathematical concept of sets, incorporating the use of Venn diagrams to identify similarities and differences.

In one classroom, Pittman's novella was compared with another book from the doubling set, *Anno's Magic Seeds* (Anno 1995). The figure below illustrates elements identified by one group of Grade 5 students and the manner in which that group classified each element.



People may wonder why repeated doubling experiences would be provided to young students. On the one hand, doubling is a fundamental act of arithmetic, linked to adding an amount to itself. One plus one is two, two plus two is four, four plus four is eight and so on. It is a little more complicated but just as natural as skip-counting by two. Yet, on the other hand, repeated doubling is represented mathematically by powers of two; for example, eight is two to the third power, which means two is multiplied by itself three times. Surely powers are not an elementary-years mathematics topic, yet all the students engaged with repeated doubling in their own way when they were exposed to these big ideas with the stories in the books.

In time, powers as repeated multiplication must make sense to students, just as addition as repeated counting makes sense in the early grades, and multiplication as repeated counting makes sense in Grades 3–5. Literature-based experiences enable students to engage with the core idea of repeated doubling before they need to think of the process as the repeated multiplication that can be symbolized with exponents as powers. As they express and extend the idea in ways of their own choosing, they build foundational experiences for the formal symbols they will learn later. When they do learn the symbol system, the children will have referents in the varied experiences they have had over the years, such as the literature-triggered mathematics described here.

Multiplication and Division Text Set

The multiplication and division text set included two books by Dayle Ann Dodds. One was especially popular with the students. At the end of the project, many students nominated Dodds' (2004) book, *Minnie's Diner*, as their favourite. In *Minnie's Diner*, a succession of brothers goes to the diner to eat. As each brother arrives, he looks at what his younger brother is eating and says, "I'll have what he's having but make mine a double." This book could also have been included in the doubling set of books. In *The Great Divide* (1999), a long distance race is under way. The number of competitors keeps reducing by half as racers get lost or fall by the wayside. In one literature-circle discussion of the book, six Grade 5 students wondered aloud whether the book involved division or subtraction. This discussion helped the children to articulate and solidify their understandings of these two processes and how they can be related. At the same time, the students enrich their understanding of multiplication as accumulated sets with the same number of elements in each set. Similarly, as larger numbers are split into equal sets in different ways, students can learn that amounts can be split into many groups each with the same number of members. Students can then see division as a formal mathematical idea for describing things that they have imagined and created, drawn and described.

As a professor of mathematics education, Mason described McElligott's (2009) book, *The Lion's Share*, as perhaps the best math-lit book he had ever read. The book features members of the animal kingdom who each divide the lion's special cake into halves, one of which they eat. Splitting into two equal parts—or dividing by two—provides an accessible starting point for the concept of division.

The book begins:

> Every year at the start of spring, the lion invited a small group of animals to join him for a special dinner. The ant had never dined with the king before. She was very nervous and wanted to make a good impression.

At the dinner, Lion produces a cake. Elephant thinks, "I could eat this in one bite, but that might seem greedy," so Elephant takes only half the cake. In turn, as the cake reaches them, each guest takes half of the remaining cake. When the cake finally gets to the ant, there is so little left that it crumples when the ant tries to slice it in half. All of the other guests criticize the ant for being greedy and selfish. Mortified, the ant humbly offers to bake another cake for the host. Not to be outdone, each of the other animals promises to bake double the number of cakes nominated by the previous animal. As it turns out, while all the other animals are busy baking their cakes, the ant is able to complete its one cake and dine in peace and harmony with the Lion King.

The students were asked to identify and discuss connections they could make to the book. Several students made text-to-text connections and discussed the similarities between this book and other books including *One Grain of Rice* and *Minnie's Diner*. Others made connections to movies like *The Chronicles of Narnia* and Disney's *The Lion King*. Some children made text-to-self connections and discussed seeing lions when they went to the zoo.

Making Connections

Students made personal connections to the content of the stories but less so to the mathematics. For instance, in *Spaghetti and Meatballs for All* (Burns and Tilley 1997), the story involves arranging tables for

a family gathering. This reminded one student of a family gathering to celebrate the birth of a newborn baby. "When I went to my auntie's house," the student said, "we helped her get some more chairs because there was a party for my other aunty who had a baby." The student easily recalled needing to get more chairs for the guests; however, she and her peers had considerable difficulty connecting to instances from their own lives from the idea of splitting a number into equal sets, like the restaurant patrons being seated at multiple tables. We value such limitations in students' responses as valid feedback about their readiness to perceive aspects of their lives in terms of the mathematical ideas they are studying, in this case multiplication. The book provides an opportunity for students to be guided to engage with the mathematics of arrangements of equal sets, so that, in time, multiplication can be real life to them.

Occasionally, a student could connect to the numerical values within the stories. In *The Wolf's Chicken Stew* (Kasza 1987), from the addition and subtraction text set, the wolf is trying to fatten up a chicken for his stew so he bakes 100 pancakes. This reminded one student of her sister: "My sister had to make a hundred cupcakes because it was the 100th day of school," she said. This and others, however, were rather basic connections to the math in the books. Just as teachers often encourage students to make connections to the texts that they read, teachers might do well to encourage students to think about the personal, individual connections they can make to the mathematics they are doing in class. When have they done some halving outside the classroom? When did they need to multiply or divide outside of the classroom? Such encouragement might help children to more fully recognize the benefits of their mathematics learning.

Participant Comments

After several weeks of working with children's trade books during math class, students were asked what they thought about including books in the math class. Below are some of the Grade 3 students' comments:

> When we read a book, it gives us an idea of the math that we're going to do.
>
> When there's a story, you get more details about what you're going to start off with.
>
> The book gives us a little bit of a hint.

A Grade 4 boy mentioned that the story "tells you more things." One Grade 5 student said that the story "teaches you why it is" while her classmate said that the story "tells you how to do it."

These interesting comments suggest that, like us, the students saw literature-triggered math as offering a kind of life raft or floatation device for children's exploration of mathematics in that it provides contextualized opportunities for learning. The books provide assistance to the children. After all, a Grade 3 student said, "When we just do math [without stories], it's just a bit harder for me." At the same time, a Grade 5 student reported, "You get confused [doing math without a story], and in the stories, you don't."

When further asked for their opinions, some of the Grades 4 and 5 students replied:

> You can enjoy the story.
>
> Whenever I do math [without a story] it's always hard for me to think.
>
> When there's a storybook, you could explain [the mathematics] better.
>
> It's easier to understand [when there's a story].

These comments suggest the students' focus wasn't on just getting right answers. The books assisted them with arriving at correct answers, but the verbs used (enjoy, think, explain and understand) suggest that the products (the correct answers) were really just an outcome of a desirable process of enjoying, thinking, explaining and understanding. Incidentally, these verbs are the type of words emphasized in the NCTM standards for talking about success in mathematics.

Concluding Comments

The use of children's literature trade books as a mathematics resource can represent a significant departure from the traditional use of math textbooks. We are not suggesting this literature-triggered approach as a replacement for more traditional approaches to math instruction. Rather, we see literature-triggered mathematics as a worthwhile supplement, believing that the mathematics that matters happens as children visualize, represent, represent and extend math beginning with the mathematics in the books.

Reflecting on the events of the previous several weeks, the Grade 5 teacher summed up the success of the project with the comment, "It's great to see them excited and thinking about math." In elementary classrooms where this excitement and incisive thinking are absent from mathematics periods, perhaps teachers would do well to consider including children's literature trade books when next they sit down to prepare their mathematics instruction. Especially for teachers who are confident in their abilities to engage students productively in activities that build

on the literature they experience, literature-triggered mathematics may offer a potent supplement to textbook-based mathematics.

Texts Sets Used in the Study

Introductory Texts (Math Everywhere)

Johnson, S T. 1998. *City by Numbers*. New York: Viking.

Scieszka, J, and L Smith. 1995. *Math Curse*. New York: Viking.

Addition and Subtraction

Bailey, L, and J Masse. 2007. *Goodnight, Sweet Pig*. Toronto: Kids Can.

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Greene, C, and T Raglin. 1989. *The Thirteen Days of Halloween*. Chicago, Ill: Children's Press.

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Palatini, M, and B Moser. 2005. *The Three Silly Billies*. New York: Simon & Schuster.

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Pittman, H C. 1999. *A Grain of Rice*. New York: Hastings House.

Multiplication and Division

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Friedman, A, and S Guevara. 1994. *The King's Commissioners*. New York: Scholastic.

Hong, L T. 1993. *Two of Everything*. Morton Grove, Ill: Albert Whitman.

Hutchins, P. 1986. *The Doorbell Rang*. New York: Greenwillow.

Matthews, L, and J Bassett. 1990. *Bunches and Bunches of Bunnies*. New York: Scholastic.

McElligott, M. 2009. *The Lion's Share*. New York: Walker.

Murphy, S J, and C Jabar. 2003. *The Sundae Scoop*. New York: HarperCollins.

Napoli, D J, and A Walrod. 2001. *How Hungry Are You?* New York: Atheneum.

Neuschwander, C, and L Woodruff. 1998. *Amanda Bean's Amazing Dream*. New York: Scholastic.

Pinczes, E J, and B Mackain. 1993. *One Hundred Hungry Ants*. Boston, Mass: Houghton Mifflin.

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Other Resources for Further Support

Gadanidis, G, and J M Hughes. 2011. "Performing Big Math Ideas Across the Grades." *Teaching Children Mathematics* 18, no 8: 486–96.

Gear, A L. 2012. "A Cultural Introduction to Math." *Teaching Children Mathematics* 18, no 6: 354–60.

Gerretson, H, and B C Cruz. 2011. "Museums, Mysteries, and Math." *Teaching Children Mathematics* 17, no 7: 404–09.

Lambereg, T, and C Andres. 2011. "Connections—Integrating Literature and Math." *Teaching Children Mathematics* 17, no 6: 372–74.

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