Building the Mathematics and Literature Connection through Children's Responses

The Connections Standard in *Principles and Standards for School Mathematics* makes the significant observation that "the opportunity for students to experience mathematics in a context is important" (NCTM 2000, p. 66). Literature provides such a contextual base by embedding the meaning of the mathematics in situations to which children can relate. In this regard, the use of literature in the elementary mathematics curriculum has steadily increased over the past few years. The publication of books that specifically feature mathematics, as well as a deeper understanding by teachers of how to integrate literature and mathematics topics, has aided this increase. This article builds on the premise that educators want children to recognize and respond to the mathematics that may be evident or embedded in literature.

Three types of literature successfully integrate mathematical concepts into a story. These include books in which mathematics is the basis for the story, books in which understanding the mathematics is integral to understanding the story, and books in which mathematical responses may emerge naturally. Although we want to be cautious about the idea of "levels" of integration, that the literature itself guides the responses of the student should be understood. Teachers must create an awareness of the connection between mathematics and literature in order for mathematical responses to occur.

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Mathematics Is the Basis for the Story

A variety of literature is published each year in which mathematics is the focus of the story (see **fig. 1**). These books have been written by authors whose primary intent is to teach a mathematical skill or concept through a picture or chapter book format. Children's book authors such as Amy Axelrod and Stuart J. Murphy have created several books within a series format. Axelrod's *Pigs* books (1997, 1998) are based on NCTM's Standards (1989) and promoted as "vehicles to introduce, reinforce, and review the concepts and skills particular to each title." These popular stories, such as *Pigs in the Pantry: Fun with Math and Cooking* (Axelrod 1997), which highlights measurement, are enjoyable and informative. Murphy's *Mathstart* series is intended to be developmentally appropriate for and correlate to grades 1 through 3. His numerous titles include *Seaweed Soup* (2001b, level one), about one-to-one correspondence; *Give Me Half!* (1996, level two), about understanding halves; and *Dinosaur Deals* (2001a, level three), which features the concept of equivalency. This series also is based on NCTM's Standards.

Other authors such as Bruce McMillan are known for writing a variety of books that include one or more titles that focus on mathematics. Each illustration in McMillan's *Jelly Beans for Sale* (1996) depicts children buying jelly beans and is

Figure 1

Examples of literature in which mathematics is the basis for the story

Adler, David A. *How Tall, How Short, How Faraway.* New York: Holiday House, 1999.

Axelrod, Amy. *Pigs in the Pantry: Fun with Math and Cooking.* New York: Simon & Schuster, 1997.

Daniels, Teri. *Math Man.* New York: Orchard, 2001.

Hoban, Tana. *Cubes, Cones, Cylinders, & Spheres.* New York: Greenwillow, 2000.

Leedy, Loreen. *Measuring Penny.* New York: Holt, 1997.

———. *Follow the Money.* New York: Holiday House, 2002.

McMillan, Bruce. *Jelly Beans for Sale.* New York: Scholastic, 1996.

Mills, Claudia. *7 × 9 = Trouble.* New York: Farrar, Straus Giroux, 2002.

Murphy, Stuart J. *Betcha.* New York: HarperCollins, 1997.

Pallotta, Jerry. *The Hershey's Milk Chocolate Multiplication Book.* New York: Scholastic, 2002.

accompanied by a corresponding equivalence such as 1¢ = 1 jelly bean. Having children represent different amounts of money for a specified number of jelly beans is one way to use this book in a mathematics classroom. The book offers six different ways for children to buy twenty-five jelly beans. In one class, the teacher challenged her students to come up with as many different ways as they could to pay for fifty jelly beans. Loreen Leedy has written and illustrated several books that emphasize money, measurement, and fractions, such as *The Monster Money Book* (2000), *Measuring Penny* (1997), and *Fraction Action* (1996). David A. Adler writes about a variety of mathematical concepts using stories that follow a predictable format. These include *Fraction Fun* (1995) and *How Tall, How Short, How Faraway* (1999).

With these types of books, the questions that the teacher asks students relate specifically to mathematics. *The Hershey's Milk Chocolate Fractions Book* by Jerry Palotta (1999) includes mathematical statements throughout the text such as "Six-twelfths is equal to one-half. When two fractions equal each other, they are called equivalent fractions." From the perspective of integration, that teachers use this type of literature as an opportunity for their students to ask mathematical questions within the context of the story is important. In this case, a teacher could use *The Hershey's Milk Chocolate Fractions Book* as the context for a study of equivalent fractions, using the pictures of the chocolate bars in the book to show the equivalence of one-half and six-twelfths. The mathematics in the book is obvious; teachers can begin to facilitate discussions centered on both mathematics and literature.

All these books, both series and individual titles, have been written with mathematics as the intent of the story. Teachers sharing these books with children are not imposing what mathematical concepts they believe the story contains, because the concepts are obvious to the reader. This aspect becomes the strength of the books; students will enjoy the story and teachers can build on a mathematics lesson generated directly from the book. More important, the books provide examples of high-quality literature that enhance and extend students' understanding of a mathematical concept.

Understanding the Mathematics Is Integral to Understanding the Story

Another type of literature that teachers may select includes books in which understanding the mathematics is integral to understanding the story but is not the basis for the story (see **fig. 2**). In sharing these types of stories, teachers have the opportunity to facilitate students' process of asking mathematical questions that stem directly from the story. The difference is that mathematics does not drive the book; rather, it is embedded within the story. The teacher must assist the students in understanding the mathematics that is in turn essential to understanding the focus of the story.

Some books incorporate mathematical concepts that students must understand in order to comprehend the story. On the surface, *Rosie's Walk* by Pat Hutchins (1968) chronicles a day in the life of a hen named Rosie. Teachers also can use the book to explore spatial relationships, because students must understand positional words such as *between, inside, outside, near,* and *on* to understand how Rosie travels throughout her day. This book specifically addresses the Geometry Standard in *Principles and Standards for School Mathematics*, in which students specify locations and describe spatial relationships (NCTM 2000). One teacher used the book to stress these spatial relationships and positional words by asking her students to act out

Figure 2

Examples of literature in which understanding the mathematics is integral to understanding the story

Cuyler, Margery. *100th Day Worries.* New York: Simon & Schuster, 2000.
Demi. *One Grain of Rice: A Mathematical Folktale.* New York: Scholastic, 1997.
Florian, Douglas. *A Pig Is Big.* New York: Greenwillow, 2000.
Halperin, Wendy Anderson. *Once Upon a Company . . . A True Story.* New York: Orchard, 1998.
Hutchins, Pat. *Rosie's Walk.* New York: Macmillan, 1968.
Lewis, J. Patrick. *Arithme-Tickle: An Even Number of Odd Riddle-Rhymes.* San Diego, Calif.: Harcourt, 2002.
Michelson, Richard. *Ten Times Better.* New York: Cavendish, 2000.
Tang, Greg. *The Grapes of Math.* New York: Scholastic, 2001.
———. *Math for All Seasons: Mind-Stretching Math Riddles.* New York: Scholastic, 2002.
Wells, Rosemary. *Emily's First 100 Days of School.* New York: Hyperion, 2000.

the positional words and relate them to Rosie's experiences in the story. The teacher asked one student to walk "around" her desk, just as Rosie went "around" the lake. She then gave the students the opportunity to ask questions about the positional words. *The Doorbell Rang*, also by Hutchins (1986), is one book that teachers readily share with students to teach division. The story line provides an enjoyable read-aloud, and as students become more familiar with the idea of sharing and division, they are able to generate similar questions themselves and story problems that relate to the story.

In Demi's *One Grain of Rice: A Mathematical Folktale* (1997), a village girl named Rani performs a good deed for the raja and is permitted to choose her own reward. Rani asks for one grain of rice, doubled every day for thirty days. Essential to understanding the story is discovering how much the number of grains of rice increases as time passes. Understanding of the story addresses both the Number and Operations Standard and the Algebra Standard. One teacher asked his students how many grains of rice the raja needed to store after a specific number of days. Another teacher also addressed the Data Analysis Standard by asking her students how they could represent the grains of rice using graphs and technology.

Even poetry can incorporate mathematical concepts. In sharing *A Pig Is Big* by Douglas Florian (2000), teachers must make sure that students understand size perceptions:

A pig is big.
A pig is fat.
A pig is bigger than my hat.
What's bigger than a pig?

After students have an opportunity to think about relative size, the answer of "a cow" certainly is acceptable. *Arithme-Tickle: An Even Number of Odd Riddle-Rhymes* by J. Patrick Lewis (2002) also is enhanced when students are able to solve the mathematical problems posed in each riddle, such as the following:

Dr. Nast said, I'll give you three shots
to get rid of those hideous spots.
One shot every half hour. Goodness sake!
How long did those nasty Nast shots take?

The students can enjoy the rhyme; however, understanding the mathematics to solve the riddle makes it more meaningful. The answers appear written backward on the bottom of the page for those who are completely stumped.

Finally, Jon Scieszka's *Math Curse* (1995) presents a humorous perspective about mathematics as Mrs. Fibonacci tells the class, "You know, you can think of almost everything as a math problem." The little boy in the book takes this comment literally and sees mathematics in all aspects of his day, until he attempts to break the "math curse" that is plaguing him. For readers, both children and adults, who have had more exposure to mathematics, the story takes on greater meaning. The reader is able to better relate to the extent of the "math curse" with more understanding of mathematics content. Students will see familiar topics such as measurement, data, and logic in the context of the little boy's breakfast, lunch, and dinner. When Mrs. Fibonacci says that she counts "1, 1, 2, 3, 5, 8, 13, . . . ," readers who understand numbers see the humor in both her response and her name. Similarly, students who have been exposed to counting in different bases will appreciate the counting of the children on planets Tetra and Binary, who have only two fingers and one finger on each hand, respectively. The illustration of the little boy's dream includes everything from pi, trigonometric functions, and Pascal's Triangle to the Pythagorean Theorem.

Although students of all ages can enjoy this book, *Math Curse* becomes more meaningful to read as students come to understand more mathematics.

In these examples, the mathematics is integral to understanding the story. Rosie's experiences in her travels across the farm are enriched by the positional words in the story, and both students and the raja in *One Grain of Rice* learn about how quickly a geometric sequence grows. Florian's "pig" encourages a variety of responses without one correct answer but several possibilities, whereas *Arithme-Tickle* provides the answer along with a strategy for how to achieve it. As with books in which mathematics is the basis of the story, teachers should ask students mathematical questions about the literature. Teachers also should give students opportunities to ask their own mathematical questions about literature in both of these cases. This second type of literature in which mathematics enriches the story's understanding is a natural progression from the first type of literature in which mathematics is the story's basis. The teacher's role is important; he or she is able to recognize the mathematical concepts that are embedded in the story and make understanding of them a natural part of students' responses. This needs to occur not through a separate lesson but rather within the context of sharing the story.

Mathematics Emerges Naturally Based on the Reader's Connection

Readers can discover mathematics in most pieces of literature. Children must have an opportunity to respond "mathematically," however, and teachers must not impose the literature on them to teach a specific skill. At times, teachers are so enthusiastic about integrating literature into the mathematics curriculum that they unintentionally detract from the literary value of the story. Other times, teachers may not acknowledge that students are making a mathematical connection to a book. In a supportive classroom community in which literature and mathematics thrive, however, both teachers and students can begin to realize that mathematics is integral not only to daily living but also to those connections that may extend into literature. Everything that teachers value about mathematics emerging from literature can be applied to the types of literature described in this article. Students should have the opportunity to think mathematically about all types of literature. In the types of literature described here, the mathematics simply is more obvious. By working with these types of literature, children grow accustomed to approaching literature from a mathematical perspective. When a teacher develops, encourages, and is aware of developing a mathematical perspective toward literature, children begin to make mathematical connections with all types of literature (see **fig. 3**).

Figure 3

Examples of literature in which mathematics naturally emerges from the story based on the reader's connection

Birdseye, Tom. *Tarantula Shoes.* New York: Penguin, 1996.
Jones, Bill T. *Dance.* New York: Hyperion, 1998.
Tunnell, Michael O. *Mailing May.* New York: Greenwillow, 1997.

One example of this occurred with a fourth-grade class that had been reading Tom Birdseye's *Tarantula Shoes* (1996). This short novel, appropriate for grades 4 and higher, tells a story about a boy trying to raise money to buy an expensive pair of sneakers. Students generated questions about the story such as the following:

- How much do the shoes cost?
- How much has he saved?
- How much does he need to buy the shoes?
- How much is the sales tax?
- How much interest would he have earned if he had the money in the bank?

By working with these types of literature, children grow accustomed to approaching literature from a mathematical perspective

These questions emerged naturally from the book, based on the students' interest in how the boy would raise enough money to purchase the shoes. The story also was relevant to these students' lives because they often discussed things they wanted to buy and how they were going to get the money to purchase them. Authenticity and relevancy often are essential to students generating mathematical connections to a story. This is true for both adults and children. Although it was important that students understood the amount of money that needed

to be raised, the other mathematical questions were not imperative to the understanding of the story but the students saw them as meaningful. The authentic experience of making their own connections to the story assisted the students in taking their understanding to another level. According to the recent National Research Council text *Adding It Up* (2001), building on students' informal knowledge is important. Literature provides an opportunity for students to bring their own connections to a story.

The teacher of a fifth-grade class shared *Dance* by Bill T. Jones (1998), a brief picture book that details the life of a dancer. The teacher presented the book as part of a unit on careers. As the students began to discuss the book, questions about a dancer's rhythm began to emerge. The teacher, who had a dance background, saw this as an opportunity to incorporate concepts such as spatial sense, geometric movement, and right angles. He had the class perform basic dance movements as they counted out sets of four in time to the music. This creative response to both the book and geometry proved very entertaining and useful for the teacher and students as the movements added to the students' experience and understanding. Part of developing awareness for students to make mathematical connections involves the teacher developing an awareness of possible mathematical connections. In this case, the teacher saw the students' questions about rhythm as an opportunity to learn about aspects of geometry.

Naturally emerging responses can come from all types of literature

Another teacher chose to read *Mailing May* by Michael O. Tunnell (1997) to her second-grade students. The children were discussing families, particularly their grandparents. *Mailing May* is a historical picture book based on the true story of a young girl who was literally "mailed" to her grandmother at a time when it was acceptable to send items such as live poultry through the postal service. May boarded a train with fifty-three cents' worth of stamps stuck to her coat, sat in the postal car with her postmaster uncle, and arrived at her grandmother's house later that day. As students began to discuss the story, they asked questions such as the following:

- How long did it take to go over the mountains on the train?
- How much would it cost to mail May today?
- How big would a baby chick be that weighed 50 pounds?
- How many miles would the trip be now?

In this discussion, the teacher gave the children the chance to discover their connections to the story. *Mailing May* was not about mathematics, nor was understanding of mathematics essential to comprehension of the story; however, the second graders were curious about many aspects of the story that just happened to involve mathematics.

In all three of these examples, the students initiated the mathematical questions based on their response to the story. The teacher did not impose a mathematics lesson based on what he or she thought were mathematical concepts in the story. An authentic connection to mathematics occurred based on the previous types of literature that were shared in the students' classrooms.

Conclusion

Naturally emerging responses can come from all types of literature, whether they are books in which the intent is mathematics, books in which understanding of mathematics is integral to understanding the story, or books that simply are good literature.

As teachers, we want to help students make connections among mathematics, literature, and their own informal knowledge. Our goal is to enhance and extend students' understanding by enhancing and extending the story, not by diverting attention from the story. With all types of literature, the teacher must read the entire story to enhance literacy development before pursuing the teaching of mathematical concepts in the story. Students should have opportunities to engage in open-ended discussions about the story and to build on their authentic connections and questions. Teachers must be aware of students' responses. Giving students time to think and to discuss both literature and mathematics is important.

Teachers should revisit or, at the very least, allow students continued access to the stories that they share. Although asking students to revisit and practice computation problems is common, revisiting literature is not. Some of the questions that both students and teachers may want to pursue often emerge with repeated readings of the story.

Mathematics and literature support students' growth in the areas of literacy and mathematical development. Literature that focuses entirely on mathematics should be a natural part of a mathe-

matics lesson. Literature in which the mathematics is embedded in the story and in which the understanding of mathematical concepts is integral to students' comprehension can be discussed in meaningful ways. Finally, students and teachers should recognize that mathematics can be found everywhere—even in the stories that they read every day. Often, all we have to do is look.

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