

Promoting Mathematical Discourse through Children's Literature

Discourse in mathematics instruction has received considerable attention since the *Standards* were first published (NCTM 1989, 1991, 2000); however, prompting mathematical discussions and creating an environment that fosters discourse are challenging tasks for teachers (Corwin 1996). Moreover, students who are not used to talking about mathematics may be uncomfortable with or reluctant to participate in discussions. Discourse in mathematics involves expressing and justifying mathematical thinking and ideas. The primary purposes of facilitating discourse are to help students become aware of others' perspectives and strategies, and to clarify and expand students' own thinking and approaches (NCTM 2000).

Children's literature involving mathematics creates a natural context for talking about mathematics (see Hellwig, Monroe, and Jacobs [2000]; Moyer [2000a, 2000b]). Because teachers and students are accustomed to using books for discussion in other subjects, such as social studies and language arts, using literature in mathematics might help teachers who are just beginning to incorporate mathematics discussions in instruction to create an environment that promotes discourse. Moreover, teachers who already use discourse in mathematics find that literature offers another opportunity for students to make meaning and build connections between mathematics and their lives (Austin 1998; Moyer 2000a).

To explain how literature can serve as a fertile ground for fostering discourse communities in mathematics, we offer four examples of books to read aloud with a class and use in mathematical discussions. Although any of these books could be used to develop a mathematics activity, we are focusing on the mathematics discussions that might emanate from using such books in instruction. We have selected recent titles from various grade levels in order to expose readers to newer, high-quality literature for teaching and learning mathematics.

A Pig Is Big

Summary

Florian (2000) wrote *A Pig Is Big* in rhyme and painted simple watercolor illustrations that appeal to young children. The book begins with the question "What's big?" On the next page, we find an answer to the question: a pig. The story continues with each page asking for something that is bigger. For example, after asking, "What's bigger than a cow?" Florian writes:

A car.
It's bigger than a cow by far.
Inside a car a cow can squeeze
And drive a pig to town with ease.

The story builds to bigger and bigger things and ends with the universe as the "biggest thing of all. Compared to it all things seem small." We

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recommend this book for prekindergarten through first grade.

Standards addressed and review of the book

This book incorporates the Measurement Standard in an enjoyable rhyming story and uses an appropriate approach for children. The story invites the reader to



From *A Pig Is Big*, by Douglas Florian. Published by Harper Collins, 2000. All rights reserved.

compare and order the size of objects and understand that size is a relative property; for example, a pig may be big, but it is small compared to the universe. Throughout the book, Florian exposes children to measurement terms such as *wide*, *dimensions*, *miles*, *feet*, *magnitude*, and *girth*. Although children may be unfamiliar with some of these words, they still can appreciate the story. The

book also provides an opportunity for children to begin to construct meanings for these words.

Suggestions for discussion prompts and questions

We recommend that the teacher read this book in its entirety to the class before beginning a discussion. Then, using specific examples from the book, invite children to share ideas for something that is bigger than a cow, for instance. After collecting a few ideas, ask students to place the new objects in order of size. As they order the objects, ask students to explain how and why they chose the various placements. This discussion can lead to ideas of direct comparison, such as "A cow is taller than a pig," and indirect comparison, such as "An elephant is bigger than a cow because a cow could fit in the classroom but an elephant could not." For further information on direct and indirect comparisons in measurement, see Van de Walle (2001).

Another line of discussion can emanate from the relative nature of size. For example, say to the students, "The book started by saying that a pig is big, but we know that it is smaller than a cow. How can a pig be both big and small?" Moving in another direction, ask the class to write a new book starting with "What's small?" and continuing with smaller and smaller objects.

Activities that could be incorporated in this discussion include telling children to place a set of objects, such as a variety of balls or a collection of household objects, in order of size; and asking children to draw members of their family, including pets, from shortest to tallest.

Neil's Numberless World

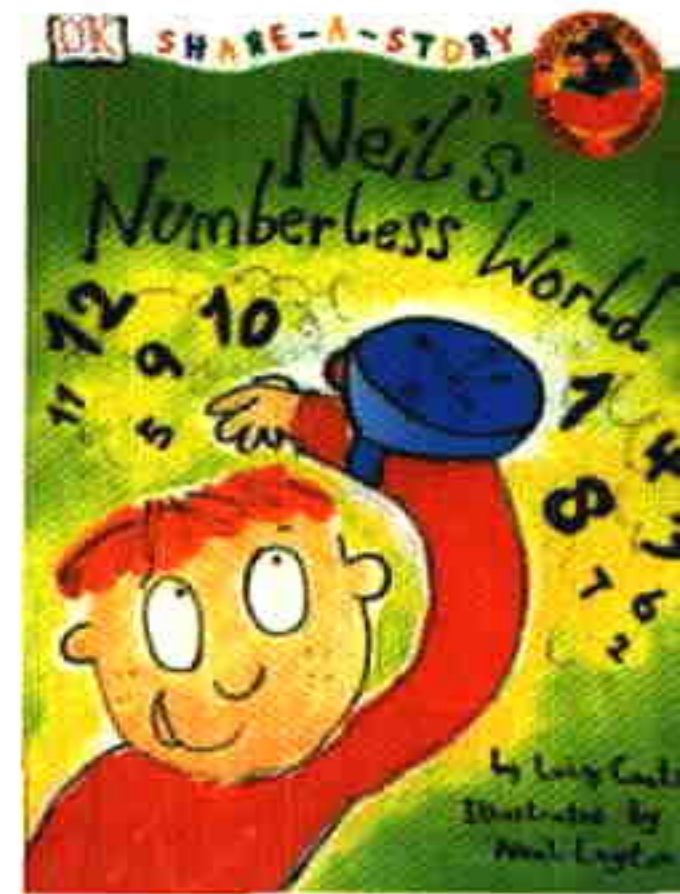
Summary

Neil's Numberless World (Coats 2000) tells an engaging story about Neil, who goes through a day without numbers. Numbers make Neil frustrated, and Neil wishes they would go away. Neil receives an early birthday present. Inside the package are a card and a watch. The card reads, "To Neil, If it's numbers that you fear, why not make them disappear?" Magically, the watch makes numbers disappear from Neil's world. Now, Neil struggles to live without numbers. Just in time for Neil's fifth birthday party, he figures out which button on his watch will make numbers return, and he realizes that he wants numbers to come back.

The book reveals everyday objects and activities in which numbers are used, including games, cooking, street addresses, money, sports, clothing sizes, calendars, and time. The inside covers of the book include some additional instructional ideas for parents and teachers. We recommend this book for first through third grades.

Standards addressed and review of the book

This book addresses ideas from the Number and Operations Standard by representing uses of number in a meaningful context. Children see numbers as identifiers, as in addresses; in counting, as in the number of eggs served for breakfast; in representing measures, as in cooking and time; and in indicating value, as in prices. The need for numbers is evident through the challenges that Neil faces in his world without numbers. In reading this book with children, we found that the story evokes a genuine concern for Neil in his numberless world. The story helps children to gain an appreciation for numerals as identifiers and numbers as quantifiers.



From *Neil's Numberless World*, by Lucy Coats, illus. by Neal Layton. Published by Dorling Kindersley Publishing, 2000. All rights reserved.

Suggestions for discussion prompts and questions

We recommend that the teacher read the first few pages of the book until Neil's numbers disappear.

At this point, ask students what might happen to Neil during his day without numbers. Other questions also could be asked, such as "Where do you see numbers in your life? How do you use numbers?" After collecting ideas, continue reading the story. After finishing the story, begin a discussion to generate more examples of how numbers are used and generalize ideas for what role numbers serve. These ideas could include counting objects, such as students in the class; identifying things or locations, such as phone numbers, license plates, and locker numbers; and measuring things, such as temperature.

Inchworm and a Half

Summary

The author of *Inchworm and a Half* (Pinczes 2001) tells the story of an inchworm attempting to measure the vegetables in a garden. Whimsical illustrations and rhyme pull young readers into this story. When the inchworm encounters a cucumber that is between one and two inches long, this creates a dilemma for the worm, who can measure only in inches. Then a half-inchworm arrives. After the inchworm presents the problem to the half-inchworm, Pinczes writes:

The little worm grinned.
"I'm a fraction, that length
should be easy for me." He
said sounding wise, "At just
half your size, I'm a one-
half-inch fraction, you see."

As the two worms move along, they notice that for every loop, or step, that the inchworm makes, the shorter worm makes two. The story continues with a one-third inchworm and a one-fourth inchworm joining the group in measuring vegetables. We recommend this book for students in third through fifth grades.

Standards addressed and review of the book

This story incorporates concepts from the Number and Operations, Measurement, and Problem Solving Standards. Fractions, part of the Number and Operations Standard, are a major theme of the book. The benchmark fractions of one-half, one-third, and one-fourth are discussed as parts

of wholes and in equivalent forms; for example, two loops from the half-inchworm cover the same distance as one loop from the inchworm. Additionally, the story illustrates the idea that we can name fractions infinitely smaller. Although this book helps to develop deeper meaning for fractions, we do not recommend it as a first introduction to fractions. Some foundation needs to be in place before students can comprehend the discussion of fractions.

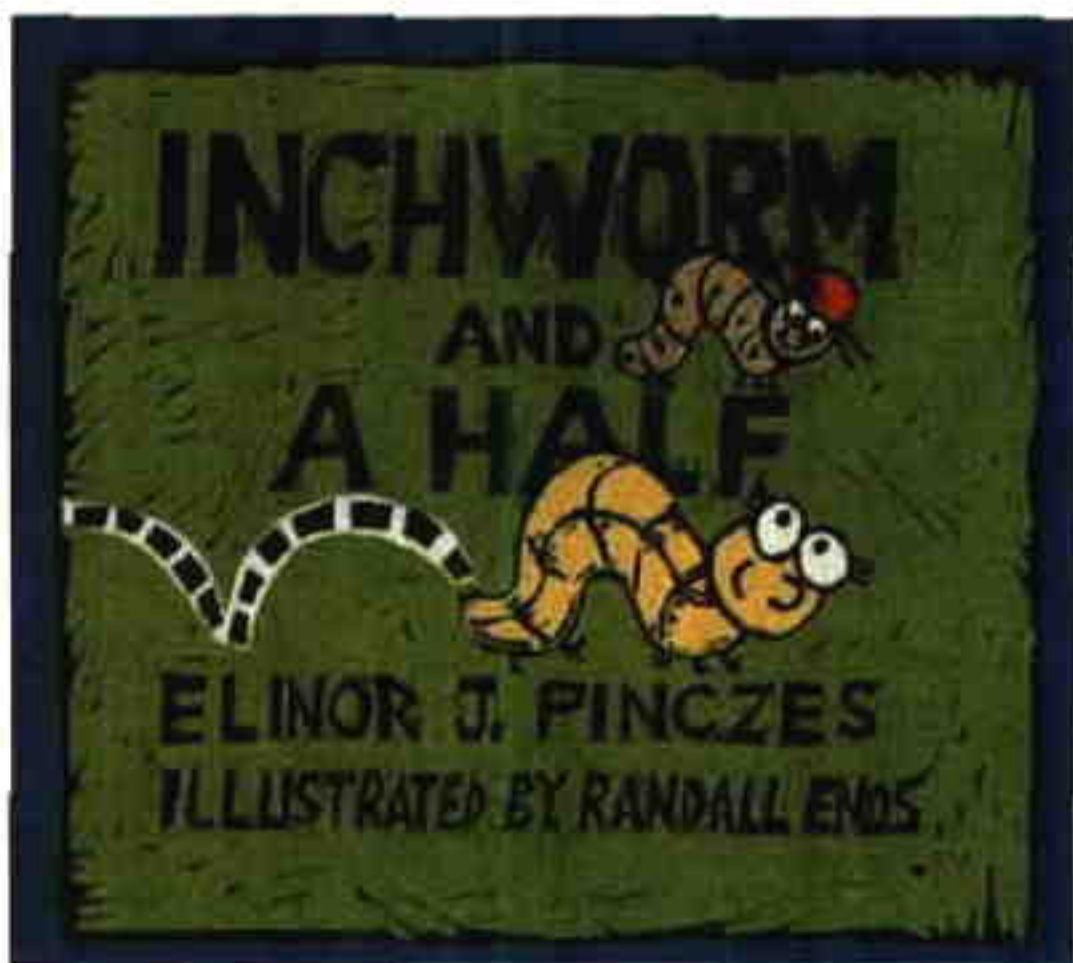
For development of measurement concepts, this book provides a wonderful transition from using non-standard units (worms) to standard units (inches). (For further discussion on using non-standard units in developing measurement concepts, see Van de Walle [2001].) Additionally, problem solving is subtly addressed in that the worms are in a problematic situation and they have to develop a plan to resolve it.

Suggestions for discussion prompts and questions

After reading the first few pages of the book, stop at the point where the inchworm encounters a dilemma in measuring the cucumber, and ask the following questions: "What is the problem that the inchworm faces? If you could talk to the inchworm, what would you suggest that he do?" Students might suggest calling the cucumber a little more than one inch or a little less than two inches, cutting the worm in half, and so on.

Next, before reading the above quotation from the half-inchworm, ask students, "How many loops does the half-inchworm make

for every loop that the inchworm makes?" Students can then be asked to draw and explain their ideas for the class. This question can be repeated for the other worms to show the pattern for unit fractions; for example, for a one-third worm, three loops cover the same distance as a whole inchworm. After finishing the book, ask the students to suggest other worms that could join the group, and discuss their size relative to the other worms. Adding other worms might generate a discussion about the pattern for the value of unit fractions; that is, as the denominator increases, the value of the fraction decreases.



From *Inchworm and a Half*, by Elinor J. Pinczes, illus. by Randall Enos. Published by Houghton Mifflin, 2001. All rights reserved.

An activity to complement this discussion is to have the students measure with pre-cut paper worms. First, ask the students to name the various worms, based on the inchworm, and then have the students measure objects around the room, deciding when each of the worms is needed.

One Riddle, One Answer

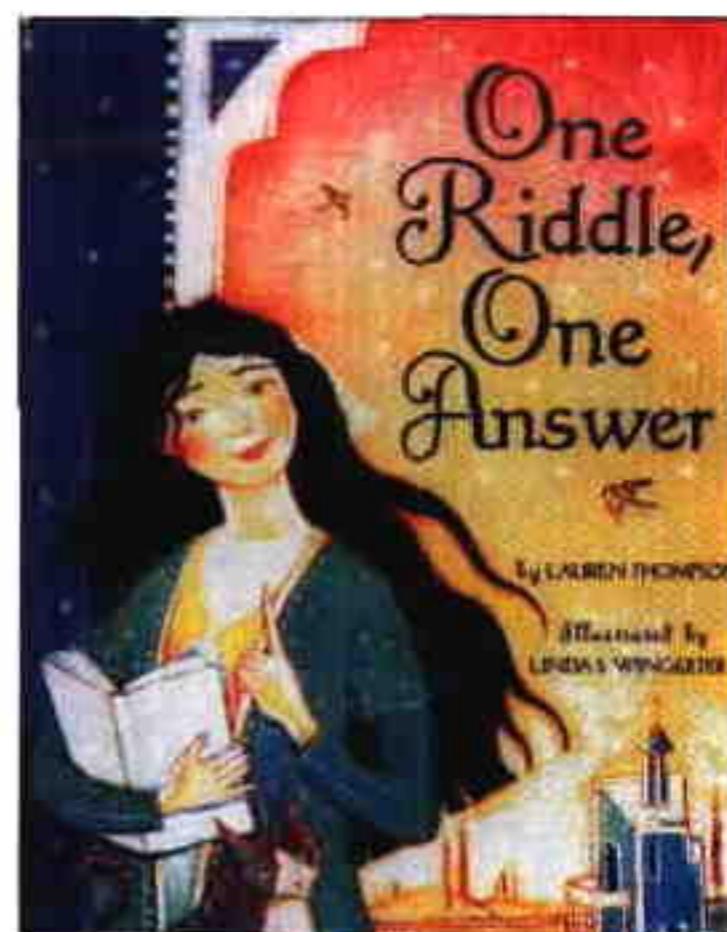
Summary

One Riddle, One Answer (Thompson 2001) is a beautifully illustrated story about a Persian princess, Aziza, who has a passion for numbers. When it is time for Aziza to marry, she poses a riddle for her suitors to solve. The riddle is: "Placed above, it makes greater things small. Placed beside, it makes small things greater. In matters that count, it always comes first; where others increase, it keeps all things the same. What is it?"

The story depicts various suitors' conjectures and reasoning as they attempt to solve Aziza's riddle. Each of the failed suitors addresses one aspect of the riddle but does not attend to the other parts. For example, the first suitor, an astronomer, proposes the sun as an answer. He states that when the sun is overhead, it makes greater things small in the shadows that are cast. Finally, the winning suitor discovers that Aziza's riddle is about number properties for the number one. Specifically, the suitor explains how one placed above a number, as a numerator in a fraction, makes the number small; one placed beside a number makes it greater (place-value notions); one is the first number in counting; and one multiplied by any number does not change its value (the identity property for multiplication). At the end of the book, Thompson discusses these number properties, the suitors' reasoning, and the Arabic number system. We recommend this book for upper elementary students.

Standards addressed and review of the book

The book weaves together elements from the Communication Standard, the Reasoning Standard, and the Number and Operations Standard. We selected this book as an example of an opportunity to foster mathematical discourse because it not only provides a platform for discussion but it also is built around a mathematical conversation. Reasoning is embedded in the story in the manner in which each suitor makes a conjecture for a solution to the riddle and then justifies the conjecture. The reader is invited to critique these conjectures as the story unfolds.



From *One Riddle, One Answer*, by Lauren Thompson, illus. by Linda S. Wingerter. Published by Scholastic Press, 2001. All rights reserved.

Finally, number properties for one provide the content on which the communication and reasoning are based.

This mathematically rich story is set in an engaging context that includes attention to diversity issues. It conveys the

idea that numbers are things to be investigated and can be objects of play. Additionally, the story subtly teaches the reader about aspects of ancient Persian culture and Arab influences on the development of our number system. At the same time, it portrays a young woman as someone who enjoys and is confident about her mathematical knowledge. One note of caution is that the book presents the riddle as having only one correct answer. In using this book in class, emphasize that many problems do not have only one answer; however, in the story, Aziza hopes a suitor will present a specific solution to her.

Suggestions for discussion prompts and questions

We suggest that you ask the students to critique each suitor's conjecture as you read the story. These critiques may be in the form of determining which aspects of each response represent valid reasoning—to communicate the idea that good thinking can be embedded in answers that are not entirely correct—and what might be lacking in each response. A question such as "What was the suitor thinking about when he came up with his solution?" addresses these issues, and it also might lead to a discussion of how a person's perspective often influences how he or she thinks about things; for example, the astronomer thought the answer was the sun. Using the words *conjecture*, *valid*, and *reasoning* in this discussion will help the students give meaning to these terms in the natural context of the story.

Before reading the last suitor's response, ask students to develop their own solutions and collect ideas. As a class or in small groups, discuss aspects of these solutions that might represent valid reasoning and aspects that are not valid or

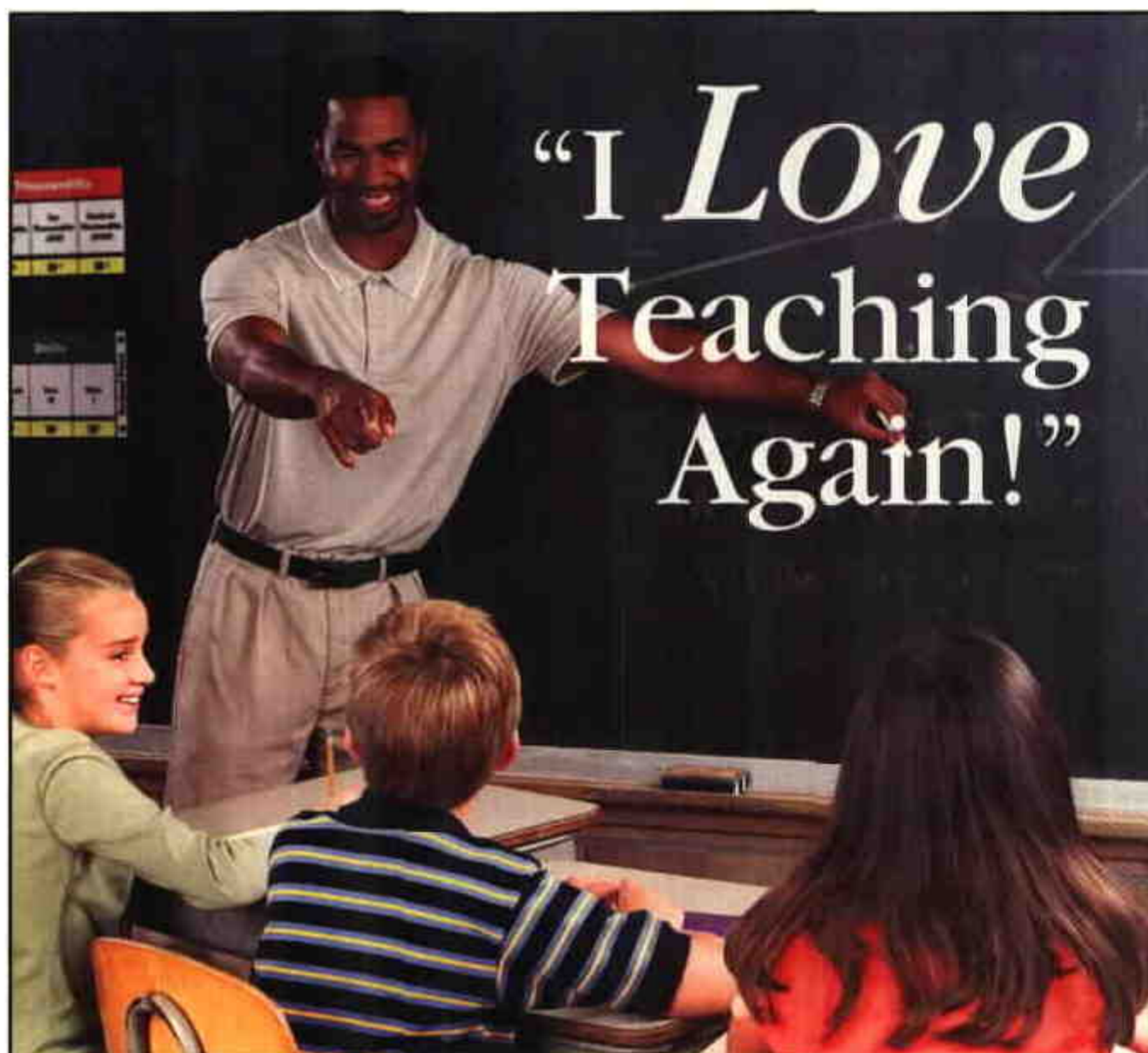
are incomplete. Then read the last suitor's response of "the number one." Before reading this suitor's justification, ask the class to think about and then share why they think the solution is or is not valid. After finishing the book, ask students to write their own number riddles, either individually or in pairs, and share these with the class.

Conclusion

Carefully selected literature holds the potential to illuminate children's understanding of and ideas about mathematics (Hepler and Van Deusen 1999). Moreover, such literature gives students a context in which to engage in mathematical discourse. Such experiences lead them to better understand mathematical processes and, at the same time, to find out how others apply mathematics to achieve their goals. Finally, as children encounter and discuss mathematics in literature, they often realize that it is "useful, interesting, accessible, and enjoyable" (Murphy 2000).

References

- Austin, Patricia. "Math Books as Literature: Which Ones Measure Up?" *The New Advocate* 11 (spring 1998): 119-33.
- Coats, Lucy. *Neil's Numberless World*. Illus. by Neal Layton. New York: Dorling Kindersley Publishing, 2000.
- Corwin, Rebecca. *Talking Mathematics: Supporting Children's Voices*. Portsmouth, N.H.: Heinemann, 1996.
- Florian, Douglas. *A Pig Is Big*. New York: Harper Collins, 2000.
- Hellwig, Stacey J., Eula Ewing Monroe, and James S. Jacobs. "Making Informed Choices: Selecting Children's Trade Books for Mathematics Instruction." *Teaching Children Mathematics* 7 (November 2000): 138-43.
- Hepler, Susan, and Ann Van Duesen. "Extenders: Ten Great Books about Mathematics." *The New Advocate* 12 (fall 1999): 376.
- Moyer, Patricia Seray. "A Remainder of One: Exploring Partitive Division." *Teaching Children Mathematics* 6 (April 2000a): 517-21.
- . "Communicating Mathematically: Children's Literature as a Natural Connection." *The Reading Teacher* 54 (November 2000b): 246-55.
- Murphy, Stuart. "Children's Books about Math: Trade Books That Teach." *The New Advocate* 13 (fall 2000): 365-74.
- National Council of Teachers of Mathematics (NCTM). *Curriculum and Evaluation Standards for School Mathematics*. Reston, Va.: NCTM, 1989.
- . *Principles and Standards for School Mathematics*. Reston, Va.: NCTM, 2000.
- . *Professional Standards for Teaching Mathematics*. Reston, Va.: NCTM, 1991.
- Pinczes, Elinor. *Inchworm and a Half*. Illus. by Randall Enos. Boston: Houghton Mifflin, 2001.
- Thompson, Lauren. *One Riddle, One Answer*. Illus. by Linda Wingerter. New York: Scholastic Press, 2001.
- Van de Walle, John. *Elementary and Middle School Mathematics: Teaching Developmentally*. New York: Longman, 2001. ▲



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