Using Literature to Teach Problem Solving and Other Important Concepts in Mathematics

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Abstract: *The authors share a snapshot of an interesting—and unexpected—exchange with a first-grader that yields insight regarding the use of literature to teach problem solving in mathematics. Additionally, the authors provide text sets for teaching students a variety of important mathematical concepts.*

Keywords: *Problem Solving, Literature, Conceptual Understanding*

1 Introduction

"*I am really starting to feel like I can be super-smart in math.*"—1st Grade Student

Recently, I (Bintz) provided a professional development workshop for elementary teachers (K-5) focusing on the development and implementation of interdisciplinary curriculum. Throughout the workshop, I shared high-quality picture books and classroom-based instructional strategies to integrate literacy and mathematics. One of the more popular picture books was *12 Ways to Get to 11* (Merriam, 1993).

At the beginning of the book, the author poses a problem: *Where is* 11? Each two-page spread invites students to use text and illustrations to find 11. For example, in one spread a little girl "picks up nine pinecones from the forest floor and two acorns." She finds 11 by adding $9 + 2 = 11$. Another spread describes objects pulled from a magician's hat, "Four banners, five rabbits, a pitcher of water, and a bouquet of flowers." In this example, students find 11 by adding $4 + 5 + 1 + 1 = 11$. Another spread describes an apple, "Six bites, a core, a stem, and three apple seeds." In this case, students find 11 by adding $6 + 1 + 1 + 3 = 11$. In the end, the book provides 12 ways to find 11.

Teachers loved 12 *Ways to Get to* 11. They felt it was "engaging" and "rich with potential for teaching mathematics." After the workshop, one teacher invited me to visit her first grade classroom so I could observe her reading this book to her students. Coincidentally, she owned the book but had not read it with her students for some time—certainly not with first graders. I gladly accepted her invitation.

Originally, I planned to spend 30 minutes in the teacher's classroom, meeting her first graders and observing her teaching as she conducted a read-aloud. I ended up spending over an hour. Before leaving, a little boy reported that the book made him feel "super-smart in math."

Afterwards, we (Bintz and Moore) spent time reflecting on this comment. It was delightful to hear, especially because the teacher said that many of her students struggled with mathematics. The little boy was one of them. Our interactions with him and his engagement with the picture book inspired us to share his story with you.

We begin by describing the classroom experience and then share samples of mathematical thinking that resulted from it. We end with lessons learned from our experience and share text sets of other literature teachers can use to teach problem solving and other important concepts in the mathematics classroom.

2 Classroom Experience

The teacher introduced me (Bintz) and then invited everyone to sit in a half-circle on the "reading rug." She showed everyone the front cover of 12 *Ways to Get to* 11 and noted that she was going to read it aloud that morning. As she read out loud, she stopped after each page and invited students to find 11. They clearly enjoyed the story and were excited to complete the task. After reading, the teacher directed some students to their desks and others to stay on the reading rug to start on the next planned math activity.

I was still sitting on the reading rug when the little boy approached me and started the following conversation.

BOY I want to tell you something.

BINTZ Okay.

BOY I am really starting to feel like I can be super-smart in math.

BINTZ Why are you starting to feel super-smart?

BOY Because I can find 11 that's different from the book.

BINTZ Really?

BOY Yeah. $20 - 9$, that equals 11.

BINTZ You're right. You *did* find 11 in a different way.

BOY There's lots of ways to find 11. You want me to show you?

BINTZ Sure.

The little boy went to get a sheet of paper and a pencil and then came back and sat down next to me. He wrote $20 - 9 = 11$ *on the paper and then continued our conversation.*

BOY Now I'll show you how to find 11 (*writes* $11 - 0 = 11$, *then* $30 - 19 = 11$ *on the paper*).

BINTZ That's right. You found 11 in different ways. (*The little boy paused.*)

BOY I can also find 11 by adding (*writes* $9 + 2 = 11$; $7 + 4 = 11$; $3 + 8 = 11$; $8 + 3 = 11$; *and so forth* (see Sample 1).

BINTZ That's really good.

The little boy turned the page over and continued, writing $20 - 9 = 11$ *again. At this point I made a suggestion.*

BINTZ Up to now you have been using addition and subtraction to find 11. Can you use both at the same time?

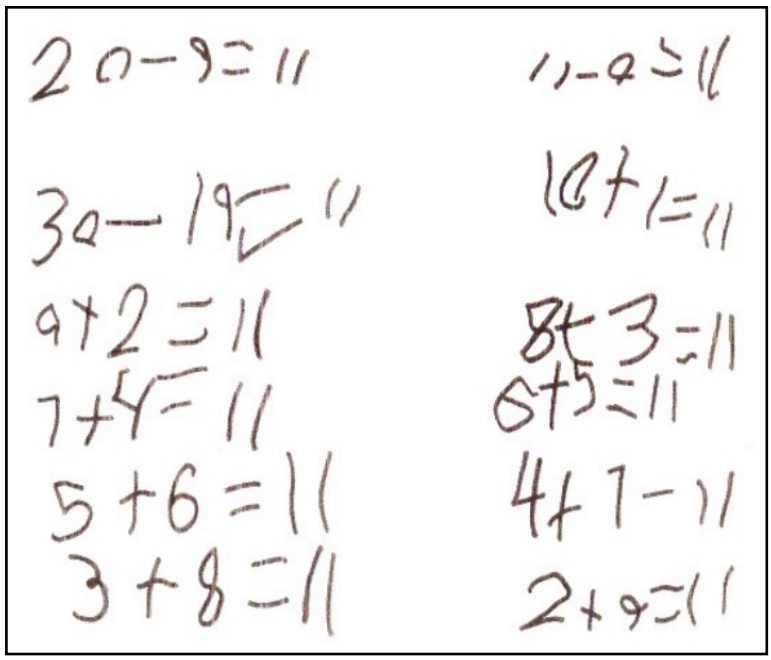

Fig. 1: *Examples of finding* 11 *with addition and subtraction.*

BOY You mean use addition and subtraction in the same word sentence?

BINTZ Yeah. Can you do that?

The boy paused and then went back to work. He wrote, $5+7-1=11$; $5+8-2=11$; $5+9-3=11$; $3+10-2=11$. *Suddenly, a girl sitting next to us saw what he was doing.*

GIRL Hey, why don't you also add multiplication?

BOY *The little boy paused and looked at me.* I dont know multiplication.

BINTZ What do you know about multiplication?

BOY *Pausing hesitantly.* I know $1 \times 1 = 1$.

BINTZ Okay. Can you use that in your number sentence?*The boy paused and then wrote* $10+1\times1=11$.

BINTZ Well done. Can you find other ways? *The boy paused and then wrote* $10-1\times1+2=11$; $10+2\times2-3=11$; $10+3\times3-8=11$. *(see Sample 2).*

TEACHER *From the other side of the room* Class, it's time to transition from math to reading.

BOY I could do more but I have to go now.

BINTZ Okay. Thanks for sharing your math work with me.

BOY You're welcome.

BINTZ I hope you liked the book and math sentences.

BOY I did. I am really starting to feel like I can be super-smart in math.

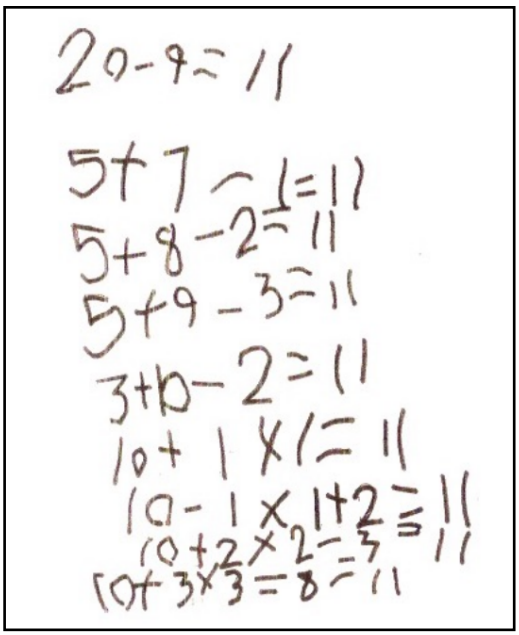

Fig. 2: *Examples of finding* 11 *with addition, subtraction, and multiplication.*

3 Lessons Learned

Although I (Bintz) am a reading educator, I have learned from this experience several important lessons about using literature to teach mathematics. One lesson is the important difference between solving problems and problem solving in mathematics. Typically, solving problems is a matter of students finding correct answers to single problems. For example, in many primary classrooms students are often provided a worksheet with many single addition (or subtraction, division, multiplication) problems to solve, e.g., $9 + 2 =?$, $12 + 6 =?$, and so forth. Problem solving is different. It posits that there are multiple possible solutions to a single problem. The distinction is important. Solving a problem asks, "How much is $9 + 2$?" Problem solving asks, "How many ways can you find 11?" The former asks for a single answer, the latter invites multiple answers. Stated differently, solving a problem requires students to find one number, the latter invites them to play with numbers. The former is students doing math, the latter is students thinking mathematically, and therefore, thinking like mathematicians.

Another lesson is that effective instruction operates on at least two levels. On one level instruction is designed to teach understanding of content. This lesson invited students to better understand addition, e.g., finding eleven. On another level instruction can promote positive dispositions. In mathematics, developing a positive disposition is essential. That is, mathematics instruction can help students enjoy mathematics and build their confidence and ability to play with numbers and think like mathematicians. This lesson helped the little boy in another way. It helped him build a positive disposition about mathematics thus his comment, "Now I am really starting to feel like I can be super-smart in math."

4 Moving Forward with More Literature

In addition to 12 *Ways to Get to* 11 (Merriam, 1993), there are many other picture books that can support student problem solving in mathematics. Some of our favorites are organized in the text set shown in Table 1.

Table 1: Text Set on Problem Solving.

- Gray, K., & Field, J. (2015). *How many legs?* London: Hodder Children's Books.
- Limentani, A. (2016). *How much does a ladybird weigh?* Great Britain: Boxer Books.
- Merriam, E. (1993). *12 ways to get to 11.* New York: Simon & Schuster.
- Sayre, A.P., & Sayre, J. (2006). *One is a snail, ten is a crab.* Candlewick Press. Somerville, MA.

Simply put, a text set is a collection of texts that are interrelated in some way, e.g. topic, theme, subject, genre, etc. (Short, Harste, with Burke, 1995), and include a range of books that reflect the needs of different students with different reading and mathematical abilities.

Text sets provide an effective way for teachers to use picture books with an entire classroom of students. A text set can include multiple picture books, all of which focus on a single theme. First, teachers read one of the picture books in the set aloud as an introduction to the mathematical theme. Then, teachers provide the whole class with a short description of each of the other books in the set, highlighting the uniqueness of each as well as connections between all books in the set. Next, teachers organize students in small groups and invite them to select one of the books to read and discuss. As a culminating event, the groups report out to the whole class what book they read and discussed and what mathematics they learned from the book.

There are also many picture books that teachers can use to teach other important math concepts, while developing positive dispositions about mathematics at the same time. We have identified several important math concepts and organized picture books in text sets by each concept (see Tables 2–11).

Table 2: Data and Probability Text Set.

- Einhorn, E. (2008). *A Very Improbable Story*. Watertown, MA: Charlesbridge.
- Herman, G. (2002). *Bad Luck Brad*. Minneapolis, MN: Kane.
- Leedy, L. (2007). *It's Probably Penny*. New York: Henry Holt.
- Murphy, S. (2001). *Probably Pistachio*. New York: HarperCollins.
- Van Allsburg, C. (1981). *Jumanji*. New York: HMH Books.

Table 3: Area & Perimeter Text Set.

- Burns, M. (2008). *Spaghetti and Meatballs for All!* New York: Scholastic.
- Murphy, S. (2002). *Racing Around.* New York: HarperCollins.
- Murphy, S. (2002). *Bigger, Better, Best!* New York: HarperCollins.
- Neuschwander, C. (2006). *Sir Cumference and the Isle of Immeter*. Watertown, MA: Charlesbridge.
- Pollack, P., & Belviso, M. (2002). *Chickens on the Move*. Minneapolis, Minnesota: Kane.

Table 4: Ratio & Proportion Text Set.

- Clement, R. (1994). *Counting on Frank*. New York: Gareth Stevens.
- McCullum, A. (2006). *Beanstalk: The Measure of a Giant*. Watertown, MA: Charlesbridge.
- Pilegard, V. (2003). *The Warlord's Puppeteers*. Gretna, Louisiana: Pelican.
- Schwartz, D. (1999). *If You Hoped Like a Frog*. New York: Scholastic.

Table 5: Multiplication Text Set.

- Birch, D. (1988). *The King's Chessboard*. New York: Puffin.
- Calvert, P. (2006). *Multiplying Menace: The Revenge of Rumpelstiltskin*. Watertown, MA: Charlesbridge.
- Demi. (1997). *One Grain of Rice*. New York: Scholastic.
- Leedy, L. (1995). 2×2 = *Boo!* New York: Holiday House.
- Losi, C. (1997). 512 *Ants on Sullivan Street*. New York: Cartwheel Books.
- Neuschwander, C. (1998). *Amanda Bean's Amazing Dream*. Watertown, MA: Charlesbridge.

Table 6: Number Sense & Place Value Text Set.

- Driscoll, L. (2003). *The Blast Off Kid*. Minneapolis, MN: Kane.
- Fisher, V. (2006). *How High Can a Dinosaur Count?* Decorah, IA: Dragonfly Books.
- Friedman, A. (1994). *The King's Commissioners*. Portsmouth, NH: Heinemann.
- LoPresti, A. (2003). *A Place for Zero*. Watertown, MA: Charlesbridge.
- Pilegard, V. (2001). *The Warlord's Beads*. Gretna, Louisiana: Pelican.
- Schmandt-Besserat, D. (1999). *The History of Counting*. New York: Collins.
- Thompson, L. (2001). *One Riddle, One Answer*. New York: Scholastic.
- Love, D. A. (2006). *Of Numbers and Stars*. New York: Holiday House.

Table 7: Division Text Set.

- Harris, T. (2008). *Splitting the Herd*. Minneapolis, MN: Millbrook.
- McEllicott, M. (2007). *Bean Thirteen*. New York: G.P. Putnams Books.
- Murphy, S. (1997). *Divide and Ride*. New York: HarperCollins.
- Pinczes, E.J. (1993). *One Hundred Hungry Ants*. HMH Books.
- Pinczes, E. J. (1995). *A Remainder of One*. New York: HMH Books.
- Turner, P. (1999). *Among the Odds & Evens*. New York: Scholastic.

Table 8: Graphing Text Set.

- Bader, D. (2003). *Graphs*. New York: Grosset and Dunlap. Dussling, J. (2003). *Fair is Fair*. New York: Fitzgerald Books.
- Glass, J. (1998). *The Fly on the Ceiling*. New York: Random House.
- Leedy, L. (2005). *The Great Graph Contest*. New York: Holiday House.
- Nagda, A.W., & Bickel, C. (2000). *Tiger Math: Learning to Graph from a Baby Tiger*. New York: Square Fish.
- Ochiltree, D. (1999). *Bart's Amazing Charts*. New York: Scholastic.
- Penner, L. R. (2002). *X Marks the Spot!* Minneapolis, Minnesota: Kane.

Table 9: Algebraic Thinking & Algebraic Readiness Text Set.

- Campbell, S. C. (2010). *Growing Patterns*. Honesdale, PA: Boyds Mills.
- Murphy, S. (2003). *Less Than Zero*. New York: HarperCollins.
- Murphy, S. (1997). *Elevator Magic*. New York: HarperCollins.
- Neuschwander, C. (2007). *Patterns in Peru*. Watertown, MA: Charlesbridge.

Table 10: Geometry Text Set.

- Adler, D. (1998). *Shape Up*. New York: Holiday House.
- Burns, M. (1994). *The Greedy Triangle*. New York: Scholastic.
- Ellis, J. (2004). *What's Your Angle, Pythagoras?* Watertown, MA: Charlesbridge.
- Friedman, A. (1994). *A Cloak for the Dreamer*. New York: Scholastic.
- Friedman, M., & Weiss, E. (2001). *Kitten Castle*. Minneapolis, Minnesota: Kane.
- Murphy, S. (2001). *Captain Invincible and the Space Shapes*. New York: HarperCollins.
- Neuschwander, C. (2001). *Sir Cumference and the Great Knight of Angleland*. Watertown, MA: Charlesbridge.
- — (1997). *Sir Cumference and the First Round Table*. Watertown, MA: Charlesbridge.
- — (1999). *Sir Cumference and the Dragon of Pi*. Watertown, MA: Charlesbridge.
- — (2005). *Mummy Math*. Watertown, MA: Charlesbridge.
- Pilegard, V. (2000). *The Warlord's Puzzle*. Gretna, Louisiana: Pelican.
- Rocklin, J. (2000). *The Incredibly Awesome Box*. New York: Cartwheel Books.
- Rocklin, J. (1998). *Not Enough Room*. New York: Cartwheel Books.

Table 11: Measurement Text Set.

- Adler, D. (2000). *How Tall, How Short, How Faraway*. New York: Holiday House.
- Herman, G. (2005). *Keep Your Distance*. Minneapolis, Minnesota: Kane.
- Kellogg, S. (2004). *The Mysterious Tadpole*. New York: Scholastic.
- Leedy, L. (2000). *Measuring Penny*. New York: Square Fish.
- McCallum, A. (2006). *Beanstalk: The Measure of a Giant*. Watertown, MA: Charlesbridge.
- Sweeney, J. (2002). *Me and the Measure of Things*. Norman, OK: Dragonfly Books.

Moreover, there is much professional literature that provides powerful rationales and practical instructional strategies for teachers to use text sets of literature to teach mathematics. In terms of rationales Carter (2009) describes how "reading picture books with mathematical themes is an excellent way to engage students with mathematical topics" (p. 606). Halpern and Halpern (2006) discuss how literature can function as a tool to integrate language arts, art, history, and science skills into the study of mathematics (p. 229). In terms of instructional strategies, Whitin and Whitin (2008) share many practical lessons that illustrate how reading, writing, and talking can help students solve rigorous problems in the mathematics classroom. Similarly, Whitin and Wilde (1995) present strategies and lessons that teachers can use with literature to not only help students solve math problems but also enrich and extend the mathematics curriculum.

Most importantly, this body of professional literature suggests that good things happen when teachers use literature, especially picture books, in the mathematics classroom. Picture books contain stories that can demonstrate "what it means to wonder mathematically" (Whitin & Wilde, 1995, p. 23). A picture book is literary tool for sparking interesting mathematical investigations (Whitin, 2008) and "often help children to pose problems and lead them to conducting interesting investigations" (Whitin & Wilde, 1995, p. 25). Perhaps most interesting, picture books can "enhance and further explain concepts and skills being studied in math textbooks" (Olness, 2007, p. 3). Ultimately, using literature in the mathematics classroom is a good idea because it provides a human perspective on mathematics. That is, it describes people putting mathematics to good use (Whitin & Wilde, 1995). The medium of story naturally carries the meaning of mathematical concepts and allows students to "let go of rules and algorithms that dont make sense to them, but they hold on to stories" (Whitin & Wilde, 1995, p. xi). So, let the reading and the math begin!

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