

# How many legs?

**Problem solving** in the early grades draws from children's fantasy and imagination informed by early adventures in reading and life (Paley 1986). The richness of their insights coupled with newly created structures for reasoning quantitatively create opportunities for teachers and children to communicate what they "see" in images often not considered as mathematical problems. Such is the case with the illustration from *Charlotte's Web* (White 1952, p. 21) that captures the chaos of Lurvy, a farm hand, trying to catch the lovable pig Wilbur after he escapes into the barnyard. Legs are everywhere and, as other animals look on, Wilbur continues to evade Lurvy. But how many legs are there?

Garth Williams's illustration depicting the scene shows one goose, one rooster, two sheep,

one horse, one dog, one pig—Wilbur—and one man—Lurvy. As in many of Williams's other illustrations in the novel, portions of the creatures are obscured. In this case, only some of the legs are visible. In particular, the only legs that are shown are Lurvy's, those of the bossy goose, three of the four legs of a dog, and two of Wilbur's legs.

## Solution strategies

The sense that children in the early primary grades make of the illustration relies on quantities they have structures for and can thus see or infer are present. The children are asked, "How many legs are in the barnyard?" Second graders' work samples show how children might reason. For some children, the only legs in the barnyard are those they can see and count. For these children the answer is nine, and they justify their answer by explaining that they thought ("I thart") (see fig. 1a) or counted ("I cant") (see fig. 1b).

Other children realize that legs are hidden—namely, two legs for Wilbur, one for the dog, two for the rooster, and four each for the sheep and horse. These children "see" some legs and infer that others belong to the creatures depicted in the illustration (see fig. 2).

Some children structure the situation using the illustration. They might show this by drawing arrows to, and writing down, the legs corresponding to each creature. Others cross out creatures as they record a number of legs, or write a number of legs on each creature in the illustration.

Still other children impose more structure on the situation. They "count the animals with four legs" and then the remaining birds and animals with two legs. These children classify the creatures as two-legged or four-legged before calculating the total number of legs (see fig. 3).

## Justifying reasoning

Children in early grades are often assumed to be too young to share their reasoning, but given the opportunity they begin to anticipate the

Building new ways of "seeing" and communicating about what they see gives children a chance to create structures in their mathematics. The May 2014 problem scenario, *How Many Legs?* presents an opportunity for students to learn to reason quantitatively, first as they relate to a photograph and then as they translate this visual information into number sentences. To access the full-size activity sheet, go to [www.nctm.org/tcm](http://www.nctm.org/tcm), Back Issues.

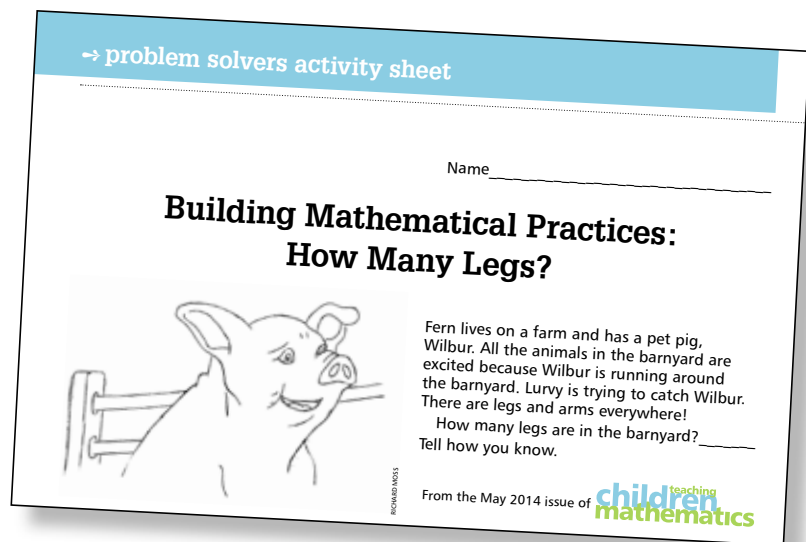


FIGURE 1

Some second graders justified their answer to the question, How do you know how many legs are in the barnyard?

(a) "Because I thought in my head." (b) "I count, and I use math to help me."

because I thought  
in my head

I can't  
And I  
Use math  
to help me.

FIGURE 2

Other children could imagine "hidden" legs in the barnyard, which they included in their count.

I counted  
the animals  
legs  
and I just counted  
the hidden legs and the  
un hidden legs.

expectations that they should communicate "what they see and think" and "how they know." Being asked what they see and think encourages children to communicate their ideas and may give rise to evidence of the ways that children structure what they see with the mathematics they know. For example, to solve this problem, some children make use of the number of legs each creature has, two or four, and then use these quantities to express the total number of legs as a number sentence. Other children illustrate partial sums, listing quantities of legs associated with particular creatures (see fig. 4).

Asking children if they can do the problem another way may reveal more approaches they believe are productive. For example, children who associate quantities with legs and find the sum may see arriving at the total as a process that involves their most powerful strategies. In figure 5, adding the number of legs yields twenty-six (see the numbers to the right of the vertical 1, 2, 3). The other methods depicted are to count, using the number sequence (labeled with a 4 to the left of the sequence of numerals)

FIGURE 3

Some children structured the situation by classifying the number of legs for different creatures:

"I can count the animals that have four legs first and count the animals that have two legs and add all of the legs together and that's how."

I can count the animals  
that have four legs  
first and count the animals  
that have two legs  
and add all of the legs  
together and that's it.

FIGURE 4

This child illustrated the partial sums of legs in the barnyard, listing each animal.

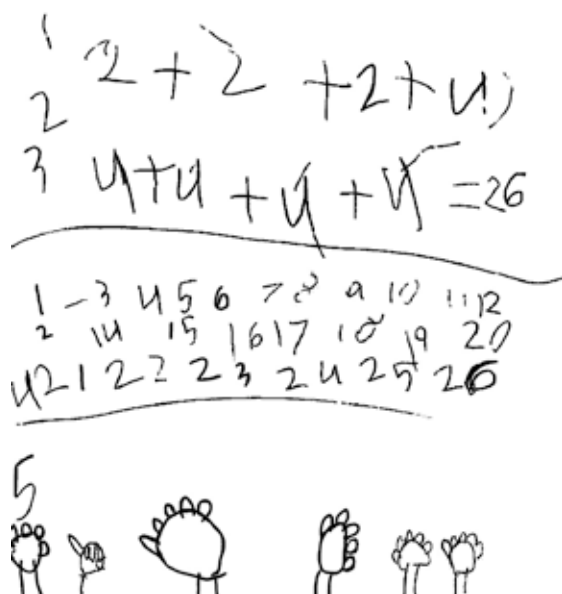
12 + 14 = 26

mon  
and  
dog  
and  
pig  
and  
duck  
and  
rooster

sheep  
and  
sheep  
and  
horse

FIGURE 5

In response to whether he could do the problem another way, this second grader added the number of legs, used the number sequence to count (labeled as "4"), and used fingers on hands (labeled as "5").



or using fingers (labeled with a 5 to the left of hands with fingers raised).

## Extensions

Illustrations in *Charlotte's Web* and other children's books create opportunities for children to reason about space or quantities. For example, capitalizing on this initial investigation, teachers may investigate illustrations that include Charlotte the spider. Illustrations of Charlotte yield a chance to structure quantities of legs including the number 8. As the children's ways of knowing develop, using the numbers 2, 4, and 8 in a single problem helps extend their use of counting sequences that support later multiplication. Stories about the experiences of Wilbur and Charlotte that include, for example, three humans provide opportunities for children to count in more sophisticated ways, such as 2, 4, 6, 10, 18. Children who approach an illustration or a problem situation in this way must know when to stop counting by 2s and how to shift to counting 4 and then 8. Other children still use recording strategies described before.

For children who need more challenge, use an extension drawn from the classic Legs in a Barnyard problem:

There are 20 legs on the farm.  
How many ducks and pigs are there?

This problem is particularly appropriate for children who classified legs in groups of two and four. They will be ready to use trial and error to find multiple solutions. Some children assume that there must be both ducks and pigs and so find two ducks and four pigs (among other answers). Other children admit the possibility that there could be just ducks—and find ten—or just pigs—and find five.

Children's ways of knowing and seeing illustrations can provide many opportunities to extend problem solving into the context of reading. Drawing from children's excitement about characters in books they read, teachers can create opportunities for children to communicate mathematical structures they are developing. Inviting children to justify their reasoning and share alternative ways to explore illustrations can reveal the multiplicity of ways that children know mathematics.

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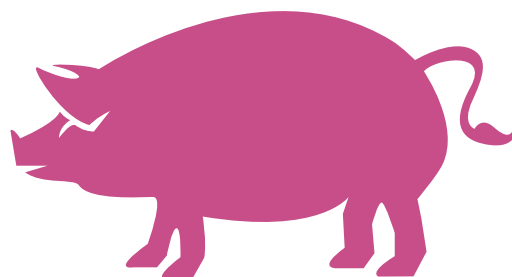
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#### REFERENCES

Paley, Vivian. 1986. “On Listening to What the Children Say.” *Harvard Educational Review* 56:122–31.

White, E. B. 1952. *Charlotte’s Web*. Illus. by Garth Williams. New York: HarperCollins Publishers.

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