**MP3, Grade 1**

**Task: Related Story Problems**

**Practice standard focus**: MP3. Mathematically proficient students at the elementary grades construct mathematical arguments—that is, explain the reasoning underlying a strategy, solution, or conjecture—using concrete referents such as objects, drawings, diagrams, and actions.

**Content standard focus**: 1.OA Understand and apply properties of operations.

**Introduction**

A major emphasis of the primary grades involves learning how to add and subtract using a variety of representations for the different kinds of contexts that are modeled by addition and subtraction. Another aspect of learning about addition and subtraction is to identify properties of the operations. Students need not learn the formal terms for these properties. Instead, students learn to identify and apply them using their own language to describe the relationships.

The challenge to identify and describe the properties of the operations is distinct from learning to calculate. In order for students to notice the relationships, it is often necessary to work with small numbers that students can easily compute. In this way, their reasoning is focused on the challenge at hand to consider the behavior of the operations rather than on computation that is at the edge of their ability.

In the example below, a first-grade teacher presents two related problems to the class. She believes that all of the students can easily solve the first problem, and most of the class can solve the second problem by using the answer to the first problem. She challenges her students to articulate and explore the generalization embedded in the two related problems.

**Classroom example**[1]:

The following is a real account from a classroom teacher.

Ms. Callendar presents the following problems to her class.

1. On Saturday, there were 5 girls and 5 boys in the pool. How many children

[1] Adapted and reprinted with permission from *Connecting Arithmetic to Algebra: Strategies for Building Algebraic Thinking in the Elementary Grades* by Susan Jo Russell, Deborah Schifter, and Virginia Bastable. Pp. 113-115. Copyright © 2011 by TERC. Published by Heinemann, Portsmouth, NH. Pseudonyms are used for teacher and students.

were in the pool?

2. On Sunday, there were 5 girls and 6 boys in the pool. Can you use the answer from the other story to help you figure out how many children were in the pool on Sunday?

She then poses questions designed to address whether the students can do more than use the result of the first problem to solve the second. Can they also talk about why it works?

Please draw a diagram that shows how knowing 5 + 5 = 10 helps you figure out 5 + 6. Why does it work?

Will it work with really big numbers, too?

The students work on the tasks and think hard about the questions. All produce correct answers to the word problems, and many explain in writing the rule they are using—expressing themselves as best they can with their first-grade knowledge of spelling.

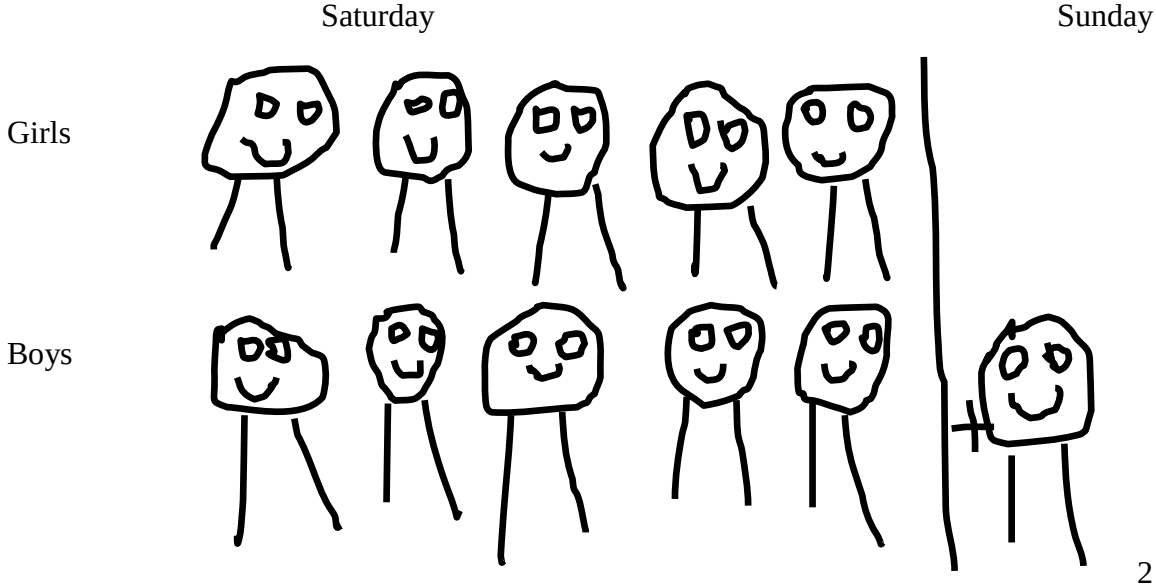
Marjorie: I no 5 + 5 = 10 and if you add one more it is six. And ten ples one is 11 so 5 + 6 = 11.

Melanie: I yousd a Helper 5 + 5 = 10 you just put 1 more on and it eqls 11.

Emma: 5 + 6 = 11 I now that 5 + 5 = 10 so the number after 10 is the anser.

These students realized that, since 5 + 5 = 10, and since 6 is 1 more than 5, then 5 + 6 must be 1 more than 10.

One child in the class, Antoine, produces a diagram demonstrating how the two story problems are related. He draws the children in the problems and, with help from Ms. Callendar, labels the different components.



The five girls and five boys to the left of the vertical line represent the first story problem, labeled "Saturday." To represent the second story problem, he incorporates the first representation, adding one boy to the right of the vertical line. In Antoine's picture, all children in the pool on Saturday come back on Sunday and one additional boy joins them. Adding one boy increases the total children by one.

In his diagram, Antoine has represented addition as the joining of sets. The conclusion—adding one boy increases the total number of children by 1—follows from the structure of his representation. That is, the diagram demonstrates *why it works* that adding 1 to an addend increases the sum by 1. In response to Ms. Callendar's final question, "Will it work with really big numbers, too?" Antoine wrote, "Yes."

**Commentary**

The task of noticing, describing, and explaining properties of the operations is distinct from learning computation. As early as first grade, students can begin to face the challenge of describing relationships they notice—for example, special cases of the properties—and explain why those relationships work. The relationship these first graders are working on is a special case of the associative property of addition: $5 + 6 = 5 + (5 + 1) = (5 + 5) + 1 = 10 + 1$. Adding 1 to an addend is equivalent to adding 1 to the sum.

In this example, Marjorie, Melanie, and Emma use familiar language to describe how they used their knowledge that $5 + 5 = 10$ to solve $5 + 6$. In his diagram, Antoine demonstrates *why* that relationship holds. He constructs an argument, using this diagram. At later grades, students can extend their understanding of this idea to articulate a conjecture about an infinite class of numbers, for example, all whole numbers. You can see the grade 2 example Related Problems:

- Part 1 http://vimeo.com/66204977
- Part 2 http://vimeo.com/66217143

and the grade 3 example Adding 1 to an Addend, Adding 1 to a Factor:

- Part 1 http://vimeo.com/66200697,
- Part 2 http://vimeo.com/66217440,
- Part 3 http://vimeo.com/66200698,
- Part 4 http://vimeo.com/66201471

for examples of older students working on the same idea.