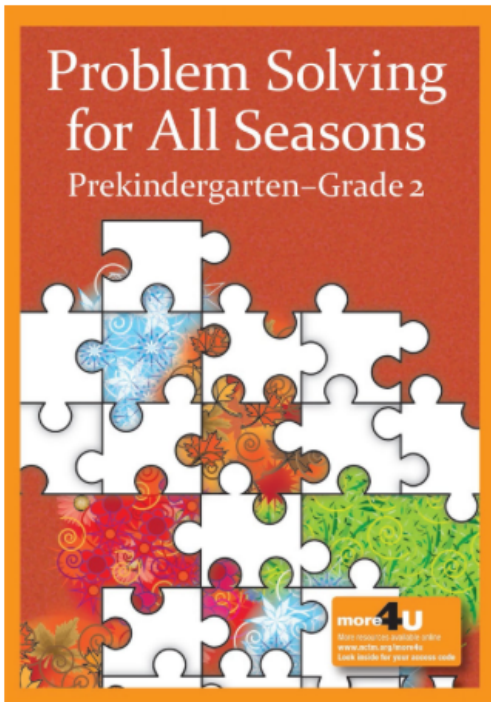


PK-2 Students as Problem Solvers

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Fold-and-Pass

Problem Solving is...



Problem Solving

- Problem solving in mathematics: “engaging in a task for which the solution method is not known in advance” (National Council of Teachers of Mathematics, 2000, p. 52).
- Hiebert (2003): Classrooms that promote students' understanding “allow mathematics to be problematic for students” (p. 54).

Problem Solving

- Failure
- Struggle
- Successes

Cognitive Demand

- Low: $2 + 1 + 3 =$
- High: On a sunny spring day, a student picked 6 flowers. The student needs your help deciding how to put the flowers into 3 vases. How many flowers could be in each vase?

Productive Struggle

- Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

Principles to Actions, 2014, p. 10

Recommendation #1

- Use tasks that promote reasoning and problem solving; explicitly encourage students to persevere; find ways to support students without removing all the challenges in a task.

Principles to Actions, 2014, p. 49

1st Grade

- This spring, 30 piglets were born on Kramer Farm. The farm needs to make pens for the 30 piglets. Each pen needs to hold the same number of piglets. Will you help the Kramer Farm find all of the ways they can pen the 30 piglets so there is the same number of piglets in each pen?



$$3 + 3 + 3 + 3 + 3 + 3 + 3 + 3 = 24$$



$$6 + 6 + 6 + 6 + 6 = 30$$



$$2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 = 20$$

$$10 + 10 + 10 = \boxed{30}$$

$$\begin{array}{ccccccc} & \circ & & \circ & & \circ & & \circ & & \circ \\ 3 & + & 3 & + & 3 & + & 3 & + & 3 \\ \circ & & \circ & & \circ & & \circ & & \circ \\ 3 & + & 3 & + & 3 & + & 3 & = \end{array}$$

$$| + | + |$$

$$\boxed{30}$$

$$\begin{array}{ccccccc} \circ & & \circ & & \circ & & \circ & & \circ \\ 5 & + & 5 & + & 5 & + & 5 & + & 5 \\ \circ & & \circ & & \circ & & \circ & & \circ \\ 5 & + & 5 & + & 5 & + & 5 & = & 30 \end{array}$$

$$= \boxed{30}$$

$$\begin{array}{ccccccc} \circ & & \circ & & \circ & & \circ & & \circ & & \circ & & \circ \\ 2 & + & 2 & + & 2 & + & 2 & + & 2 & + & 2 & + & 2 \\ \circ & & \circ & & \circ & & \circ & & \circ & & \circ & & \circ \\ + & 2 & + & 2 & + & 2 & + & 2 & + & 2 & + & 2 & + & 2 \\ \circ & & \circ & & \circ & & \circ & & \circ & & \circ & & \circ \\ 2 & + & 2 & + & 2 & + & 2 & + & 2 & + & 2 & = \end{array}$$

$$\begin{array}{c} \circ \circ \circ \circ \circ \\ \circ \circ \circ \circ \circ \\ 10 \end{array} + \begin{array}{c} \circ \circ \circ \circ \circ \\ \circ \circ \circ \circ \circ \\ 10 \end{array} + \begin{array}{c} \circ \circ \circ \circ \circ \\ \circ \circ \circ \circ \circ \\ 10 \end{array} = \boxed{30}$$

$$\begin{array}{ccccccc} \circ & & \circ & & \circ & & \circ & & \circ & & \circ \\ 6 & + & 6 & + & 6 & + & 6 & + & 6 & + & 6 \\ \circ & & \circ & & \circ & & \circ & & \circ & & \circ \\ 6 & + & 6 & + & 6 & + & 6 & = \end{array}$$
$$\boxed{30}$$

Recommendation #2 and #3

- Ask students to explain and justify how they solved a task. Value the quality of the explanation as much as the final solution.
- Give students the opportunity to discuss and determine the validity and appropriateness of strategies and solutions.

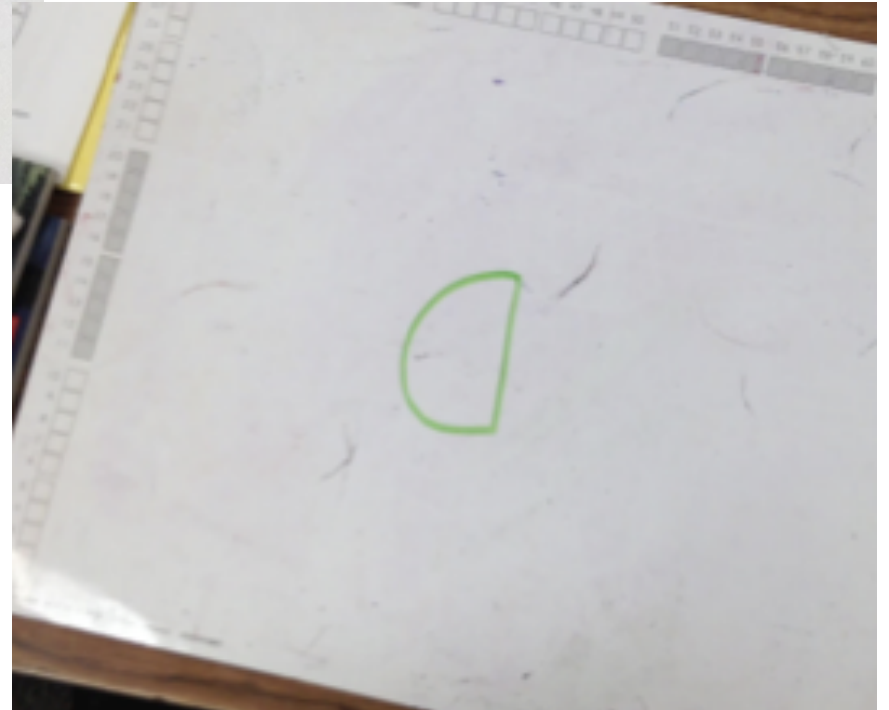
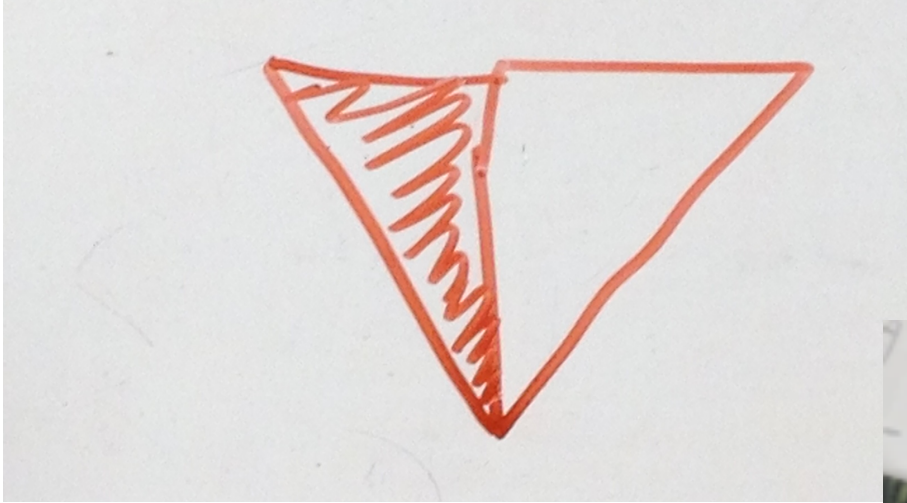
Principles to Actions, 2014, p. 49

2nd Grade Beach Towels

Getting Ready: Activate prior knowledge; be sure the problem is understood; and establish clear expectations.

- What are two representations of $\frac{1}{2}$?
- What are two representations for $\frac{1}{4}$?

1/2

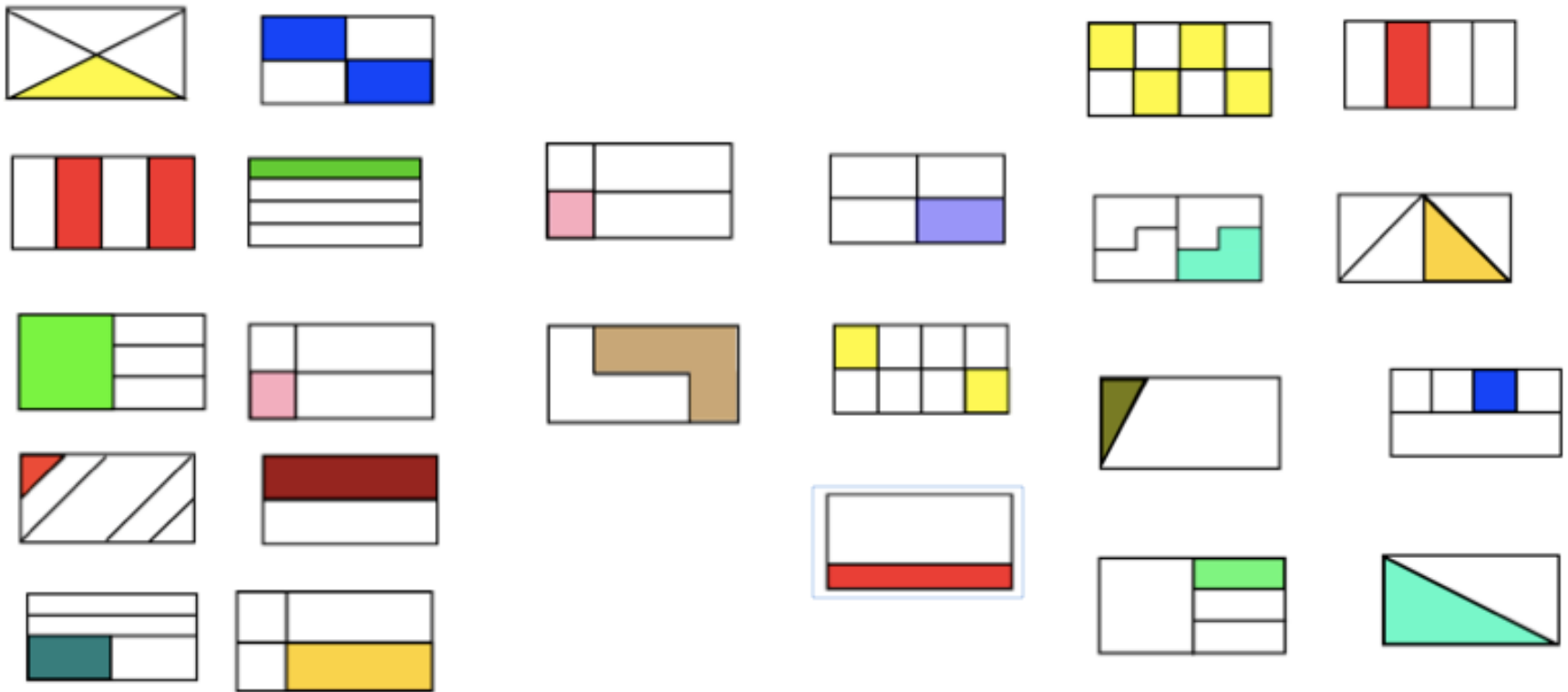


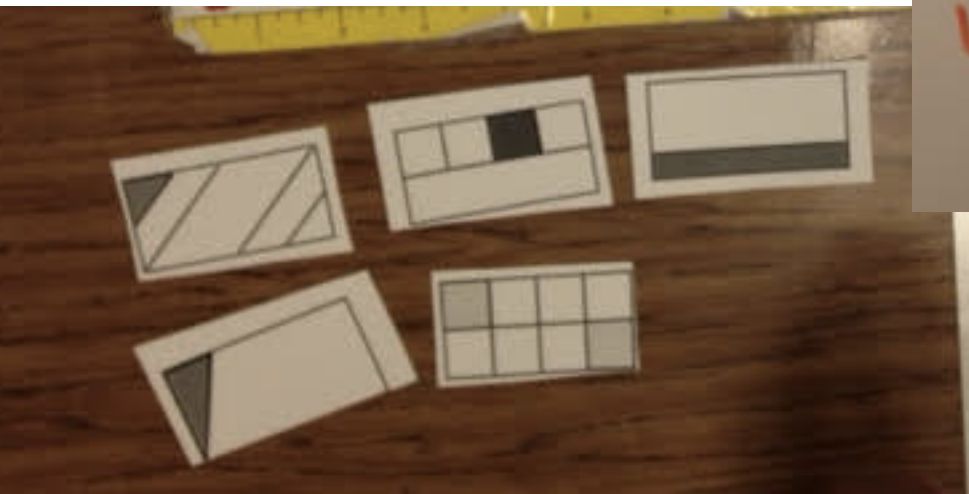
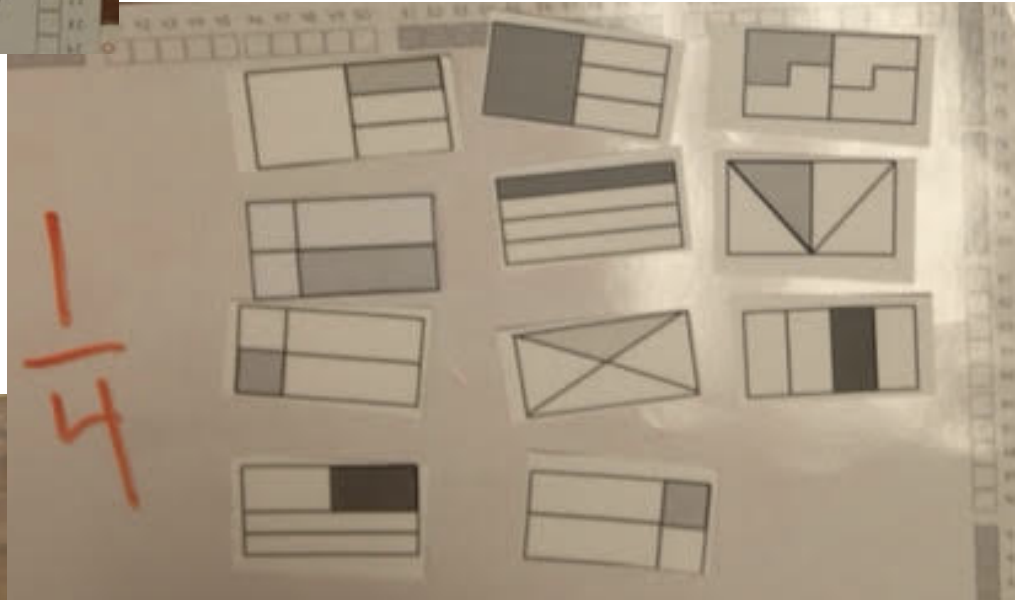
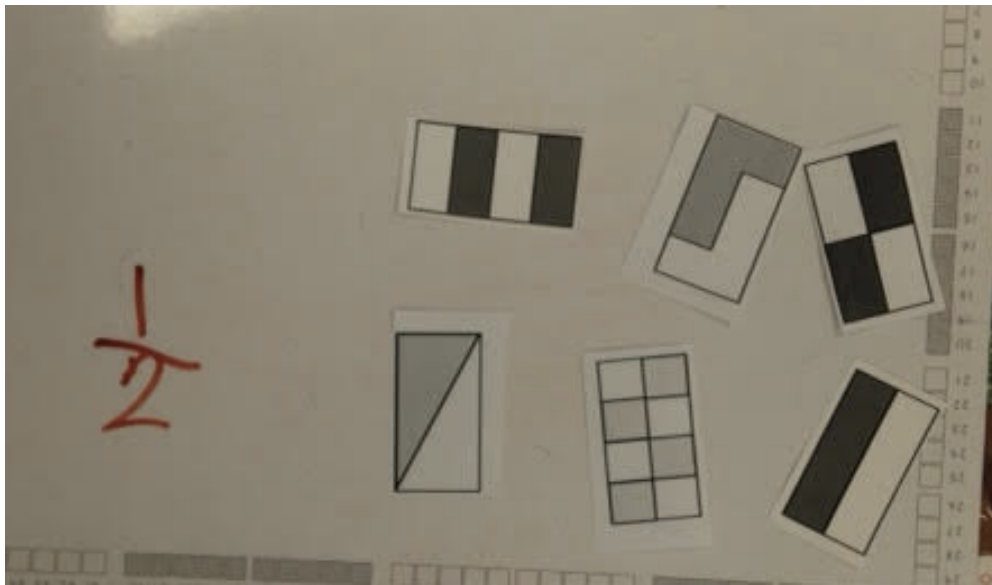
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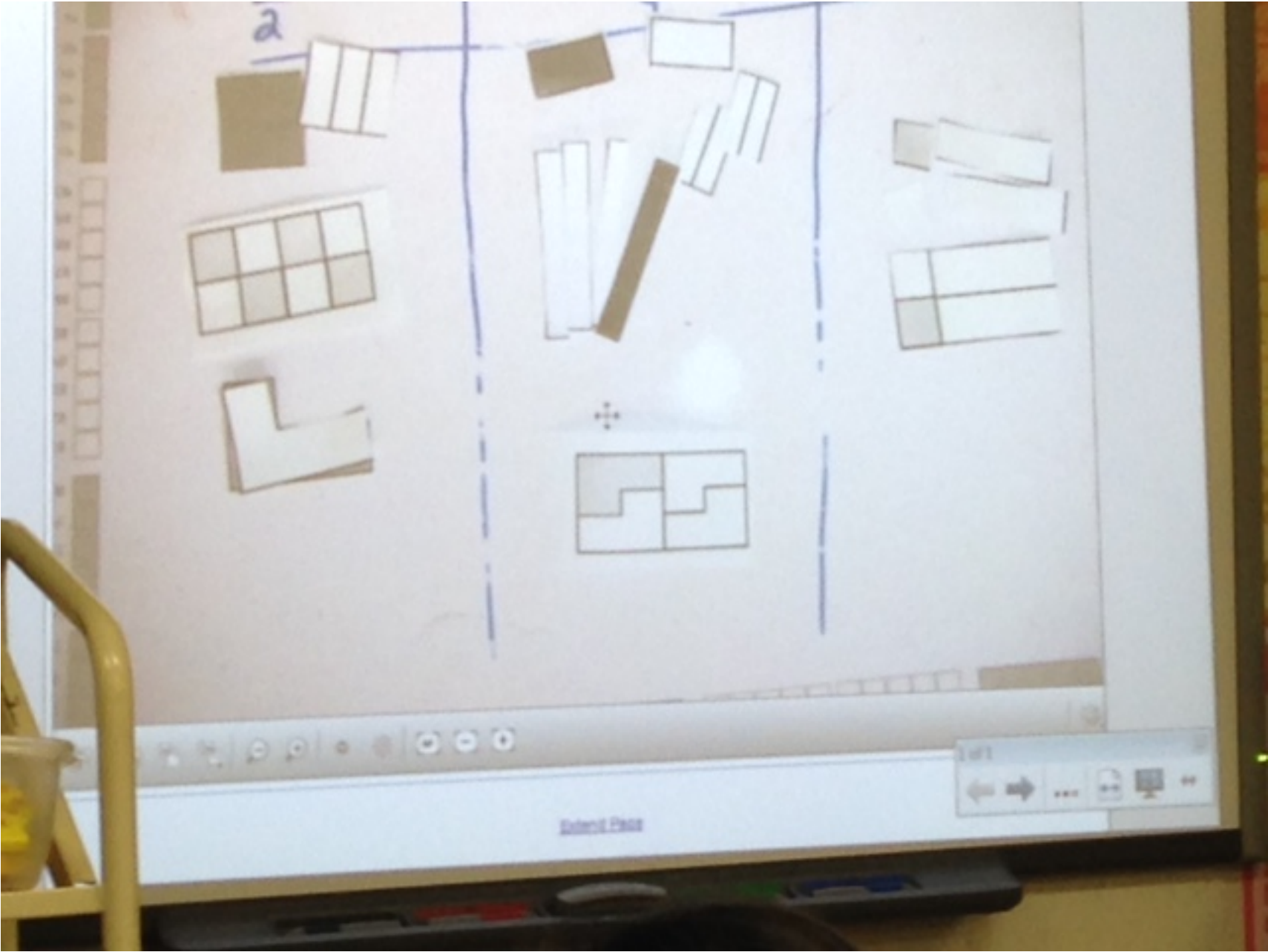


Campers at Swan Lake receive beach towels to use for their stay. In order for the Swan Lake staff to keep track of their beach towels, they have decided that campers who stay in Campsite A receive towels that have color on exactly half of the towel. Campers in Campsite B receive towels that have color on exactly one fourth of the towel. Campers in Campsite C receive towels that do not have color on half or a fourth of the towel. At the end of each day, Swan Lake staff members must sort the towels. Below are pictures of the towels. Can you help sort the towels?

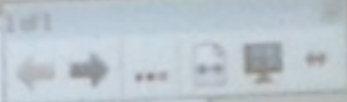
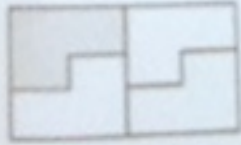
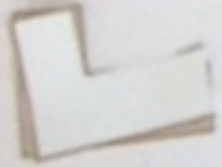
Students Work: Let go!; notice students' mathematical thinking; provide appropriate support; and provide worthwhile extensions.







a



External Device

Recommendations #4 and #5

- Give students **access to tools** that will support their thinking processes.
- Ask students to explain their thinking and **pose questions** that are based on students' reasoning, rather than on the way that the teacher is thinking about the task.

Principles to Actions, 2014, p. 49

K Camping Trip

Jose is going camping with a group of family friends. Twelve people will be on this camping trip. They will have the following tents with them:

6 two-person tents

4 three-person tents

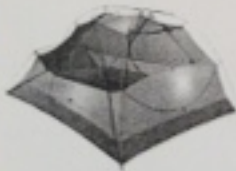
2 six-person tents

How could the twelve campers be arranged in the tents?

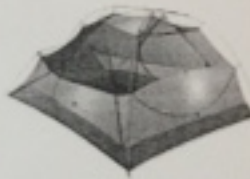
This tent holds 6 people.

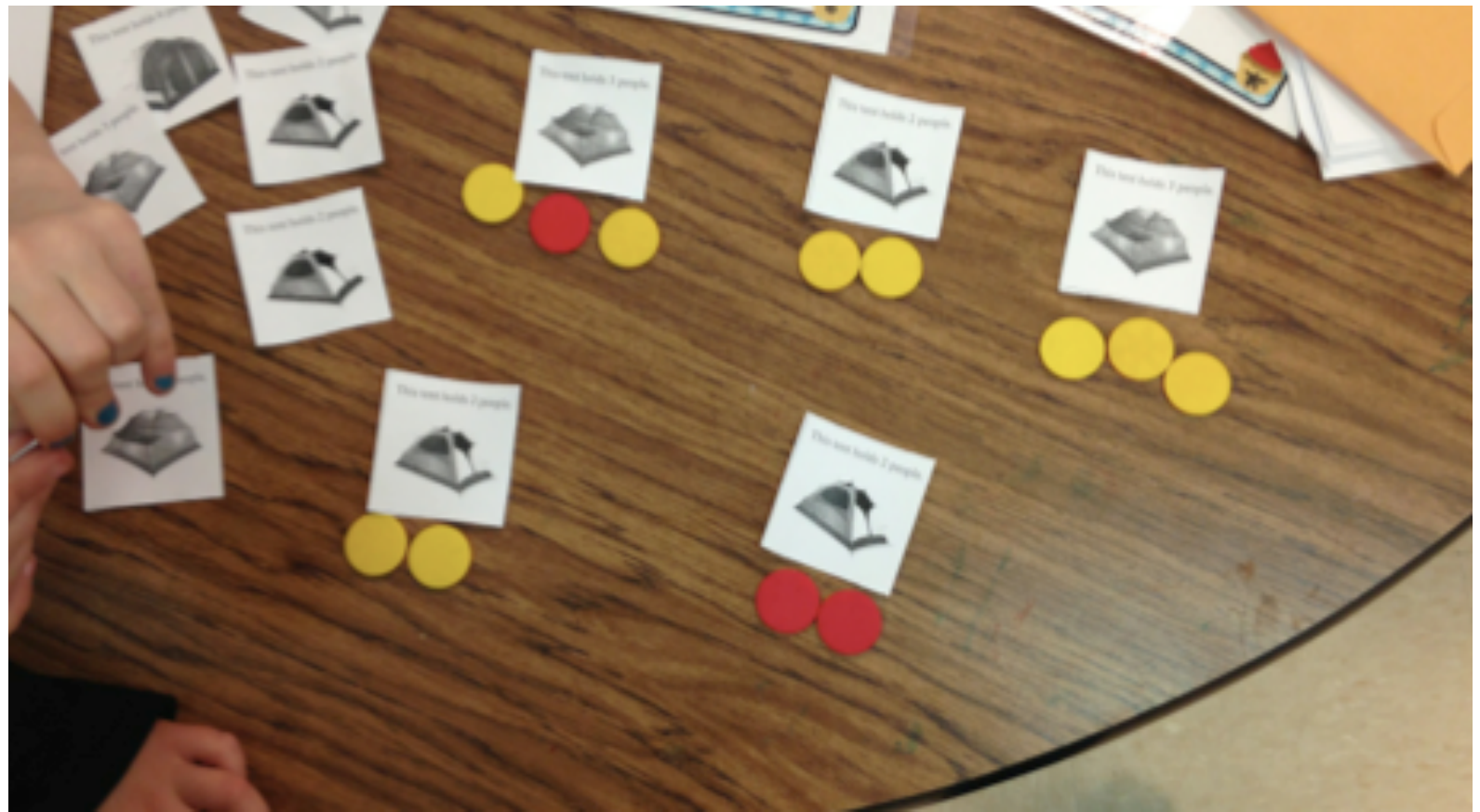


This tent holds 3 people.



This tent holds 3 people.





$$2 + 3 + 3 + 2 + 2 = 12$$

$$3 + 2 + 3 + 2 + 2 = 12$$

$$6 + 6 = 12$$

$$2 + 2 + 2 + 2 + 2 = 12$$

$$3 + 3 + 3 + 3 = 12$$

Step: Make a drawing or write an equation to represent your thinking.

$$2 + 2 + 2 + 2 + 2 + 2 = 12$$

$$3 + 3 + 3 + 3 = 12$$

$$6 + 6 = 12$$

$$6 + 3 + 3 = 12$$

$$3 + 3 + 2 + 2 + 2 = 12$$

Support productive struggle in learning mathematics

Teacher and student actions

What are *teachers* doing?

What are *students* doing?

Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusion and struggle.

Asking questions that are related to the sources of their struggles and will help them make progress in understanding and solving tasks.

Persevering in solving problems and realizing that is acceptable to say, "I don't know how to proceed here," but it is not acceptable to give up.

Helping one another without telling their classmates what the answer is or how to solve the problem.

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