WHY DO THEY DO THAT??

Using the Research to Improve Problem Solving

Sometimes student reasoning seems like this

Session Objectives

- Share some of the research on problem solving
- Reflect on our own practices in supporting students with problem solving (either as a teacher or as a coach)
- Inspire future conversations with teams regarding problem solving practices
- Introduce a new easy to implement strategy or provide support for your teams to include this strategy

Let's Explore

How do you approach this problem?

Jack climbed up the beanstalk at a uniform rate. At 2:00 p.m., he was one-sixth of the way up, and at 4:00 p.m. he was three-fourths of the way up. What time will he arrive at the top of the beanstalk?

What the BRAIN does:

Attention to mathematical phrasing

Creates Visual-Schematic Models

-"Schemata" – "problem types"
structures to organize the incoming information

Control systems that monitor for sense making

Two Kinds of Problem Solvers

Genuine Problem Solvers

- Attend to and use the situation to make sense of the math
- Use a variety of linguistic structures to organize information
- Create situational and mathematical models (either mental or visual)

Superficial Problem Solvers

- Ignore the realistic constraints of the situation
- Quickly pick out the numbers from the problem and perform an operation
- Are unable to explain the meaning of the numbers used or the answer.

(Rosales, et al, 2012; Depaepe, et al., 2010; Greer, 1997).

A closer look at Superficial Problem Solving…

Forces the numbers into some mathematical equation –either the most recently studied, something triggered by the key words – or just the easiest.

Finds the numbers

Listens for isolated key words or phrases

Little to no regard for sense making. Cannot explain what the numbers mean – "it's the answer"

Instructional Moves

MORE of This

- Emphasize situational understanding – what makes sense
- DRAW pictures and label the values as they relate to the context
- Have students TALK about their models and solutions in context
- START every lesson with context
- Explore a variety of PROBLEM TYPES
- Take time to discuss math specific phrasing
- An answer that means something and Makes SENSE!

LESS of That

- Circle the numbers underline the word that tells you what to do.
- Rushing to fit in more problems
- Limiting problem solving to the end of a unit or lesson
- Saving the problem solving until after students have mastered a particular process
- Jumping straight to a predetermined solution equation
- Accepting a number only as the solution

(Dixon, Nolan, Adams, Brooks, & Howse, 2016; Van de Walle, 2004; Greer, 1997; Jonassen, 2003; Boonen, et al. 2013; Fosnot & Dolk, 2001)

So what .....

How is this useful to me?

THE IMPORTANCE OF MODELS

What do you mean model?

Situational Models

- The use of spatial reasoning to organize the information presented in a problem.
- Representations of the problem as presented in the context
- Pictures vs. Visual-Schematics

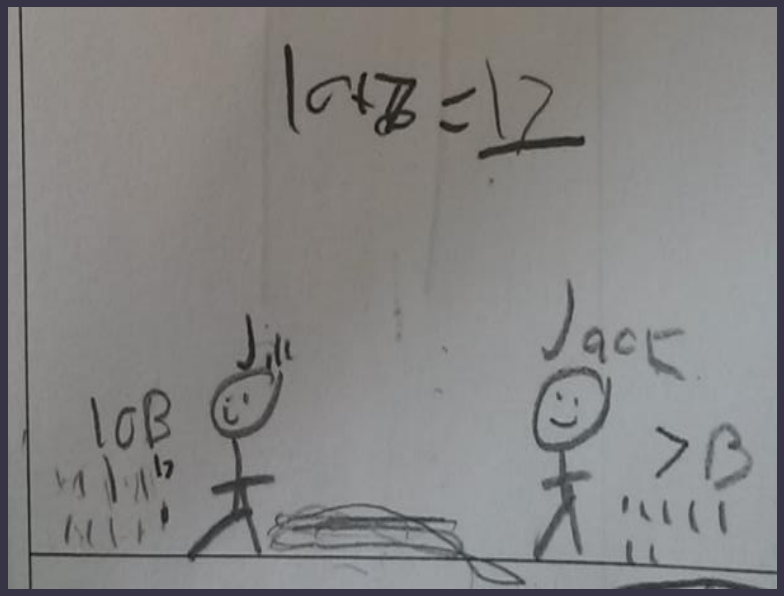
Mathematical Models

- Equations
- Algorithms
- Tables
- Patterns
- Graphs
- The process used to determine the answer

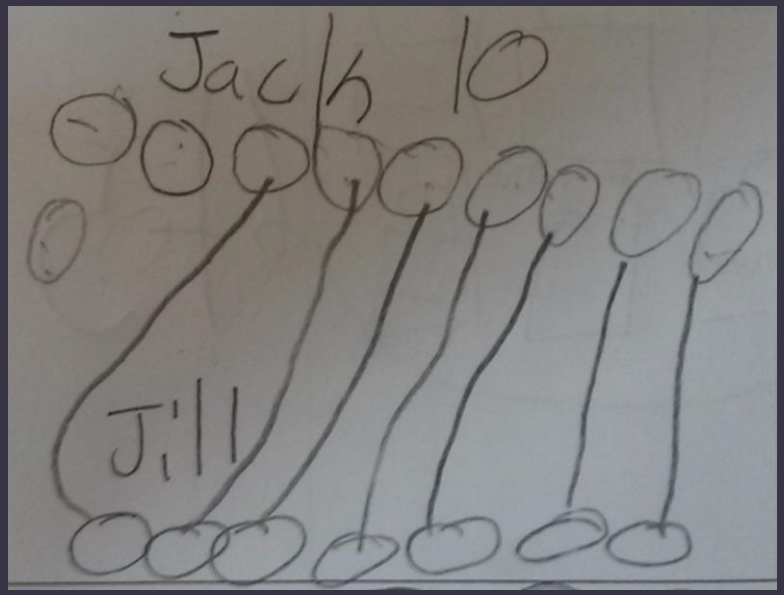
(Boonen, et al., 2013; Greer, 1997; Jonassen, 2003; Rosales, et al., 2012)

What's the difference?

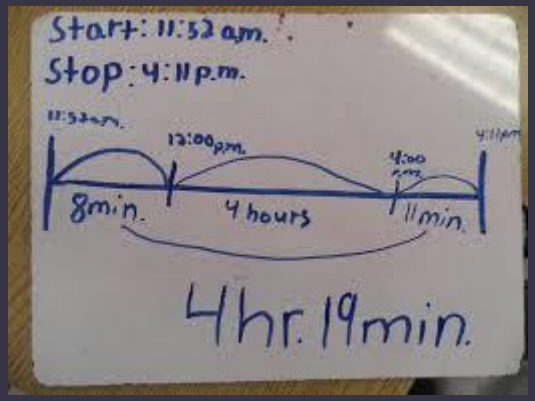
Picture

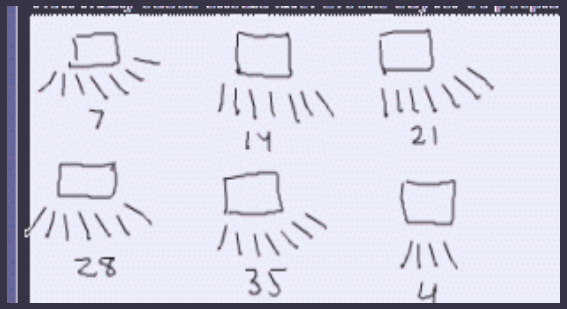


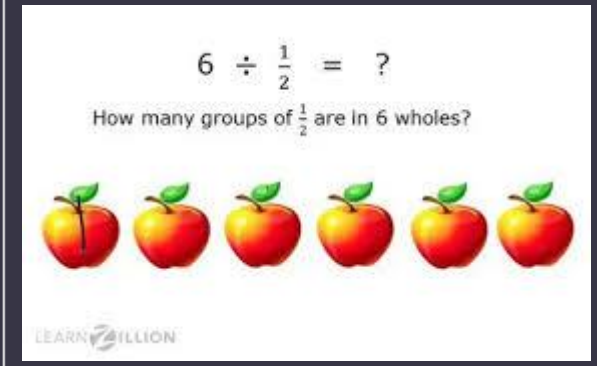
Visual –Schematic Representaion

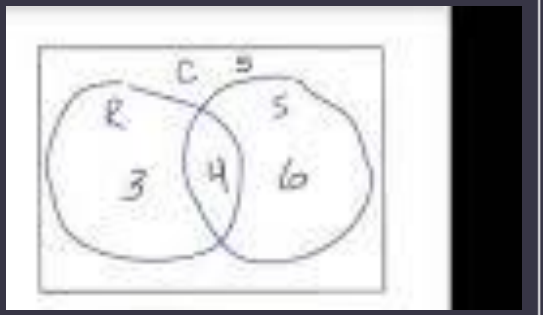


Many Models

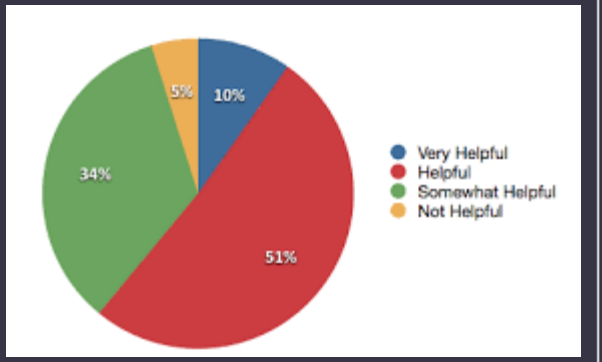

Start: 11:52 a.m.
Stop: 4:11 p.m.
8 min.
4 hours
11 min.
4hr. 19min.


7
14
21
28
35
4


6 ÷ 1/2 = ?
How many groups of 1/2 are in 6 wholes?


C
B
S
3
4
6


Part/Part Whole Problems
Part
Part
Whole
Comparison Problems
Difference
Equal Parts
One Part
Whole


10%
51%
34%
5%
Very Helpful
Helpful
Somewhat Helpful
Not Helpful

Instructional Suggestions for Improving Modeling

- Make it part of your instruction
  - Direct instruction
  - Planned for during problem solving discussion
  - Allow extra time
- Use think alouds - (what model did you visualize for this problem)
- Compare models among students
- Present a variety of models

NUMBERLESS WORD PROBLEMS

What did you say?

- Mathematical problems presented without quantities

Contexts can be presented with the numbers:

- covered
- changed into symbols like shapes
- mumbled (when presented orally)
- or rewritten to a vague quantity descriptor such as "some" "many" "a few"

The All City art competition had record enrollment this year. Many girls signed up. That is quite a few more than the boys who also signed up.

Focus

If we want students to pay more attention to the context of a problem. Let's help them do that.

The All City art competition had record enrollment this year. Many girls signed up. That is 87 more than the boys who also signed up.

Gradual Exposure

Gives you time to have a discussion of key vocabulary or phrases

The All City art competition had record enrollment this year. 345 girls signed up. That is 87 more than the boys who also signed up.

Strategic Discussion

Vocabulary

Estimation

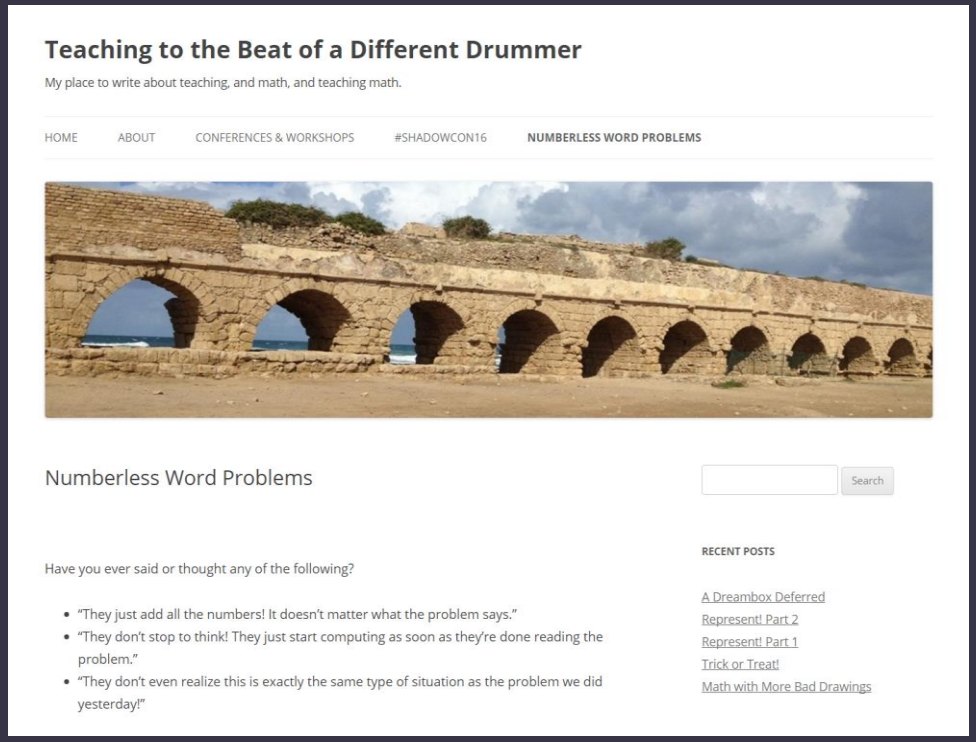
Variety of questions

The All City art competition had record enrollment this year. 345 girls signed up. That is 87 more than the boys who also signed up. How many students have enrolled in the competition?

Builds Confidence

- Scaffolded for success
- Plenty of opportunity to clarify misunderstandings

More Information



Teaching to the Beat of a Different Drummer

My place to write about teaching, and math, and teaching math.

HOME ABOUT CONFERENCES & WORKSHOPS #SHADOWCON16 **NUMBERLESS WORD PROBLEMS**

Numberless Word Problems

Search

Have you ever said or thought any of the following?

- "They just add all the numbers! It doesn't matter what the problem says."
- "They don't stop to think! They just start computing as soon as they're done reading the problem."
- "They don't even realize this is exactly the same type of situation as the problem we did yesterday!"

RECENT POSTS

A Dreambox Deferred
Represent! Part 2
Represent! Part 1
Trick or Treat!
Math with More Bad Drawings

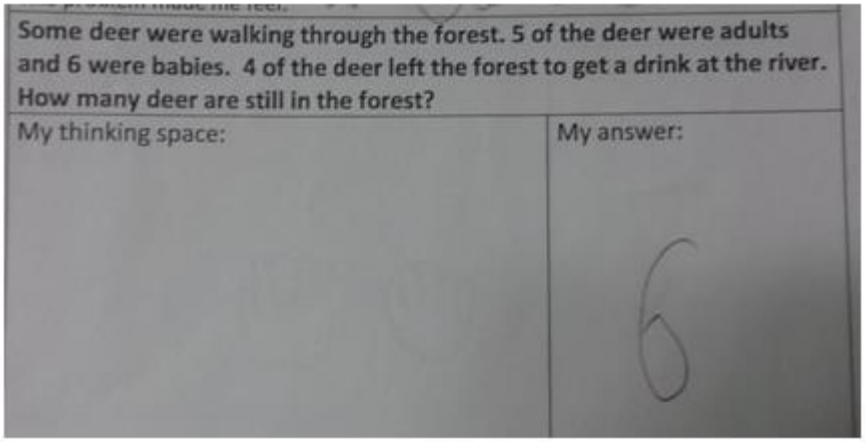
Details

- NOT EVERY WORD PROBLEM
  - Introduce a new concept or problem type
  - Practice modeling
  - Make the discussion around the problem richer
  - Once or twice a week
- 10 – 20 minutes (maybe faster – just don't rush)
  - First few times may take a little longer
- Doesn't have to match current content
- Start with more familiar problem types. Then work up to the more complicated ones.

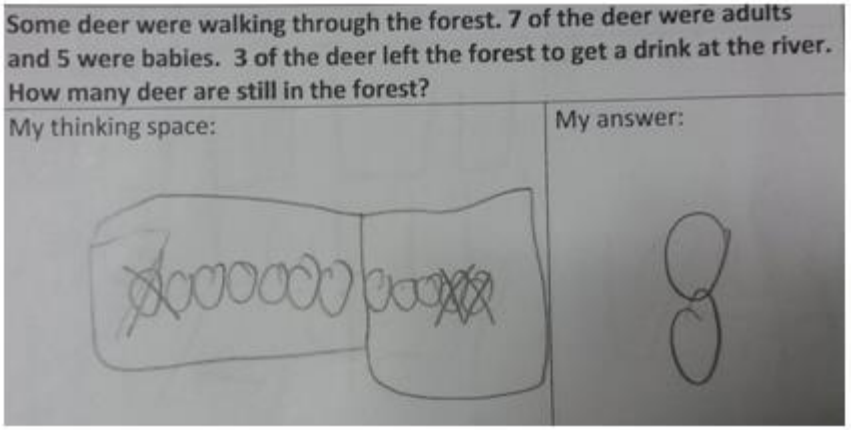
YOUR RESULTS COULD LOOK LIKE THESE

First grader: Jennifer

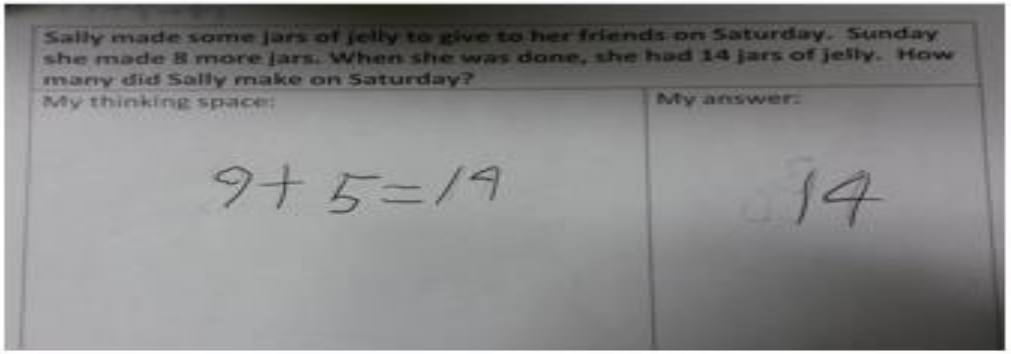
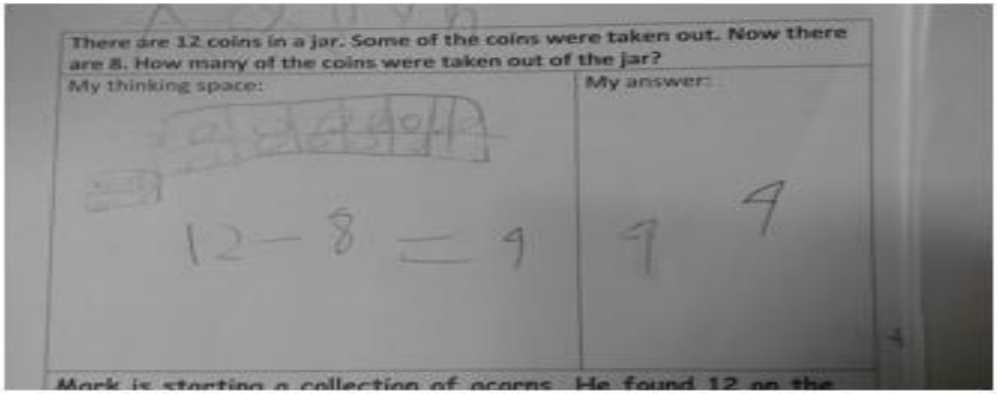
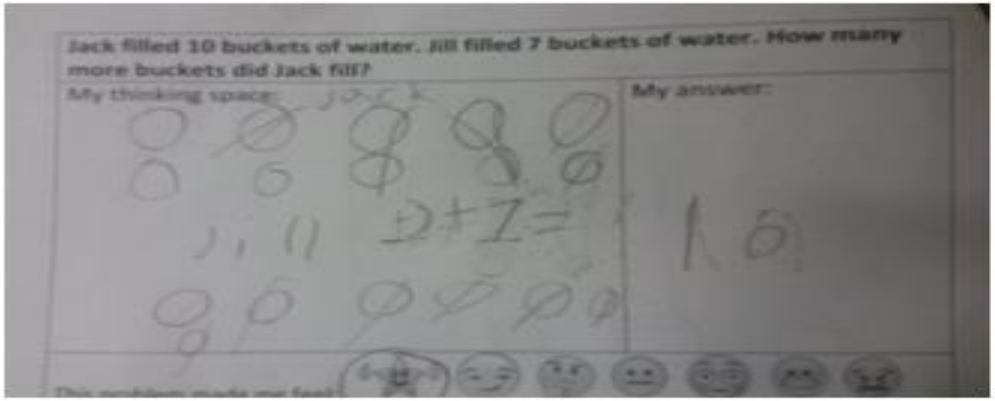
Pre Assessment: October – Score: 0



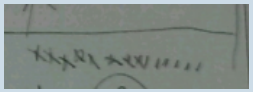
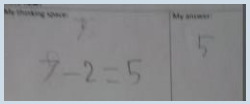
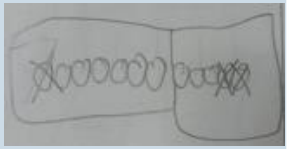
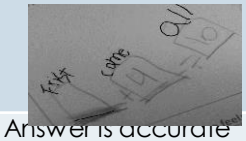
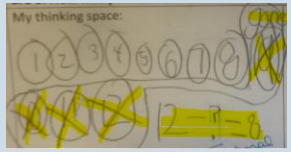
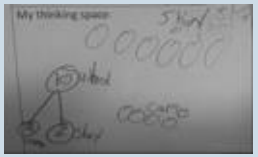
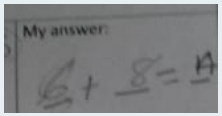
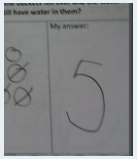
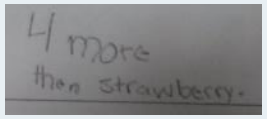
Post Assessment: Mid-November – Score: 3

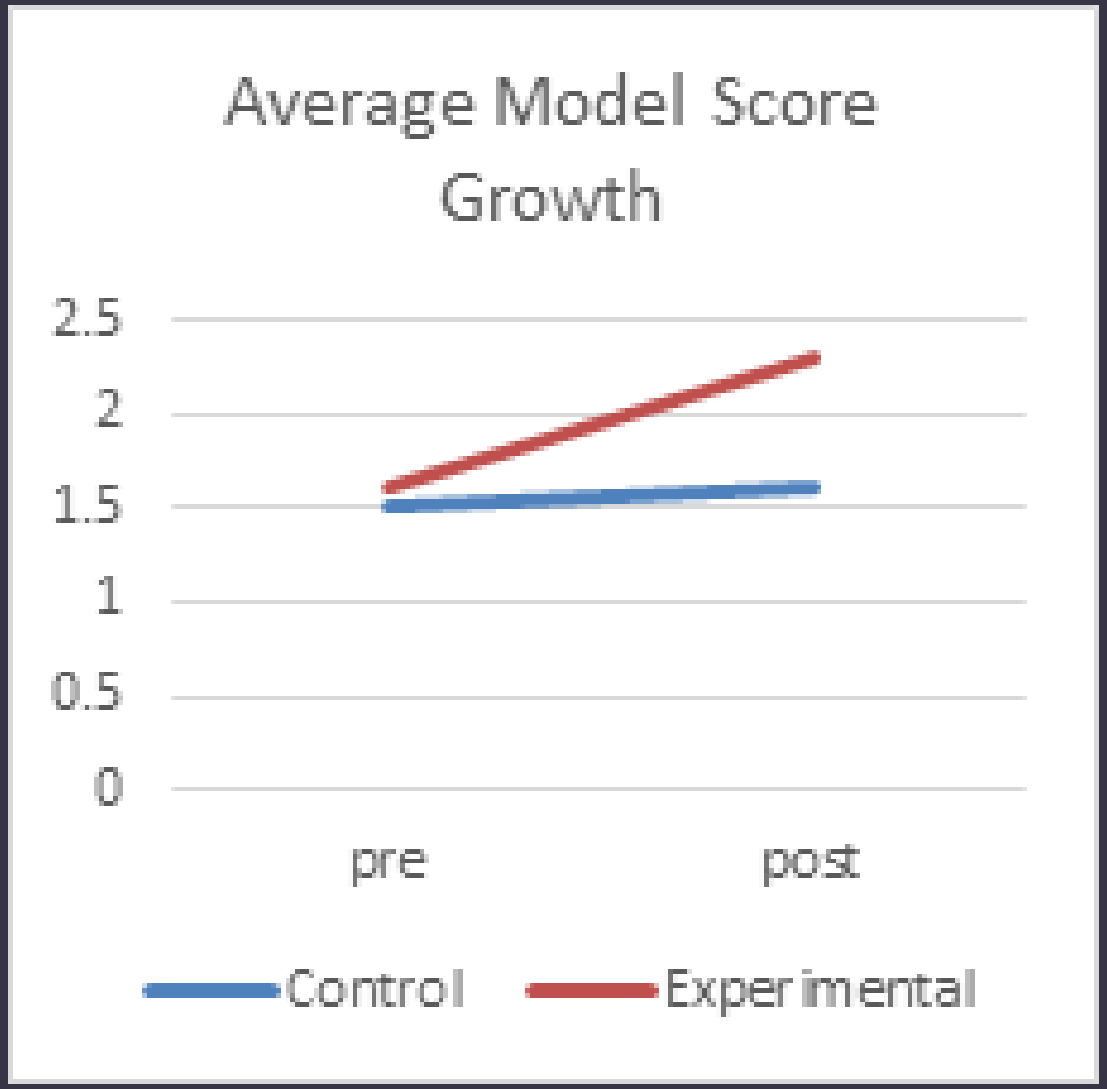


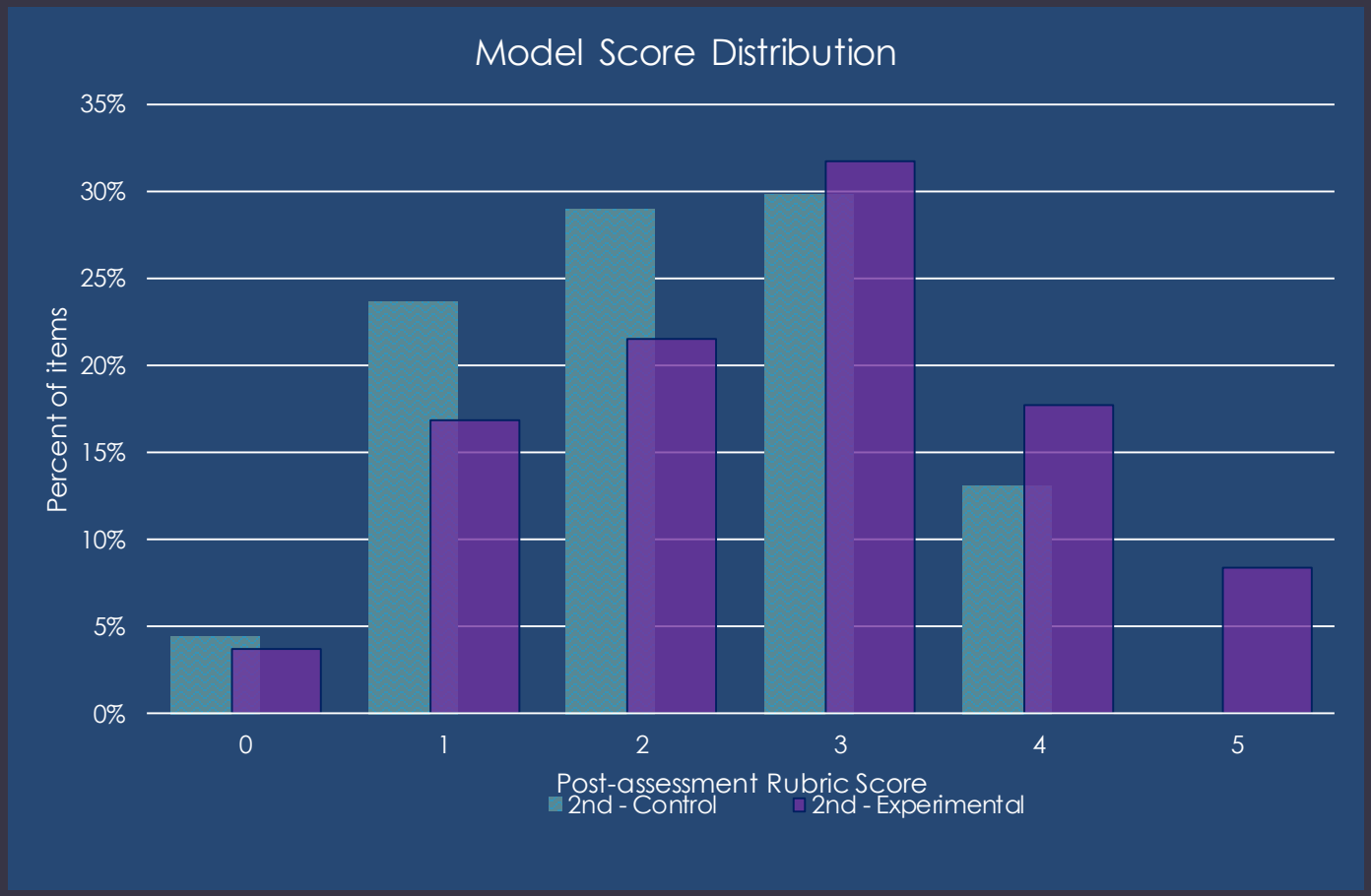
Note: This is a two-step problem, which is not part of the standards for first graders especially in November. This student miscalculated the answer on the post-assessment, but the model clearly shows that her reasoning regarding the situation has improved.

Progress Check 1	
Progress Check 2	
Post Assessment	

A Problem Solving Approach Rubric

	Level 0	Level 1 Superficial Approach	Level 2	Level 3	Level 4	Level 5 Genuine Approach	
MODEL/ Representation/ Reasoning	No evidence of student thinking	Student thinking represented lack of reasoning about the situation and how to solve it Picture, Direct model or solution equation used (wrong operation modeled). OR – Student modeled only the answer	Direct modeling (fingers, tallies, or circles) All grouped together or crossed out OR- Solution equation only (for example student wrote 12 – 8 = 4 when situation was 12 - ? = 8, without any proof of reasoning) - little evidence of situational reasoning  	Situational modeling/ reasoning is emerging ex. Individual items are drawn like in direct modeling (Especially when situational and solution models match) but groupings are separated to show the parts of the problem OR - Situational Equation shown with no model or labels (12 - ?= 8) 	Model includes evidence of student reasoning about the situation problem, includes labels or action markers Or – Situational equation with labels used to convey thinking.  	Student uses multiple models (pictures, equations, part/whole boxes, etc.) with labels reflecting the connection to the situation  	Students will eventually internalize the pictorial model and are able to move directly to a mathematical model for familiar problem types. This will be evident by ability to explain and label the numbers and operations used.
ACCURACY	Incorrect answer was recorded, incorrect or no operation was chosen.	Answer is correct with no supporting evidence	Correct Operation, Inaccurate Calculation Or- Partially correct in the case of 2 or more step problems	Answer is correct, but not separated from the equation, so it cannot be assumed that student knows which part of the equation is the "answer" 	Answer is accurate (numeric only) 	Answer is accurate and includes a label or sentence to connect it back to the context. 	


Average Model Score Growth
2.5
2
1.5
1
0.5
0
pre
post
Control
Experimental


Model Score Distribution
35%
30%
25%
20%
15%
10%
5%
0%
Percent of items
0
1
2
3
4
5
Post-assessment Rubric Score
2nd - Control
2nd - Experimental

THANK YOU

Kimberly Hayden
Facilitator of Elementary Mathematics
Stafford County Public Schools
Haydenka@staffordschools.net