

Explain, Justify and Critique – Oh My!

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NCTM Annual Meeting, Boston, MA April 16, 2015 - *How can you support your students' ability to explain and justify their thinking and critique the reasoning of others? Come see what this looks like in the elementary classroom and get ideas and tools to support your own students work in this area.*

Standard for Mathematical Practice #3 –

Construct viable arguments and critique the reasoning of others.

From Public Schools of North Carolina – Unpacking the Standards

<http://www.ncpublicschools.org/acre/standards/common-core-tools/#unmath>



In Kindergarten, mathematically proficient students begin to clearly express, explain, organize and consolidate their math thinking using both verbal and written representations. Through opportunities that encourage exploration, discovery, and discussion, kindergarten students **begin to learn how to express opinions, become skillful at listening to others, describe their reasoning and respond to others' thinking and reasoning.** They begin to develop the ability to reason and analyze situations as they consider questions such as, “Are you sure...?”, “Do you think that would happen all the time...?”, and “I wonder why...?”



Mathematically proficient students in First Grade continue to develop their ability to clearly express, explain, organize and consolidate their math thinking using both verbal and written representations. Their understanding of **grade appropriate vocabulary** helps them to construct viable arguments about mathematics. For example, when justifying why a particular shape isn't a square, a first grade student may hold up a picture of a rectangle, pointing to the various parts, and reason, “It can't be a square because, even though it has 4 sides and 4 angles, the sides aren't all the same size.” In a classroom where risk-taking and varying perspectives are encouraged, mathematically proficient students are **willing and eager to share their ideas** with others, **consider other ideas** proposed by classmates, and **question ideas** that don't seem to make sense.



Mathematically proficient students in Second Grade accurately **use definitions and previously established solutions to construct viable arguments** about mathematics. During discussions about problem solving strategies, students **constructively critique the strategies and reasoning of their classmates.** For example, while solving $74 - 18$, students may use a variety of strategies, and after working on the task, can discuss and critique each others' reasoning and strategies, **citing similarities and differences between strategies.**



In third grade, mathematically proficient students **may construct arguments using concrete referents, such as objects, pictures, and drawings.** They refine their mathematical communication skills as they participate in mathematical discussions that the teacher facilitates by asking questions such as “How did you get that?” and “Why is that true?” They explain their thinking to others and respond to others' thinking.



4th - Mathematically proficient fourth grade **students experiment with representing problem situations in multiple ways** including numbers, words (mathematical language), drawing pictures, using objects, making a chart, list, or graph, creating equations, etc. Students need opportunities **to connect the different representations and explain the connections.** They should be able to use all of these representations as needed. Fourth graders should **evaluate their results in the context of the situation and reflect on whether the results make sense.**



In fifth grade mathematically proficient students may construct arguments using concrete referents, such as objects, pictures, and drawings. They **explain calculations based upon models and properties of operations and rules** that generate patterns. They **demonstrate and explain the relationship** between volume and multiplication. They **refine their mathematical communication skills** as they participate in mathematical discussions involving questions like “How did you get that?” and “Why is that true?” They explain their thinking to others and respond to others' thinking.

Our Hints: Require explanations and justifications regularly in all subject areas, question both right and wrong answers, pick a few stems to focus on, mark quality justifications and critiques, ask WHY??

Plus. www.kenkennuzzle.com for free nuzzles to develop justifications

Name _____ Date _____

Task Title _____

- _____ Read the task carefully.
- _____ Underline or circle the important facts.
- _____ Restate the question in your own words.

I need to find _____

_____ Select a strategy. _____

Record the steps as you solve the problem.

Solve It.

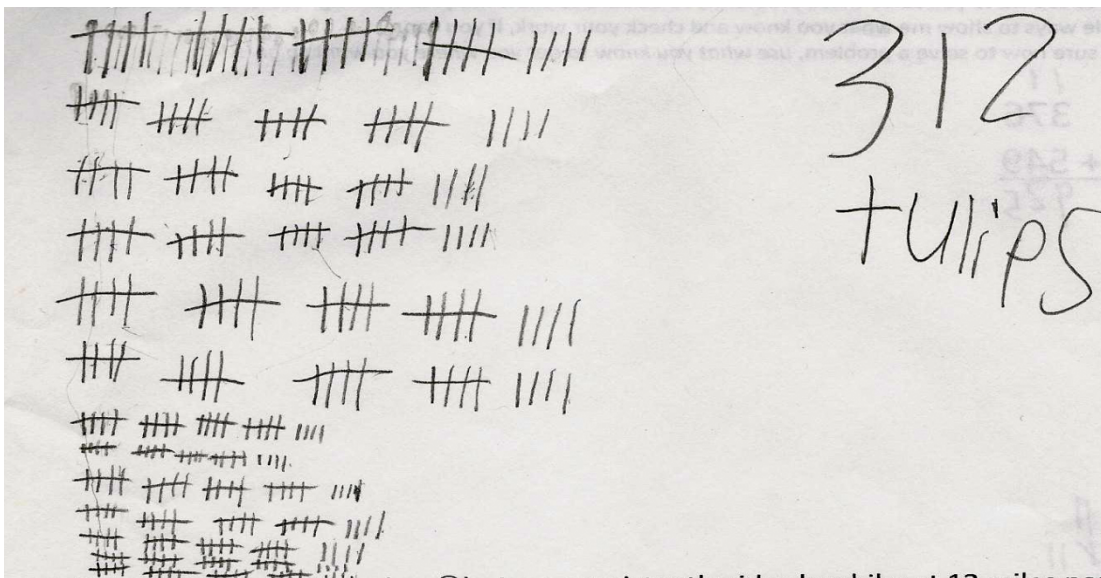
Justify it.

ANSWER STATEMENT: _____

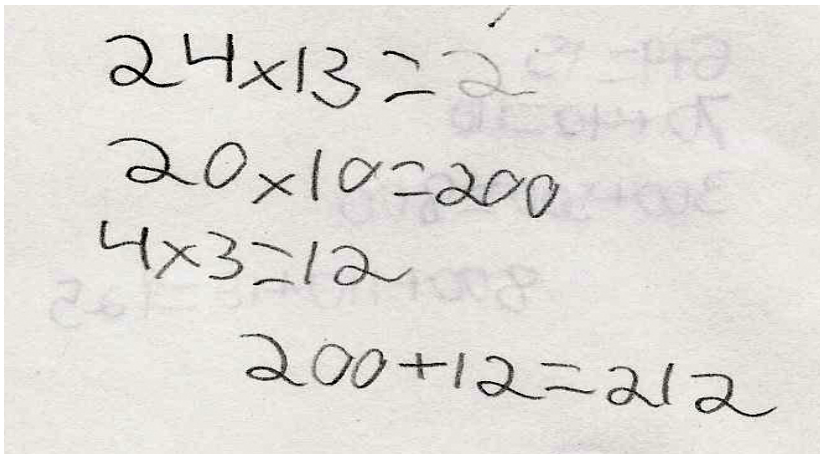
Did the student EXPLAIN, JUSTIFY or YOU DON'T KNOW?

Grade 3 task - Bill planted 24 tulips in each row. He planted 13 rows of tulips. How many tulips did he plant in all?

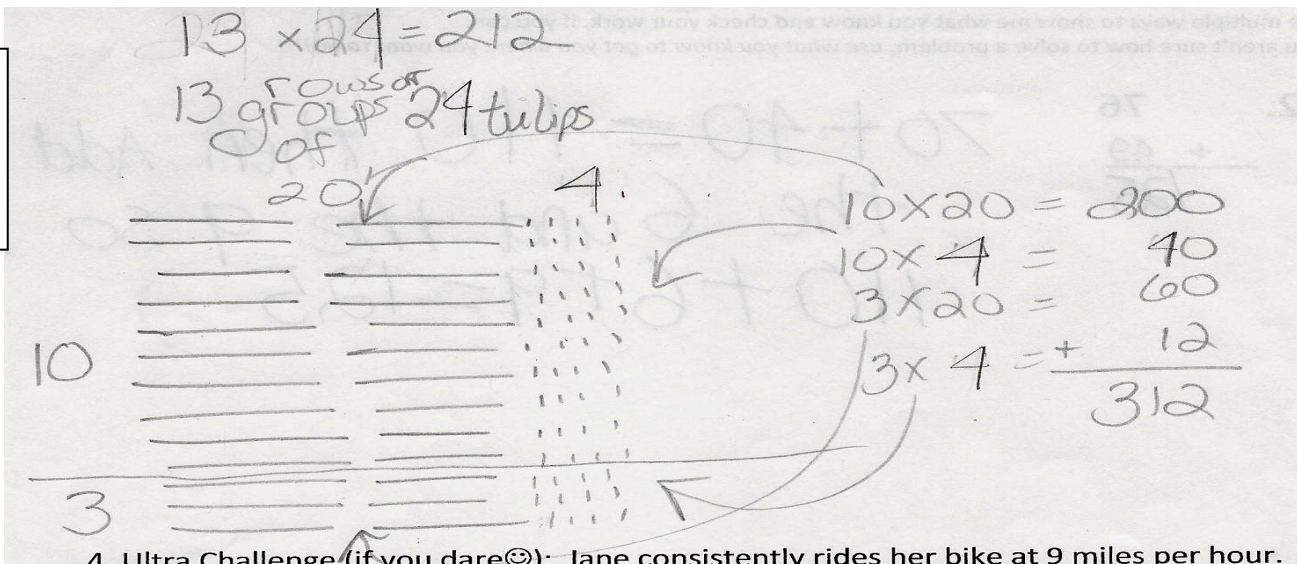
Student Work
A



Student Work
B



Student Work
C



Sample Accountable Talk Questions

Do you agree/disagree with that? Why?

What do you still have questions about?

What would you like to add to what (name) said about ___?

How is this the same/different as ___?

Do you think that method will always work? Why/why not?

How is that strategy similar/different than yours?

How does that (drawing, model, strategy) supports this work?

What did you do next? Why?

ACCOUNTABLE TALK

- I noticed that...
- I wonder...
- I was confused...
- This reminds me of...
- I like...
- I didn't like...
- I think...
- I believe...
- I don't know what you mean by...
- This reminds me of...
- I agree because...
- I disagree because...
- I want to add...
- Why do you think that?
- Can you tell me more about that?
- Can you explain that another way?
- When we __, it helped me __

+ -

4+		1-
1-		
3	1-	

9-1 www.kenken.com

+ -

3	1-	
1-	8+	1

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x

3x		12x
6x		
		1

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+ -

8+		
	1-	2-
3		

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+

8+			6+
7+	3+		
		7+	
6+		3	

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+ - x ÷

45x		4-	2÷	3+
20x				
	9+	30x		
			8+	1-
3+				

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HOW TO PLAY KENKEN®

1. Fill in each square with a single number. In a 3x3 grid, use the numbers 1 through 3. In a 4x4 grid, use the numbers 1 through 4. In a 5x5 grid, use the numbers 1 through 5...and so on.
2. Do not repeat numbers in any individual row or column. For example, in a 3x3 grid, each column and each row should be filled in with the numbers 1, 2, and 3, with no duplication.
3. Each heavily outlined set of squares is called a "cage." The numbers in each cage must combine (in any order) to produce the target number indicated in the top corner by using the mathematical operation next to the target number.
4. A number may be repeated within a cage as long as it is not in the same row or column.