Sparking Insights and Igniting Passion: The Power of Our Questions

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Greater Louisville Council of Teachers of Mathematics
Oct. 16, 2019

"By expanding the types of questions we ask, we shift our focus from doing math to thinking mathematically."

Moving Beyond "*What's the Answer*?"

Question 1: How?

Focus: procedures

Molly had 6 cookies.
She ate some.
She had 2 left.
How many did she eat?

Mrs. King wanted to put a new tile floor in her kitchen.
She ordered 30 tiles and when she opened the box saw that 2/5 of them were cracked.
How many tiles were cracked? Explain how you did it.

Explain how to solve for e.
$9e+4=-5e+14+13e$

Explain how you would find the total.
Number Talk Images website: **http://ntimages.weebly.com/**

Question 2: Why?

Focus: conceptual understanding, justification

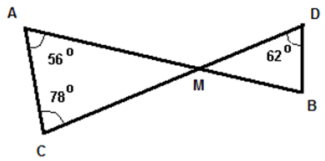
In the long jump, Molly jumped 52 inches, Bailey jumped 4 feet 7 inches, and Blake jumped 1 yard, 1 foot, 2 inches. Who jumped the farthest? Justify your answer.

Interpreting Remainders
a) Boxes of markers are on sale for $4.00 each. Mrs. King has $30.00. How many boxes of markers can she buy? Why?
b) Mr. Smith gave his 4 children $30.00 to share equally. How much money did each child get? Why?
c) There are 30 children in a 4^{th} grade class. Each table seats 4 children. How many tables will be needed? Why?

Dan observes that
He says:
I think that if we are dividing a fraction by a fraction with the same denominator, then we can just divide the numerators.
Is Dan's conjecture true for all fractions. Explain your thinking.
From Illustrative Mathematics, grade 6

If you are given the sum of the squares of three consecutive integers, what five digits can never occur in the ones place? Prove your answer. *(Call the integers x - 1, x, and x + 1. The squares will then be $x^2 - 2x + 1$, x^2, and $x^2 + 2x + 1$, yielding a sum of $3x^2 + 2$. X^2 must end in 0, 1, 4, 5, 6, or 9. This means that the sum of the squares could end in 0, 2, 5, 6, or 7 and will never end in 1, 3,4, 8, or 9.)*
Dr. Ron Pelfrey, ARSI Resource Collaborative, University of Kentucky

Find the size of angle MBD and justify your answer.



Agree or Disagree?
1 hundred, 15 tens, and 3 ones is the same as 2 hundreds, 5 tens, and 3 ones

5.25 > 5.4

15 is a prime number

Aaron said: The sine of acute angle A of a right triangle cannot be greater than the cosine of angle B in the same triangle. Do you agree? Explain.

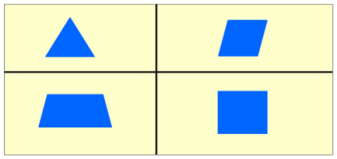
From *More Good Questions: Great Ways to Differentiate Secondary Mathematics Instruction* by Marian Small and Amy Lin

Eliminate It!

21	63
17	42

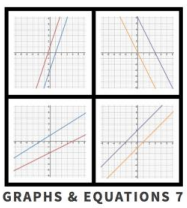
MATH in PRACTICE

Eliminate It!



MATH in PRACTICE

https://wodb.ca/graphs.html
Mary Bourassa

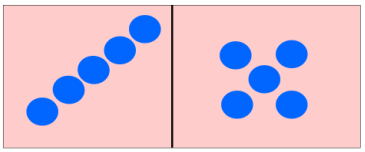


GRAPHS & EQUATIONS 7
from Hunter Patton

Question 3: How does this compare to…?

Focus: observation, connections

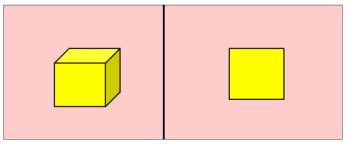
Alike and Different



Alike and Different

16 25

Alike and Different

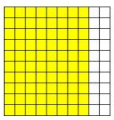


Alike and Different

$2x + 5$ $x^2 + 5$

Observing Decimals

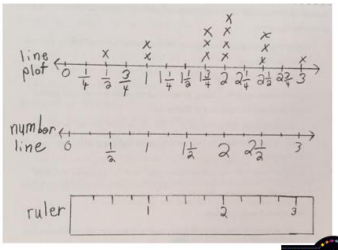
- Model 0.80 using any model.
- Model 0.8 using the same model.
- How are they alike? How are they different?



From Van de Walle, *Teaching Student-Centered Mathematics*

MATH in PRACTICE

In what ways are line plots, fraction number lines, and rulers alike?
In what ways are they different?

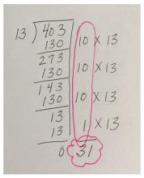


MATH in PRACTICE

Progressions

Grade 5

- Partial quotient division with 2-digit divisors



Grade 6

- Long division with standard algorithm
- What does this remind you of?
- How are the processes alike and different?

MATH in PRACTICE

Comparing Strategies

- What strategy would you use to compare $\frac{3}{17}$ and $\frac{6}{33}$?
- Would you use the same strategy to compare $\frac{4}{10}$ and $\frac{5}{9}$?
- Explain.

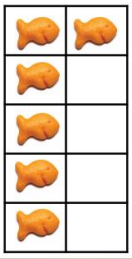
Adapted from: *More Good Questions: Great Ways to Differentiate Secondary Mathematics Instruction* by Marion Small and Amy Lin

Question 4: What do you notice?

Focus: observations, inquiry

Read *Fish Eyes* by Lois Ehlert

Show 5.



5 + 1 = 6

Record and discuss results.

5 + 1 = 6
3 + 1 = 4
7 + 1 = 8
2 + 1 = 3

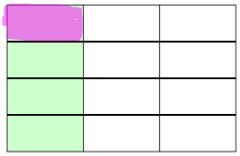
What do you notice?
What is 4 + 1? How do you know?
Try it. Were you right?
Could you add 1 without using the counters? How?
What happens when you add 1 to a number?

Exploring Fraction Division

Four friends have $\frac{1}{3}$ pan of brownies to share. How much of the pan will each friend get if they share it equally?

$\frac{1}{3} \div 4 = n$

Create a model to show the problem.



$\frac{1}{3} \div 4 = \frac{1}{12}$

Try a few more, record, observe

$\frac{1}{3} \div 4 = \frac{1}{12}$

$\frac{1}{3} \div 3 = \frac{1}{9}$

$\frac{1}{4} \div 2 = \frac{1}{8}$

What do you notice?

Predict $\frac{1}{4} \div 4$.

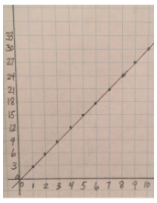
Create a model to check your prediction.

Why is this happening?

What is the rule?

Exploring Proportional Reasoning

Think of two variables where one doubles when the other doubles. Create a table of values and draw a graph that shows this relationship. What do you notice?



For example: # people, # eyes or # triangles, # sides

From *Good Questions: Great Ways to Differentiate Mathematics* by Marian Small

What do you notice?

Join our *Math in Practice* Facebook Group for lots more!

Question 5: What's the big idea?

Focus: generalizing

Investigating the Commutative Property with Models

2 plates of 5 cookies **5 plates of 2 cookies**

2 x 5 = 10 5 x 2 = 10

Investigating the Commutative Property with Models

- 2 plates of 5 brownies 2 x 5 = 10
- 5 plates of 2 brownies 5 x 2 = 10
- 2 plates of 3 brownies 2 x 3 = 6
- 3 plates of 2 brownies 3 x 2 = 6
- 2 plates of 4 brownies 2 x 4 = 8
- 4 plates of 2 brownies 4 x 2 = 8

What do you notice?

Do you think it will always happen? Why or why not?
If 2 x 6 = 12, what is the product of 6 x 2? Try it.
What is the rule?

The Effect of Our Actions

What does 10^1, 10^2, 10^3... mean?

Week	My thinking		People holding doors for others
1	10	10^1	10
2	10 x 10	10^2	100
3	100 x 10 (10 x 10 x 10)	10^3	1,000
4	1,000 x 10 (10 x 10 x 10 x 10)	10^4	10,000
5	10,000 x 10 (10 x 10 x 10 x 10 x 10)	10^5	100,000

What do you notice?

Question 6: What did you learn?

Focus: summarizing, reflecting, closure

What do you know? About what do you still have questions?

What did you discover? What do you still wonder?

What did you learn today? What would you like to talk about tomorrow?

What was easy? What was hard?

Finding Good Questions

Math in Practice (Heinemann Publishing) *www.mathinpractice.com*

Good Questions for Math Teaching: Why Ask Them and What to Ask by Nancy Canavan Anderson and Lainie Schuster

Good Questions: Great Ways to Differentiate Mathematics Instruction in the Standards-Based Classroom by Marian Small

More Good Questions: Great Ways to Differentiate Secondary Mathematics Instruction by Marian Small and Amy Lin

3-Act Tasks

Graham Fletcher (elementary/middle)
Dan Meyer (secondary)

www.illustrativemathematics.org

https://www.youcubed.org/

https://nrich.maths.org/

Open-Ended Questions for Mathematics:
https://www.uky.edu/OtherOrgs/ARSI/www.uky.edu/pub/arsi/openresponsequestions/grade4org.pdf

Our questions…

…help students construct a vision of mathematics as more than procedures and right answers.

…challenge thinking.

…spark insights.

…ignite curiosity and passion.

Ask questions that empower your students to think like mathematicians!

Teacher Resource Books by Sue O'Connell

Published by Heinemann (www.heinemann.com)

Math in Practice **(www.mathinpractice.com)**

This series is filled with lesson ideas, instructional strategies, practice tasks, and many online printable resources to make teaching K-5 math more meaningful and more fun. There is a book for each grade level K-5 that contains a wealth of grade-specific activities, as well as a *Guide for Teachers* filled with instructional strategies to support greater understanding of math concepts. A *Guide for Administrators* offers tips and strategies for math coaches/administrators. Visit the website at **www.mathinpractice.com** to view samplers, see videos, and learn more about the series.

Putting the Practices into Action - Implementing the Common Core Standards for Mathematical Practice K-8
with John SanGiovanni

The Standards for Math Practice are the heart and soul of the Common Core State Standards. This book explains each standard in teacher-friendly terms and highlights practical activities to make the standards come alive in classrooms. It contains PLC study group questions and online resources.

Mastering the Basic Math Facts for Addition and Subtraction
Mastering the Basic Math Facts for Multiplication and Division
with John SanGiovanni

Through investigations, discussions, visual models, children's literature, and hands-on explorations, students explore the math operations, and through engaging, interactive practice achieve fluency with basic facts. A teacher-friendly CD filled with customizable activities, templates, recording sheets, and teacher tools simplifies your planning and preparation. Over 450 pages of reproducible forms are included in English and Spanish translation.

The Math Process Standards Series

Each book in this series is a practical guide for helping students refine their skills in the highlighted math process (problem solving, communication, reasoning, representations, connections). You will find specific teaching strategies and tips to help all students strengthen their skills. Included with each book is a CD filled with teacher tools and customizable student activities to allow you to change names, data, or spacing for a quick way to differentiate instruction within your classroom.

Introduction to Problem Solving ***Introduction to Communication***
Introduction to Representation ***Introduction to Reasoning and Proof***
Introduction to Connections

All books in this series are available for Grades PK-2, Grades 3-5, and Grades 6-8.

Now I Get It: Strategies for Building Confident and Competent Mathematicians, K-6

Good teaching is the critical factor that helps students "get" math. This book is a practical handbook for the teaching of mathematics, with chapters addressing the teaching of problem solving, the use of manipulatives, differentiating instruction, effective teacher questioning, increasing math talk, and much more. The book includes a CD with over 100 pages of resources to support teachers including manipulative templates, math facts game templates, a bibliography of math-related literature, center ideas, math websites, problem-solving and writing tasks, and a variety of other practical resources.

For additional resources, visit Sue's website at www.qualityteacherdevelopment.com
Follow Sue on Twitter @SueOConnellMath
Gather strategies and ideas on Facebook by liking Sue's Facebook page (Quality Teacher Development) or joining the Math in Practice Facebook group!