Real-World Investigations that Engage Students in the Mathematical Practices

NCTM Conference Nashville

Friday, November 19, 2015

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Agenda

- Research

- Sonya's Savings Plan

- Roberto's Trail Mix

- The Apple

- Guitars

Authentic Data

- Intrinsic Motivation / Engagement
  - Daniel Pink, *Drive*
  - Creativity and perseverance
- Problem Solving Skills
  - Steve Leinwand, *Accessible Mathematics*
  - Abundant data presented in tables, charts, and graphs
  - Make conjectures and draw conclusions

"Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace."

Standards for Mathematical Practice MP4

Benefits of Project Based Learning

- – Three year project in 2 British secondary schools
- – Project-based students significantly outperformed traditional instruction
  - Skills
  - Conceptual
  - Applied knowledge
  - 3 times as many students passed the national exam

Jo Boaler, 2002

Mindset

Growth

- Talents and abilities can be developed over time

- Mistakes are opportunities to learn

- Resilience and perseverance

- Effort creates success

- Students think about how they learn

Fixed

- Talent alone creates success

- Reluctant to take on challenges

- Stay in the comfort zone

- Fearful of making mistakes

- It is important to 'look smart' in front of others

- You are either smart/talented or not

Carol Dweck

Grouping of Practice Standards

1. Make sense of problems and persevere in solving them
6. Attend to precision

2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others

Reasoning and explaining

4. Model with mathematics

5. Use appropriate tools strategically

Modeling and using tools

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

Seeing structure and generalizing

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Life Impact

2X success predictor

"Worked on a long-term project that took several classes to complete"

"Used what you were learning about to develop solutions to real problems in your community or in the world"

Gallup 2013

The Real World: Grades 3-5

Discuss using the Precision Partners Techniques

1's and 2's
Look, Lean, Listen, Low Voice
Precision Pairing

The Real World: Grades 3-5

Place Value Unit

- We are going to be learning about place value. What are the units in our number system?

- What units does money come in?

- If someone gives you money, how can you tell how much money they are giving you?

Desire to Learn

Topic	Unit Launch	Sonya's Savings Plan
What I Know	**What I Want to Know**	**What I Learned**
• Add tens and hundreds • Multiply by tens • Round to the tens and hundreds • Subtract tens and hundreds • how to say large numbers • save money • the thousands place is • I know where the tens and the ones are	• I want to multiply by 5 numbers • divide large numbers • multiply 10 numbers • multiply by 10	

A Three-Tiered Approach to Data

- Tier 1 – Data provided, student learns a heuristic model

- Tier 2 – Some data provided, student adds to the heuristic model

- Tier 3 – All data created by the student, student uses the heuristic model as an analytical tool

Alleah's Bus

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Alleah's School – TIER I

Alleah's School—Alleah's Data

Alleah learned about fractions at school. Her teacher told her to look for fractions in the world around her. As she was getting on her bus to go home, she began to look at her world in terms of fractions.

- Look at the picture of what Alleah saw on the next page and use it to write the fractions in the data chart below.

- Then, compare each fraction to 1/2 and explain whether the fractional part in the picture is less than, equal to, or greater than 1/2.

Find this in the Picture	Write the Fraction	Compare the Fraction: Is it less than, equal to, or greater than 1/2?
Fraction of the students who are on the school bus		
Fraction of the bus windows that are closed		
Fraction of the students who are wearing glasses		
Fraction of the students who are wearing baseball hats		
Fraction of the students who are waving		
Fraction of the students riding the bus that are at the back of the bus		

Understanding Fractions: Tier I

Find this in the Picture	Write the Fraction	Compare the Fraction: Is it less than, equal to, or greater than 1/2?
Fraction of the students who are on the school bus	4/8	equal to ½
Fraction of the bus windows that are closed	5/6	greater than ½
Fraction of the students who are wearing glasses	1/8	less than ½
Fraction of the students who are wearing baseball hats	2/8	less than ½
Fraction of the students who are waving	3/8	less than ½
Fraction of the students riding the bus that are at the back of the bus	3/4	greater than ½

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Alleah's School - Create Some Data

Tier

Total number of students: Number of students in the class picture who...	Write the Fraction	Is the fraction less than, equal to, or greater than 1/2 of the class?
Have brown eyes 7	7/12	greater than 1/2
Have blue eyes 4	4/12	less than 1/2
Have eyes that are not brown or blue 1	1/12	less than
Have black hair 3	3/12	less than
Have brown hair 4	4/12	less than
Have red or blonde hair 1 4	1/12 4/12	
Wear glasses 2	2/12	Less than 1/2
Who smiled in the picture 12	12/12	More than 1/2
Who wore blue shirts 5		
Who wore red shirts 3		
Who wore green shirts 2		

Your School – TIER III

- In what ways can you describe your class? Some of the ways you can describe them are by their likes and dislikes or activities. Write statements about how you will describe your class in the table below.

- What fraction of the students in your class is described by each statement?

- Explain whether the fractional part is less than, equal to, or more than 1/2 of the class.

Total number of students: Number of students in the class who…	Write the Fraction	Is the fraction less than, equal to, or greater than 1/2 of the class?

Questions for Reflection:

- How did you choose your descriptors?

- How can you summarize the data in your table?

Tier III

Total number of students:		Is the fraction less than, equal to, or greater than 1/2 of the class?
Number of students in the class who...	Write the Fraction	
likes Dogs 15	$\frac{15}{25}$	greater than $\frac{1}{2}$
likes cats 8	$\frac{8}{25}$	less than $\frac{1}{2}$
likes tacos 13	$\frac{13}{25}$	greater than $\frac{1}{2}$
likes pizza 10	$\frac{10}{25}$	less than $\frac{1}{2}$
likes gymnastics 8	$\frac{8}{25}$	less than $\frac{1}{2}$
likes soccer 14	$\frac{14}{25}$	greater than $\frac{1}{2}$

stions for Reflection:

How did you choose your descriptors?   by taking everyone from the class and asking by
6 disitions and they would say thier fav.

How can you summarize the data in your table?

we took the number of people who liked thier fav stuff and made them in a fraction and witch fraction is greater than or less than or equal than $\frac{1}{2}$.

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Student Reflections– Grade 3

Questions for Reflection:

1. • How did you choose your descriptors? *question #1: We chose our discriators by asking everyone their favorites.*

2. • How can you summarize the data in your table?

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question #2: more than 1/2 of the students like soccer in our class.

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Questions for Reflection:

• How did you choose your descriptors? *My math class decided on two things for 1 topic to put down*

• How can you summarize the data in your table? *Out of 23 most students lik dogs out of cats, and tacos out of pizza, and soccer out of Gymnastics.*

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Three-Tiered RWI's

Trail Mix – Adding Fractions
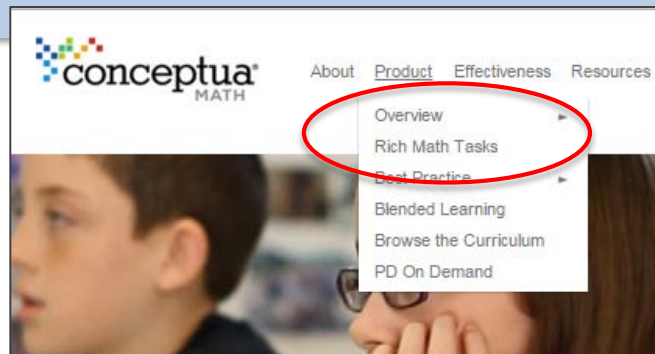
...ate at least 5 bags of trail mix. Fill each bag with up to 1 cup of trail mix. Use the data table to show how you wou... each bag.

...w much of each ingredient do you need to make all of the bags? You can use no more than 1 cup of each ingredie...

Ingredient	Amount used in bag 1	Amount used in bag 2	Amount used in bag 3	Amount used in bag 4	Amount used in bag 5	Amount of each needed
Marshmellows	1/8	3/8	2/8	2/8	1	8/8
Carmels 5/8	1/8	1/8	1/8	1	4/8	8/8
M&Ms 7/8	1	1	2/8	1/8	3/8	6/8
Smarties 2/8	2/8	1	1	1	1/8	3/8
Bacon 4/8	1/8	2/8	1/8	1/8	1/8	5/8
Skittles 5/8	1/8	1	2/8	2/8	1/8	6/8
Jolly Ranchers 6/8	2/8	2/8	1	2/8	1	6/8
Total amount	1cup	1cup	1cup	1cup	1cup	

...ns for Reflection:

...ld you want to eat the trail mix you created? Do you think your friends and family would enjoy it?

...did you choose the fractions you used to complete this problem?

- Create at least 5 bags of trail-mix. Fill each bag with up to 1 cup of trail mix. Use the data table to show how you would fill each bag.

- How much of each ingredient do you need to make all of the bags? You can use no more than 1 cup of each ingredient.

Ingredient	Amount used in bag 1	Amount used in bag 2	Amount used in bag 3	Amount used in bag 4	Amount used in bag 5	Amount of each needed
Marshmallows 7/8	2/8	3/8	1/8	1/8	0/8	0/8
Jolly Ranchers 5/8	1/8	0/8	1/8	2/8	1/8	0/8
M and Ms 3/8	1/8	0/8	1/8	0/8	1/8	0/8
Skittles 4/8	0/8	0/8	1/8	1/8	2/8	0/8
Cashews 5/8	1/8	1/8	1/8	1/8	1/8	0/8
Pretzels 5/8	2/8	1/8	0/8	1/8	1/8	0/8
Gummie Worm-1 1/8	1/8	3/8	3/8	2/8	2/8	0/8
Total amount	1 cup	1 cup	1 cup	1 cup	1 cup	

Questions for Reflection:

- Would you want to eat the trail mix you created? Do you think your friends and family would enjoy it?
- Why did you choose the fractions you used to complete this problem?

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- What ingredients will you use to make your trail mix? Write them in the data table.

- Create at least 5 bags of trail mix. Fill each bag with up to 1 cup of trail mix. Use the data table to show how you would fill each bag.

- How much of each ingredient do you need to make all of the bags? You can use no more than 1 cup of each ingredient.

Ingredient	Amount used in bag 1	Amount used in bag 2	Amount used in bag 3	Amount used in bag 4	Amount used in bag 5	Amount of each needed
mini Donuts 8/8	1/8	1/8	1/8	1/8	1/8	3/8
Sprinkle 8/8	2/8	2/8	2/8	2/8	0/8	0/8
Root Beer 8/8	1/8	1/8	1/8	1/8	3/8	3/8
Sour Heads 8/8	1/8	1/8	1/8	1/8	0/8	3/8
Candy Cains 8/8	1/8	1/8	1/8	1/8	1/8	3/8
KitKats 8/8	1/8	1/8	1/8	1/8	1/8	0/8
Gummy Bear 5/8	1/8	1/8	1/8	1/8	1/8	
Total amount	1 CUP	1 Cup	1 Cup	1 cup	1 cup	

works largest

Questions for Reflection:

- Would you want to eat the trail mix you created? Do you think your friends and family would enjoy it?
- Why did you choose the fractions you used to complete this problem?

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ate at least 5 bags of trail mix. Fill each bag with up to 1 cup of trail mix. Use the data table

ach bag.

much of each ingredient do you need to make all of the bags? You can use no more than 1 cup of each ingredient.

Ingredient	Amount used in bag 1	Amount used in bag 2	Amount used in bag 3	Amount used in bag 4	Amount used in bag 5	Amount of each needed
Mini donuts 8/8	7/8	7/8	3/8	1/8	1/8	3 1/8
Sprinkals 8/8	2/8	2/8	2/8	2/8	0/8	0 1/8
root beer 8/8	1/8	1/8	1/8	1/8	3/8	1 1/8
Jerky heads 8/8	1/8	1/8	1/8	1/8	1/8	3/8
Candy cane 8/8	1/8	1/8	1/8	1/8	1/8	3/8
kickkats 8/8	1/8	1/8	1/8	1/8	1/8	3/8
World largest	1/8	1/8	1/8	1/8		
Total amount	1 cup	1 cup	1 cup	1 cup	1 cup	

gummy bear 5/8

ns for Reflection:

ld you want to eat the trail mix you created? Do you think your friends and family would enjoy it?

did you choose the fractions you used to complete this problem?

Trail Mix – Watching the Discourse

Boy: --bag numbers 7 and 5, finish those ones?

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Sonya's Savings Plan: Includes Discussion Guides

Special Thing You Are Saving For	Cost
T-Shirt	$12
Amusement Park Trip	$125
Moped	$1,198

Available for free at
www.conceptuamath.com
Browse the Curriculum
Place Value: 4th Grade

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3 – Act Task by Graham Fletcher

With discussion
guides

The Apple

An apple is placed in the left pan of balance. The apple weighs 5 ¼ ounces. How many 3/8 ounce blocks need to be places in the right pan to level the balance?

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The Apple
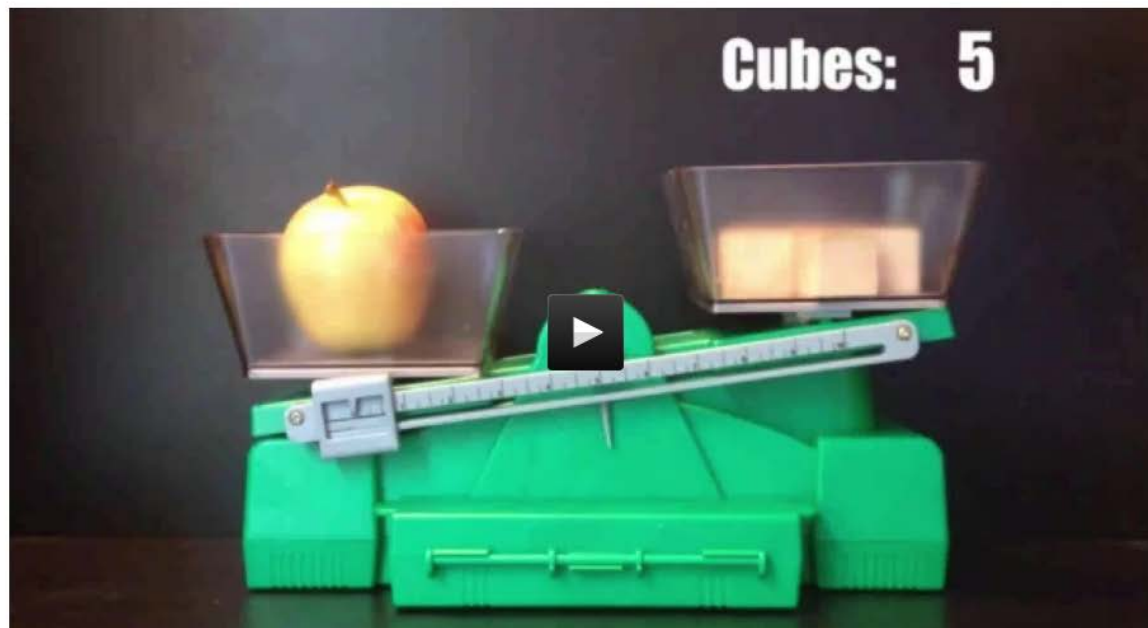
Find more from Graham Fletcher at - -
http://gfletchy.com/3-act-lessons/

Instant Estimation – Real World

- Inches, feet, yards, miles
- Ones, tens, hundreds, thousands, millions
- Pennies, dimes, dollars, tens, hundreds, thousands, hundred thousands, millions

Seeing Mathematics Around You

What fractions do you see?
**What division problems can you generate from this picture?**

Fractions and Division

- Fractions
  - ½ gallon, ¼ gallon (1 quart)
  - ¾ of the container
  - ½ of a quart
  - 1 ½ bottles
- Division
  - Share (½ gallon, ½ bottle, 1 ½ bottles, 3/8 gallon) between x people
  - How many glasses of ¼ of a bottle are in the glass bottles?
  - 3/8 gallon is how many quarts?

The Guitar: A Great Connector

Notice and Wonder!
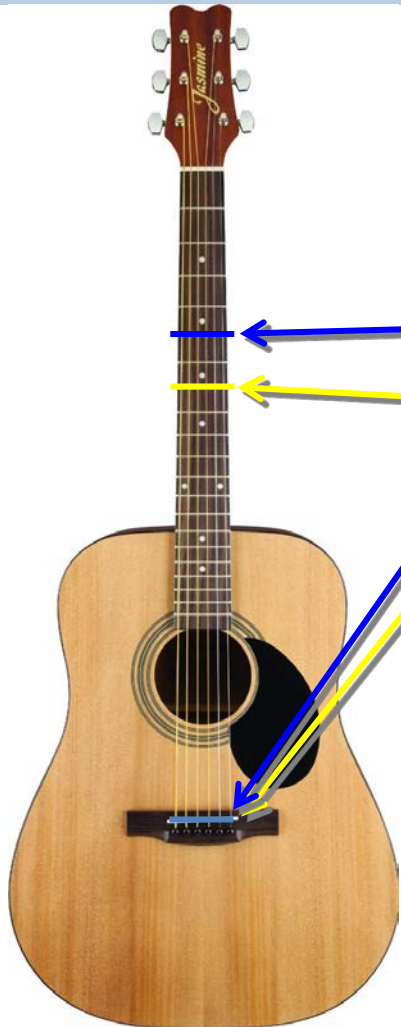
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Guitar Math
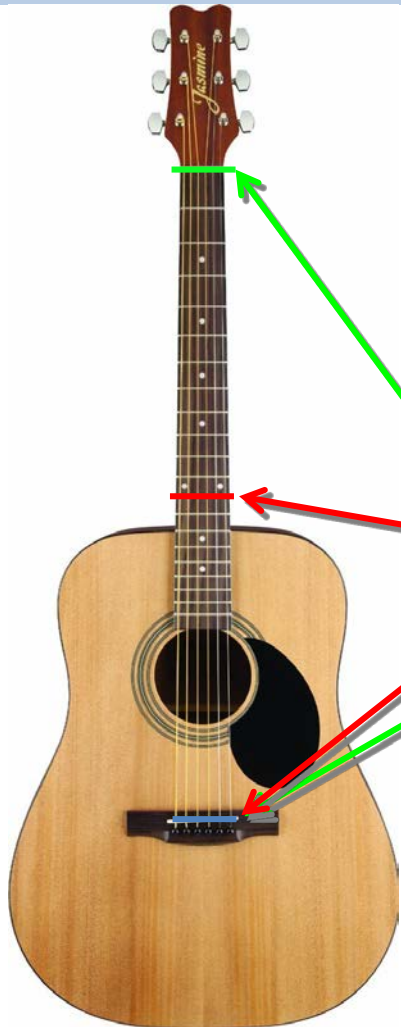
String Length	Name	Frequency
1/2 string	Octave	2/1
Whole string	Unison	1

The Guitar is a Fraction Machine

String Length	Name	Frequency
3/4 string	Fourth	4/3
2/3 string	Fifth	3/2

Measuring Frequencies

Use an App

Guitar Toolkit on iOS

G-String on Android

Make sure it shows the frequency

3 Tiers with a Guitar

1. Use one string. Have students:
   1. Play the full length, 12th fret, 7th fret, and 5th fret.
   2. Measure the proportions.
   3. Measure the frequency using a free app.
2. Invite them to try other strings, and other guitars. Use the same three measures.
3. Bring in a violin, and include other, similar instruments: cello, bass, mandolin, banjo.

Videos on Music and Math in the Classroom

http://www.conceptuamath.com/nctm-handout-videos.html

Tying the Themes Together

- Multi-session problem
- Directly related to student life
- Persevering in a growth mindset
- Reasoning, making sense, and having deep discussions

2X!

Stay in Touch

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