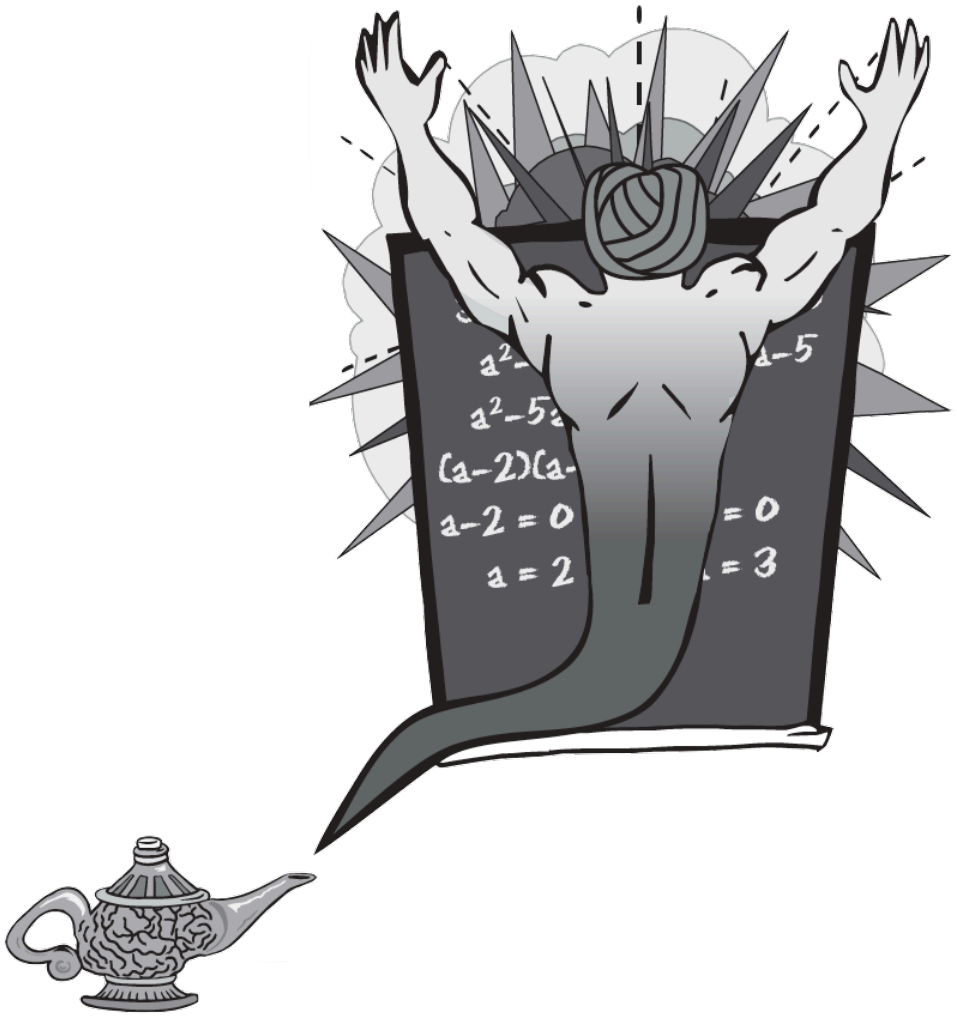
Ultimate Cosmic Power:

In An Itty-Bitty Thinking Space

Algebraic Reasoning for OK-MAP, June 2017



Chris Shore

The Math Projects Journal

shore@mathprojects.com

@MathProjects

#OKMAP2017

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What is Your Million-Dollar Talent?

The Mindset Shift

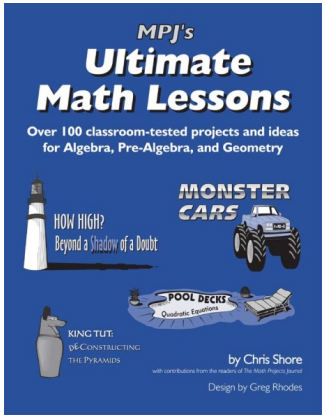
Fixed Mindset

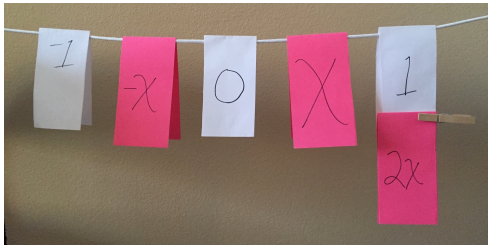
Growth Mindset ...

They are that smart
&
We are that good!

… of the teachers!

The World That I Come From





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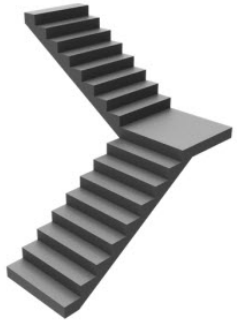
Today's
Ultimate Cosmic Power

WHY?

Define Algebraic Reasoning



HOW?

Learn the Key to Teaching Algebraic Reasoning

WHAT?

Engage in Lessons for Algebraic Reasoning

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What is Algebraic Reasoning?

according to the uninitiated…

"Algebra would be a lot easier if they just told you what x was." -- Scott, Class of '94

"Only in math do you put two things together and get a smaller thing." -- Neal, Class of '99

"You math teachers aren't very good. My whole life you have been asking people to find x. Why can't you find it yourselves?" -- Angry English Teacher

What is Algebraic Reasoning?

according to you…

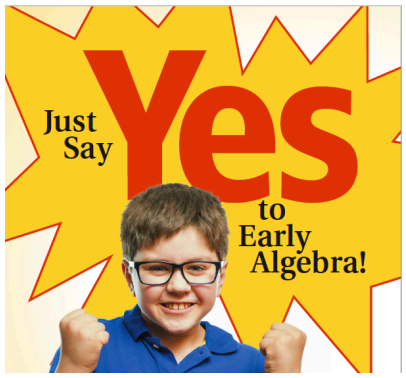
Code:

What is Algebraic Reasoning?

according to a disgruntled math teacher…

"x + 3 = 5 is NOT algebra."

Twenty students are in your class. How many boys, how many girls? What other combinations of boys and girls can there be in a class of twenty students? Using the variables *b* for the number of boys and *g* for the number of girls, how can we represent all possible combinations of boys and girls?

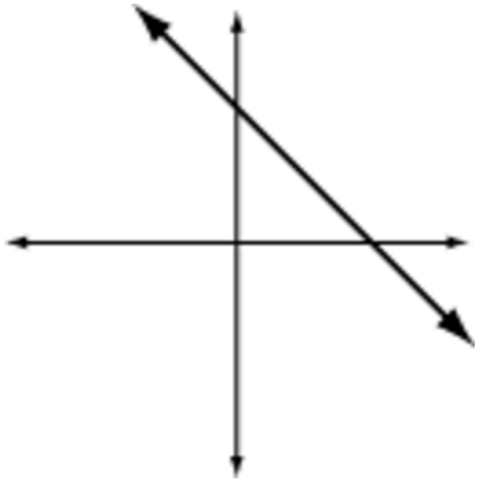


b + g = 20

What is Algebraic Reasoning?

according to me (and the ancients) …

$$x + y = 7$$



What is Algebraic Reasoning?

according to your Oklahoma State Standards …

… algebra is more than moving symbols around. It is about …

*understanding **patterns**, **relations** and **functions**, **representing** and **analyzing** mathematical situations and structures using algebraic **symbols**, using mathematical **models** to represent and **understanding** quantitative **relationships**, and analyzing **change** in various contexts.*

What is Algebraic Reasoning?

according to the Progression …

Algebraic Reasoning & Algebra (A)		
Sixth Grade (6)	Seventh Grade (7)	Pre-Algebra (PA)

What is Algebraic Reasoning?

According to the State's Vision & Guiding Principles…

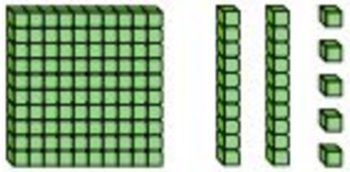
… a strong mathematics program that emphasizes and engages [mathematically proficient and literate students] in problem solving, communicating, reasoning and proof, making connections and using representations.

Equity

Problem Solving

Technology

Curiosity, Enjoyment & Understanding



What is Algebraic Reasoning?

According to the Mathematical Actions & Processes…

Throughout their Pk-12 education experience, mathematically literate students will:

Develop a Deep and Flexible Conceptual Understanding
Demonstrate a deep and flexible conceptual understanding of mathematical concepts, operations, and relations while making mathematical and real-world connections. Students will develop an understanding of how and when to apply and use the mathematics they know to solve problems.

Develop Accurate and Appropriate Procedural Fluency
Learn efficient procedures and algorithms for computations and repeated processes based on a strong sense of numbers. Develop fluency in addition, subtraction, multiplication, and division of numbers and expressions. Students will generate a sophisticated understanding of the development and application of algorithms and procedures.

Develop Strategies for Problem Solving
Analyze the parts of complex mathematical tasks and identify entry points to begin the search for a solution. Students will select from a variety of problem solving strategies and use corresponding multiple representations (verbal, physical, symbolic, pictorial, graphical, tabular) when appropriate. They will pursue solutions to various tasks from real-world situations and applications that are often interdisciplinary in nature. They will find methods to verify their answers in context and will always question the reasonableness of solutions.

Develop Mathematical Reasoning
Explore and communicate a variety of reasoning strategies to think through problems. Students will apply their logic to critique the thinking and strategies of others to develop and evaluate mathematical arguments, including making arguments and counterarguments and making connections to other contexts.

Develop a Productive Mathematical Disposition
Hold the belief that mathematics is sensible, useful and worthwhile. Students will develop the habit of looking for and making use of patterns and mathematical structures. They will persevere and become resilient, effective problem solvers.

Develop the Ability to Make Conjectures, Model, and Generalize
Make predictions and conjectures and draw conclusions throughout the problem solving process based on patterns and the repeated structures in mathematics. Students will create, identify, and extend patterns as a strategy for solving and making sense of problems.

Develop the Ability to Communicate Mathematically
Students will discuss, write, read, interpret and translate ideas and concepts mathematically. As they progress, students' ability to communicate mathematically will include their increased use of mathematical language and terms and analysis of mathematical definitions.

What is Algebraic Reasoning?

Why Teach It?

Teaching Algebraic Reasoning

Through Explicit Instruction

H.O.T.S.

Dr. John Star

"Math does not teach Problem Solving."

"Only the explicit teaching of thinking teaches thinking."

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Teaching Algebraic Reasoning

Through Problem Solving

Exercise

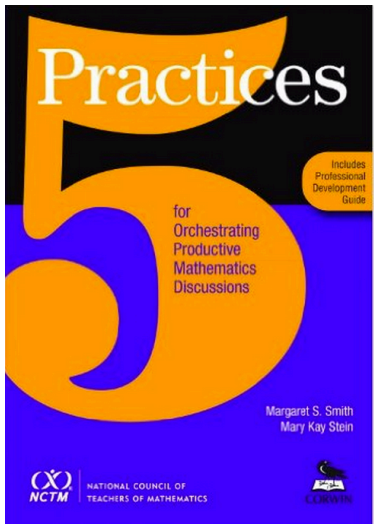
Problem

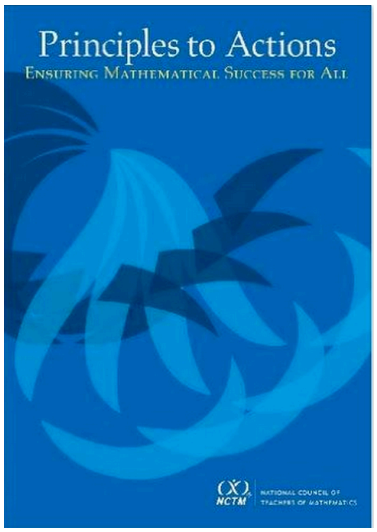
Don't Know How

Have the Ability

Crisis

Teaching Algebraic Reasoning
Through Tasks





Dr. Peg Smith

"It's all about the task.

It's all about the task.

It's all about the task."

Teaching Algebraic Reasoning

Through Tasks

"a problem that provides an opportunity to develop mathematical ideas and [thinking]."

-- Adding It Up (2001)

Tasks = Problems used to teach Content & Processes

Teaching Algebraic Reasoning

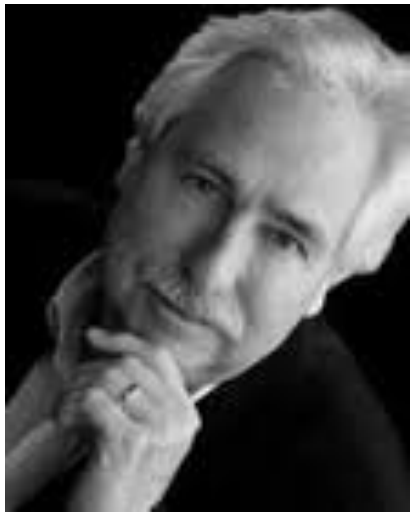
To Whom?

"Accelerated" Remedial Math Students with Rich & Robust Tasks

Dr. Uri Treisman

ALL Kids!

Dave Foster



50% False Positives
Among 8th Grade Geometry
From CST to SBAC

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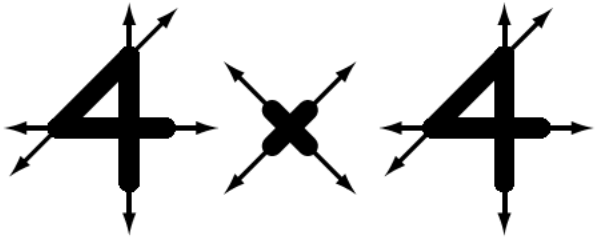
Teaching Algebraic Reasoning

How Is It Best Taught?

Lessons for Algebraic Reasoning



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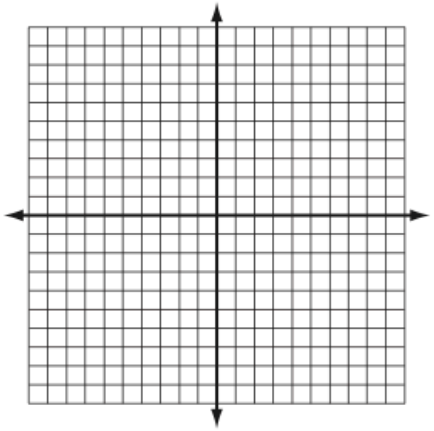
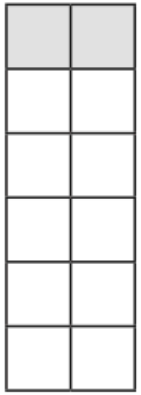




Equation:

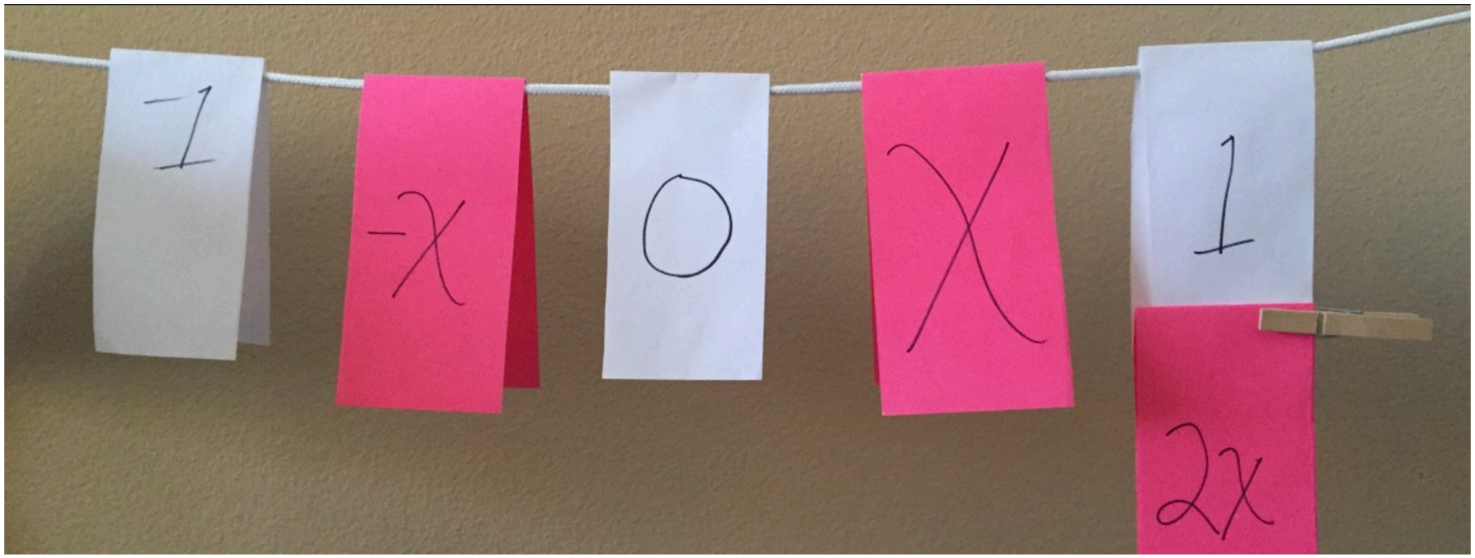
_____

Scenario: **Fred moves into town with no friends, and makes one new friend every day.**

Lessons for Algebraic Reasoning

The Master Number Sense Maker!

Clothesline Math



#clotheslinemath

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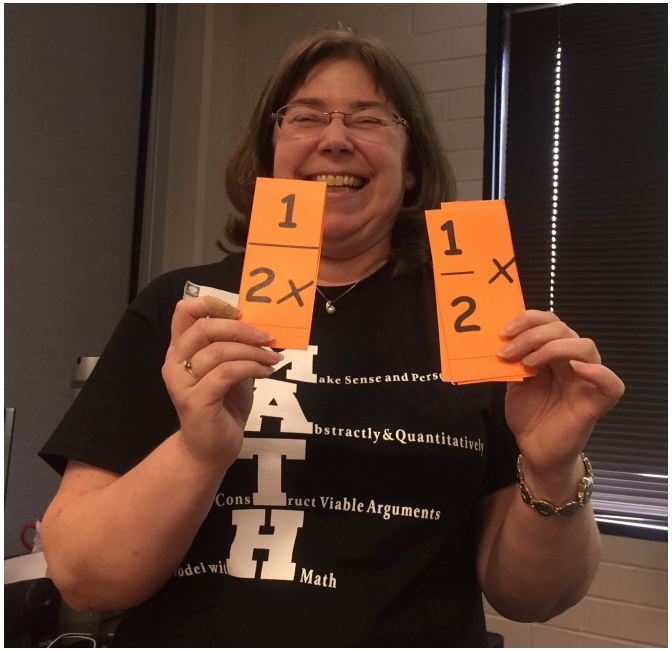
Clothesline Math

A Brief History



Molly Daley
@mdaley15

I've just been Clotheslined or maybe kicked in the head. @MathProjects #55thNWMC

Clothesline Math

Exponential Decay or Oder of Ops?

$$y = 6\left(\frac{1}{2}\right)^x$$

$6\left(\frac{1}{2}\right)^0$	$6\left(\frac{1}{2}\right)^1$	$6\left(\frac{1}{2}\right)^2$

Clothesline Math Handout

The Clothesline

Name: _____

Date: _____

For each set, record the given values, expressions or drawings. After the discussion of their placement on the clothesline, record them on the number line.

1. _____, _____, _____

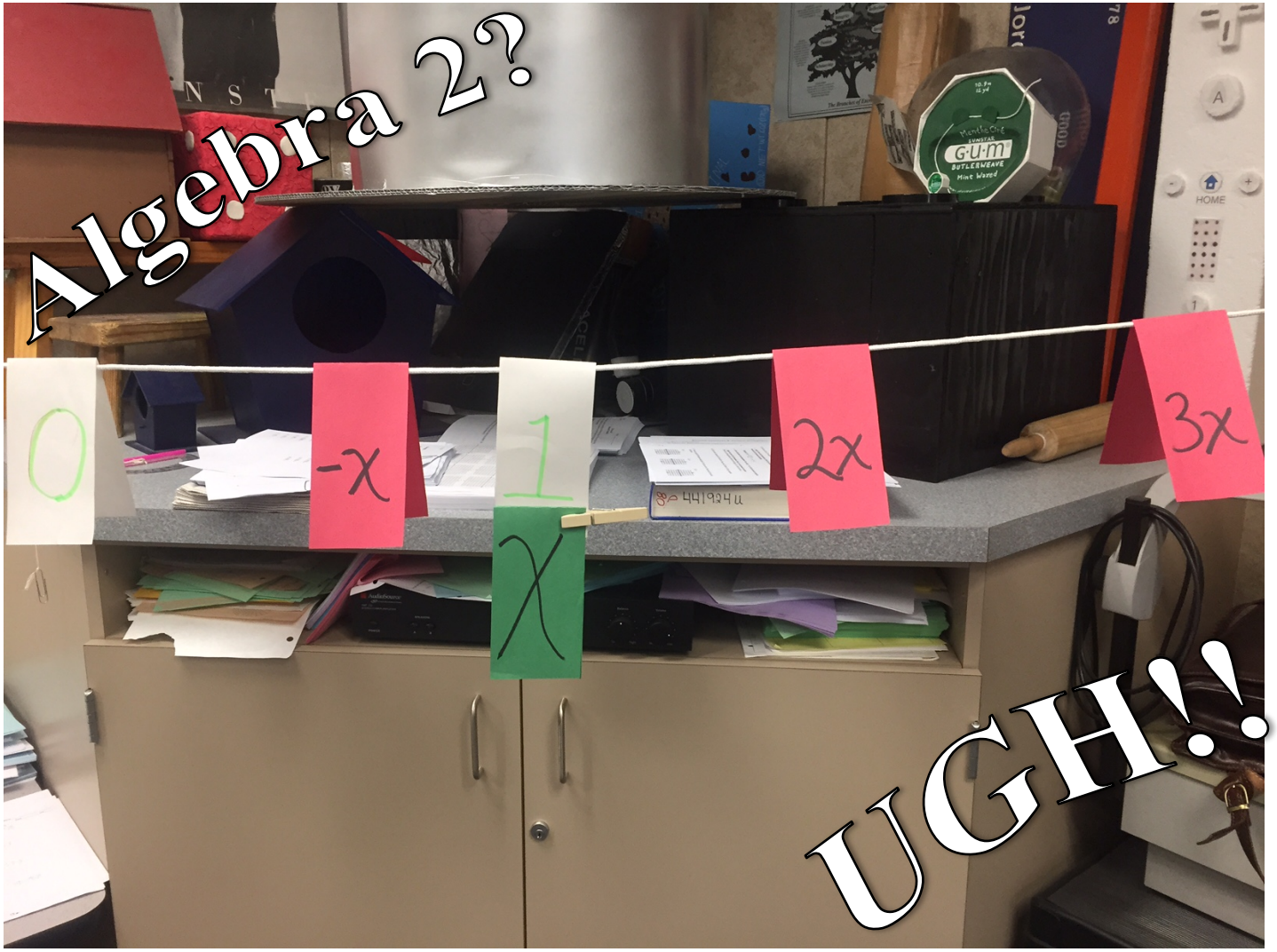
Discussions, Deductions & Decisions

Clothesline Statistics

Logarithms

$\log_4 16$	$\log_2 \frac{1}{8}$	$\ln 1$

Clothesline



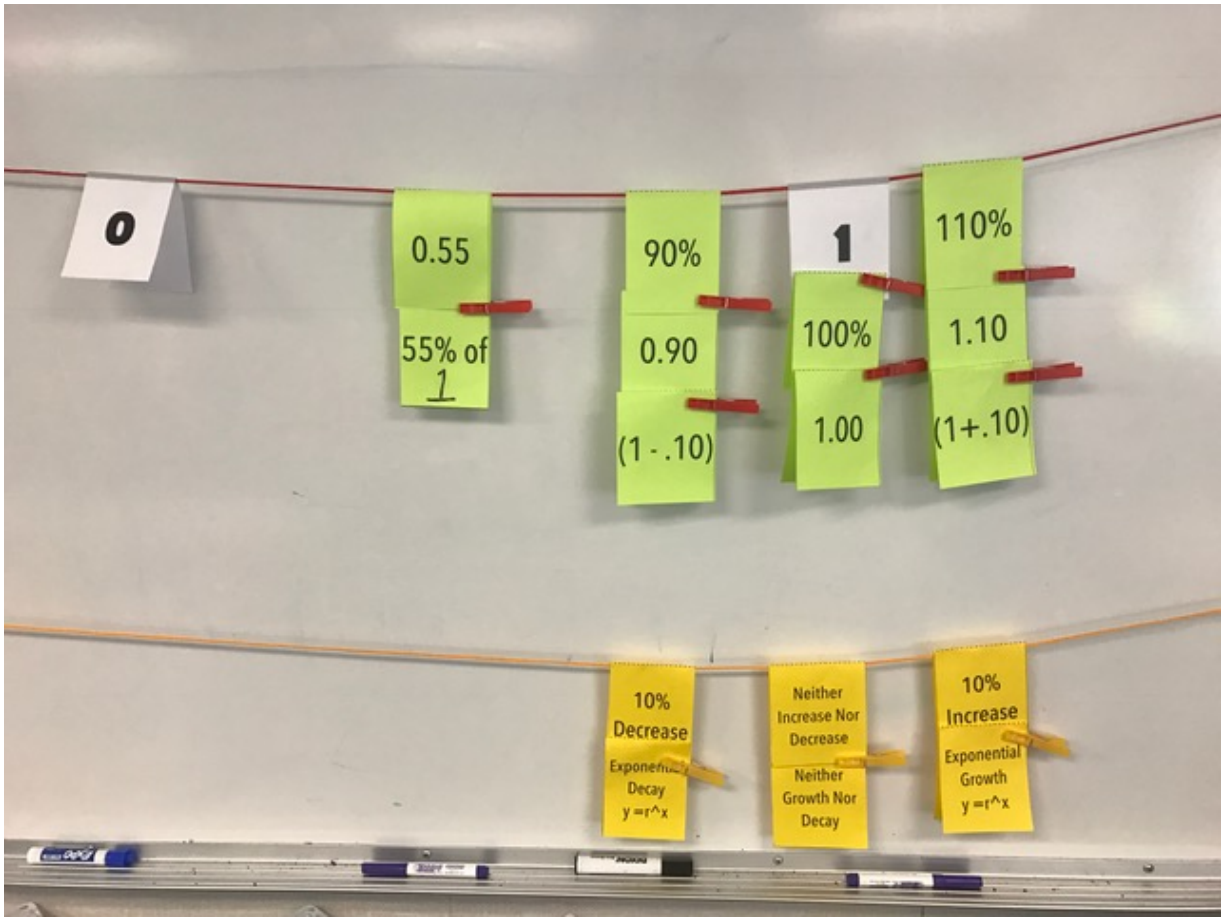
Clothesline Math as Review

$\sqrt[3]{8}$ $25^{\frac{1}{2}}$ -2.5 5^{-2} $(-2)^0$ $\frac{3}{2}$ $\sqrt{2}$

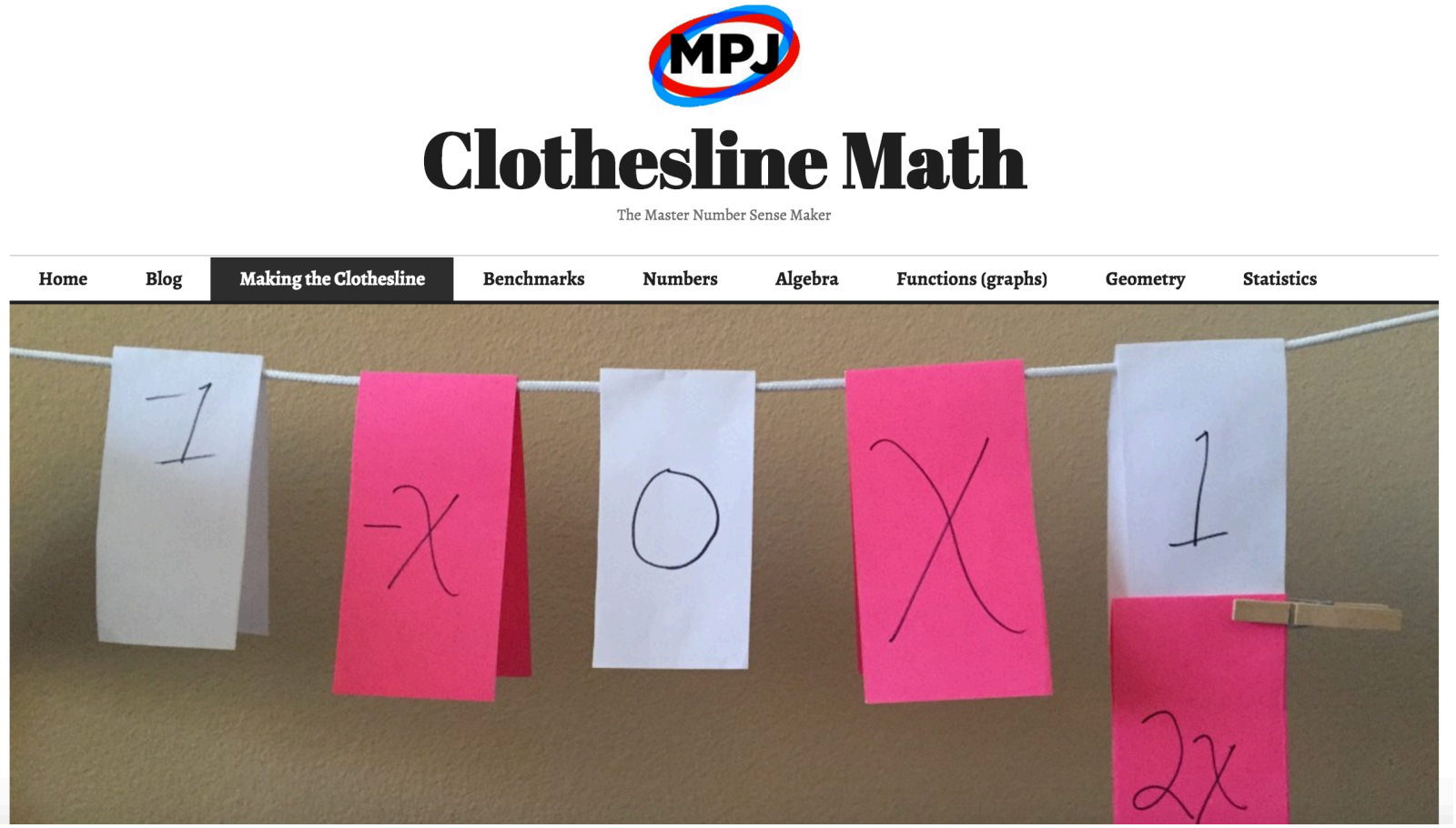
73% $16^{\frac{1}{4}} + 32^{\frac{1}{5}}$ $4^{\frac{3}{2}}$ -0.08 $-\sqrt{3}$ $8^{-\frac{1}{3}}$ $\sqrt{42}$

Clothesline Math

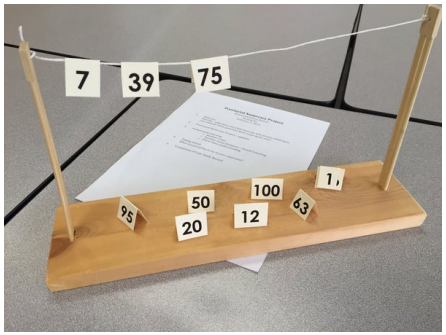
on conceptual warm-ups

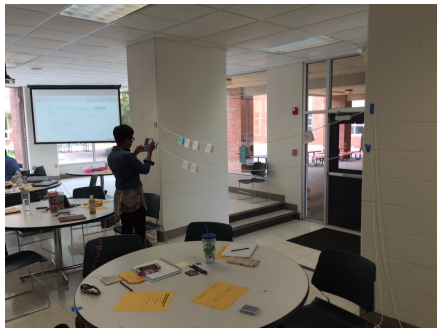


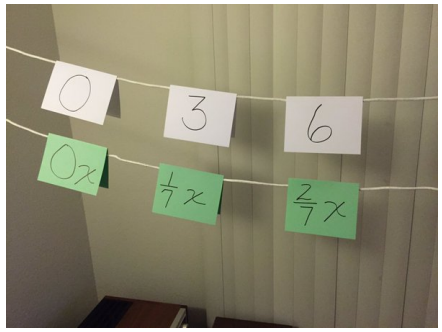
www.clotheslinemath.com

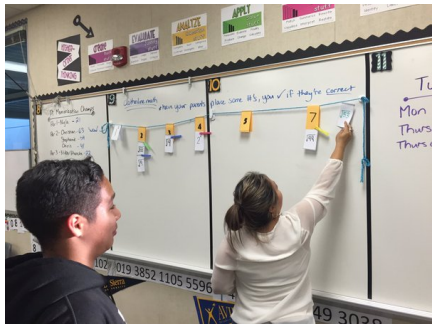


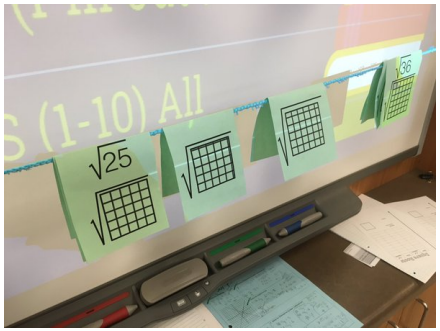
Clothesline Math Around the Nation

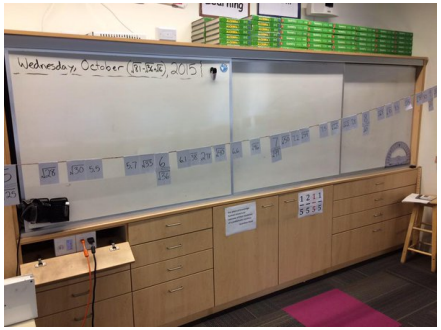


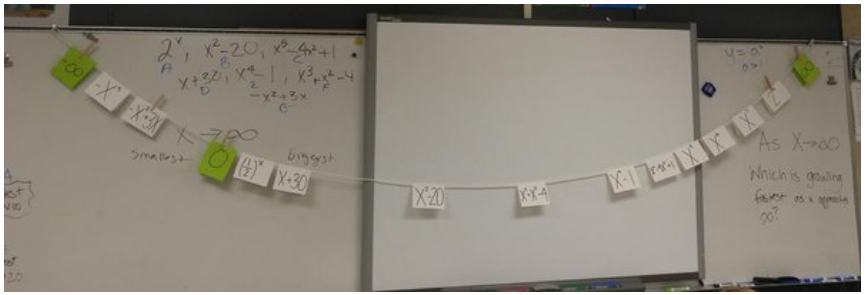


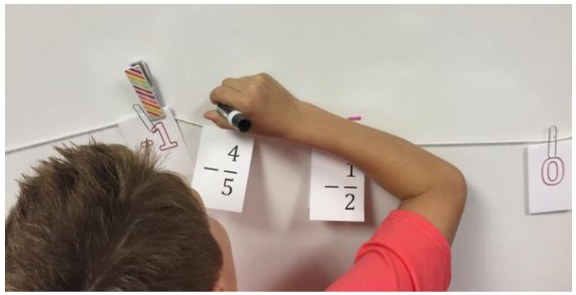






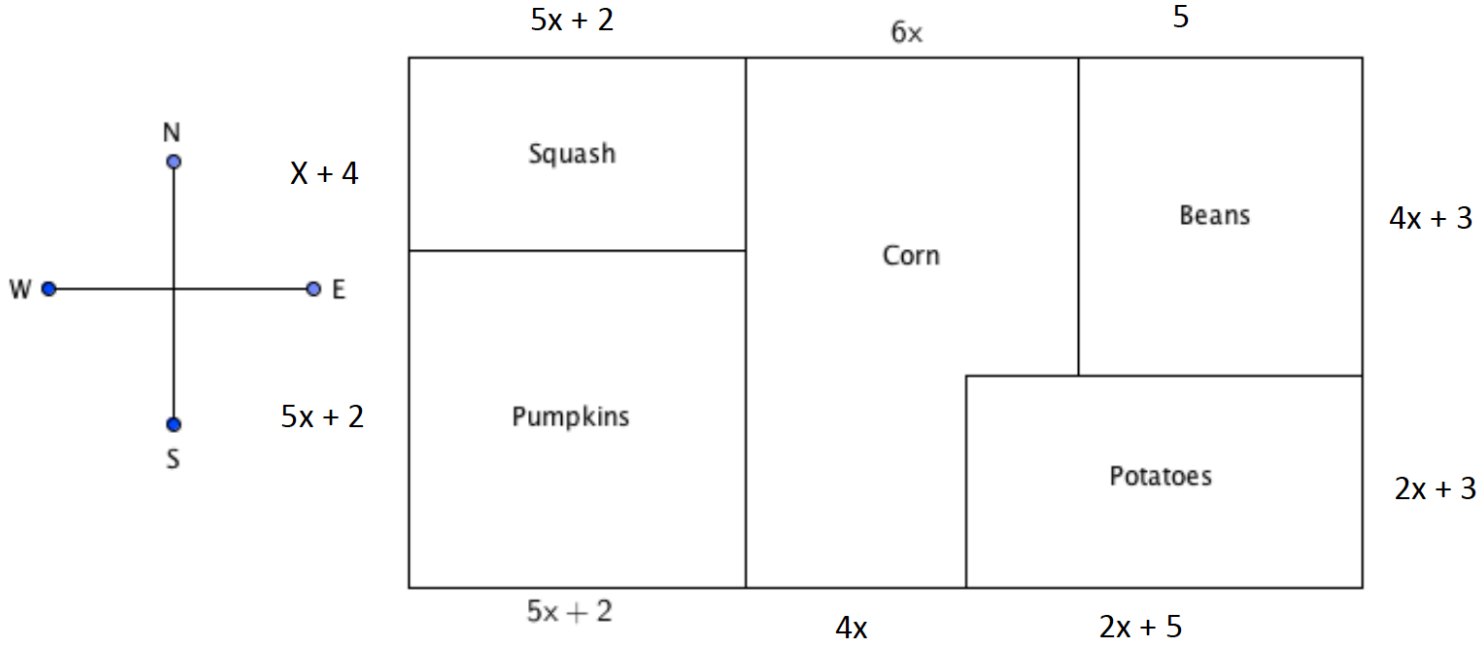






Lessons for Algebraic Reasoning

Polynomial Farm



Day 1 & 2

Lessons for Algebraic Reasoning

Conceptual ➔ Procedural ➔ Application Practice

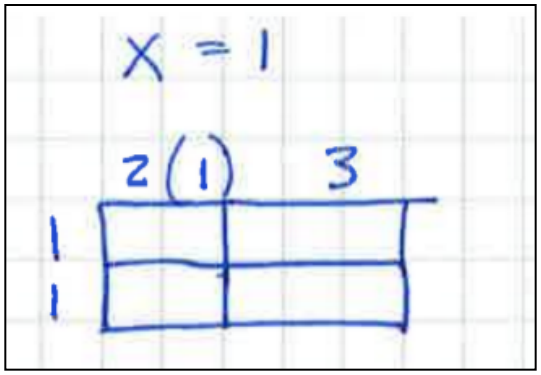
	4in.	5in.
2in.	A	B
3in.	C	D

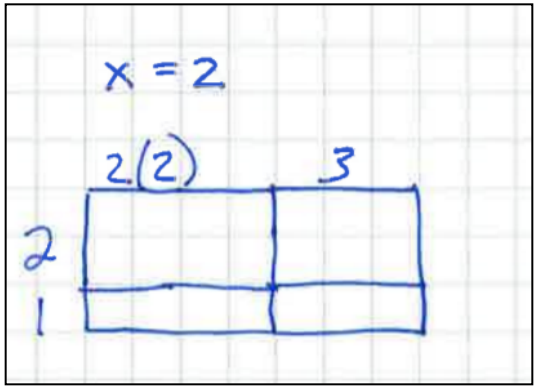
	2x	3
x	A	B
1	C	D

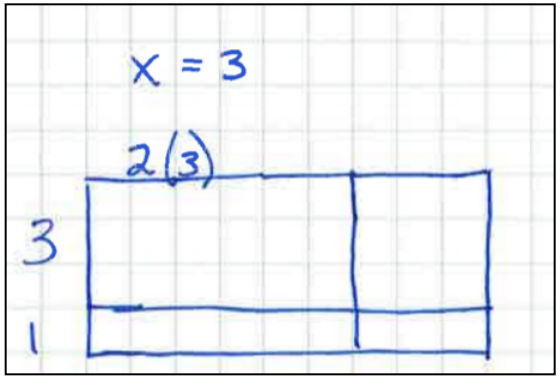
	Perimeter	Area
A		
B		
C		
D		
Large Rectangle		

Day 3

Lessons for Algebraic Reasoning

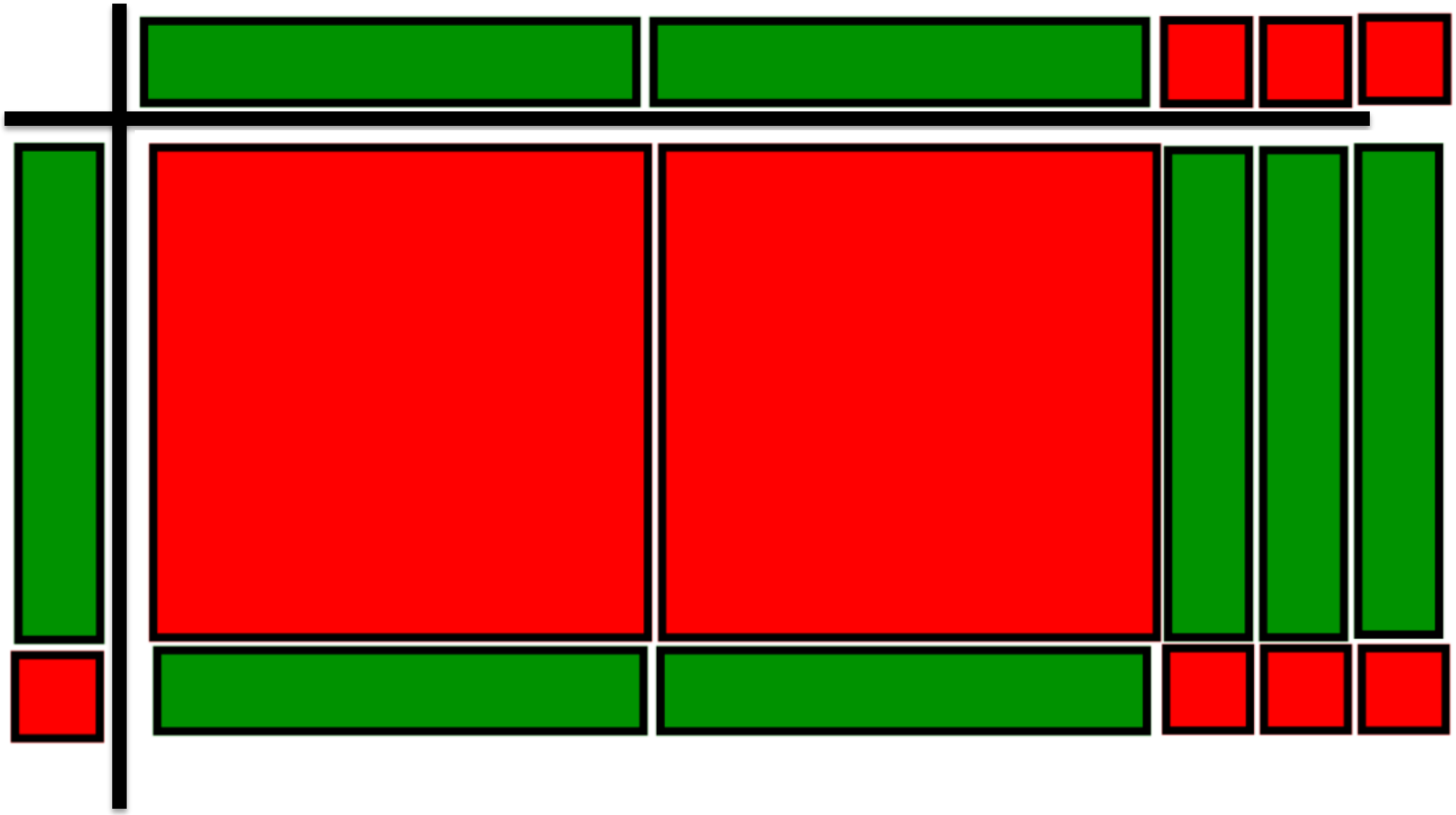






Day 4

Lessons for Algebraic Reasoning

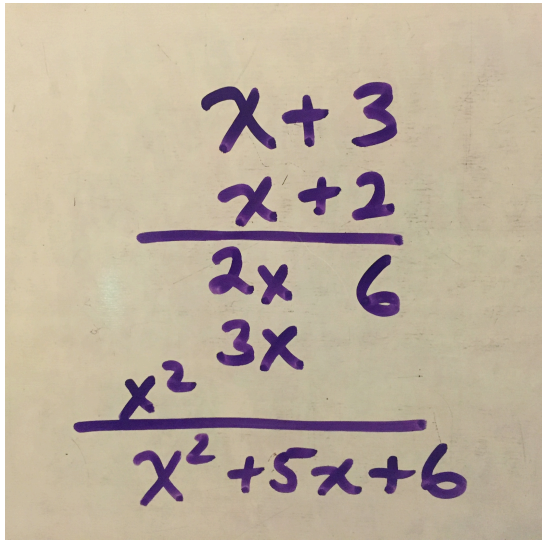


Day 6

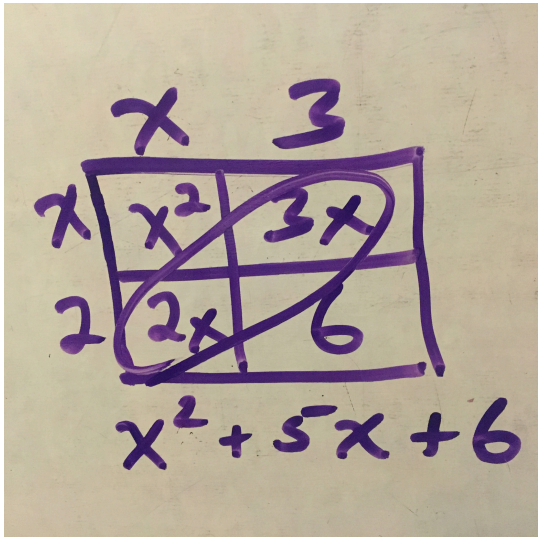
Lessons for Algebraic Reasoning

Conceptual → Procedural → Application Practice

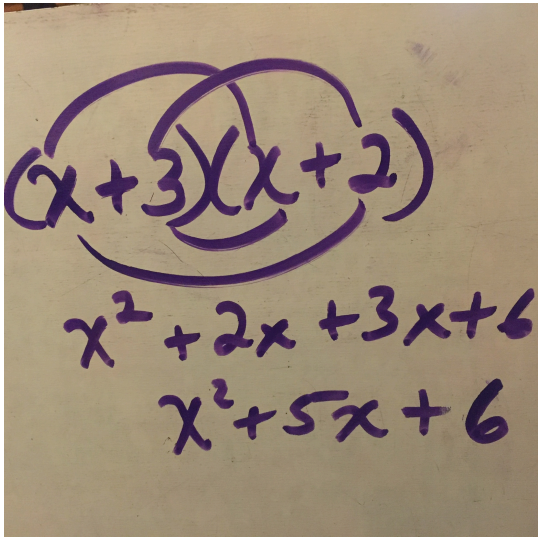
Stacking Method



Area Model
Box Method

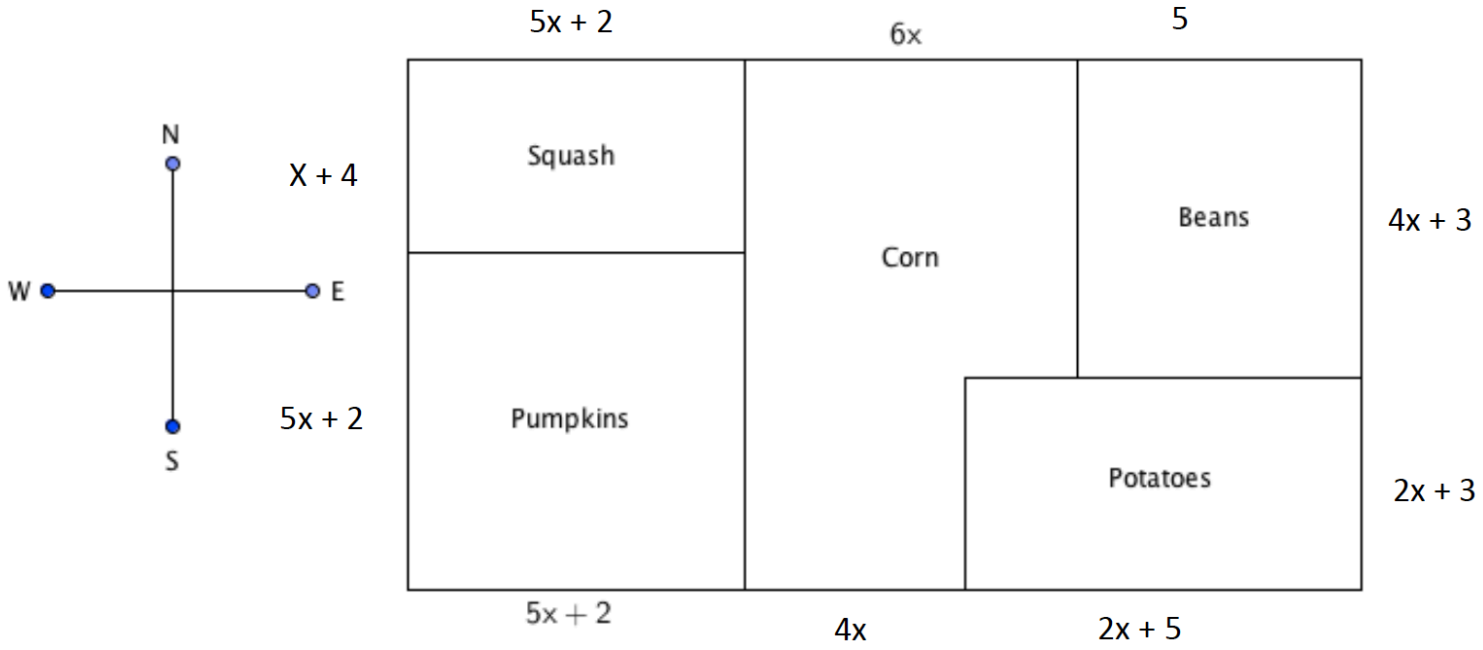


FOIL method



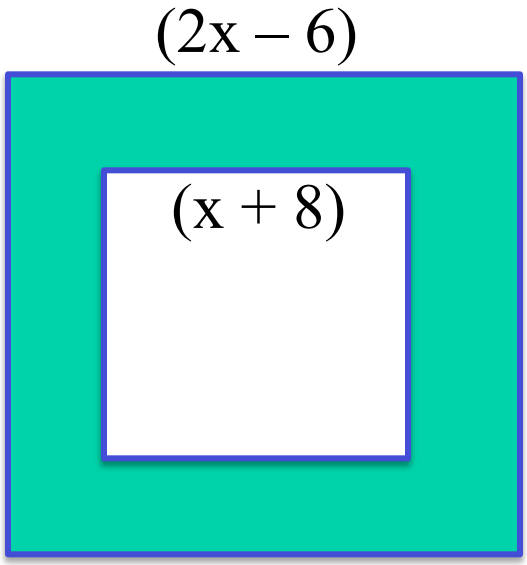
Day 7

Lessons for Algebraic Reasoning



Lessons for Algebraic Reasoning

Audra is framing a square painting with side lengths of (x + 8) inches. The total area of the painting and the frame has a side length of (2x - 6). The material for the frame is $0.10 per square inch.

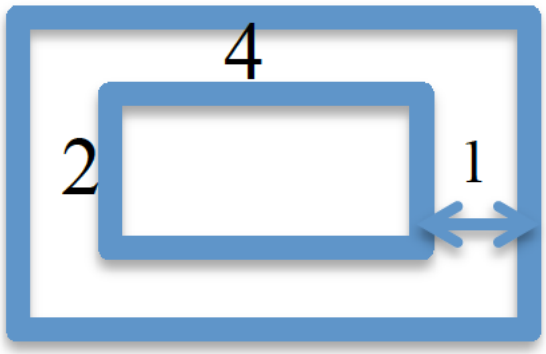


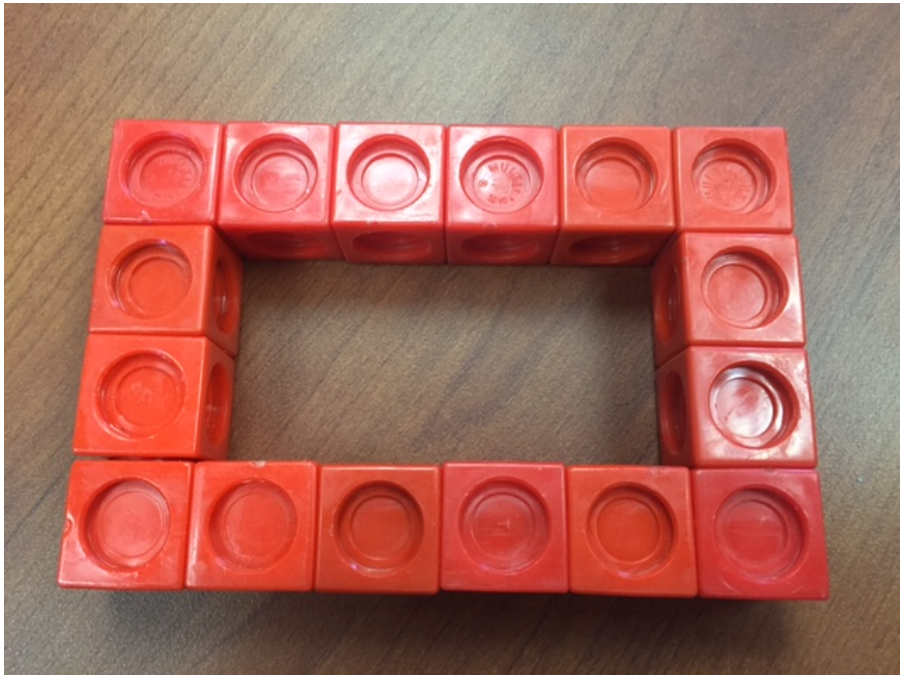
$(2x - 6)^2 - (x + 8)^2$

1. Write the expression for the area of the painting.
2. Write the expression for the area of the painting and the frame.
3. Write the expression for the area of the frame.
4. Find the area of the frame if x=16.
5. Find the cost of the material for the frame.

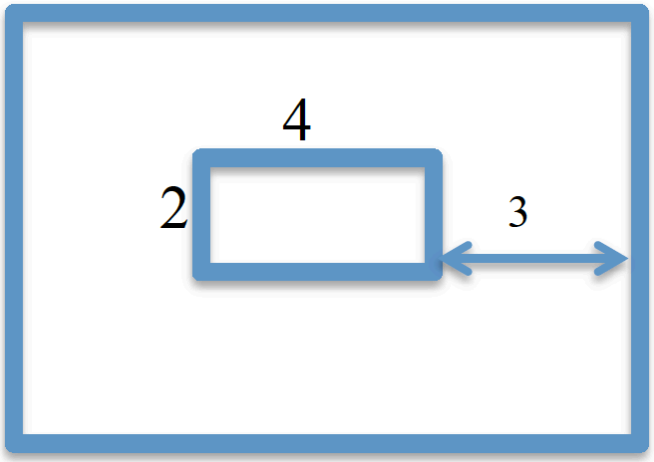
Day 10-11

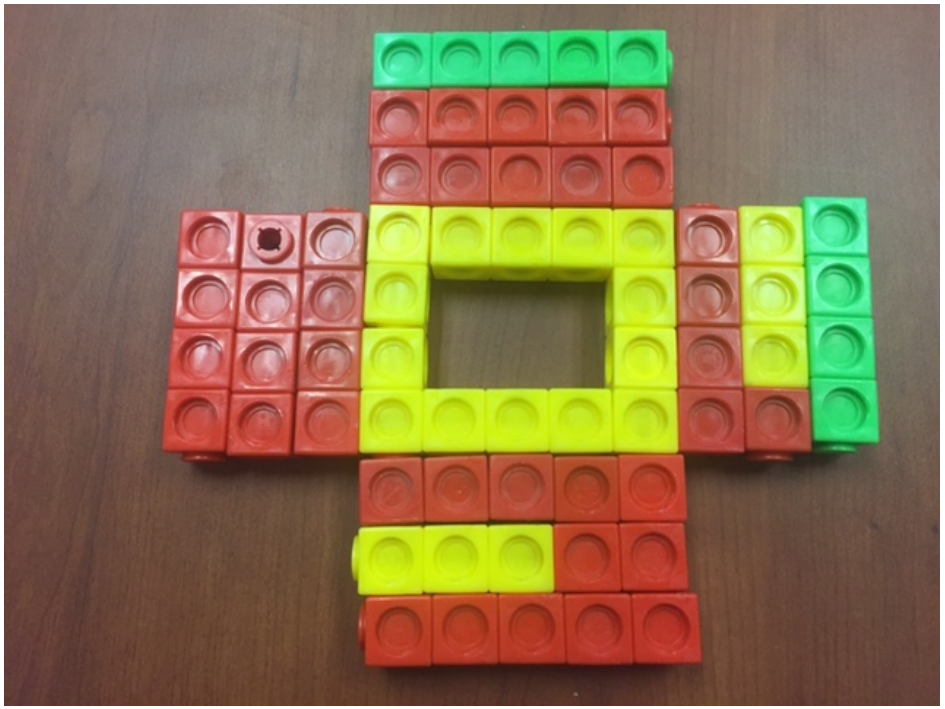
Lessons for Algebraic Reasoning





Lessons for Algebraic Reasoning

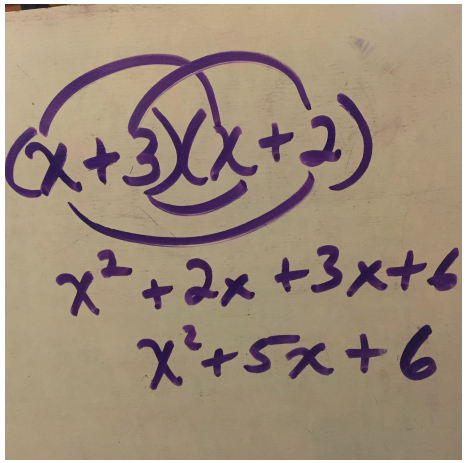


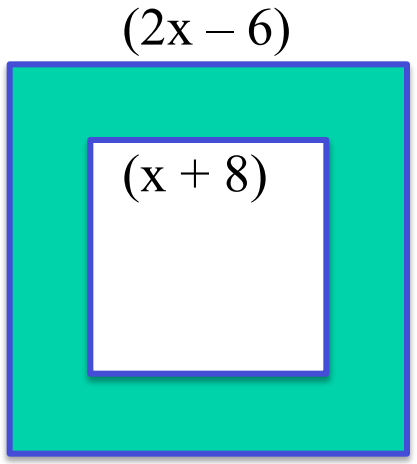


Lessons for Algebraic Reasoning

Conceptual ➔ Procedural ➔ Application Practice

	2x	3
x	A	B
1	C	D





Lowest Grade on District Benchmark for Polynomials = **76%**

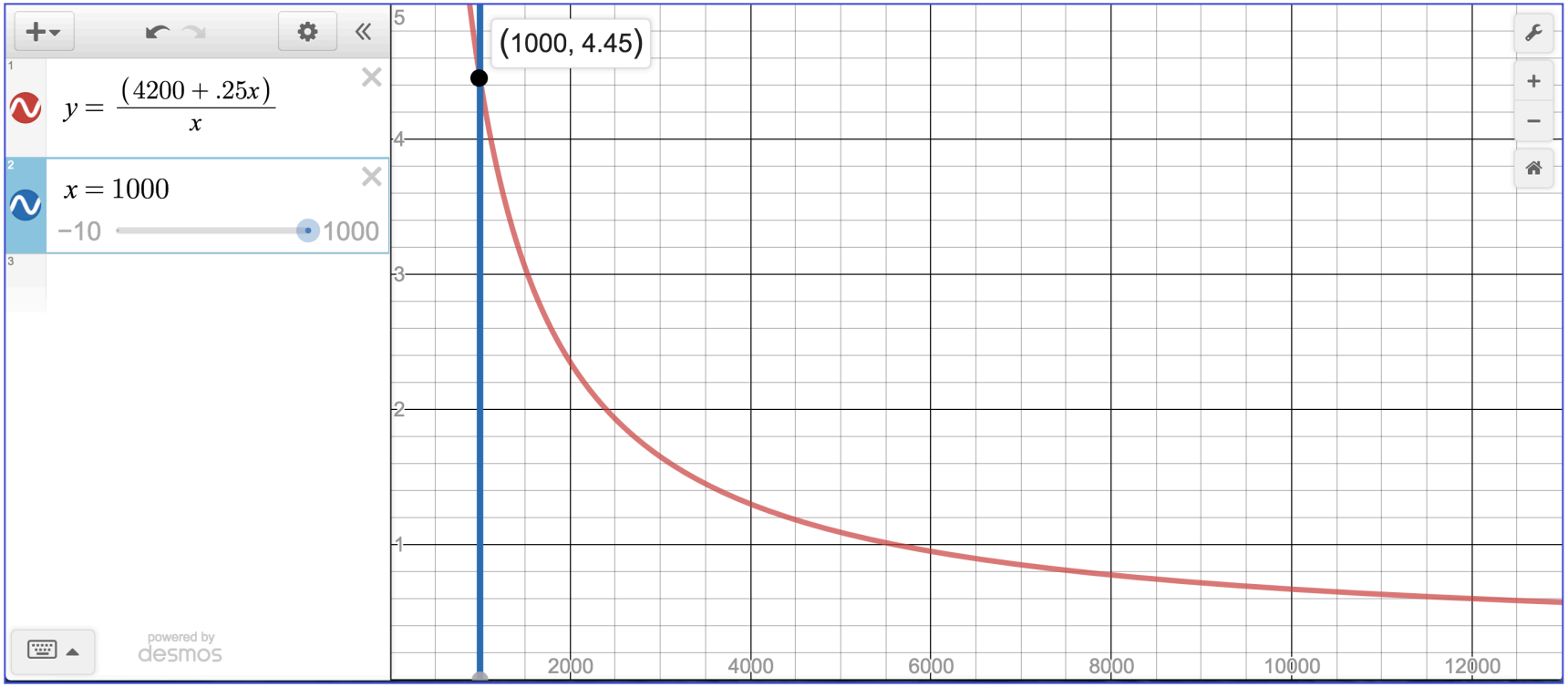
Day 15

Lessons for Algebraic Reasoning

Optimal Bait Company

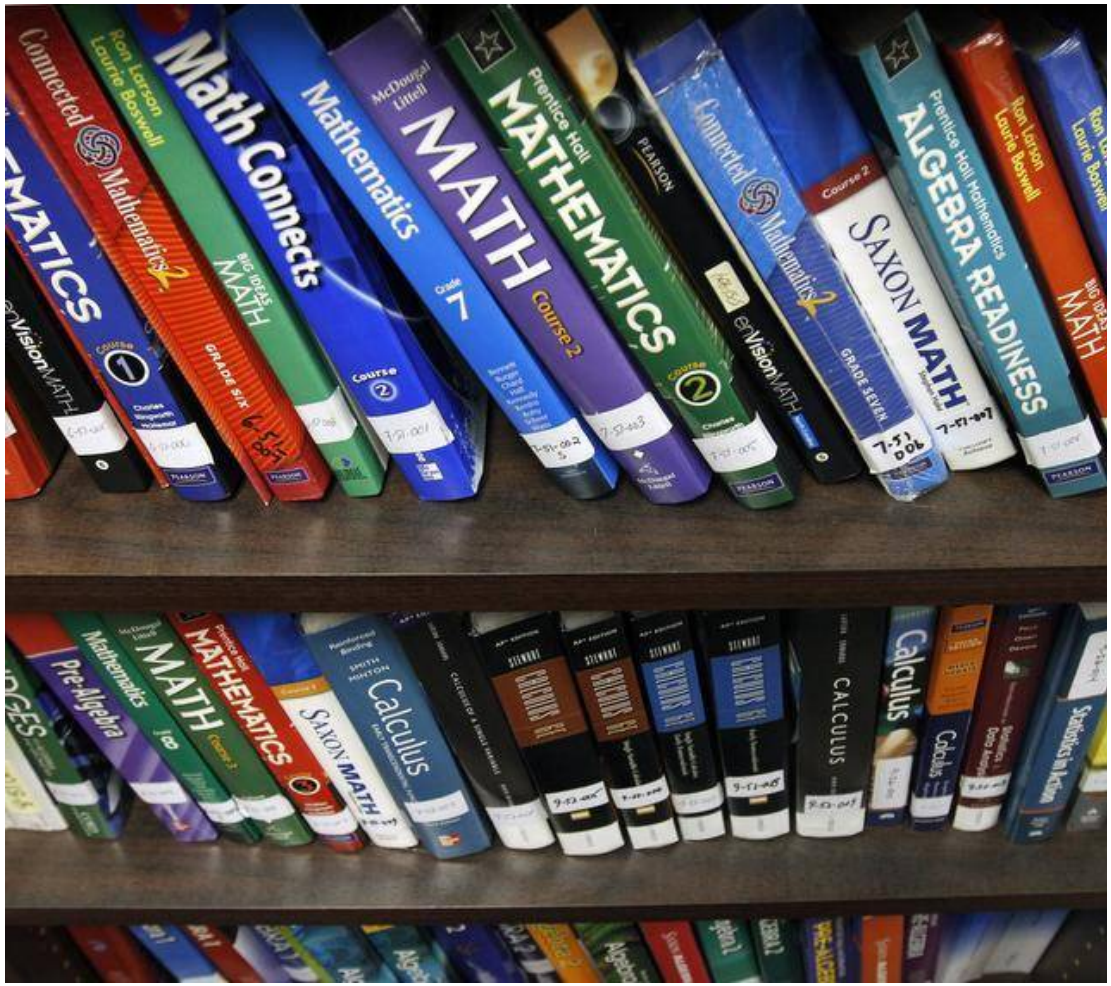
#1, 2 & 5

Lessons for Algebraic Reasoning



Lessons for Algebraic Reasoning

What About From Your Textbooks?



Teaching Algebraic Reasoning

What Lessons and Techniques Will You Use?

Thoughts on Math

by the Initiated

"If you know how to do one problem inside and out, you can do a hundred just like it."

-- Seheti, Math Teacher from India

"You just showed us several ways to do one problem, instead of one way to do several problems."

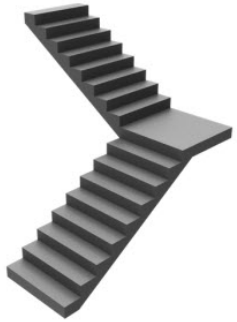
"Exactly!" -- Conversation with Dr. Tom Bennett, CSU San Marcos

"Poetry is the language of love. Math is the language of everything else." -- Jon, Class of '99, U.S. Navy

Ultimate Cosmic Targets

WHY?

Define Algebraic Reasoning



HOW?

Learn the Key to Teaching Algebraic Reasoning

WHAT?

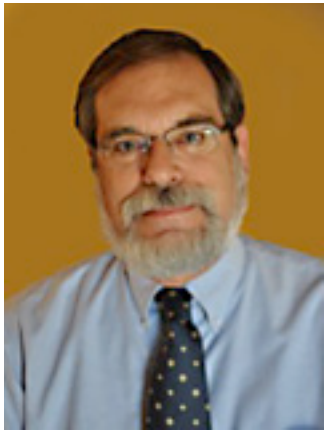
Engage in Lessons for Algebraic Reasoning

MPJ

Call to Action

Fail Grandly

No Real Risk



10%

2-Week Rule

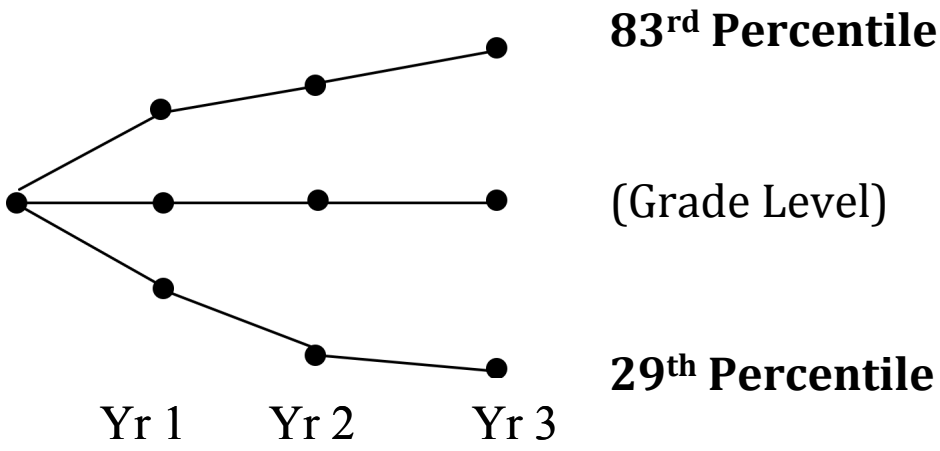
1 Thing

MPJ

Teacher Action is the Difference

"The greatest influence in the quality of the education that a student receives is the decisions that a teacher makes on a daily basis."

-- Dr. William Schmidt, University of Michigan



Teacher Action is the Difference

Teachers matter most.

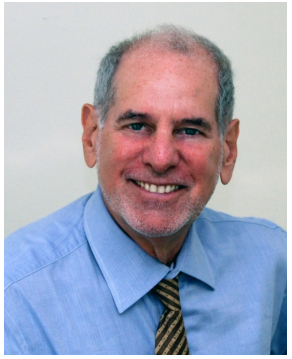
-- Dr. William Schmidt, University of Michigan

Teachers matter most.

-- Peg Smith, University of Pittsburgh

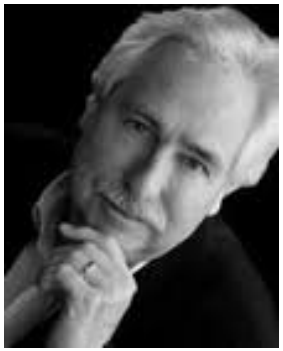
Teachers matter most.

-- Tim Kanold, Adlai E. Stevenson HS, Chicago



Poverty matters … a lot.

-- Dr. Uri Treismen, University of Texas, Austin



Teachers matter most.

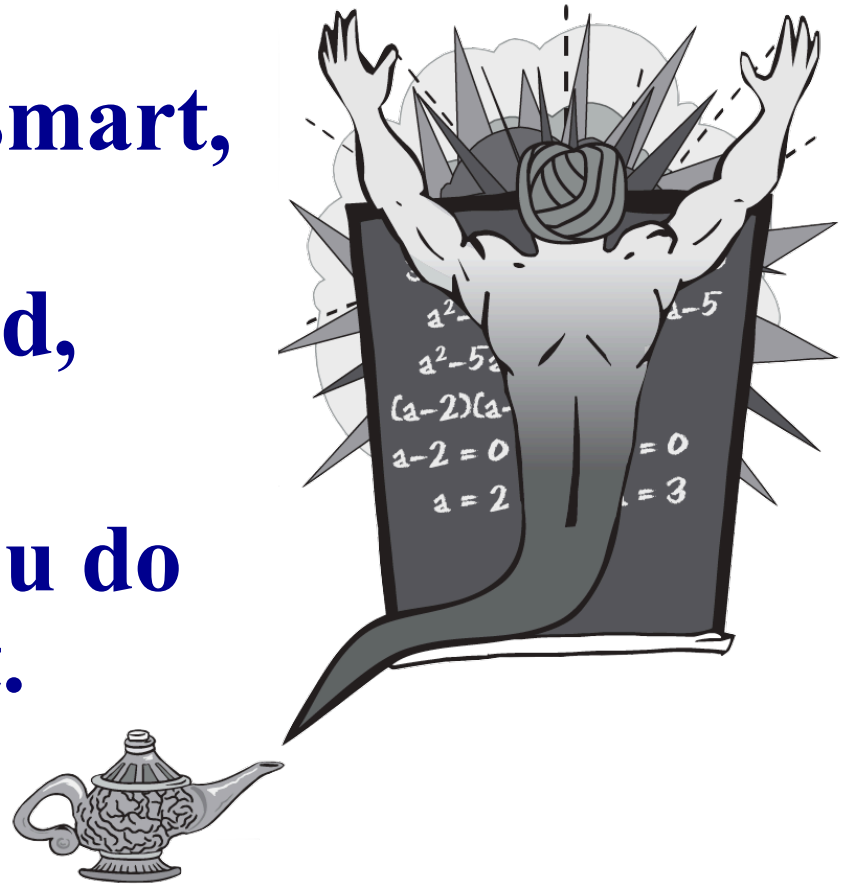
-- David Foster, Silicon Valley Math Initiative, CA

MPJ

Instill Ultimate Cosmic Power in your students …

because they are that smart,
and
we are that good,

and because what you do matters the most.



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