Polynomial Farm & the C-P-A Progression

Chris Shore
The Math Projects Journal
Murrieta Valley USD, CA

@MathProjects

Embrace our differences to the 3rd degree!

Polynomial Farm & the C-P-A Progression

$$x + x = ?$$

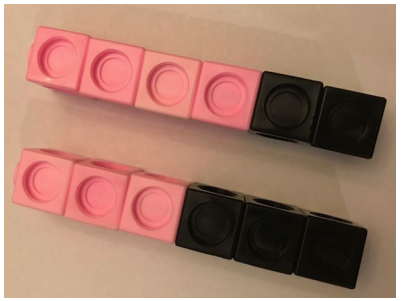
A) $2x$ B) x^2

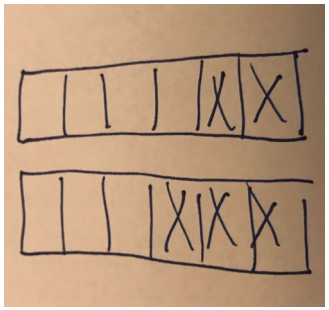
How do you know?

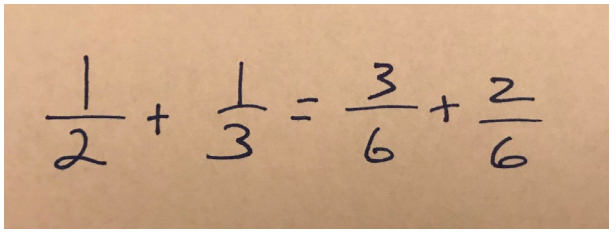
MPJ

The C-P-A Progression

Concrete → Representational → Abstract







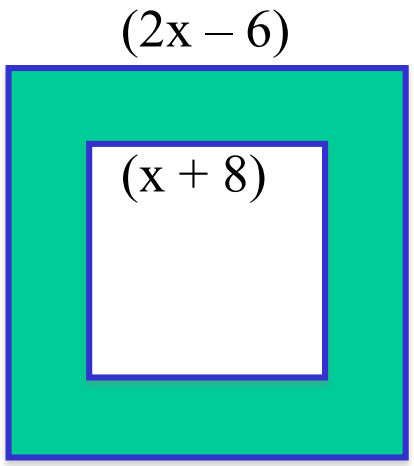
Concrete → Pictorial → Abstract

Conceptual → Procedural → Application

The C-P-A Progression

Goals for today

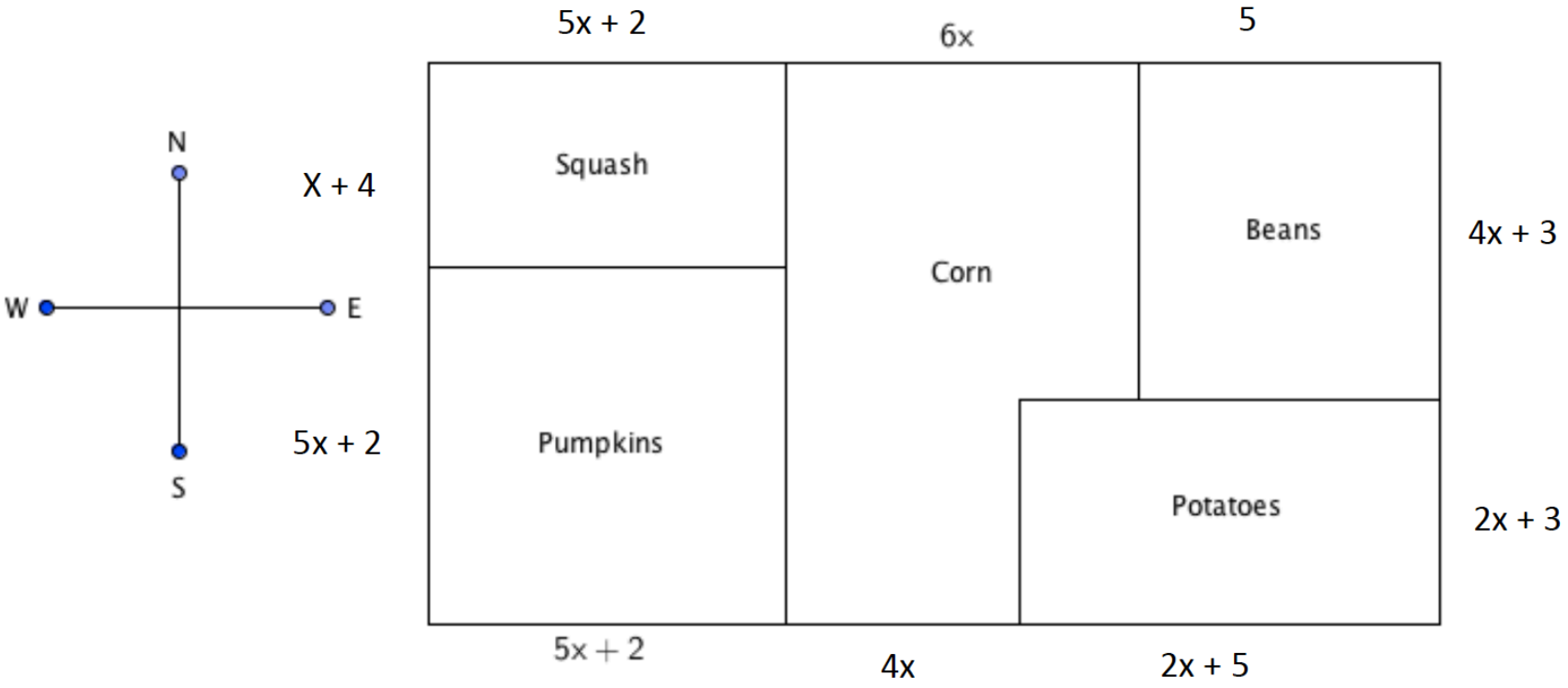
Conceptual ➔ Procedural ➔ Application



Amount	Ingredient
1 cup	flour
1 cup	yellow cornmeal
4 teaspoons	baking powder
$\frac{3}{4}$ teaspoon	salt
$\frac{3}{4}$ cup	sugar
2	eggs
1 cup	milk

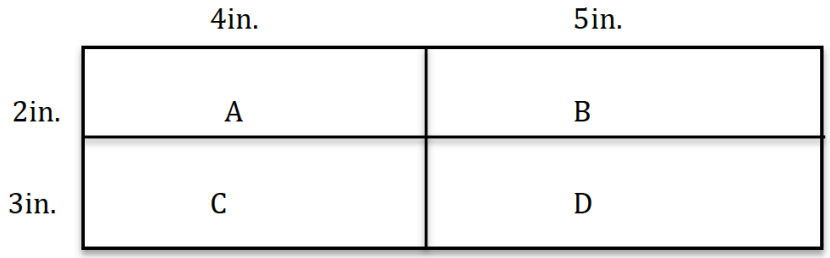
Polynomial Farm

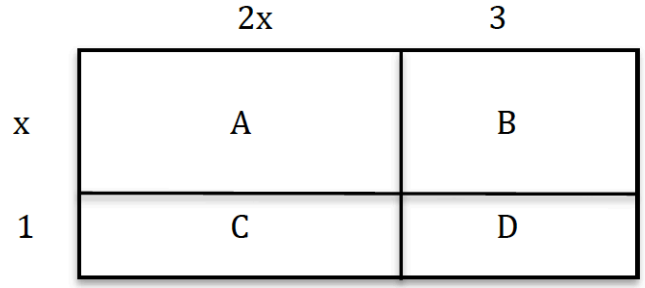
Conceptual ➔ Procedural ➔ Application



Polynomial Farm Day 1… & 2

Conceptual ➔ Procedural ➔ Application

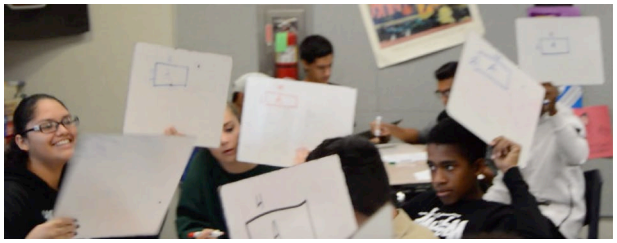




	Perimeter		Area	
A	12	6x	8	$2x^2$
B	14	2x + 6	10	3x
C	14	4x + 2	12	2x
D	16	8	15	3
Large Rectangle	✗ 28	6x + 8	45	$2x^2 + 5x + 3$

(x + 1)(2x + 3)

Polynomial Farm
Video Example of
Group Work & Student Discourse



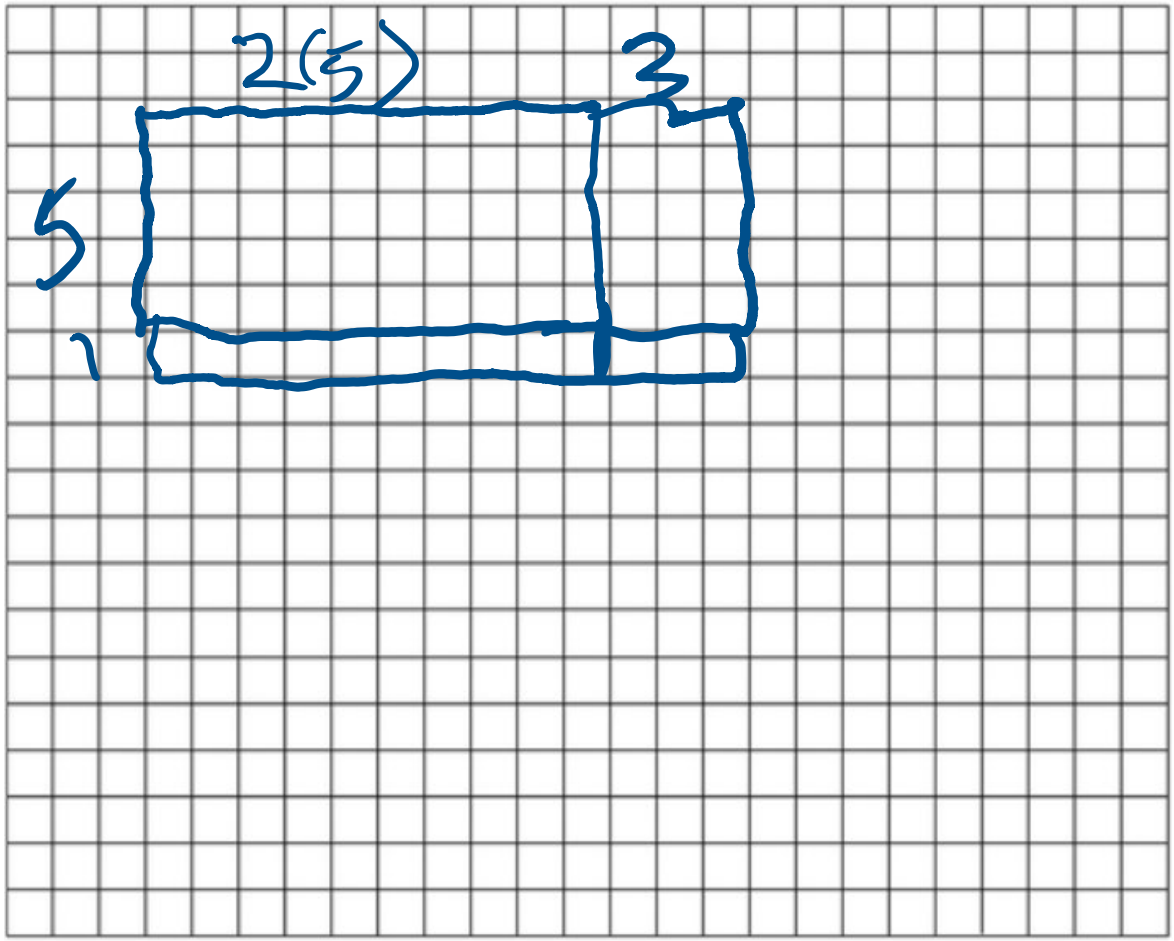
Group Expectations

Group Dynamics

Passionate Argument

Polynomial Farm Day 3

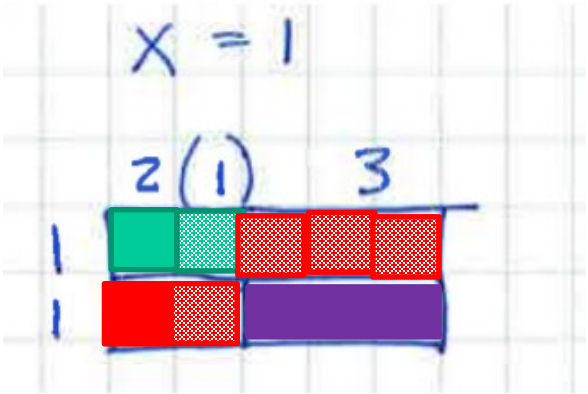
Conceptual ➔ Procedural ➔ Application

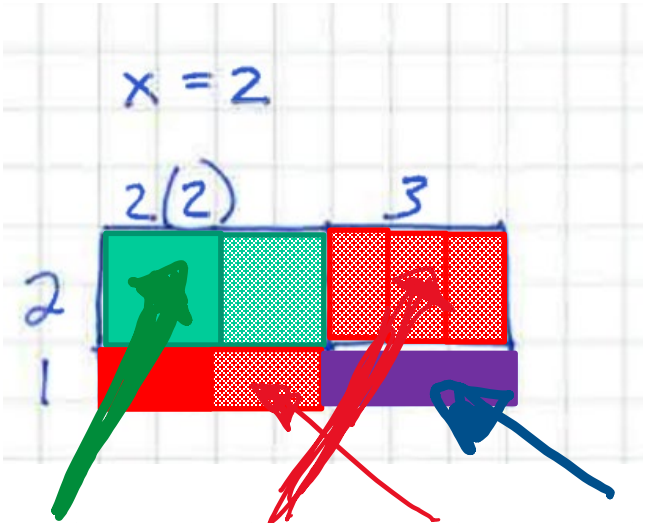


$x = 5$

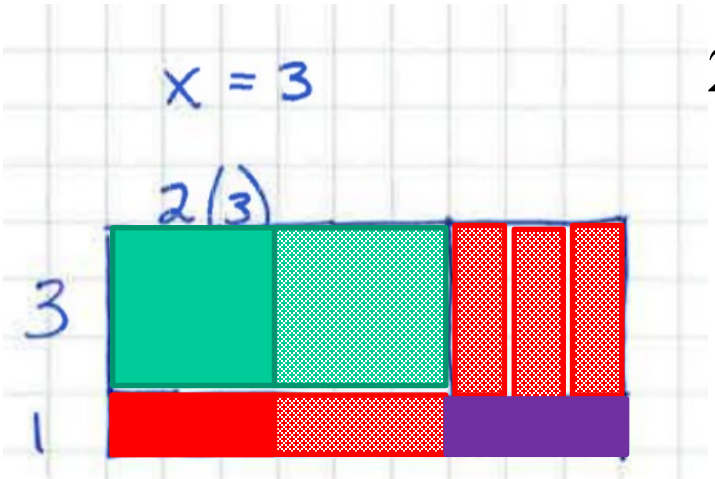
Polynomial Farm Day 3

Conceptual ➔ Procedural ➔ Application





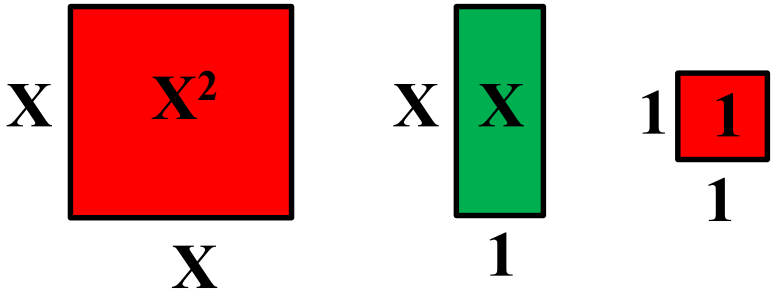
$2x(x) + 3(x) + 2x(1) + 3(1)$

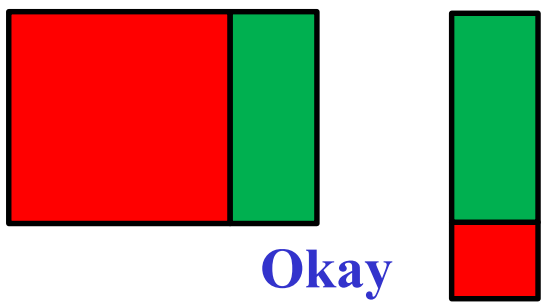


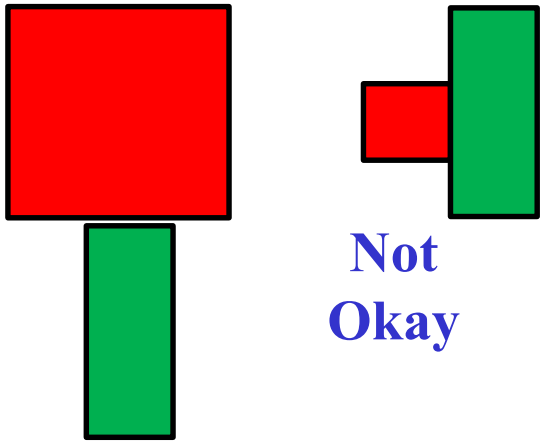
$2x^2 + 5x + 3$

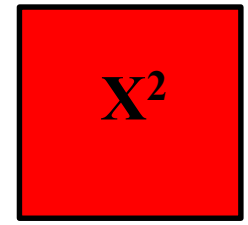
Polynomial Farm Day 4

Introduction of Algebra Tiles









Polynomial Farm Day 4

Conceptual → Procedural → Application

$$(x + 1)(2x + 3) = 2x^2 + 5x + 3$$

Polynomial Farm Day 5

Conceptual → Procedural → Application

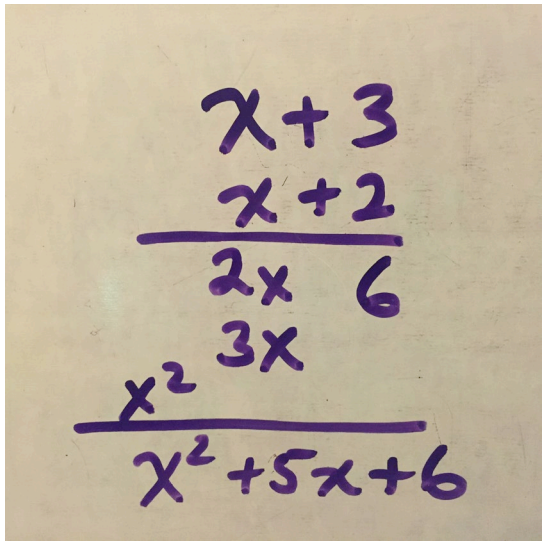
Group Quiz

Adding, Subtracting & Multiplying Polynomials

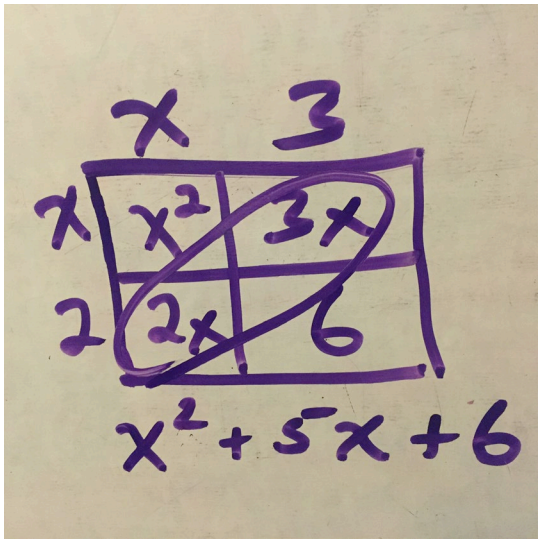
Polynomial Farm, Day 6

Conceptual → Procedural → Application

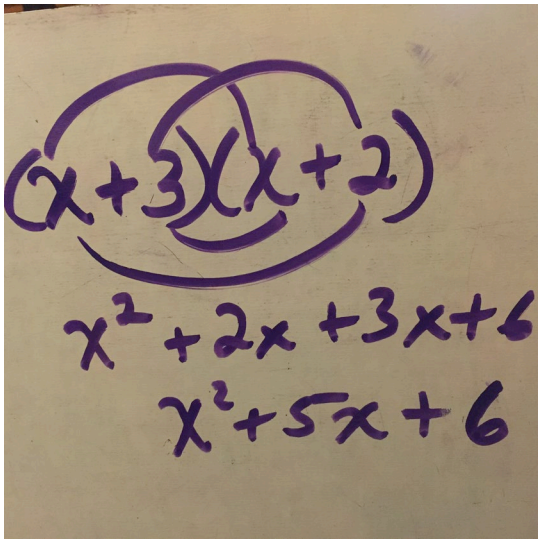
Stacking Method



Area Model
Box Method



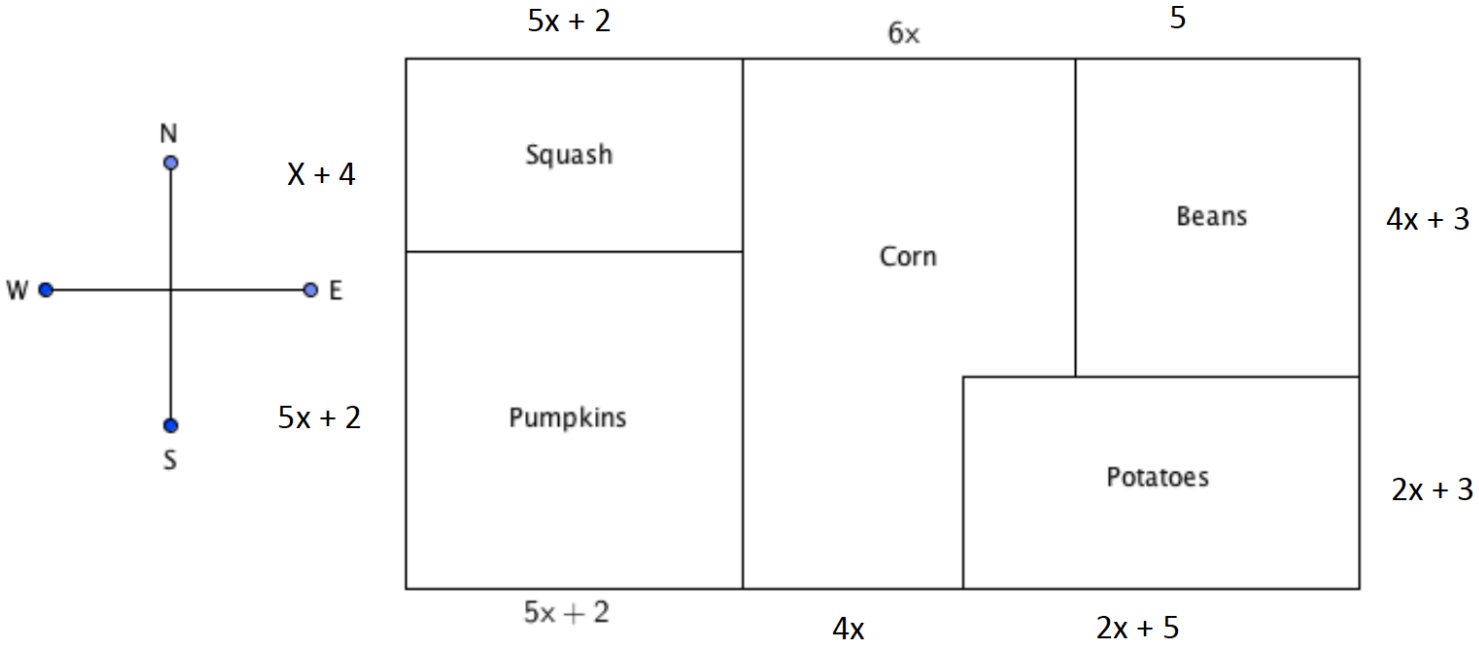
FOIL method



$$(x + 2)(x + 3) = x^2 + 5x + 6$$

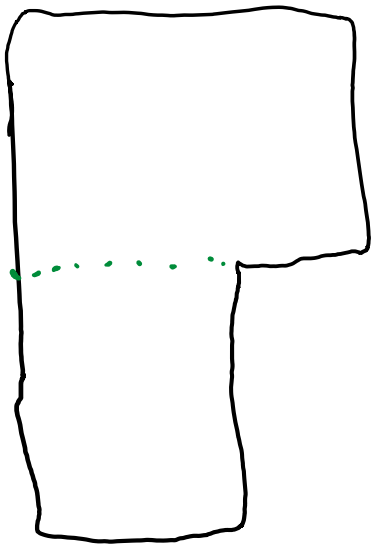
Polynomial Farm, Day 7

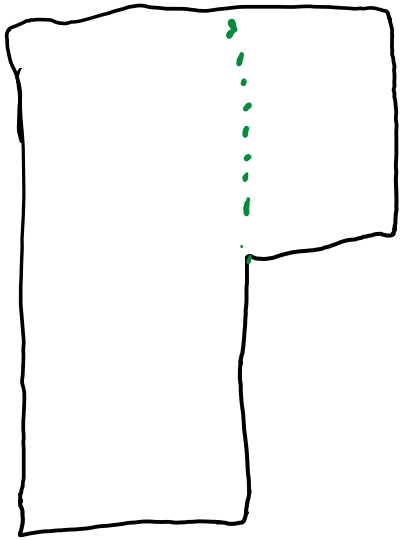
Conceptual ➔ Procedural ➔ Application

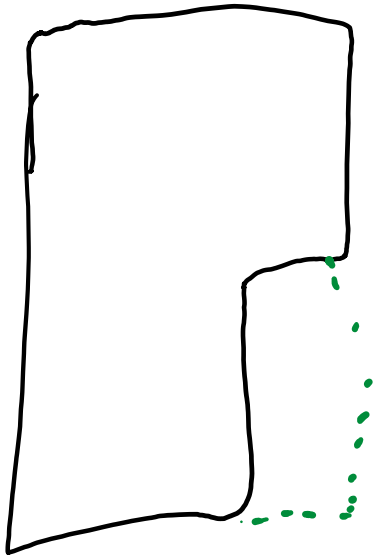


Polynomial Farm, Day 7

Conceptual ➔ Procedural ➔ Application







Polynomial Farm, Day 8 & 9

Conceptual → Procedural → Application

Day 8: Support Strategies

$$(3x + 5)^2$$

$$(a + b)(a - b)$$

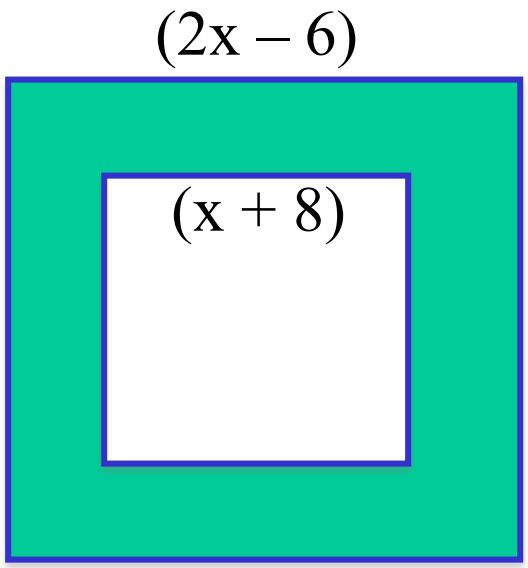
$$(x + 5)(x^2 + 2)$$

$$2x(x + 4) + (x + 5)(3x - 2)$$

Day 9 Notes & Practice

Polynomial Unit, Decision Time

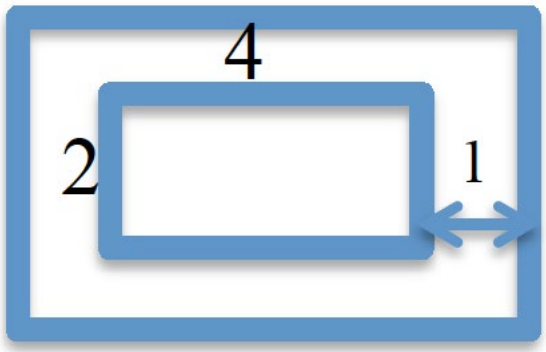
Audra is framing a square painting with side lengths of (x + 8) inches. The total area of the painting and the frame has a side length of (2x - 6). The material for the frame is $0.10 per square inch.

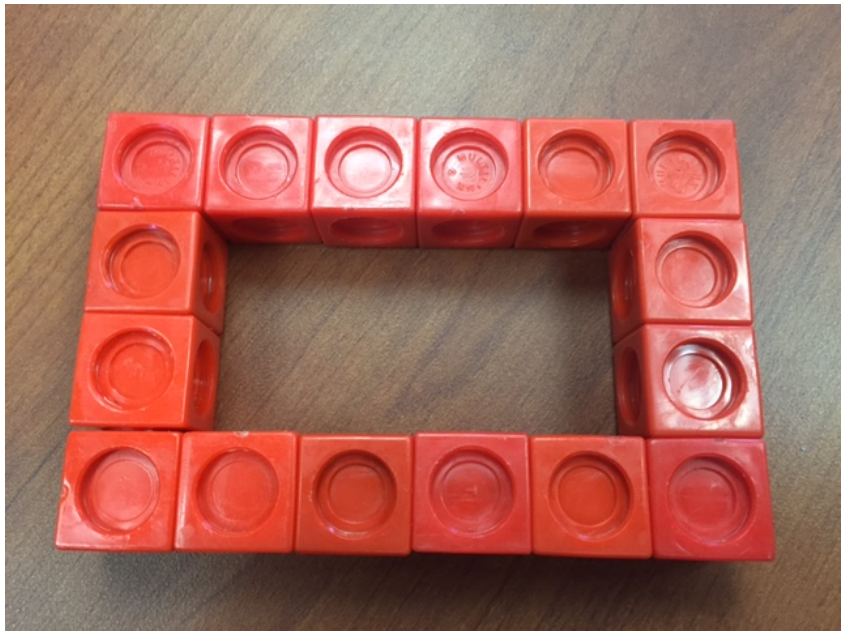


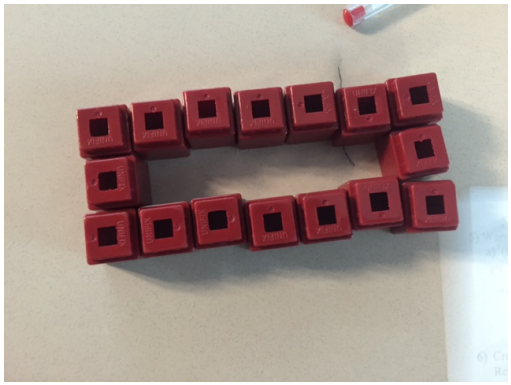
$(2x - 6)^2 - (x + 8)^2$

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.

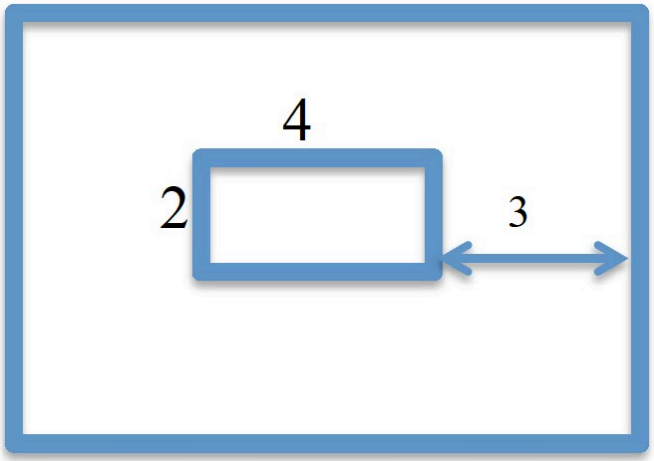
Polynomial Unit, Day 10

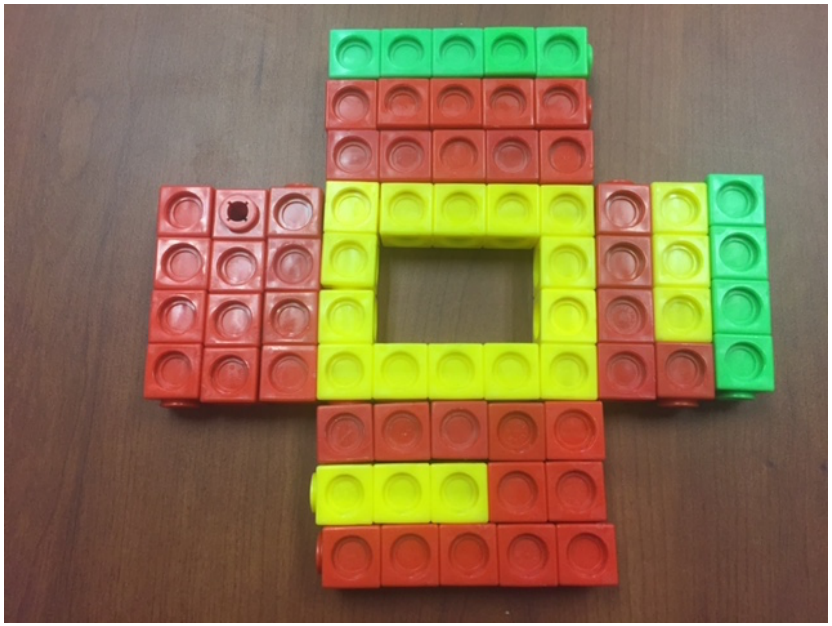


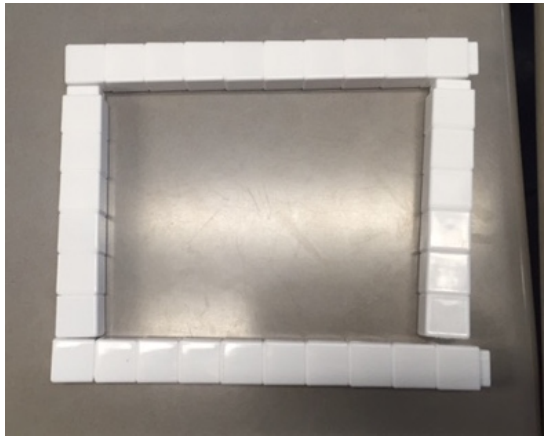


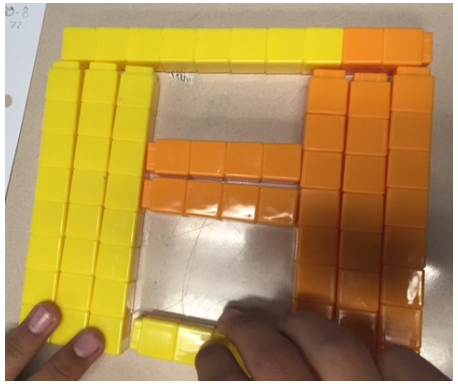


Polynomial Unit, Day 10

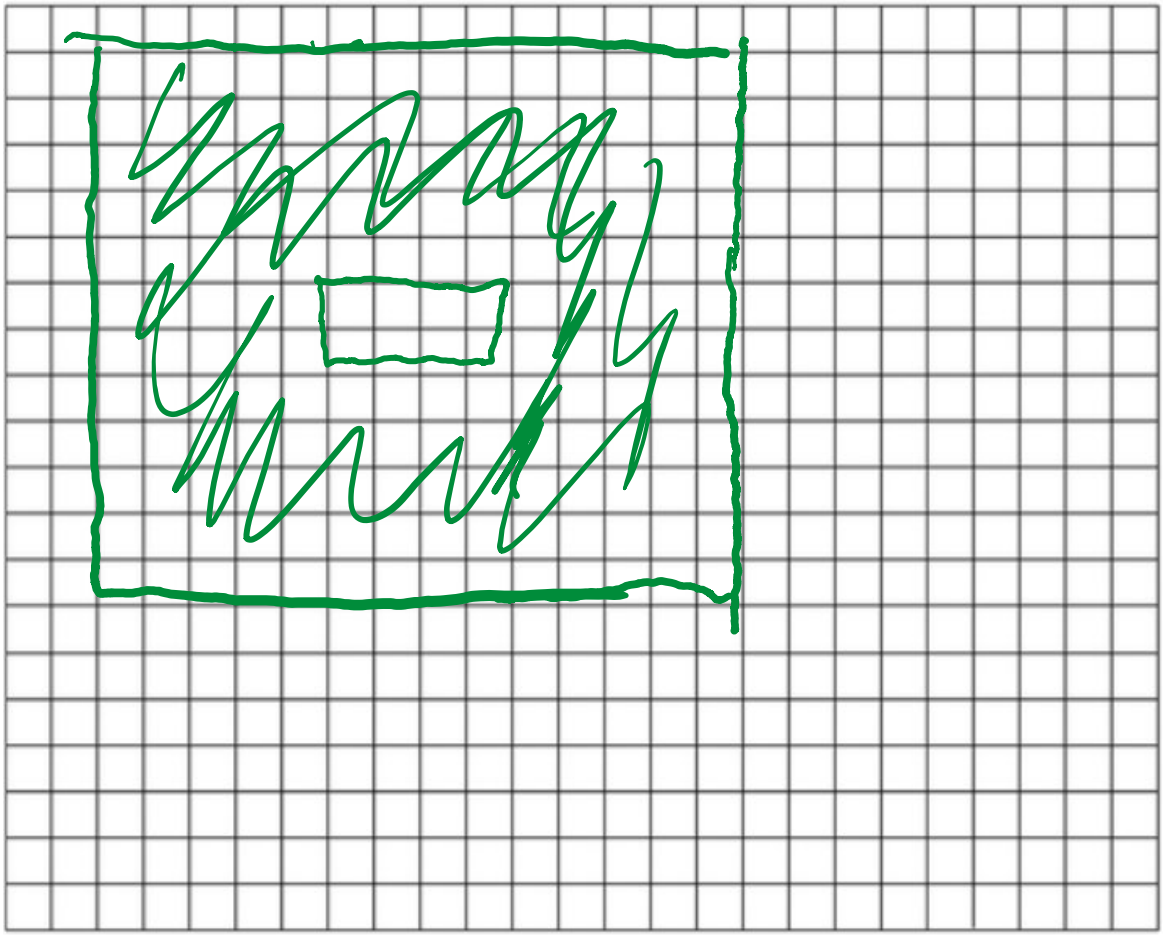




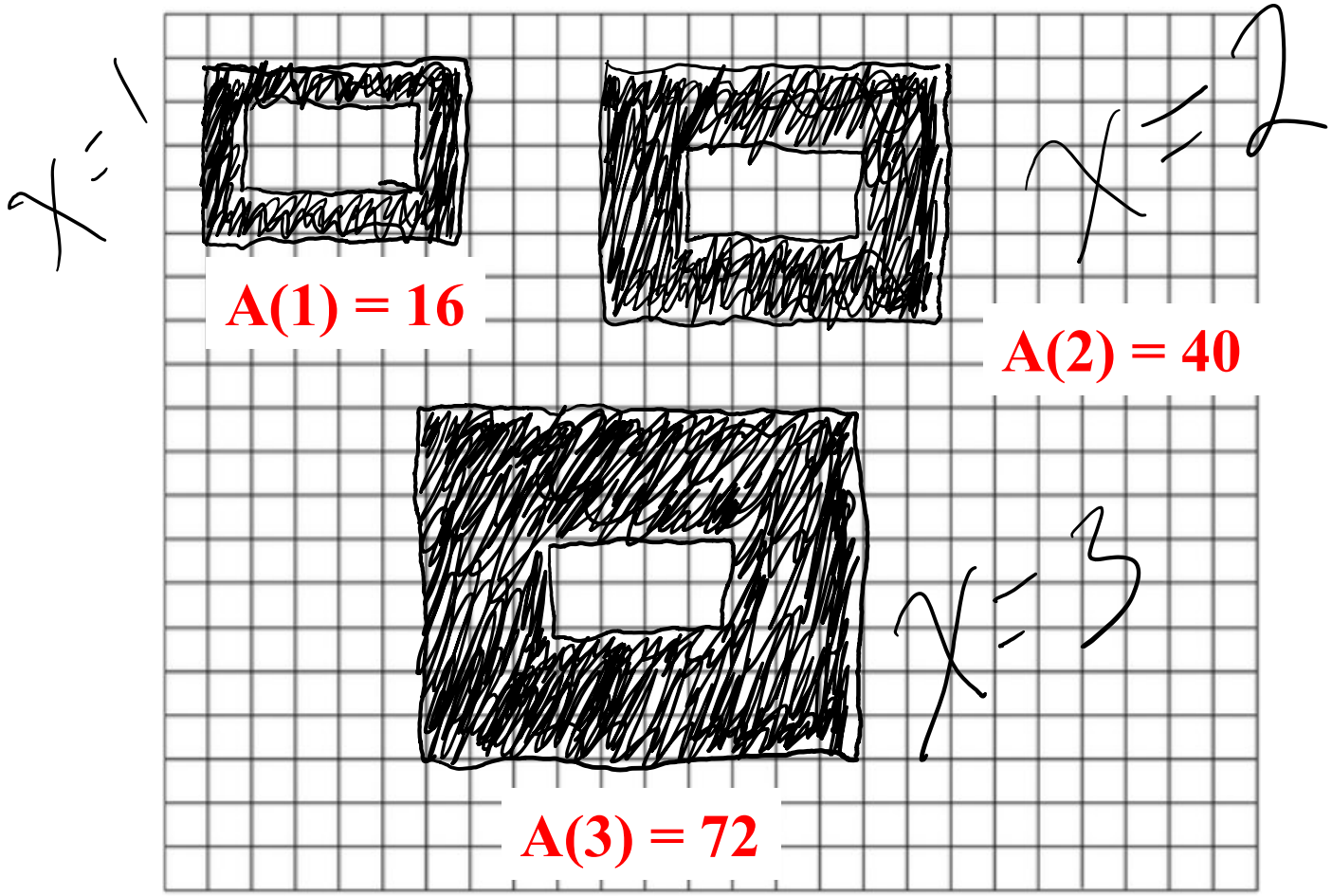




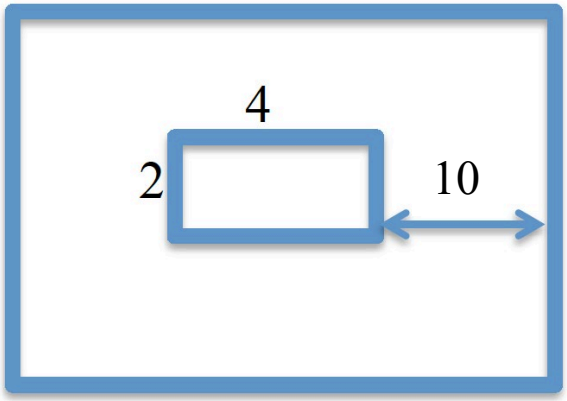
Polynomial Unit, Day 11

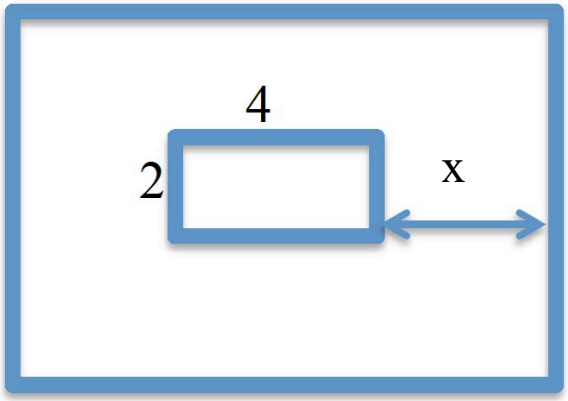


Polynomial Unit, Day 11



Polynomial Unit, Day 11



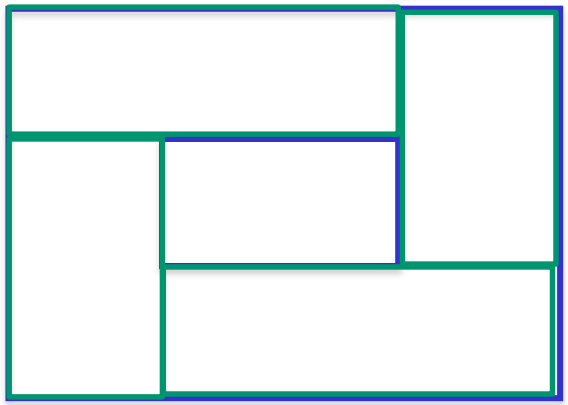


x^2	$4x$	x^2
$2x$		$2x$
x^2	$4x$	x^2

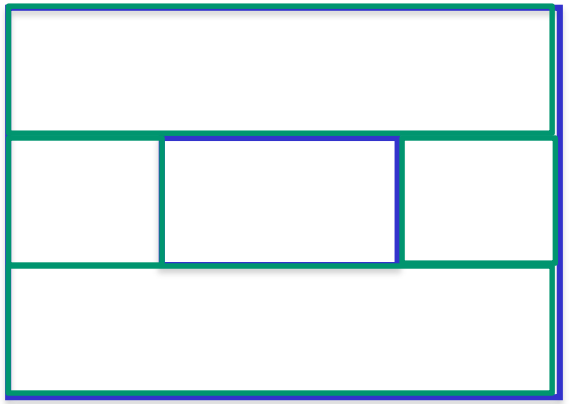
$4x^2 + 2(2x) + 2(4x)$

Polynomial Unit, Day 11

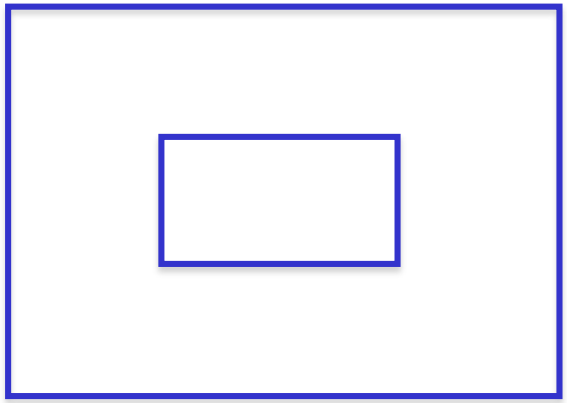
$4x^2 + 2(2x) + 2(4x)$



$2x(x+4)+ 2x(x+2)$



$2x(2x+4) + 2(2x)$



$(2x+4)(2x + 2) – (2)(4)$

$4x^2 + 12x$

Polynomial Unit, Day 11

$$A(x) = 4x^2 + 12x$$

$$A(1) = 4(1)^2 + 12(1) = 16$$

$$A(2) = 4(2)^2 + 12(2) = 40$$

$$A(3) = 4(3)^2 + 12(3) = 72$$

$$A(10) = ?$$

MPJ

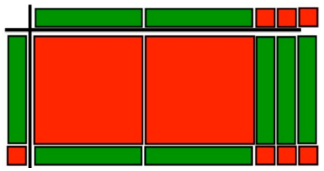
Polynomial Unit, Day 12-15

- Notes & Practices
- Group Quiz
- Review
- Test

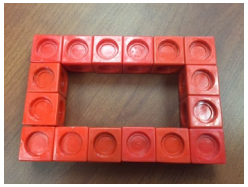
MPJ

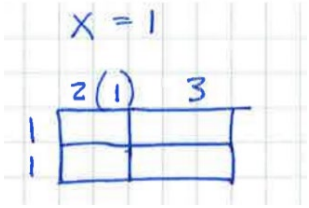
Polynomial Unit Results

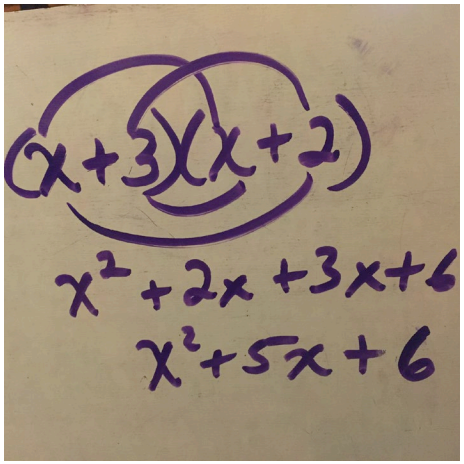
Conceptual ➔ Procedural ➔ Application Practice

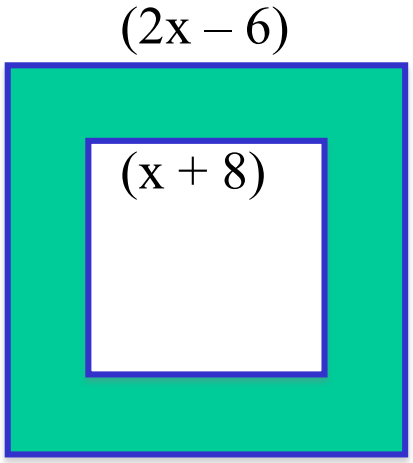


	2x	3
x	A	B
1	C	D









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

C-P-A Progression in 1st Grade

Subtract multiples of 10 in the range 10-90 using concrete models or drawings.

Conceptual Task

Practice Standard: Recognizing Patterns

Taking 10 Away

1. Build 98 with base-10 blocks.
2. Subtract 10 and say the number sentence out loud.
3. Keep subtracting 10 until you get as close to 0 as possible.
4. What pattern did you notice while subtracting?

C-P-A Progression in 1st Grade

Subtract multiples of 10 in the range 10-90 using concrete models or drawings.

Application Tasks

Practice Standard: Solving Problems

Beads and Stickers

1) Marta is stringing beads on a necklace. She has 34 beads. She used 20 for her necklace. How many beads does she have left?

2) Bill had 87 stickers. He used 50 stickers in his class. How many stickers did he have left?

C-P-A Progression in 4th Grade

Multiply a fraction by a whole number. For example, use a visual fraction model to represent $\frac{5}{4}$ as the product 5 x $(\frac{1}{4})$, recording the conclusion by the equation $\frac{5}{4} = 5 \times (\frac{1}{4})$.

Conceptual Tasks

Practice Standard: Seeing Structure

Party Snacks

- Coach Ashley is giving Gatorade to her team of 18 players. If each player drank $\frac{1}{4}$, how much Gatorade did the team drink?

C-P-A Progression in 4th Grade

Multiply a fraction by a whole number. For example, use a visual fraction model to represent $\frac{5}{4}$ as the product 5 x $(\frac{1}{4})$, recording the conclusion by the equation $\frac{5}{4} = 5 \times (\frac{1}{4})$.

Application Tasks

Practice Standard: Seeing Structure

Making Muffins

Your corn muffin recipe makes 9 muffins, but you want to make 18 muffins. How much of each ingredient is needed to make 18 muffins?

Amount	Ingredient
1 cup	flour
1 cup	yellow cornmeal
4 teaspoons	baking powder
$\frac{3}{4}$ teaspoon	salt
$\frac{3}{4}$ cup	sugar
2	eggs
1 cup	milk

Why the C-P-A progression?

From NCTM

FOCUS

"…teachers must focus on the mathematical ideas embedded within the standards. Attention should not be limited to the development of procedural skill. Rather, conceptual understanding along with application of mathematical ideas should play a key role in students' learning."

Students need it to be good mathematicians.

MPJ

Why the C-P-A progression?

Assessments

Notes-Oriented → **Task-Oriented**

40% **60%**

Students need it for their state assessments.

Why the C-P-A progression?

Students will need it in the work force.

Critical Thinking, Communication, Collaboration, Creativity

Top 10 skills

WORLD ECONOMIC FORUM
COMMITTED TO IMPROVING THE STATE OF THE WORLD

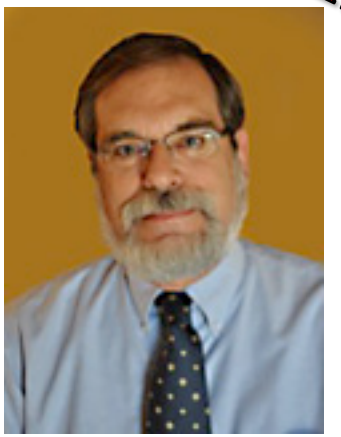
in 2020	in 2015
1. Complex Problem Solving	1. Complex Problem Solving
2. Critical Thinking	2. Coordinating with Others
3. Creativity	3. People Management
4. People Management	4. Critical Thinking
5. Coordinating with Others	5. Negotiation
6. Emotional Intelligence	6. Quality Control
7. Judgment and Decision Making	7. Service Orientation
8. Service Orientation	8. Judgment and Decision Making
9. Negotiation	9. Active Listening
10. Cognitive Flexibility	10. Creativity

Clothesline Math

Call to Action

Fail Grandly

No Real Risk

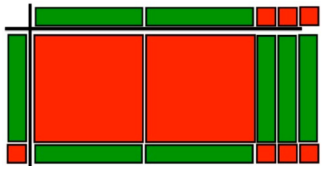


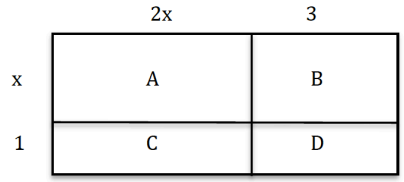
2-Week Rule

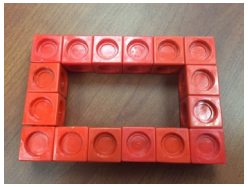
10%

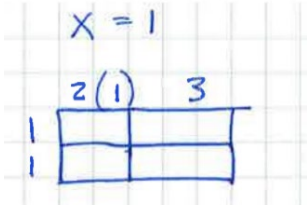
Teach through the C-P-A Progression…

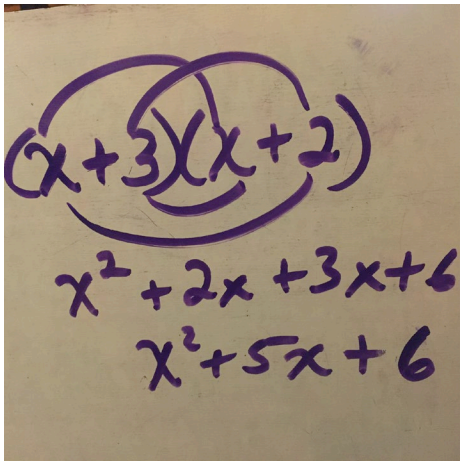
…with the faith that they can learn it, and that we can teach it to them,

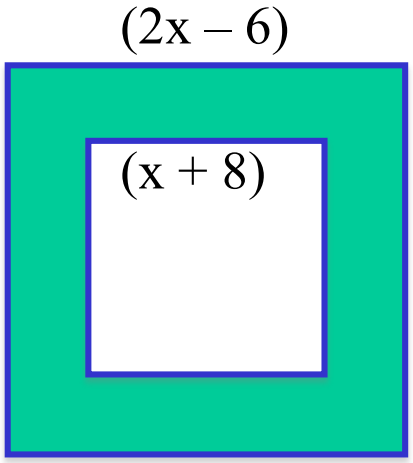






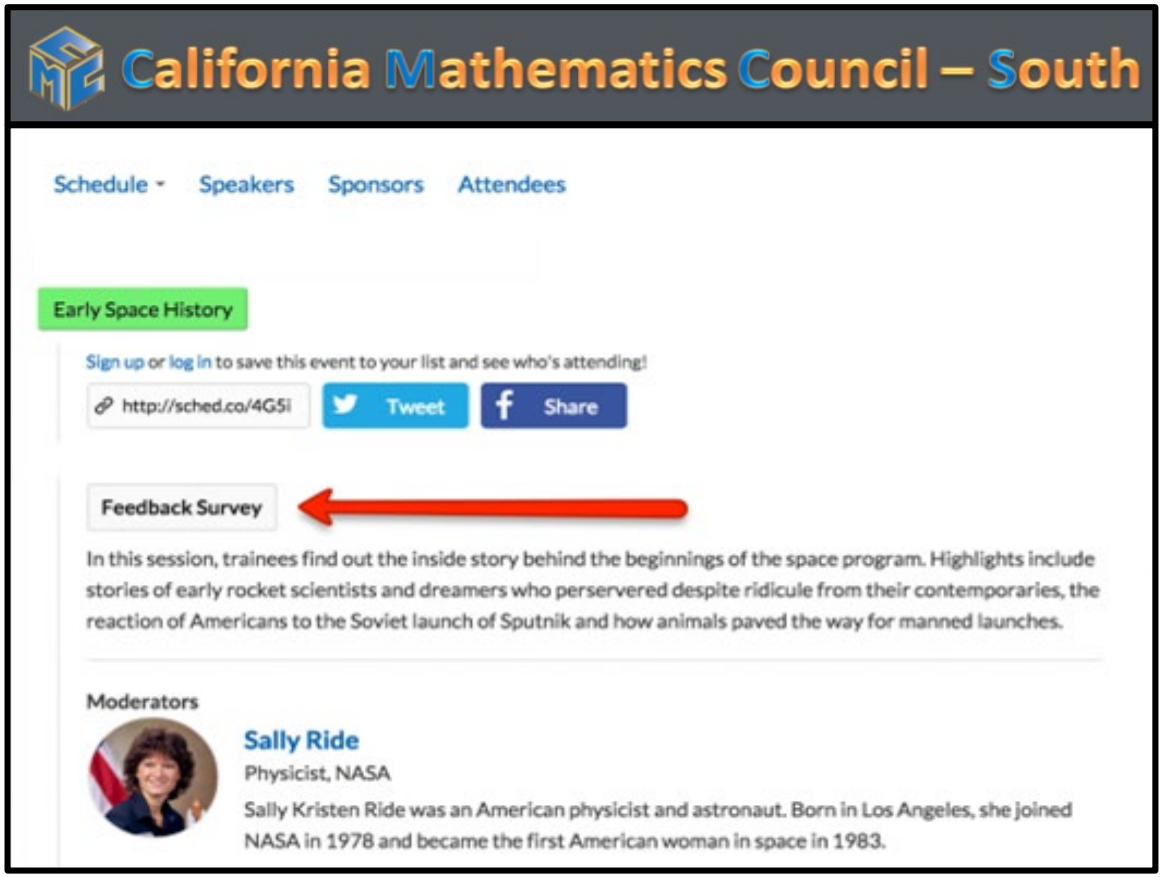






…so you can change this world, one math lesson at a time.

Speaker Evaluation



In the app

Go to this session's page, then click the "Feedback Survey" button