

Please have a seat at the content
level you are *most familiar*.

Coaching teacher teams through the process of
Vertical Articulation: Secondary Mathematics

Let's get Vertical!

Coaching teacher teams through the process of
Vertical Articulation : Secondary Mathematics

The background features a dark blue grid. A white line graph with circular markers is overlaid on the grid, showing a fluctuating trend. The graph starts at a low point, rises to a peak, falls to a trough, rises to a higher peak, falls to a lower trough, and then rises again towards the end. The text is centered in the upper half of the image.



Cassie Sisemore



@CassieSisemore

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Breanne Phillips



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Round Table

Please Introduce yourself to your table members.

Share the State, County, School and Grade Level
you teach, support, coach



Please Stand Up!

If you are a...

- A Teacher
- An Instructional Coach or Teacher on Special Assignment
- An Administrator



Central Valley of California

Examples



Non-Examples



About VUSD...

- Large suburban school district in the Central Valley of California
 - 12 Secondary Schools
 - 3 Alternative Education Schools
 - 26 Elementary Schools
 - 3000 Employees
 - 29,000 students
 - 14.4% English Language Learners
 - 62.1% Free/Reduced Lunch



Today's Objectives

We will:

- Discuss various activities involving *vertical articulation*.
 - Participate in one Vertical Articulation Activity.
 - Develop Next steps for your district.
- 
- A decorative background graphic at the bottom of the slide. It features a white line graph with circular markers at various points, showing an overall upward trend with some fluctuations. Below the line graph is a bar chart with numerous vertical bars of varying heights, rendered in a light blue color. The entire graphic is set against a dark blue background with a subtle grid pattern.

What is Vertical Articulation?

Whip Around

Efforts to improve the understanding of the progression of mathematics across grade levels in order to improve coherence.



Different Types of Professional Development

Lead Teachers only

- All Day PDs
- Mini PDs delivered within Curriculum Development Meetings
- District Office

ALL Teachers

- Led by Lead Teachers
- During PLC time
- On Site

Today's Focus will be the work we have done with our...

Lead Teachers only

- 3 All Day PDs
- At our District Office

Our 'guides' as we planned for Lead Teacher Teams

- ▣ Progression Documents
- ▣ Our Mathematics Vision
- ▣ CA CCSS-M Frameworks
- ▣ Big Ideas of each grade level
- ▣ "REAL" Priority standards

Progression Documents.



<http://ime.math.arizona.edu/progressions/>

- Draft High School Progression on Statistics and Probability.
- Draft High School Progression on Algebra
- Draft High School Progression on Functions
- Draft High School Progression on Modeling
- Draft 7-HS Progression on Geometry
- Draft High School Progression on Quantity.



Vision for... *Mathematics*

The VUSD math program will surpass expectations in student learning as a result of collaboration, goal setting and the implementation of the Standards for Mathematical Practices.

C - Collaborative Culture

L - Learning is Visible

A - Access and Equity

S - Student Centered

S - Standards for Mathematical Practices

What Students Learn in Mathematics I

Students in Mathematics I continue their work with expressions and modeling and analysis of situation. In previous grade levels, students informally defined, evaluated, and compared functions, using them to model relationships between quantities. In Mathematics I, students learn function notation and develop the concepts of *domain* and *range*. Students move beyond viewing functions as processes that take inputs and yield outputs and begin to view functions as objects that can be combined with operations (e.g., finding $(f + g)(x) = f(x) + g(x)$). They explore many examples of functions, including sequences. They interpret functions that are represented graphically, numerically, symbolically, and verbally, translating between representations and understanding the limitations of various representations. They work with functions given by graphs and tables, keeping in mind that these representations are likely to be approximate and incomplete, depending upon the context. Students' work includes functions that can be described or approximated by formulas, as well as those that cannot. When functions describe relationships between quantities arising from a context, students reason with the units in which those quantities are measured. Students build on and informally extend their understanding of integer exponents to consider exponential functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. They also interpret arithmetic sequences as linear functions and geometric sequences as exponential functions.

Students who are prepared for Mathematics I have learned to solve linear equations in one variable and have applied graphical and algebraic methods to analyze and solve systems of linear equations in two variables. Mathematics I builds on these earlier experiences by asking students to analyze and

"Big Ideas"

Developed by the Lead Teachers
on Day 1 of Vertical Articulation.

Based on ideas from the
California State frameworks

Math 1

Algebraic Manipulation

- Rearranging and collecting terms
- Factoring and canceling common factors in rational expressions
- Properties of Exponents
- *Model and analyze situations by interpreting expressions and create equations

Understand Functions

- Function Notation
- Domain and Range
- Interpret and Translate between representations
- Compare linear (arithmetic) and exponential (geometric sequences)

Congruence based on rigid motion.

- Definition of Congruence
- Triangle congruence
- Formal Constructions

Applications of Pythagorean Theorem

- In the regular coordinate system
- Verify geometric relationships including
 - special triangles and quadrilaterals
 - Slopes of parallel and perpendicular lines.

Statistics and Probability

- Compare two data distributions and differences between populations
- Drawing Inferences from random sampling to create data sets.

Priority standards should be...

17

R.E.A.L.

R: Readiness Standard

Do students need this skill for the next level of instruction level or as a foundation for the next grade?

E: Enduring Standard

Does this standard appear at multiple grade levels?

A: Assessed (CAASPP, SAT)

Is the standard assessed as a major or additional/supporting standard?

L: Leverage Standard

Does this standard provide knowledge and skills that are valuable in multiple disciplines?

Planning For Day 1

What aha's do we want teachers to have?
How should Teachers be grouped?



Planning For Day 1

We wanted our teachers to:

- ▣ Have a better understanding of their grade level content.
- ▣ To better understand how our assessments aligned to our Big Ideas.
- ▣ To recognize that connectedness between each grade levels' Big Ideas

All Day PD for Leads

The Teams

20

HORIZONTAL TEAMS

1. GRADE 7
2. GRADE 8
3. 8TH GRADE INTEGRATED MATH 1
4. 9TH GRADE INTEGRATED MATH 1
5. INTEGRATED MATH 2
6. INTEGRATED MATH 3

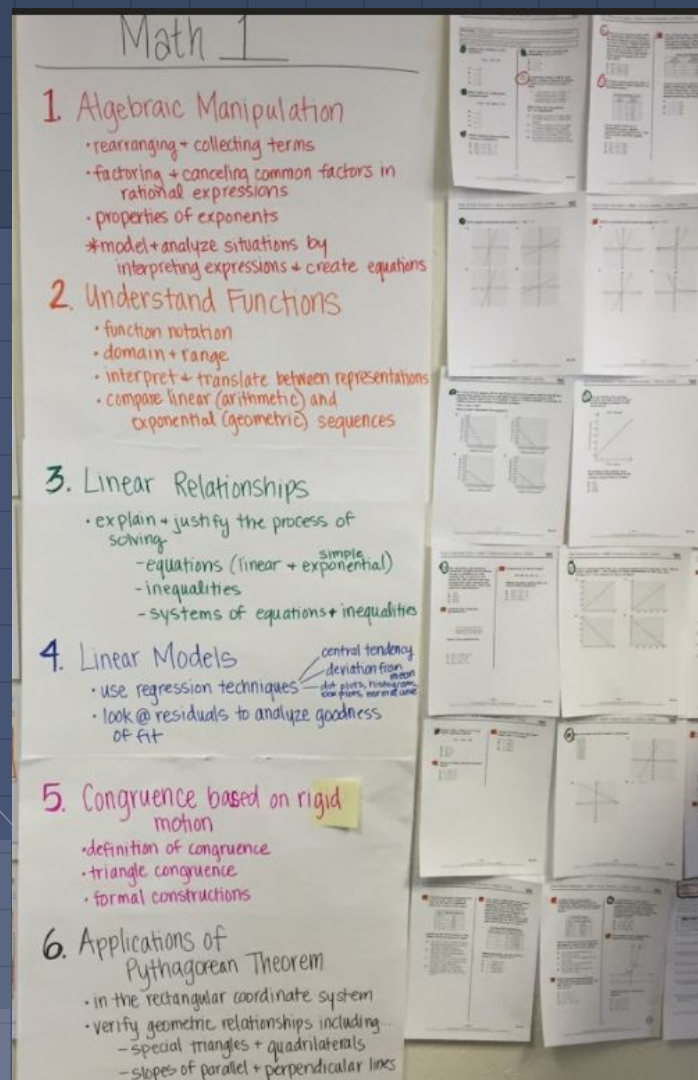
VERTICAL TEAMS

1. GREEN: GRADE 7 → MATH 3
2. BLUE: GRADE 7 → MATH 3
3. GOLD: GRADE 7 → MATH 3
4. RED: GRADE 7 → MATH 3

All Day PD for Leads The Product

Day 1 Developing our Big Ideas:

- Teachers read standards frameworks section "*What students Learn in Math __.*"
- Poster their color coded Big Ideas of each Grade Level
- Aligned Final Assessment items with Big Ideas using color coding.



3	<p>Vertical Teams GWHS-VO-Breanne RHS-GA-Cassie EDHS-LJ-Laurie MWHS, Divis- Debbie</p>	<p><u>Math 3</u> begins: Our standard is A.APR____ which is _____describe standard_____. We solve this problem by Solution Pathway. Students need to know Learning Progression before learning this standard.</p> <p><u>Math 2:</u> We support Math 3's standard by teaching standard _____. We solve this problem by Solution Pathway. Students need to know Learning Progression before learning this standard.</p> <p>Math 1, Math 8 and Math 7 follow, respectively, using Math 2's frame.</p>	<p>Algebra Problem from each vertical team and Note-taking Guide Poster: Give each team blank copy of problems. Teams poster student friendly language for vertical learning progression.</p>	<p>To make vertical learning progressions visible.</p>
4	<p>Vertical Teams GWHS-VO-Breanne RHS-GA-Cassie EDHS-LJ-Laurie MWHS, Divis- Debbie? Phil?</p>	<p>Repeat Steps 2,3 for:</p> <ol style="list-style-type: none"> Functions Geometry Statistics 	<p>Vertical Problems template for Algebra--grade level specific. Algebra Problem from each vertical team and Note-taking Guide Give each team blank copy of problems. Teams poster student friendly language for vertical learning progression.</p>	<p>To</p> <ul style="list-style-type: none"> Continue to deepen connections between grade levels relate our Big Ideas to our daily lessons

Day 2 continued

- Used color coded team documents to create Big Ideas and color coded assessments

6 Linda sets an appointment with an electrician who is charging a flat fee of \$80 for parts plus \$55 per hour of labor. Which of these represents an inequality she can use to solve for the number of hours the electrician can work if Linda wants to spend no more than \$325?

- A. $80x + 55 \geq 325$
- B. $55x + 80 \leq 325$
- C. $55x + 80 \geq 325$
- D. $80x + 55 \leq 325$

7 The table shows how the cost of an automobile repair depends on the time it takes.

Automobile Repair Costs	
Time (hours)	Cost (dollars)
1	85
2	145
3	205
4	265

8 At a school dance, there were 2 people on the dance floor when the music started. After that the number of people dancing increased as shown in the table.

Dance Participation	
Time (minutes)	Number of People Dancing
0	2
1	6
2	18
3	54

Assume that the pattern in the table continues. Which equation can be solved for t , the time in minutes when the number of people dancing will reach 200?

- A. $2 \cdot \frac{3}{t} = 200$
- B. $2 \cdot 3t = 200$
- C. $2 \cdot t^3 = 200$
- D. $2 \cdot 3^t = 200$

Math 1

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- *Model and analyze situations by interpreting expressions and create equations

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Day 2 cont'd: Vertical Articulation Activity

Horizontal Teams

1. Solve one problem from four domains.
2. Describe Solution Pathway for each problem.
3. Describe the learning progression for each problem.

Let's Do This!

Please move into Vertical Teams

VERTICAL TEAM ASSIGNMENTS



A

B

C

D

VERTICAL TEAM A

Vertical Articulation Activity

Vertical Teams

1. Vertically align problems on poster paper.
2. Write Learning Targets for each assessment item to demonstrate the learning progression from grade 7 through Integrated Math 3
3. Record on note taking guide how one grade level supports the next.

Gallery Walk

As a group, begin visiting posters.

Leave feedback on posters using sticky notes.

Feedback can be questions, comments or even “a-ha’s”



End of Day Two

The Product

- Student Friendly Learning targets for each domain.
- Gallery Walk and Post its revealed further questions and comments for consideration

Algebra

Math 3: A.PR.3
Students can find the zeros given a higher degree polynomial.

Math 2: A.SSE.3
Students will identify the graph of a quadratic function using zeros, vertex, or axis of symmetry.

Math 1: A.REI.10
Students can graph a line given a linear equation and identify possible solutions as ordered pairs on the line.

8th: 8.EE.5
Students understand unit rate as slope and are able to compare different proportional relationships.

7th: 7.EE.4A
Students write and solve linear equations.

Algebra

Math 2

Math 2

Math 3

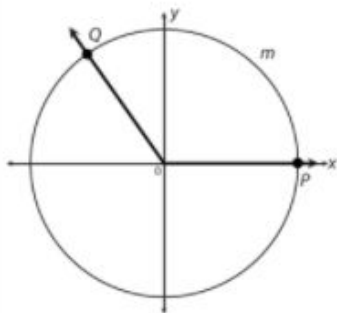
Category: (F.T.F.) Trigonometric Functions

Cluster: Extend the domain of trigonometric functions using the unit circle.

Standard:

A

In the unit circle below, the arc between points P and Q has length m .



If the coordinates of point Q are $(-\frac{1}{2}, \frac{\sqrt{3}}{2})$, then what is the value of $\tan(m)$?

- A. $-\sqrt{3}$
- B. $-\frac{\sqrt{3}}{3}$
- C. $-\frac{1}{2}$
- D. $\frac{\sqrt{3}}{2}$

Solution Pathway

Learning Progression

<p>Student objectives to students to</p> <p>Stats & Prob</p> <p>Functions</p>	<p>Standard: Supports M2 by: PEP 3</p> <p>$y = mx + b$</p> <p>transform</p> <p>make table</p> <p>subst. values</p> <p>Affected by k</p> <p>*Add m, k to ab. value</p>	<p>Standard: Supports M3 by: PEP 3</p> <p>Quadratic</p> <p>Function Chg</p> <p>std vs. vertex form</p> <p>affected by a, h, k</p>
<p>Functions</p>	<p>Notes</p> <p>7th Grade</p> <p>Standard: 7.5 Supports M8 by</p> <p>basic ops</p> <p>vocab</p> <p>• set up</p> <p>part of</p> <p>data</p>	<p>2</p> <p>zer</p> <p>sk</p>
<p>Statistics and Probability Example</p>	<p>Standard: Supports M8 b</p> <p>7.RP.2.d</p> <p>Read / Make</p> <p>Reach graph</p> <p>Vocab</p> <p>intervals /</p> <p>(,) p</p>	<p>to side</p>

Day 3: Planning

(12/5) Planning 7-11 Math Articulation

What do you want teachers know/be able to do by the end of the day?

FOCUS ON STUDENTS

7th/8th : See the importance of their standards for upper grades

7-11 : What is priority/supporting & w/

Math1 : See what students do in 7th/8th (they think kids know nothing - pre-assess*)

② Which standards are in multiple grade levels?

7-11 Want to fix things

Math 1/2 - Focus on teaching practices

7-11 - How to integrate standards (cohesive)

What would make me, as a teacher/learner, feel good about the way I spent the day?

- Have an "aha" experience
- Address my "felt need"
- Something I want to use
- Gain clarity & insight
- Validation of work already done
- Have my questions answered
- Feel connected with colleagues at different grade levels.
- Feel comfortable (we're all on the same side)

Issues

- Teaching topically

- forgetting

② How to teach so they remember

① Re-engage w/o reteaching

what is being taught? → How to re-engage?
& When

- Barriers: if learned procedurally (only), harder to retrieve

- "Not assessed at our grade level; therefore not a priority."

Priority standards should be...

R.E.A.L.

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Do students need this skill for the next level of instruction level or as a foundation for the next grade?

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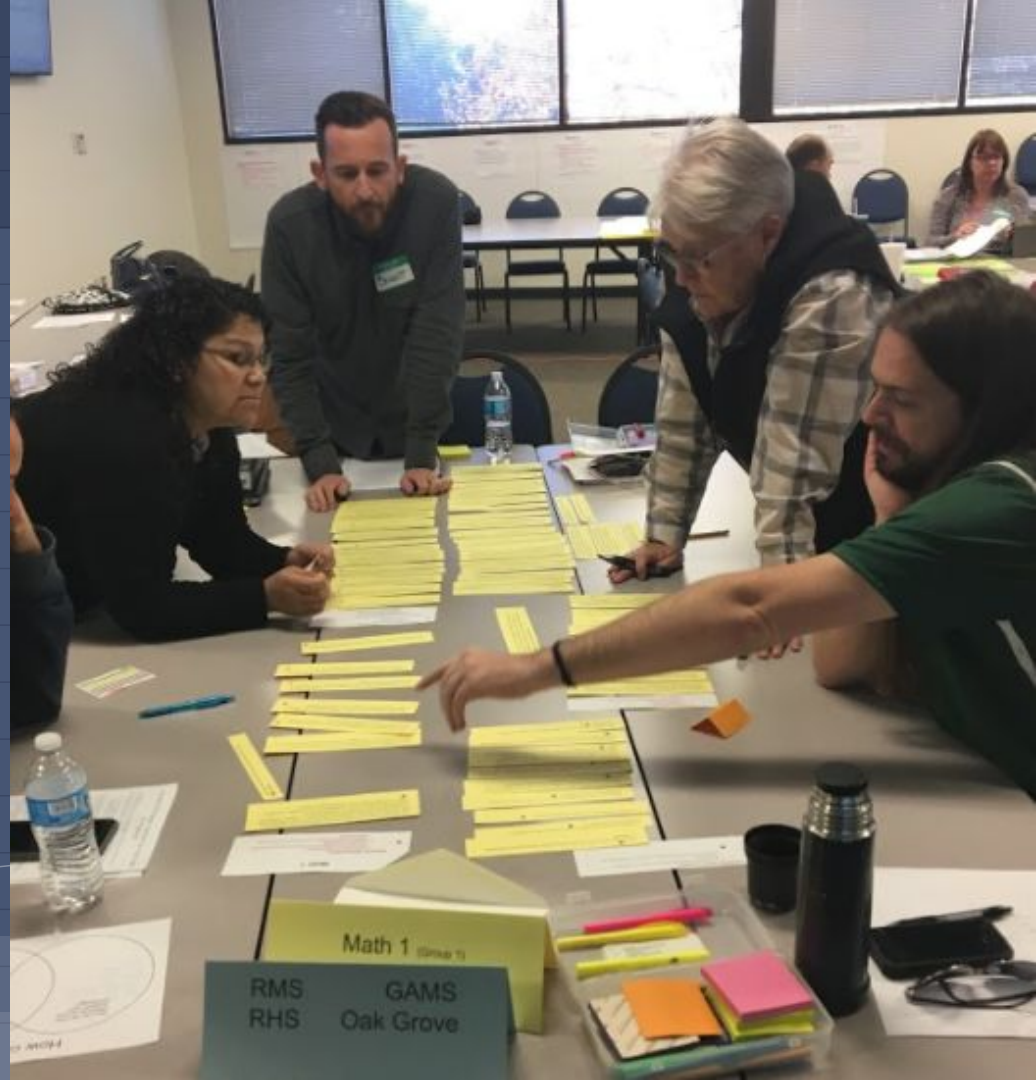
L: Leverage Standard

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Day 3: Process

Horizontal Teams

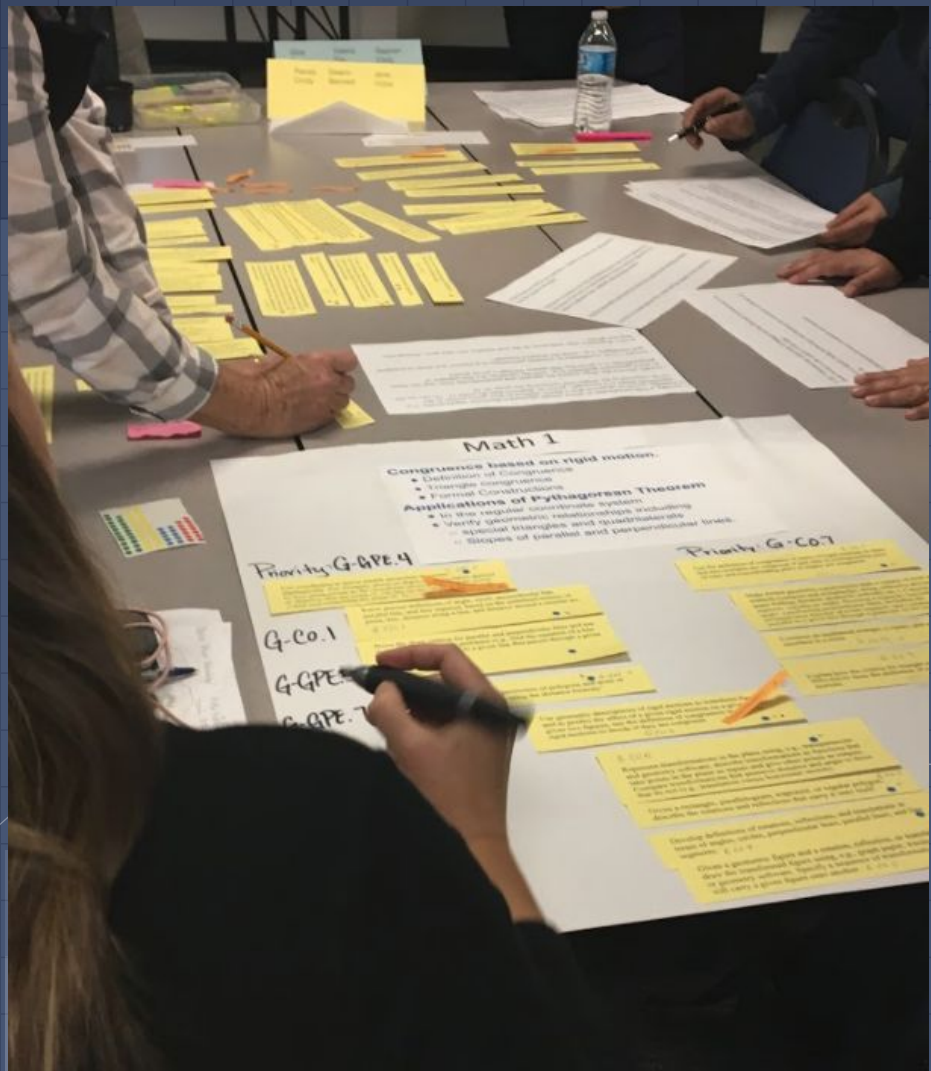
- Sort Standards into Big Ideas
- REAL: Prioritize standards
- Cluster remaining standards under each priority



Day 3: Process

Horizontal Teams

- Sort Standards into Big Ideas
- REAL: Prioritize standards
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Math 8

Expression and Equations

- Understand the connections between proportional relationships, lines and linear equations
 - $y=mx$, $y=mx+b$, slope, y-intercept, constant rate of change
- Analyze and solve systems of linear equations.

$$\begin{aligned} y &= 2x + 1 \\ y &= 3x - 4 \\ 3x - 4 &= 2x + 1 \end{aligned}$$

Interpret the equation $y=mx+b$ as defining a linear function, and graph it as a straight line. Give examples of functions that are linear. For example, the function $f(x)=3x+1$ gives the area of a square as a function of its side length x . For linear functions, the graph is a straight line. For example, the graph of $f(x)=3x+1$ is a straight line with slope 3 and y-intercept 1.

8.EE.3

Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successfully transforming the given equation into simpler forms, such as an equation of the form $x=p$, $x=p+q$, or $x=p+q+r$ where p , q , and r are different numbers.

8.EE.2

Solve linear equations with rational number coefficients, including those whose solutions require expanding expressions using the distributive property and collecting like terms.

8.EE.1

Solve linear equations in one variable.

8.EE.1

Solve and solve pairs of simultaneous linear equations.

8.EE.8

Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

8.EE.9

Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve systems of three linear equations in three variables algebraically.

8.EE.10

Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given constraints for two quantities, determine whether the first part of a process increases the total through the second part.

8.EE.11

Prerequisite

Algebra

- Model and analyze situations by interpreting expressions and create equations
- Rearranging and collecting terms
- Factoring and canceling common factors in rational expressions
- Properties of Exponents
- Create and solve exponential equations
- System of Equations
 - Linear Equations, Inequalities and Systems
 - Writing, Solving (with justification), Interpreting and translating among various forms

Priority: A-REI.1

Express each step in solving a simple equation as following from the equality of numbers stated at the previous step, stating then the justification that the original equation has a solution. Convert a verbal equation to a verbal equation.

Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve systems of three linear equations in three variables algebraically.

Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given constraints for two quantities, determine whether the first part of a process increases the total through the second part.

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Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given constraints for two quantities, determine whether the first part of a process increases the total through the second part.

Math 1

Mini Priority

Priority: A-CED.2

Represent constraints by equations or inequalities, and by systems of equations or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing motion and cost constraints on a number line.

Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V=IR$ to highlight resistance R .

Understand that the graph of an equation in two variables is the set of all its solutions plotted on the coordinate plane, often forming a curve (which could be a line).

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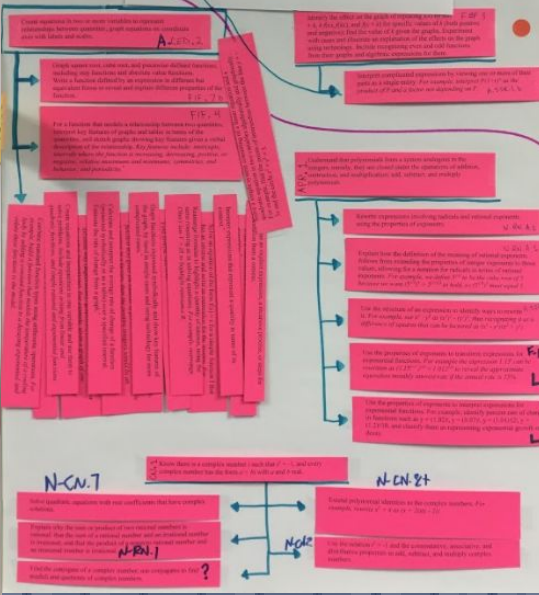
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Math 2

Extend Laws of Exponents

- Extend solution sets to include complex numbers
- Relationships between number systems
- Create and Solve Equations and Inequalities Involving Linear, Exponential and Quadratic Expressions
- Systems involving linear, quadratic and exponential
- create and solve equations and inequalities
- expression structure.



Next Steps

What will you do to ensure that your teacher teams continue to learn about the progression of mathematics across grade levels?



We are Visalia Unified.
We educate kids.
We create futures.

#OTOM

One Team One Mission

#NCTMAAnnual

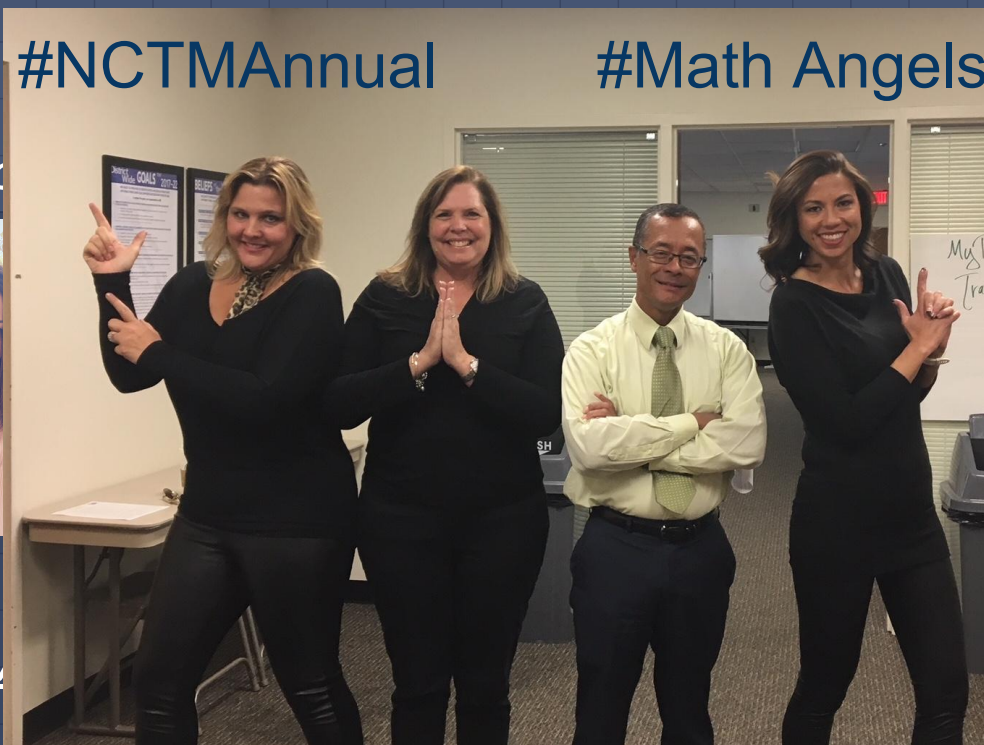
#Math Angels

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Stay Co



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