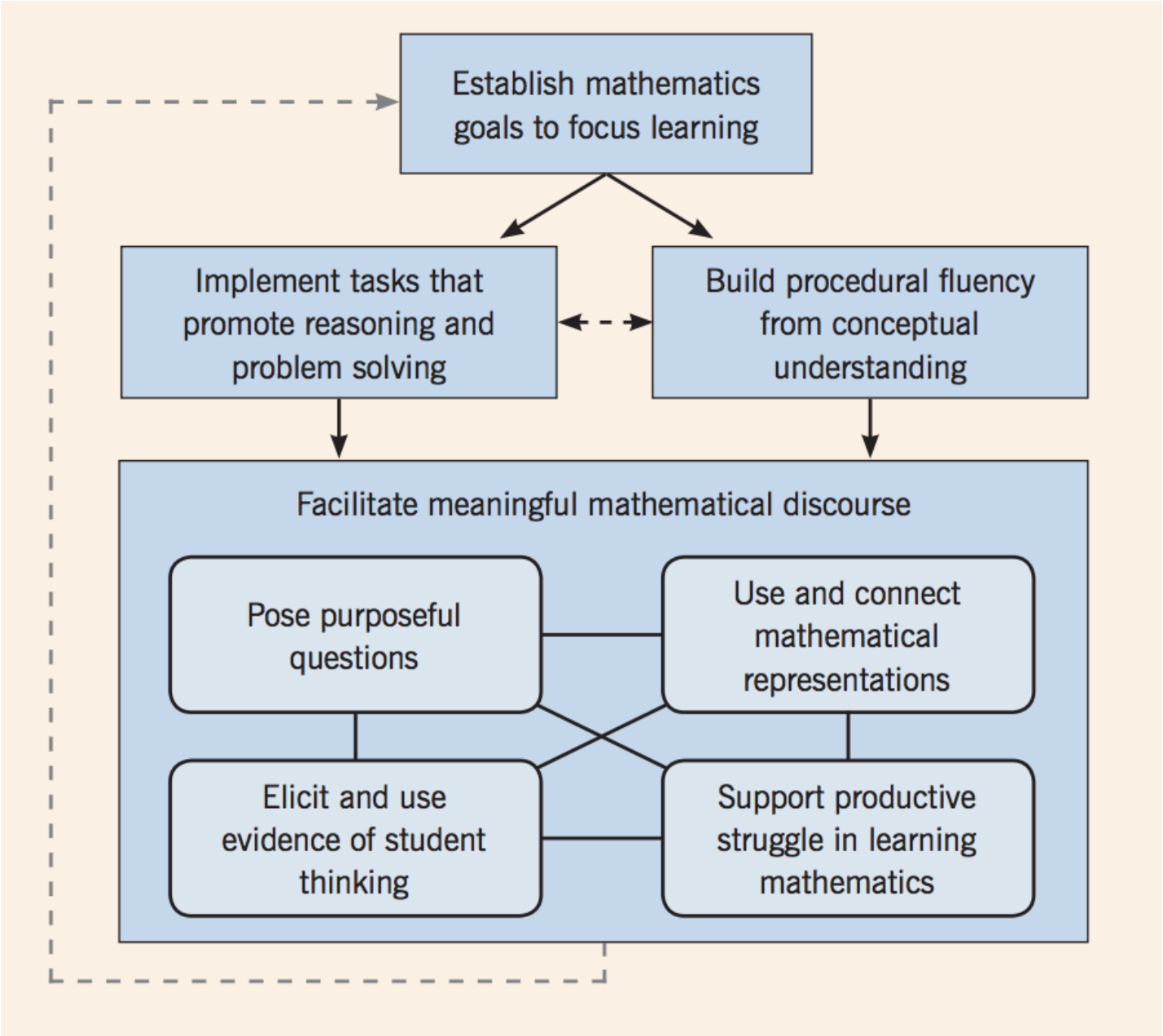
- NCTM
- 2014
- Standards for teachers

Principles to Actions: Effective Teachers

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning math.
- Elicit and use evidence of student thinking.

(NCTM, 2014)



Smith, M.S., M.D. Steele, and M.L.Raith. *Taking Action: Implementing Effective Mathematics Teaching Practices in Grades 6-8.* Reston, VA: National Council of Teachers of Mathematics, 2017.

What does square root mean? nth root?

- Estimate the square root of 7
- Estimate the cube root of 10

What does square root mean? nth root?

- Estimate the square root of 7
- Estimate the cube root of 10

- $2 \bullet 2 \bullet 2 = 8$, therefore $\sqrt[3]{8} = 2$
- $8^{1/3} = 2$
- $(2 \bullet 2 \bullet 2)^{1/3} = 2$

What does square root mean? nth root?

- Estimate the square root of 7
- Estimate the cube root of 10

PtA: Use and Connect Mathematical Representations

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PtA: Implement tasks that promote reasoning and problem solving

Systems of Equations

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Solve the system of equations

$$x + 2y = 3$$

$$4x + 5y = 6$$

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Solve the system of equations

$$x + 2y = 3$$
$$4x + 5y = 6$$

And this one

$$7x + 8y = 9$$
$$10x + 11y = 12$$

Graph the equations: What do you notice? Wonder?

- $x + 2y = 3$
- $5x + 3y = 1$
- $0.5x + 1y = 1.5$
- $x - 2y = -5$
- $100x + 101y = 102$
- $100x - 101y = -202$

Teague, 2018

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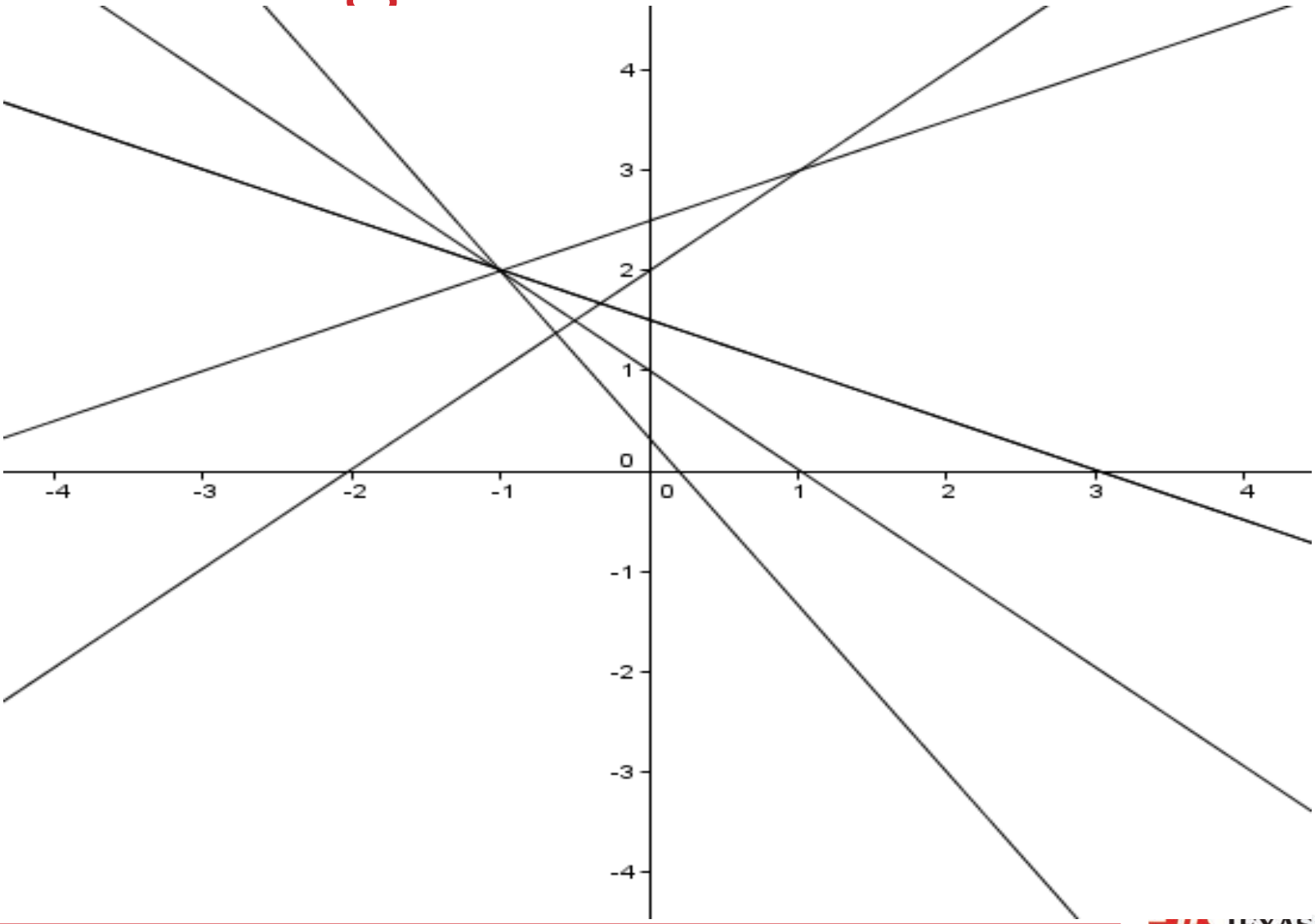
What do you see? What is interesting?



Solving Systems of Equations

How did the task

- promote reasoning and problem solving?
- Use and connect mathematical representations?

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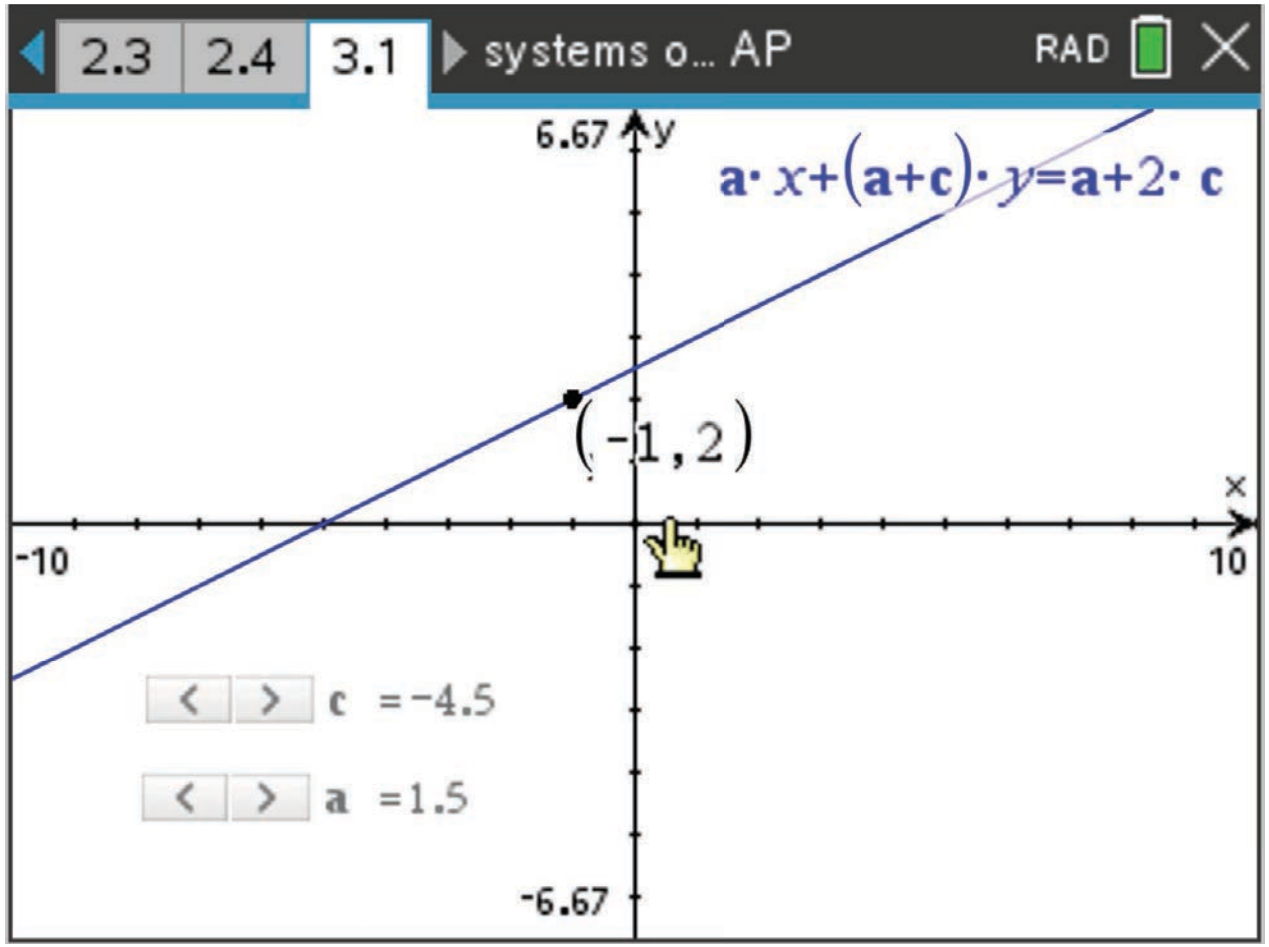
Generalizing coefficients as an arithmetic sequence



PtA: Facilitate meaningful mathematical discourse

Finding a “good” window

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PtA: Build procedural fluency from conceptual understanding

Using Structure to Solve Equations

Building Concepts: Expressions and Equations, 2014

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PtA: Building procedural knowledge from conceptual knowledge

- Conceptual Knowledge:
  - Makes connections visible,
  - enables reasoning about the mathematics,
  - less susceptible to common errors,
  - less prone to forgetting.

- Procedural Knowledge:
  - Strengthens and develops understanding
  - allows students to concentrate on relationships rather than just on working out results

NRC, 1999

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How do we make this happen?

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Teaching and Learning Practices

- Learning: Mathematical Practices for Students
  - habits of mind which students should employ as they are engaged in doing mathematics
- Teaching: Mathematical Teaching Practices
  - teacher instructional behaviors that support student learning

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How students should work: Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

CCSS, 2010

Teaching Standards

Student Math Practice Standards

Content Standards

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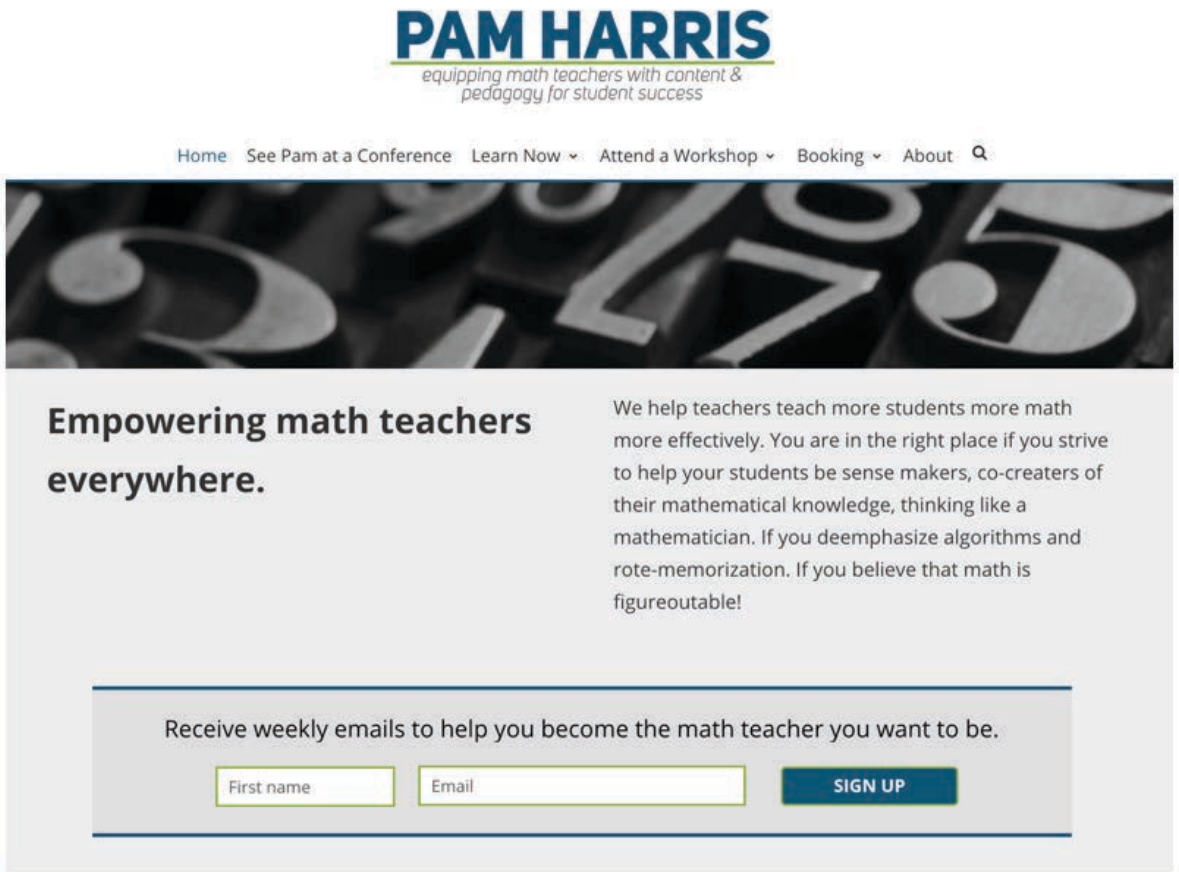
Connect with Gail

@GailBurrill

Connect with Pam



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The only reasons to ask questions are:

(Black et al., 2004)

To PROBE or uncover students' thinking.

- understand how students are thinking about the problem.
- discover misconceptions.
- use students' understanding to guide instruction.

To PUSH or advance students' thinking.

- make connections
- notice something significant.
- justify or prove their thinking.

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PtA: Pose purposeful questions

PtA: Facilitate meaningful mathematical discourse

- Questioning is an essential part of helping students to make progress but only if it causes thinking or elicits evidence that informs our teaching.