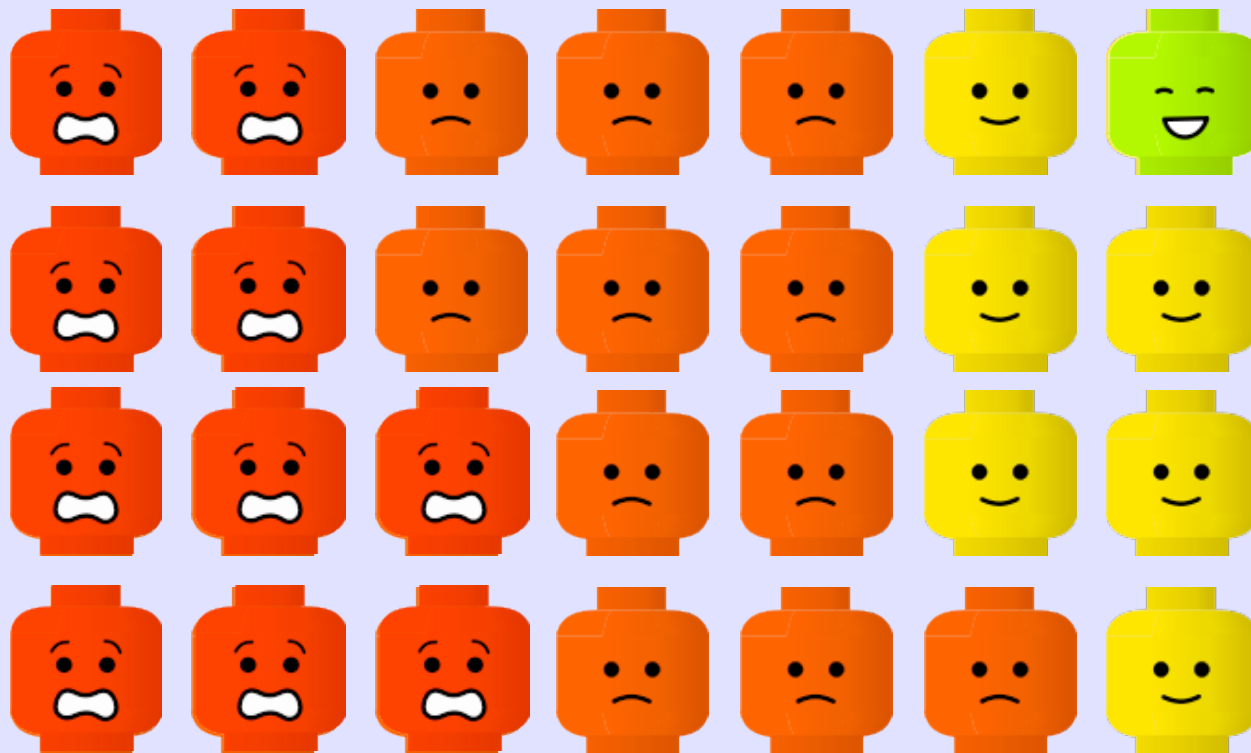


# Re-envisioning Secondary School Mathematics

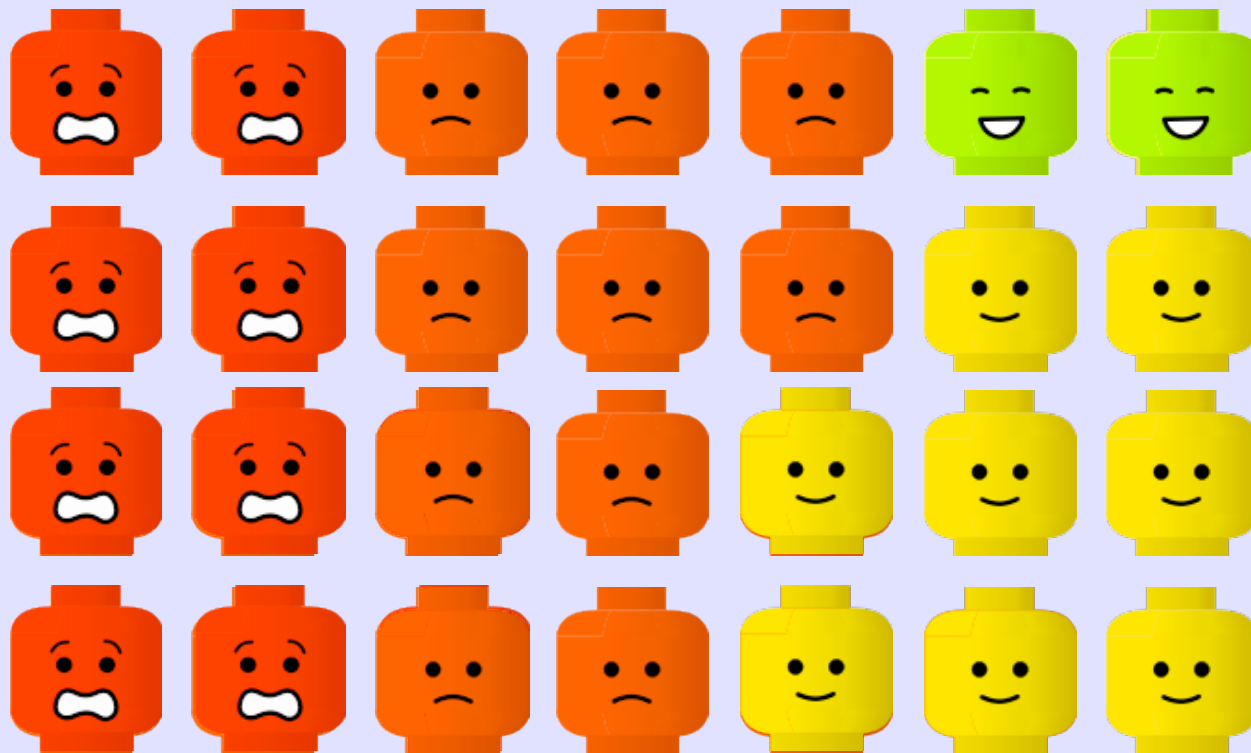
W. Gary Martin  
Auburn University

Why Do We Need a  
New Vision?





# Consider a Class of 28 Typical U.S. Seniors



# Class of 28 Typical Eighth Graders



# National Assessment of Educational Progress (NAEP): Data from 2009 and 2011

Icon	Level	Definition	Grade 8	Grade 12
	<b>Proficient</b>	solid academic performance	37%	26%
	<b>Advanced</b>	superior performance	8%	3%
	<b>Basic (or below)</b>	partial mastery of prerequisite knowledge and skills	63%	74%
	<b>Below Basic</b>	lacks mastery of prerequisite knowledge and skills	27%	36%

Why?

# The “Typical” Mathematics Classroom

- Go over the homework
- Go over the new material
- Students begin work on their homework.
- (Maybe a word problem or two.)



# Consequences

- Lack of motivation
  - “Why are we doing this?”
- Lack of engagement
  - “This is boring...”
- Lack of understanding
  - “No thinking required!”



**What Is the  
Alternative?**

# National Council of Teachers of Mathematics (NCTM)

A public voice of mathematics education  
supporting teachers to ensure equitable  
mathematics learning of the highest quality  
for all students through vision, leadership,  
professional development and research.

[www.nctm.org](http://www.nctm.org)

# History of NCTM's Standards

## **1980** -- *An Agenda for Action*

- Advocated for a coherent and comprehensive curriculum focusing on problem solving

## **1989** -- *Curriculum and Evaluation Standards for School Mathematics*

- Set forth national standards organized around three grade bands, including content and process standards (problem solving, reasoning, communication, and connections)

# History of NCTM's Standards

## **2000** -- *Principles and Standards for School Mathematics*

- Updated the 1989 standards, including four grade bands. Consistent content and process standards (adding representation) across the grades.

## **2006** -- *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*

- Set forth the most important mathematical topics for each grade level, based on *Principles and Standards*, incorporating the processes.

## **2009** -- *Focus in High School Mathematics: Reasoning and Sense Making*

- A renewed focus on the process standards through the lens of reasoning and sense making.

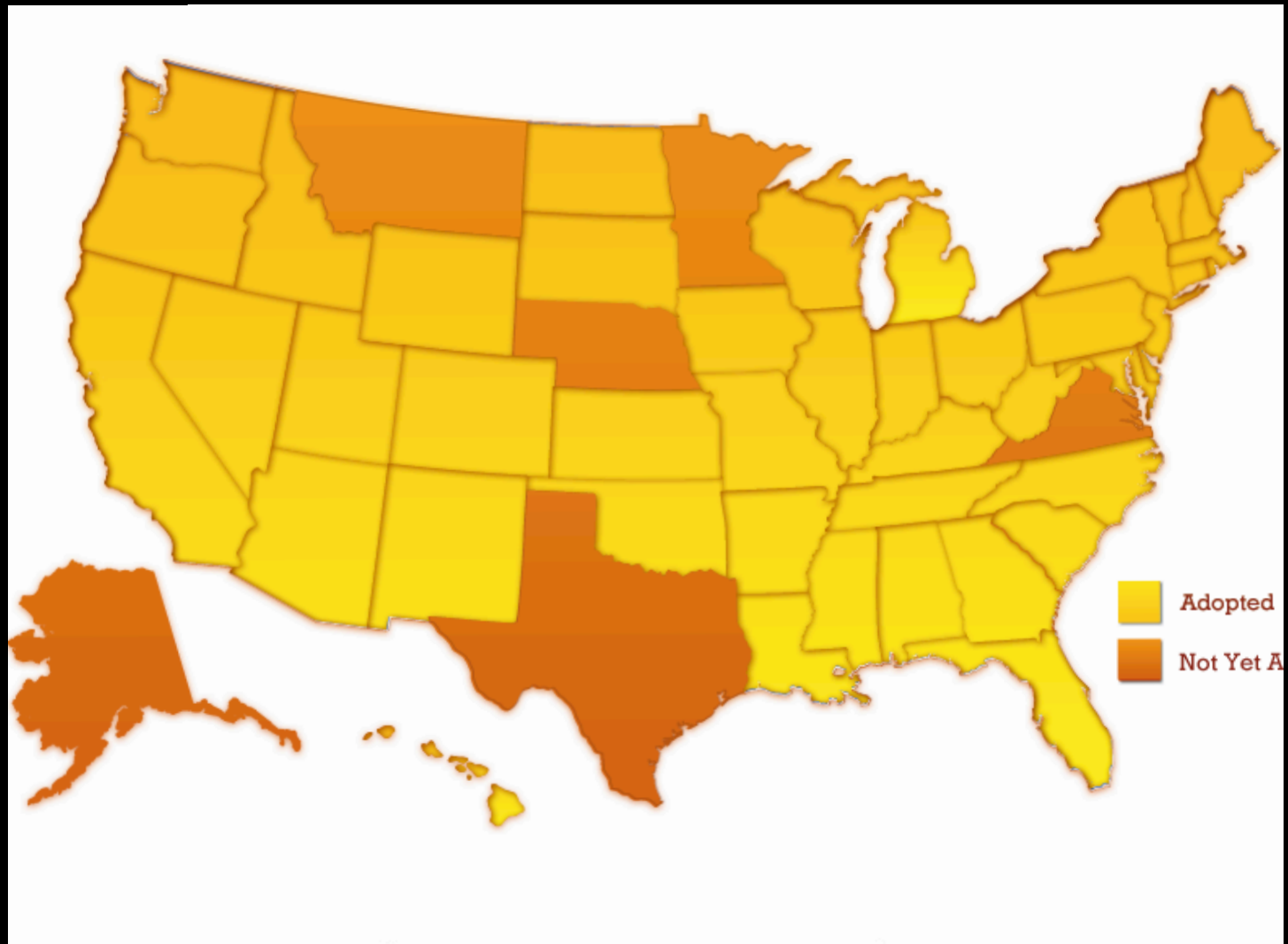
# Reasoning and Sense Making

“A focus on reasoning and sense making, when developed in the context of important content, will ensure that students can accurately carry out mathematical procedures, understand why those procedures work, and know how they might be used and their results interpreted.”

(NCTM, 2009, p. 3)

# Common Core State Standards for Mathematics (2010)

These standards define the knowledge and skills students should have within their K-12 education careers so that they will graduate high school able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs.



# Adopting States

# Standards for Mathematical Practice

- Varieties of expertise that mathematics educators at all levels should seek to develop in their students.
- These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education.



# 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.

An Example:  
“The Tilted Patio”

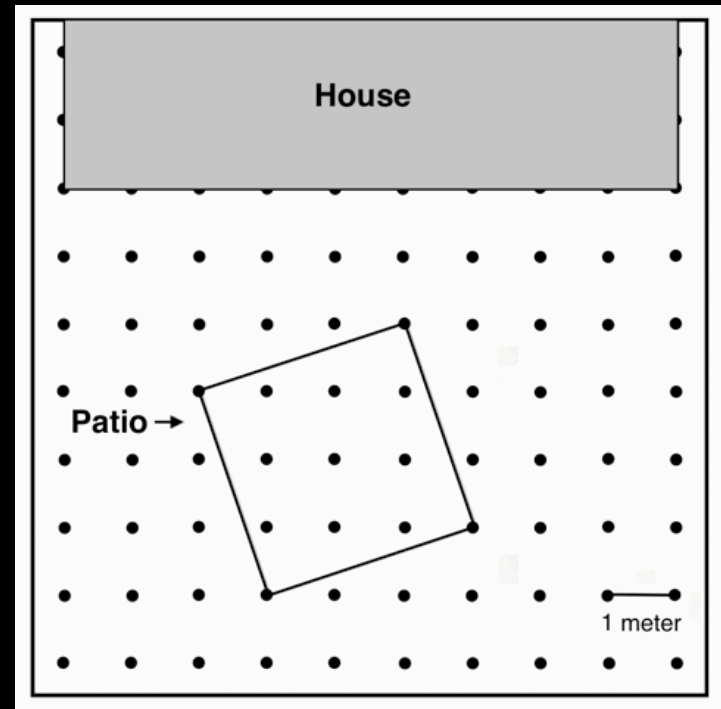
# Important Note

- Put on your “student hat.”
- Solve the problem using only the mathematics that a typical seventh-grade student would know.
  - That is, don’t apply any well-known formulas or theorems!
- Actually solve the problem!

## “The Tilted Patio”

Mrs. Dawson decides to build a square patio behind her house, fashionably tilted as shown in the diagram.

1. How many square meters of ceramic tile will she need to cover her patio? Explain your answer.
2. How many meters of fencing will it take to enclose the patio? Explain your method.



# Getting Started

- Reflect individually -- pens/pencils down.
  - How might you productively approach this problem?
- Discuss with a colleague.
  - Actually solve the problem. Don't just talk about solving it. Don't talk about what students would do.
- What is your conclusion? Be prepared to justify your answer!

# “Teacher Hats”

- Discuss:
  - How is this approach different from the “typical” mathematics classroom?
  - What mathematics is addressed?

# How Is This Different?

- Start with a problem  $\Leftarrow$  LAUNCH
- Engage student thinking  
(often in small groups)  $\Leftarrow$  EXPLORE
- Build mathematical conclusions  
(usually as a full group)  $\Leftarrow$  SUMMARIZE
- Apply what was learned to  
solve other problems  $\Leftarrow$  APPLY

# “Teaching Via Problem Solving”

- Enhances motivation
  - The reasons for doing mathematics are more apparent.
- Increases engagement
  - Challenging and interesting, not repetitive.
  - (Plus they may also get to work together!)
- Builds understanding
  - Students need to think through the mathematics for themselves.



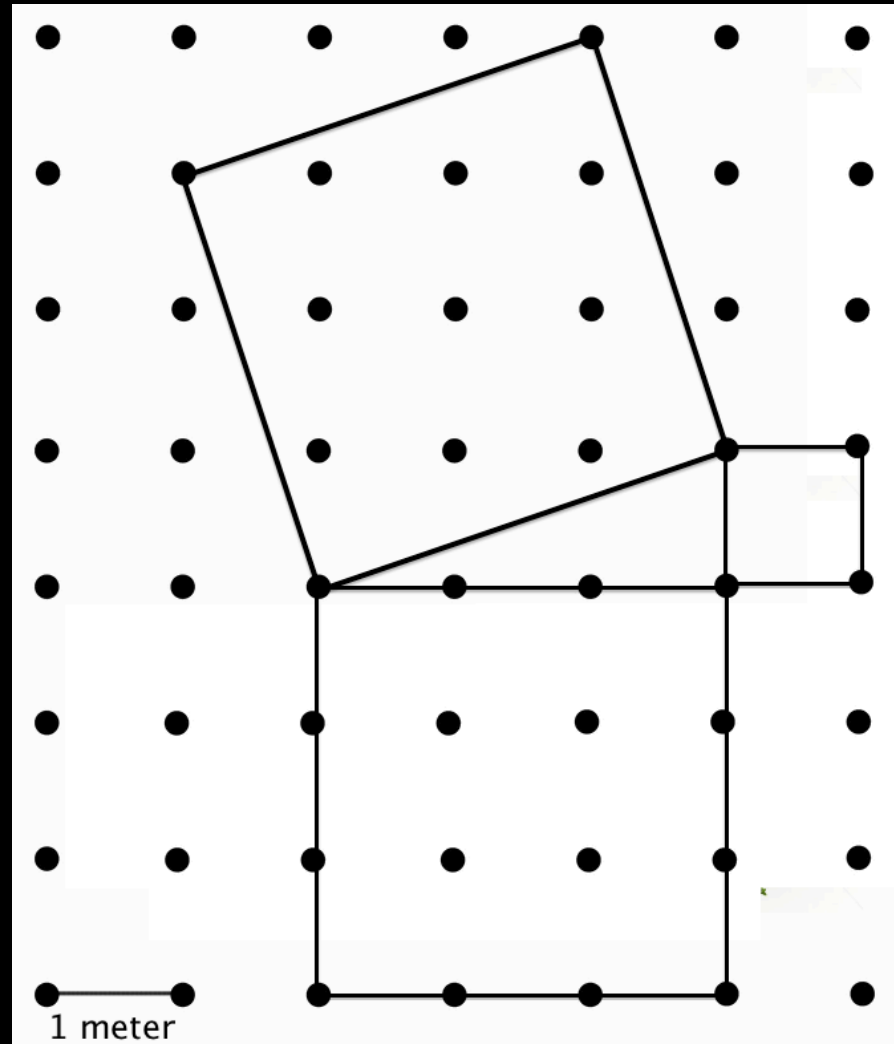
# Content

## **Grade 8, Expressions and Equations**

2. Use square root and cube root symbols to represent solutions to equations of the form  $x^2 = p$  and  $x^3 = p$ , where  $p$  is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that  $\sqrt{2}$  is irrational.

[8.EE.2]

# One Step Further...



# More Content

## **Grade 8, Geometry**

6. Explain a proof of the Pythagorean Theorem and its converse.
7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.  
[8.G.6-7]

# Standards for Mathematical Practice

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# Standards for Mathematical Practice

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# Resources for the New Vision

- *See hand-out.*

Conclusion

# Final Thoughts

## Favorite Sayings:

- “Mathematics is not a spectator sport.”
- “He/she who actually does the work reaps the benefits.”
- “The only way to truly LEARN mathematics is to actually DO mathematics!”



# Making a Difference

Figure 18. Trend in eighth-grade NAEP mathematics average scores



# Take a Moment to Reflect...

- Somewhere on your sheet, write down one idea you will take from this talk and apply to your teaching.

**Build the New Vision  
for Mathematics in Your  
Classroom!**