High-Leverage Actions for Mathematics Education Leaders

Diane J. Briars
Immediate Past President
NCSM

NCTM 2011 Annual Meeting & Exposition
April 14, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

That's Me

- Lives in Pittsburgh
- First time NCTM Conference attendee
- Elementary mathematics leader
- Middle school mathematics leader
- High school mathematics leader
- Administrator
- University mathematics leader

What is NCSM?

International organization of and for mathematics education leaders:

- Coaches and mentors
- Curriculum leaders
- Department chairs
- District supervisors/leaders
- Mathematics consultants
- Mathematics supervisors
- Principals
- Professional developers
- Publishers and authors
- Specialists and coordinators
- State and provincial directors
- Superintendents
- Teachers
- Teacher educators
- Teacher leaders

43rd NCSM Annual Con
Indianapolis, Indiana • April 11–13, 20
Fuel your leadership engine
Be there for the green flag as Karen Cator's keynote address, Transforming American Education: Learning Powered by Technology opens the 43rd NCSM Annual Conference on April 11, 2011.
Make your plans and save the dates:
The National Council of Supervisors of Mathematics Improving Student Achievement Series
No. 7/Spring 2010
Research-Informed Answers for Mathematics Education Leaders
LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE
Improving Student Achievement in Mathematics by Promoting Positive Self-Beliefs
... many students have difficulty in school not because they are incapable of performing successfully but because they are incapable of believing they can perform successfully ... Consequently, parents and teachers do well to take seriously their share of the responsibility in nurturing the self-beliefs of their children and students, for it is clear that these beliefs can have beneficial or destructive influences.
Pajares & Schunk, 2002
Our Position
The National Council of Supervisors of Mathematics believes that in order to help students learn challenging, standards-based mathematics, educators must establish a classroom climate that promotes positive self-beliefs about intelligence and academic ability. We believe that teacher actions can significantly affect students' self-beliefs and that — as these student self-beliefs deepen and strengthen — teacher beliefs do so as well. Positive self-beliefs, as well as positive experiences in mathematics, increase student motivation and engagement.
Mathematics educators can best instill positive student beliefs about their intelligence and ability to do mathematics when we:
• Understand that educators play a crucial role in student motivation.
• Know that equity requires that educators reflect on their individual beliefs about intelligence and whether or not they believe that all children can learn mathematics.
• Establish a learning environment that promotes a view of intelligence as malleable and fosters a sense of belonging for each student.
• Recognize and act upon the fact that even students who currently appear not to care, do want to learn and be challenged.
• Ensure that all students have the right to authentic and meaningful mathematics curricula taught in engaging and accessible ways.
The NCSM Improving Student Achievement Series is a set of position papers designed to provide research-based practices for school and district mathematics education leaders.
• Use mathematics as a forum for students to reach a better understanding of themselves as learners by providing opportunities for them to experience and recognize that hard work and perseverance results in deeper understanding and higher achievement.
• Teach and model the meaning of effective effort.
• Foster positive and encouraging relationships with students and among students by providing opportunities for students to engage in peer-to-peer learning communities.
• Implement assessment for learning strategies that involve students in goal setting, presentations of their learning, and self-reflections.
• Provide descriptive feedback to students about their work to help students identify the strengths and weaknesses of their mathematics strategies and suggest action steps for improvement.
Research that Supports Our Position
In its Principles and Standards for School Mathematics, the National Council of Teachers of Mathematics (2000) put forth an ambitious vision of school mathematics that requires that all students engage in meaningful mathematics. For students even to try engaging in meaningful mathematics, however, it is critical that we not underestimate what it takes to motivate them to succeed in school. The National Mathematics Advisory Panel (2008), for example, found that 62% of Algebra I teachers reported "working with unmotivated students" is the "single most challenging aspect of teaching Algebra I successfully." In addition, former American Psychological Association president Robert Sternberg

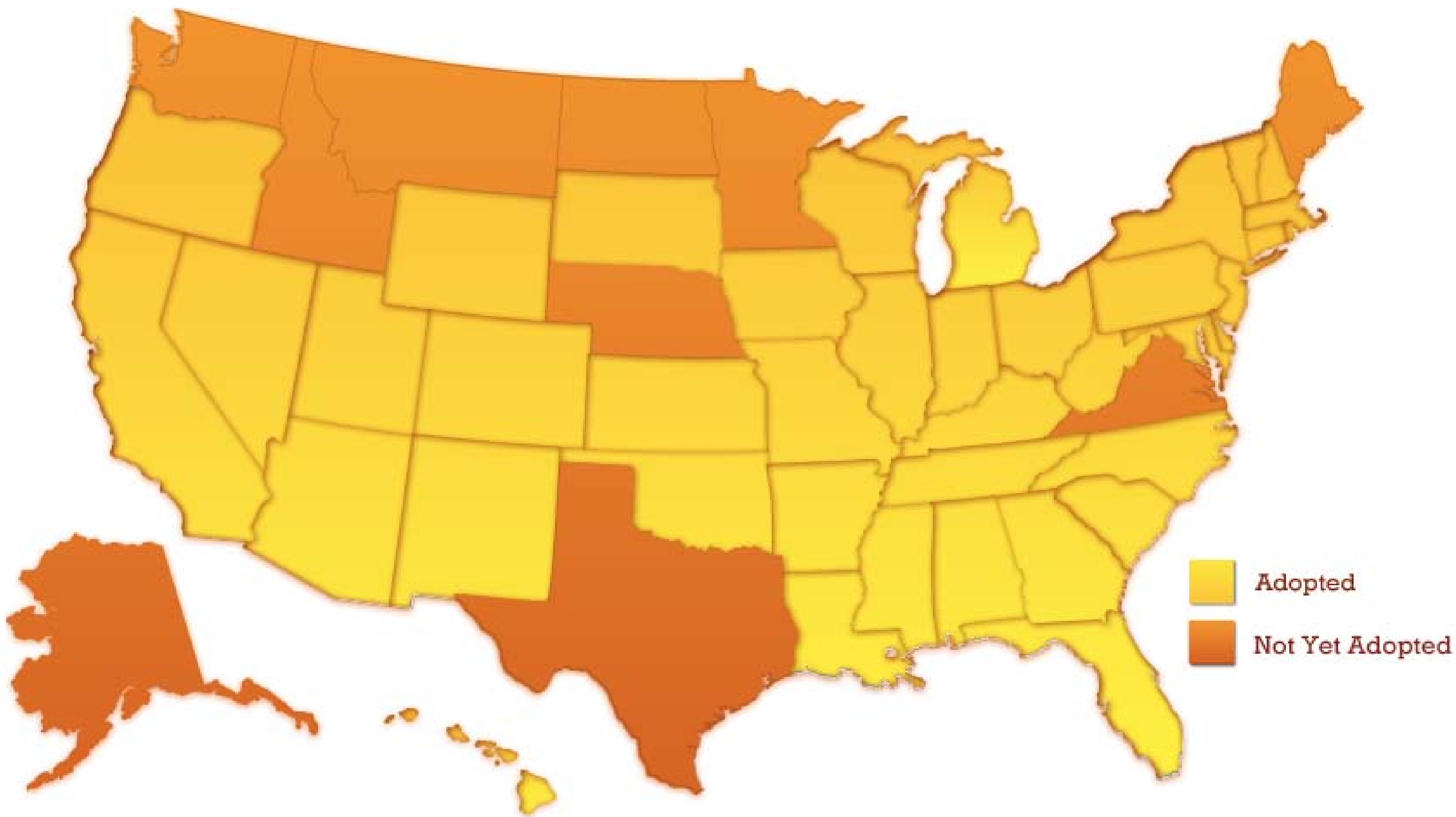
NCSM Position Papers

1. Effective and Collaborative Teams
2. Sustained Professional Learning
3. Equity
4. Students with Special Needs
5. Assessment
6. English Language Learners
7. Positive Self-Beliefs
8. Technology

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

" The Common Core State Standards represent an opportunity – once in a lifetime – to form effective coalitions for change." Jere Confrey, August 2010



Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

CCSS: A Major Challenge/Opportunity

- College and career readiness expectations
- Rigorous content and applications
- Stress conceptual understanding as well as procedural skills
- Organized around mathematical principles
- Focus and coherence
- Designed around research-based learning progressions whenever possible.

Briars, NCTM, 2011

Challenge

- Essential for all students to succeed at high levels in mathematics.
- How can we:
  - Increase the effectiveness of our mathematics curriculum, instruction, and assessment.
  - Ensure that all students are achieving at high levels.

Briars, NCTM, 2011

High-Leverage Actions

Research-informed actions that produce the greatest benefits for your efforts.

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

Research-Informed Actions

Instructional practice should be informed by high-quality research, when available, and by the best professional judgment and experience of accomplished classroom teachers.

National Math Panel, 2008

Relevant Research

- How people learn;
- How students learn mathematics;
- Particular challenges in learning specific mathematics content;
- Established principles of mathematics learning and instruction;
- New approaches to knowing what students know;
- Effective instruction for special needs students;
- Student motivation;
- Teacher supports;
- Language and literacy related to mathematics learning.

Briars, NCTM, 2011

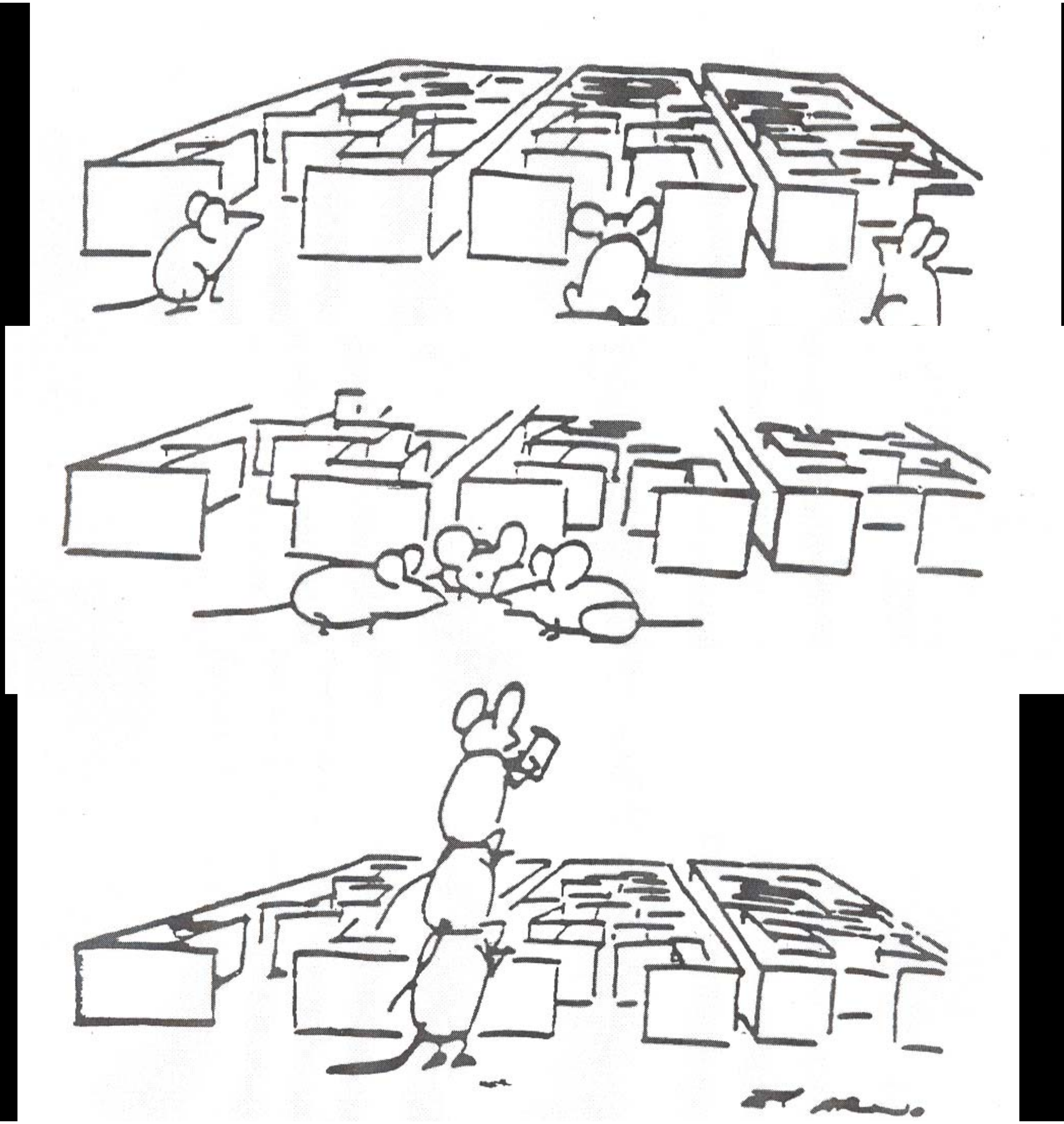
“Wisdom of practice” can/should inform research, but it is not a substitute for research.

Realistic Expectations

- Research is most useful when it provides an understanding of why a particular strategy, intervention, approach or program works (Hiebert 2003).
- Research on general learning principles can provide a basis for effective instructional practices.

Research Results

- *How People Learn*, NRC, 1999, 2005
- *Adding It Up: Helping Children Learn Mathematics*, NRC, 2001
- *Knowing What Students Know: The Science and Design of Educational Assessment,* NRC, 2001
- *Foundations for Success*, National Mathematics Advisory Panel, 2008
- *Educational Researcher*, Response to NMAP Report, December 2008
- QUASAR project
- TIMSS, 1999



Collaborate!

Engage teachers in working in collaborative teams

- Grade level/course meetings
  - Common assessments
  - Common unit planning
  - Differentiating instruction
- Cross grade/course meetings
  - End-of-year/Beginning-of-year expectations

Learners should

- Acquire conceptual knowledge as well as skills to enable them to organize their knowledge, transfer knowledge to new situations, and acquire new knowledge.
- Engage with challenging tasks that involve active meaning-making.

Hiebert & Grouws, 2007

What Are Mathematical Tasks?

Mathematical tasks are a set of problems or a single complex problem the purpose of which is to focus students' attention on a particular mathematical idea.

Briars, NCTM, 2011

Why Focus on Mathematical Tasks?

- Tasks form the basis for students' opportunities to learn what mathematics is and how one does it;
- Tasks influence learners by directing their attention to particular aspects of content and by specifying ways to process information;
- The level and kind of thinking required by mathematical instructional tasks influences what students learn; and
- Differences in the level and kind of thinking of tasks used by different teachers, schools, and districts, is a major source of inequity in students' opportunities to learn mathematics.

Briars, NCTM, 2011

The QUASAR Project

- Assisted schools in economically disadvantaged communities to develop instructional programs that emphasize thinking, reasoning and problem solving in mathematics.
- Worked with lowest achieving middle schools in six urban sites.
- Studied the impact of high quality curricula and professional development upon student achievement.

Comparing Two Mathematical Tasks

Martha was re-carpeting her bedroom which was 15 feet long and 10 feet wide. How many square feet of carpeting will she need to purchase?

Stein, Smith, Henningsen, & Silver, 2000, p. 1

Comparing Two Mathematical Tasks

Ms. Brown's class will raise rabbits for their spring science fair. They have 24 feet of fencing with which to build a rectangular rabbit pen in which to keep the rabbits.

1. **If Ms. Brown's students want their rabbits to have as much room as possible, how long would each of the sides of the pen be?**
2. **How long would each of the sides of the pen be if they had only 16 feet of fencing?**
3. **How would you go about determining the pen with the most room for any amount of fencing? Organize your work so that someone else who reads it will understand it.**

Stein, Smith, Henningsen, & Silver, 2000, p. 2

Compare the Two Tasks

Discuss:

- How are Martha's Carpeting Task and the Fencing Task the same and how are they different?

Cognitive Level of Tasks

- Lower-Level Tasks
  (e.g., Martha's Carpeting Task)

- Higher-Level Tasks
  (e.g., The Fencing Task)

Lower-Level Tasks

- Memorization
  - What are the decimal equivalents for the fractions $\frac{1}{2}$ and $\frac{1}{4}$?
- Procedures without connections
  - Convert the fraction 3/8 to a decimal.

Briars, NCTM, 2011

Higher-Level Tasks

- Procedures with connections
  - Using a 10 x 10 grid, identify the decimal and percent equivalents of 3/5.
- Doing mathematics
  - Shade 6 small squares in a 4 x 10 rectangle. Using the rectangle, explain how to determine:
    a) The decimal part of area that is shaded;
    b) The fractional part of area that is shaded.

"Not all tasks are created equal, and *different tasks will provoke different levels and kinds of student thinking*."

Stein, Smith, Henningsen, & Silver, 2000

"The level and kind of thinking in which students engage determines what they will learn."

Hiebert et al., 1997

Briars, NCTM, 2011

Opportunities for *all* students to engage in high-level tasks?

- Examine tasks in your instructional materials:
  - Higher level?
  - Lower level?
- Where are the higher-level tasks?
- Do *all* students have the opportunity to do higher-level tasks?
- Examine the tasks in your assessments:
  - Higher level?
  - Lower level?

Briars, NCTM, 2011

Getting Started with High Cognitive Demand Tasks

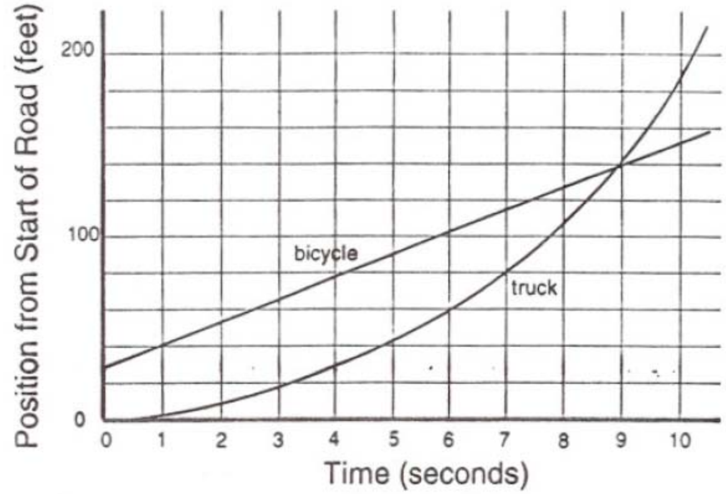
- Replacement lessons:
  - – Supplement existing instructional materials with hcd tasks.
  - – Modify existing tasks to increase their cognitive demand.
- Adopt/purchase instructional materials that feature hcd tasks.
- Use assessments that feature hcd tasks.

Briars, NCTM, 2011

Bike and Truck

Bike and truck

A bicycle and a truck are going along a road in the same direction. The graph below shows their positions as a function of time:



1. After how many seconds, roughly, does the truck overtake the bike?

2. What is the speed of the bicycle? Show how you arrived at your answer.

3. When is the truck going roughly the same speed as the bike? Describe briefly how you know.

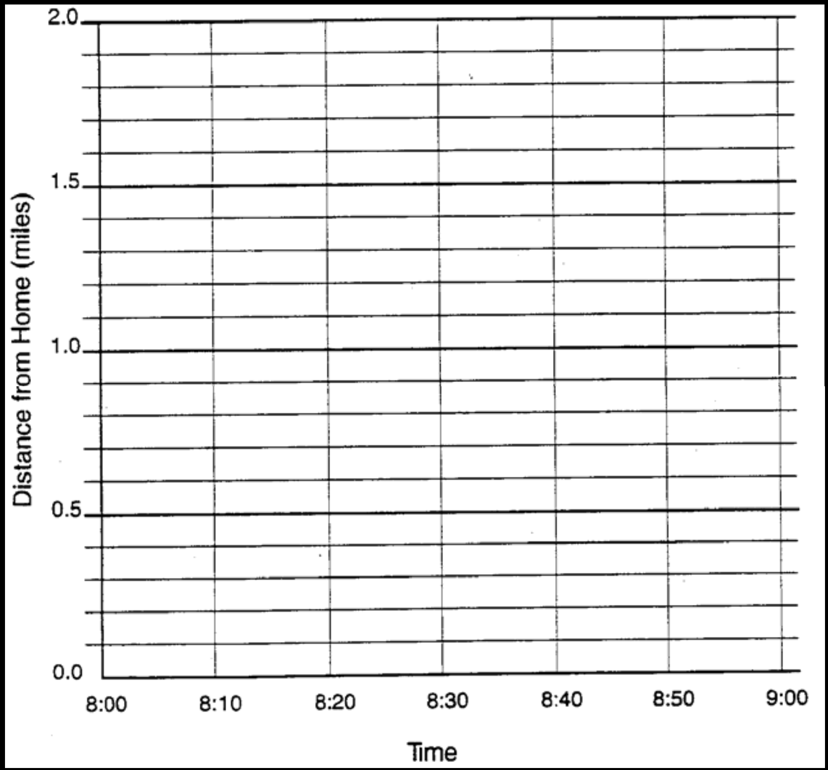
Walker Walks

Every morning Walker Bryce walks 1.7 miles to school.

He leaves his house at 8:05 and walks 1.2 miles, then waits for Bobby and Denise.

When they show up, all three of them start walking to school together. They arrive ten minutes later at 8:55.

Draw a graph that could show Walker's journey to school.



New Standards Reference Exam Released Tasks, 1996

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

HCD Assessment Tasks

Mitch claims that

3 ÷ 6 and 6 ÷ 3

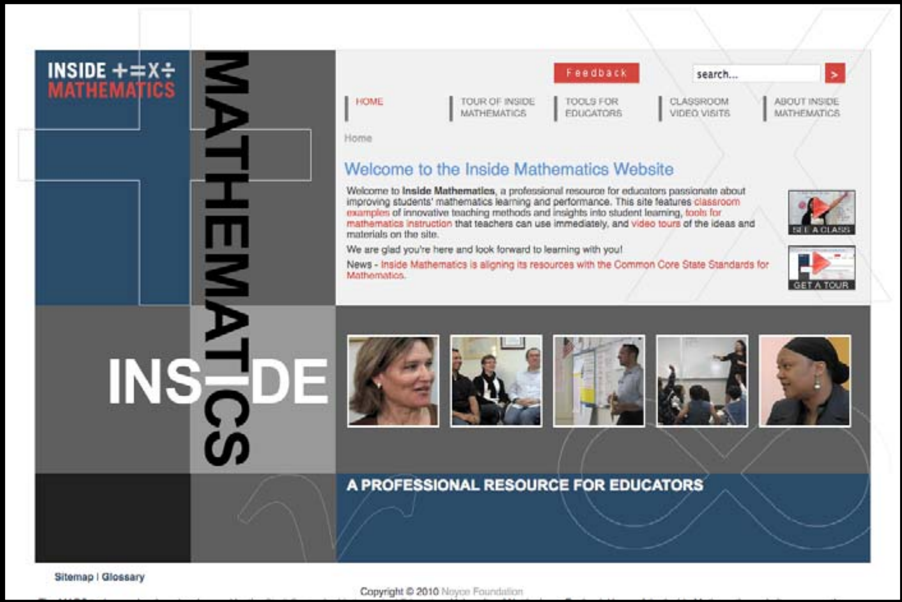
are the same. Sally is not sure.

Is Mitch correct? Explain your answer to Mitch and Sally so that they will understand.

Inside Mathematics

Inside Mathematics has resources for:

- Classroom Teachers
- Mathematics Coaches
- School Principals



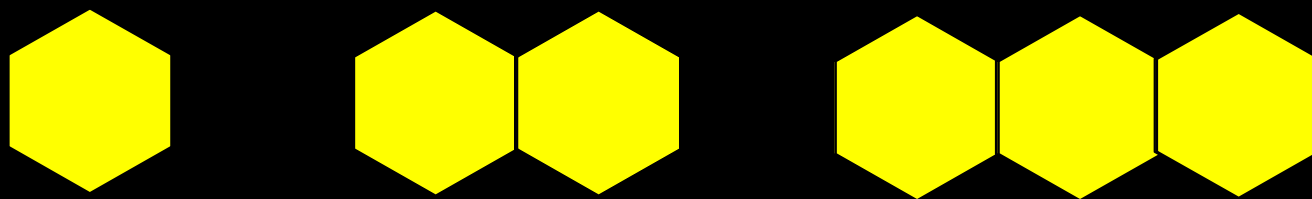
Including:

- ✓ Mathematics Tasks and Lessons
- ✓ Classroom Video
- ✓ Sample Student Work
- ✓ Rubrics
- ✓ Teacher Reflections and
- ✓ More….

http://www.insidemathematics.org

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

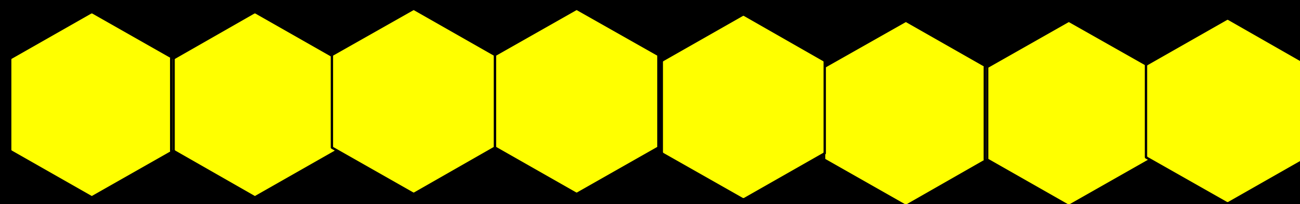
Hexagon Trains



- Compute the perimeter for the first four trains.
- Determine the perimeter for the tenth train without constructing it.
- Write a description /expression that could be used to compute the perimeter of any train in the pattern.
- Find as many different ways as you can to represent the perimeter of any train.

Briars, NCTM, 2011

Hexagon Trains



- Explain what each student was thinking to find the perimeter of the n^{th} train.
- Connect your explanation to the picture of the tables.

Terri: $1 + 4n + 1$

Tim: $1 + 2(2n) + 1$

Jerry: $5 + 4(n – 2) + 5$

Linda: Multiply n times 6, then subtract n-1 times 2.

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM NETWORK COMMUNICATE SUPPORT MOTIVATE

Research-Informed Instructional Strategies

- **Combine graphics with verbal descriptions** to facilitate encoding of individual mathematical representations and to make conceptual connections between representations.
- **Incorporate analyzing and explaining examples of both correct and incorrect solutions;** Incorrect examples that anticipate common student misconceptions push students to more deeply process and reason with greater understanding.

IES Practice Guide, 2007

The Mathematical Tasks Framework

TASKS

as they appear in curricular/ instructional materials

→

TASKS

as set up by the teachers

→

TASKS

as implemented by students

→

Student Learning

LSC Evaluation Study

While teachers were using the materials more extensively in their classrooms, there was a wide variation in how well they were implementing these materials. Teachers were often content to omit rich activities, skip over steps and jump to higher level concepts, or leave little time for students to 'make sense' of the lessons.

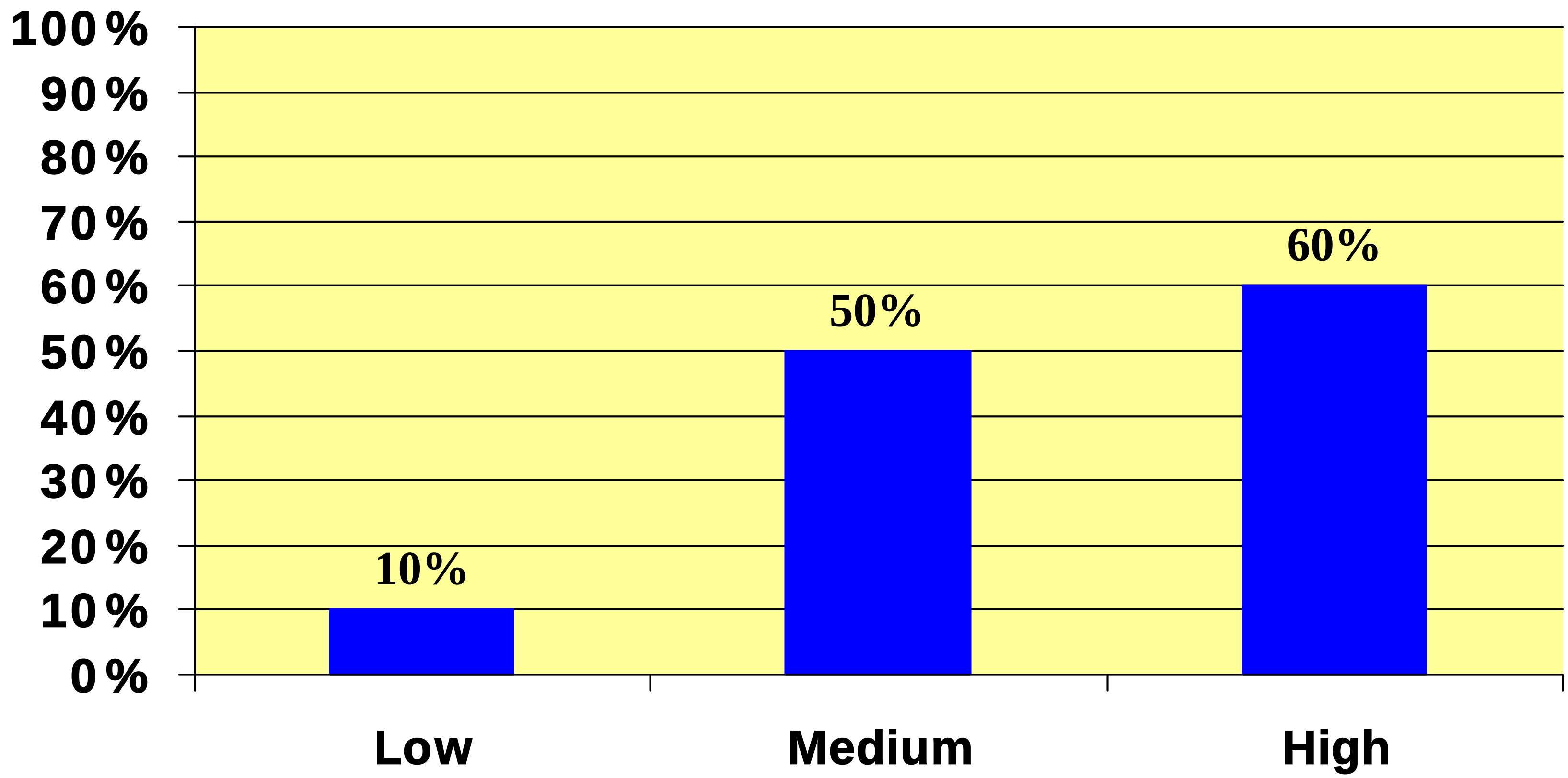
Weiss, et al, 2006

LSC Evaluation Study

In fact, classroom observations indicated that the lessons taught as the developers intended were more likely to provide students with learning opportunities than those that were "adapted."

Weiss, et al, 2006

Highly-Rated Lessons by Adherence to Standards-Based Materials

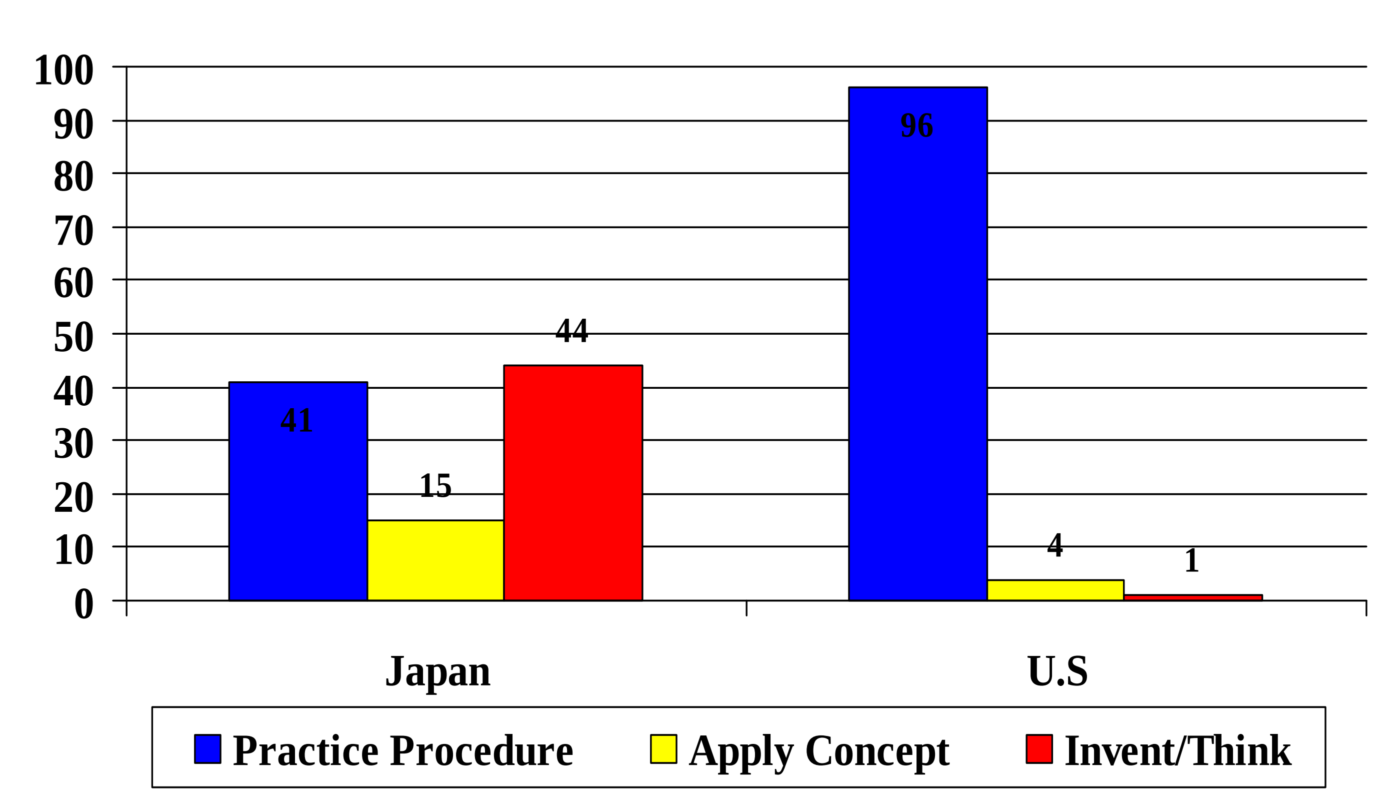


Weiss et al., 2002

Briars, NCTM, 2011

TIMSS Video Studies

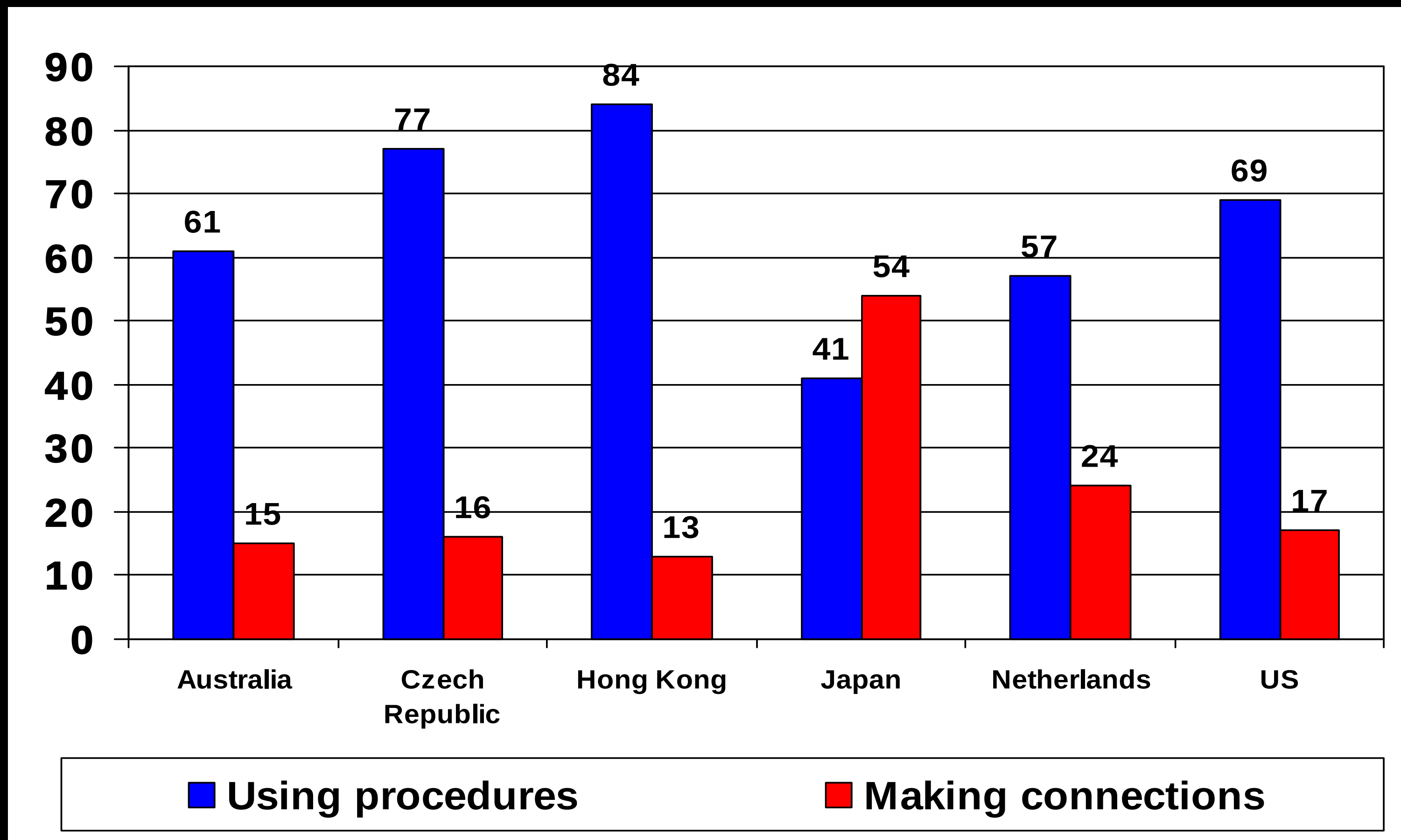
Average Percentage of Seatwork Time in Each Country Spent Working on Three Kinds of Tasks



Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

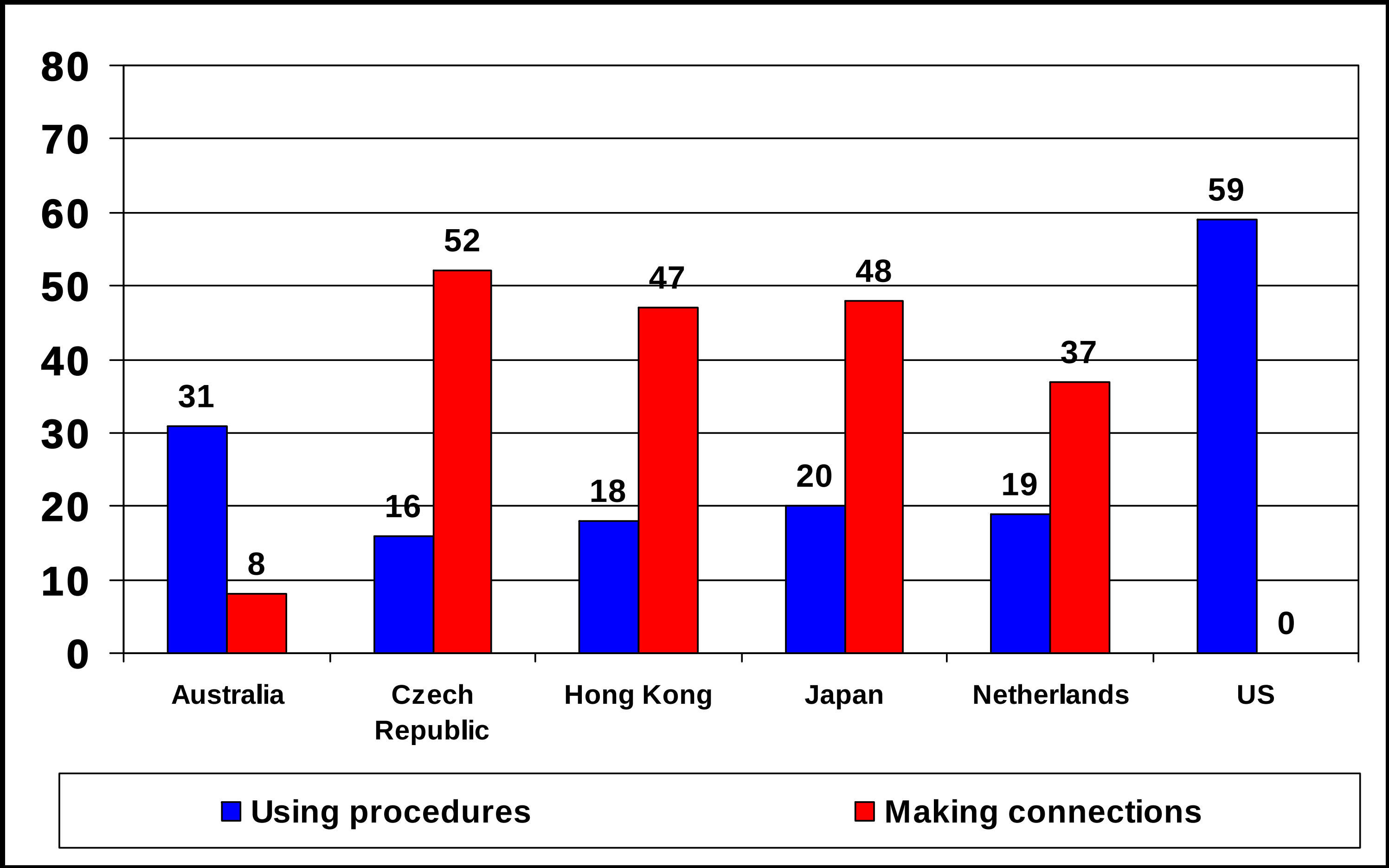
Types of Math Problems Presented
1999 TIMSS Video Study



Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

How Teachers Implemented *Making Connections* Math Problems



Briars, NCTM, 2011

Effect on student achievement

	Task Set-Up	Task Implementation	Student Learning
A.	High →	High →	High
	Low →	Low →	Low
C.	High →	Low →	Moderate

Stein & Lane, 1996

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

Core Premise

Every teacher implements high cognitive demand tasks to promote high levels of learning by every students.

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

How Many Students Will Experience a High Quality Instructional Program?

	K	1	2	3	4	5
	Ms. A	Ms. C	Mr. E	Ms. G	Ms. I	Ms. K
	Ms. B	Mr. D	Ms. F	Ms. H	Mr. J	Ms. L
64 Students	32	16	8	4	2	1

Briars, NCTM, 2011

What Happened?

Which of the following are even numbers?

a. 89

b. 138

c. 150

d. 245

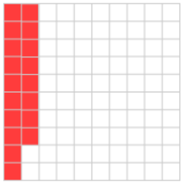
On-going cumulative distributed practice improves learning and retention.

1. If it rained 3 days out of 20 days, what percent of the days did it rain?

   Answer:

   Evidence for answer:

2. If the large square represents one whole, what fraction is represented by the shaded area?



   Answer:

   Evidence for answer:

3. Which symbol (<, >, *or* =) correctly describes the relationship between these two numbers.

   $\frac{9}{16}$ ☐ 0.5625

   Evidence for answer:

4. There are 6 boys to every 9 girls in the 6th grade at Ripple River School. There are a total of 75 students in the 6th grade. How many boys are there in the 6th grade?

   Answer:

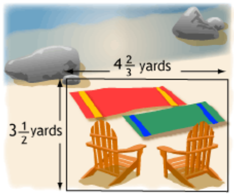
   Evidence for answer:

5. Meghan works at an ice cream shop and makes $8.25 per hour. Lucas works for a landscaper and makes $6.50 per hour. How much more does Meghan make each hour?

   Answer:

   Evidence for answer:

6. How long of a piece of rope do the girls need to totally enclose their space at the beach?



   Answer:

   Evidence for answer:

Students' Beliefs about Their Intelligence Affect Their Academic Achievement

- Fixed mindset:
  - Avoid learning situations if they might make mistakes
  - Try to hide, rather than fix, mistakes or deficiencies
  - Decrease effort when confronted with challenge
- Growth mindset:
  - Work to correct mistakes and deficiencies
  - View effort as positive; increase effort when challenged

Briars, NCTM, 2011

Students' Beliefs about Their Intelligence Affect Their Academic Achievement

When confronted with challenging school transitions or courses, students with growth mindsets outperform those with fixed mindsets, even when they enter with equal skills and knowledge.

Briars, NCTM, 2011

Students Can Develop Growth Mindsets

- Explicit instruction about the brain, its function, and that intellectual development is the result of effort and learning has increased students' achievement in middle school mathematics.
- Teacher praise influences mindsets
  - Fixed: Praise refers to intelligence
  - Growth: Praise refers to effort, engagement, perseverance

Briars, NCTM, 2011

Using Assessment Results

New Standards Reference Exam

- Skills
- Concepts
- Problem Solving

NSMRE Performance Levels

- Achieved the Standard with Honors
- Achieved the Standard
- Nearly Achieved the Standard
- Below the Standard
- Little Evidence of Achievement

PPS 2005 Grade 10 NSMRE Results
% Meeting or Exceeding Standard
All students, including PSE

	All	White	AA
# of students	1026	604	400
Skills	41%	62%	20%
Concepts	27%	44%	9%
Problem Solving	19%	35%	5%

NSMRE Performance Levels

- Achieved the Standard with Honors
- Achieved the Standard
- Nearly Achieved the Standard
- Below the Standard
- Little Evidence of Achievement

Grade 10 Results for Stable Attenders
NSMRE Skills
All students, including PSE

	All	**White**	**AA**
# of students	1026	604	400
% of test takers	59%	70%	49%
% Met or Exceed	51%	66%	27%
% Below	31%	21%	47%
% Little Evidence	8%	5%	13%

Briars, NCTM, 2011

Grade 10 Results for Stable Attenders
NSMRE Concepts
All students, including PSE

	All	White	AA
# of students	1026	604	400
% of test takers	59%	70%	49%
% Met or Exceed	36%	50%	13%
% Below	31%	22%	45%
% Little Evidence	6%	3%	12%

Briars, NCTM, 2011

Grade 10 Results for Stable Attenders

NSMRE Problem Solving

All students, including PSE

	All	White	AA
# of students	1026	604	400
% of test takers	59%	70%	49%
% Met or Exceed	21%	32%	5%
% Below	42%	39%	46%
% Little Evidence	26%	15%	43%

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

TESA

Observing for Equity—

- Who is engaged?
- Who is called on?
- What type of questions are asked to which students?
- Amount of wait time?

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

High Leverage Action

- Collaborative teams
- High cognitive demand tasks
- On-going review and distributed practice
- Positive self-beliefs
- Using assessment data to disspell myths.

Briars, NCTM, 2011

Reflection: Now What?

What actions will you take based on research-informed best practices?

- What do you need to learn?
- Who will you work with?
- What do you need to integrate into your practice or into the practices of your school or district?
- Who will support you?

Briars, NCTM, 2011

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

NCSM Professional Development Opportunities

- **NCSM Summer Leadership Academy**
  - **June 21-23 in Atlanta, GA**
- **Fall One-Day Seminars**
  - **October 19 in Atlantic City, NJ**
  - **October 26 in St. Louis, MO**
  - **November 2 in Albuquerque, NM**

www.mathedleadership.org

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE

Thank You!

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM
NETWORK
COMMUNICATE
SUPPORT
MOTIVATE