High-Leverage Actions for Mathematics Education Leaders

Diane J. Briars
President, NCSM
42nd Annual NCSM Conference
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That's Me

- Lives in Pittsburgh
- First time NCSM Conference attendee
- Elementary mathematics leader
- Middle school mathematics leader
- High school mathematics leader
- Adminstrator

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.

High-Leverage Actions

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

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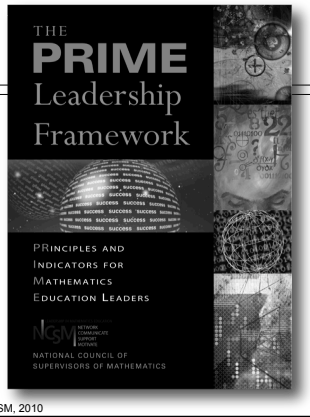

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NCSM Position Papers

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

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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

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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

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

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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.

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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

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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

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Learners should

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

Hiebert & Grouws, 2007

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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.

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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.

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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.

Edward A. Silver, Margaret S. Smith, Mary

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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

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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, & Sil

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)

The Quasar Proj

Lower-Level Tasks

- Memorization
  - What are the decimal equivalents for the fractions ½ and ¼?
- Procedures without connections
  - Convert the fraction 3/8 to a decimal.

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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.

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"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

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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?

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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.

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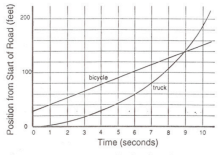
Bike and Truck

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.

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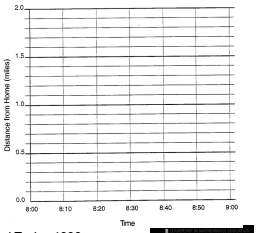
Walker Walks

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

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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.

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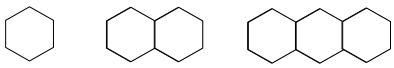
Hexagon Trains



- 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.

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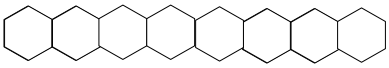
Hexagon Trains



- 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: $5 + 4(n - 2) + 5$

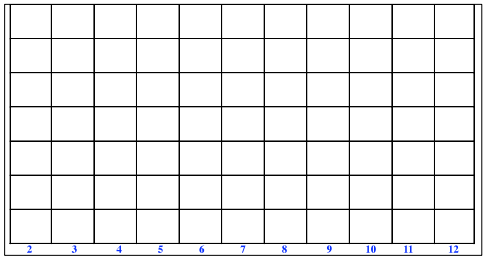
Linda: Multiply n times 6, then subtract n-1 times 2.

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

Graphing Dice Throws



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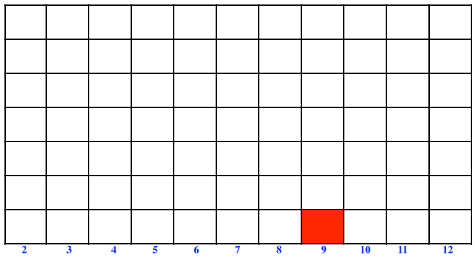

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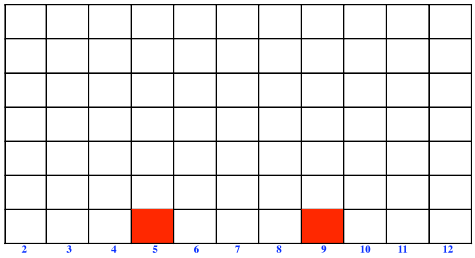

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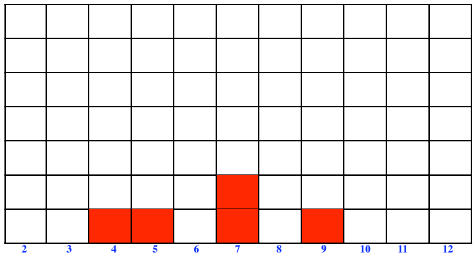

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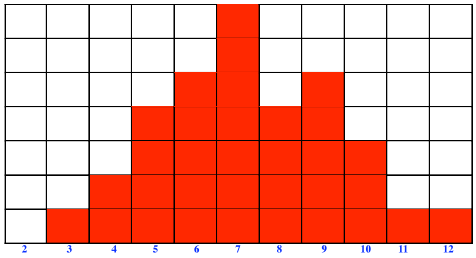
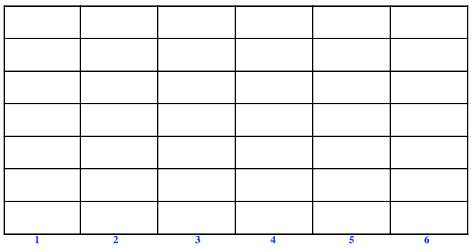


Graphing Dice Throws

"My children are "low level", so I do the activity using 1 die."

Graphing Dice Throws



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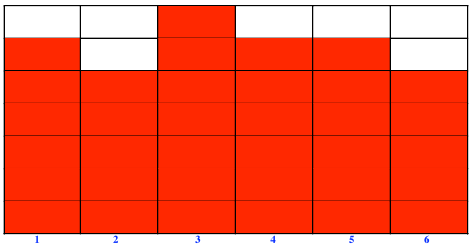
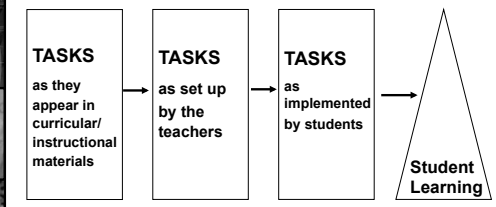


The Mathematical Tasks Framework



Stein, Smith, Henningsen,

Briars, NCSM, 2010

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

Briars, NCSM, 2010

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 a

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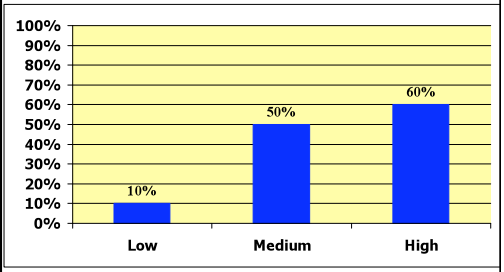
Highly-Rated Lessons by Adherence to Standards-Based Materials



Weiss et al., 2002

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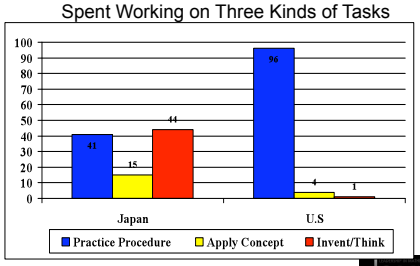
TIMSS Video Studies

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



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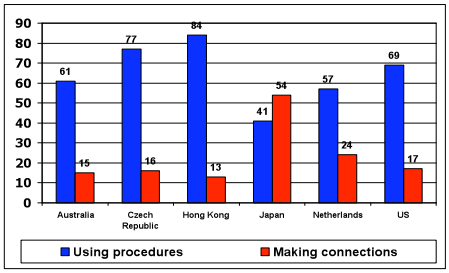
Types of Math Problems Presented
1999 TIMSS Video Study



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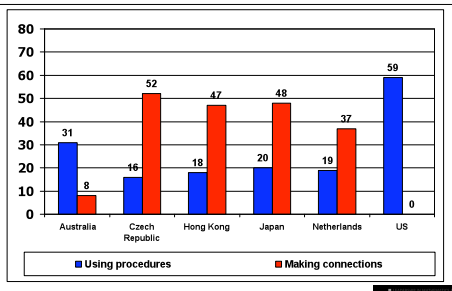
How Teachers Implemented *Making Connections* Math Problems



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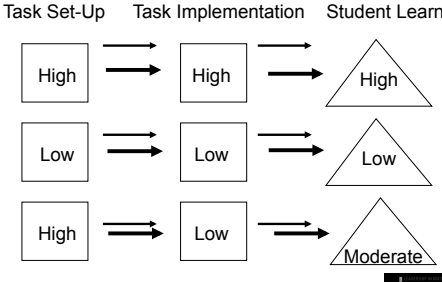
Effect on student achievement



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Core Premise

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

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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, NCSM, 2010

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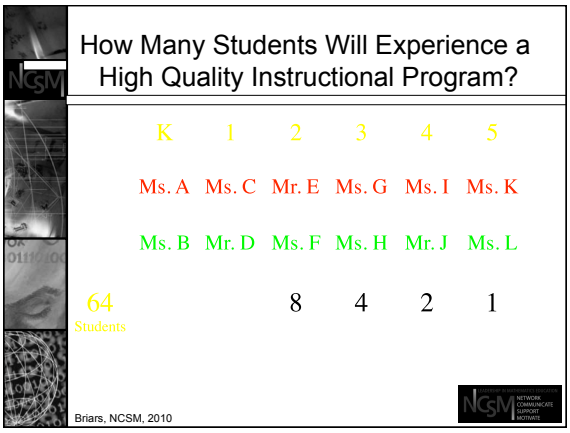
Briars, NCSM, 2010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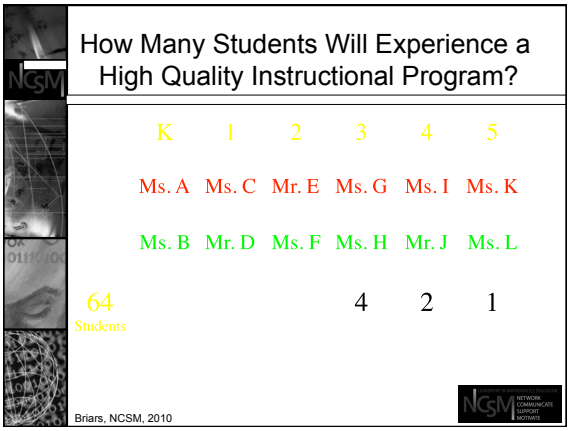
Briars, NCSM, 2010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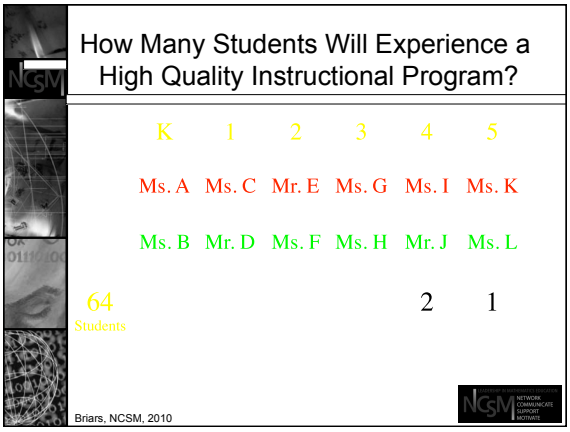
Briars, NCSM, 2010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Briars, NCSM, 2010

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Briars, NCSM, 2010

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Briars, NCSM, 2010

Challenge

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

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What Happened?

Which of the following are even numbers?

a. 89

b. 138

c. 150

d. 245

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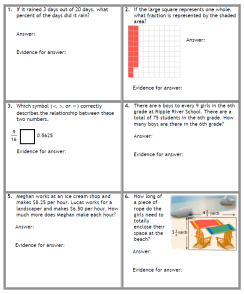
On-going cumulative distributed practice improves learning and retention.



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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

Dweck, 2007

Briars, NCSM, 2010

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.

Dweck, 2007

Briars, NCSM, 2010

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

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Using Assessment Results

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New Standards Reference Exam

- Skills
- Concepts
- Problem Solving

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NSMRE Performance Levels

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

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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%

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NSMRE Performance Levels

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

Briars, NCSM, 2010

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, NCSM, 2010

Grade 10 Results for Stable Attenders

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Briars, NCSM, 2010

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Briars, NCSM, 2010

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, NCSM, 2010

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, NCSM, 2010

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, NCSM, 2010

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, NCSM, 2010

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, NCSM, 2010


NCSM Professional Development Opportunities
NCSM Leadership Conferences
– June 15-18 in Chicago, IL Area
– June 22-25 in Houston, TX
– August 16-19, New York City
Fall One-Day Seminars
– October 6 in Denver
– October 13 in Baltimore
– October 27 in New Orleans
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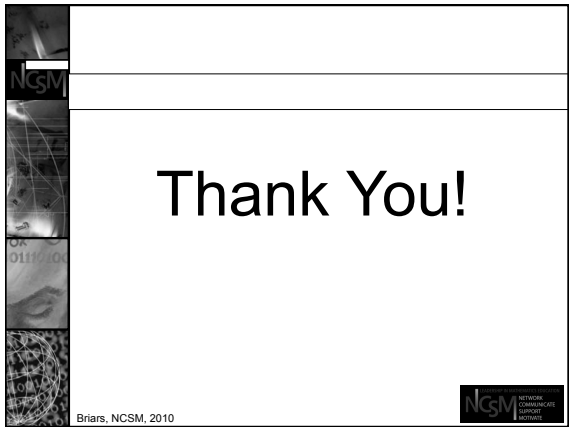
Thank You!
Briars, NCSM, 2010