

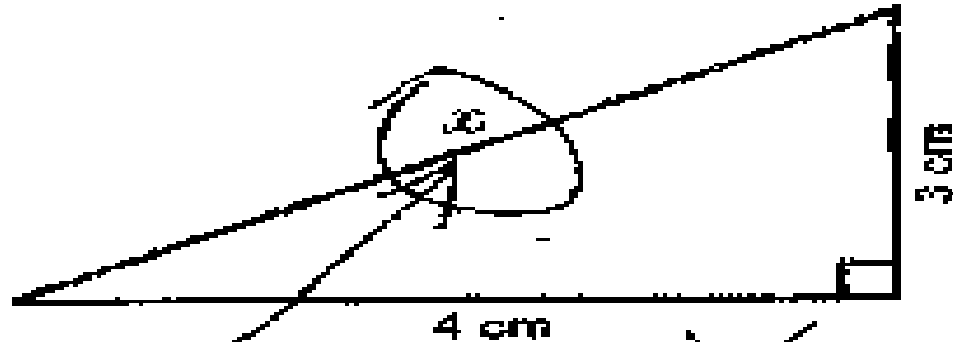
What Works in Math

Larry Nyland ♦ Ray Houser ♦ Tarra Patrick
WERA December 2009

- A Personal Quest
- Educated Guesses
- Saving Math Lives

What Works in Math

3. Find x .



Here it is X O

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Content

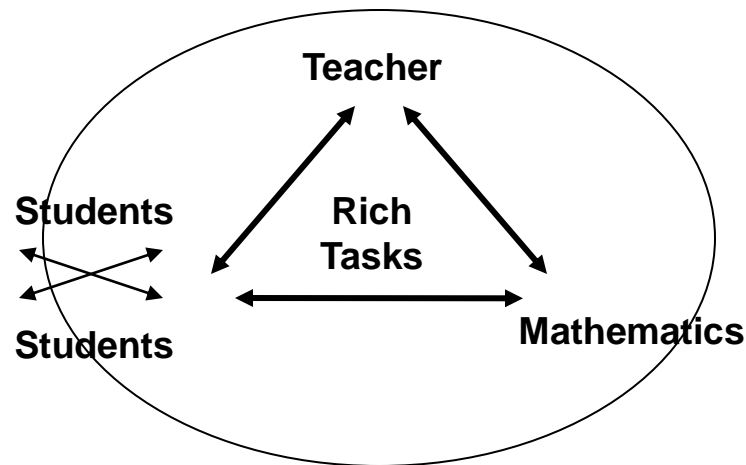
- OSPI, SBE, PESB work
- Teaching that matters
- District work that matters
- Resources
- Exemplars
- Engaging staff

Goals

- Know something more about math
- Know resources for math
- Take away ... and apply
- Ideas on engaging

- Dream of network ... one stop shop

The Instructional Core



Source: Cited in Adding It UP as adapted from Cohen and Ball, 1999.
Rich Tasks from City, Elmore, Fiarman and Teitel

A Personal Quest

- Handwashing saves 30,000 lives
- Saving 30,000 math lives
- One stop shop ... for what works
- Learning to learn ... 10,000 hours

- *Quick success is picking what matters, and sticking with it ... for eight years.*
 - Terry Edwards

Participants

- Roles
- Goals

Why Math?

- State and National Requirements
- Why math matters

State requirements and resources

Standards/Expectations –

- Updated Washington Math Standards (2008) to reflect the best state and national standards.
- The math standards are now known as Performance Expectations (PEs) instead of GLEs.
- Draft national “common core” standards for K-12 will be released soon. This is an effort of a coalition of governors and state superintendents.

State requirements and resources

Assessments –

- Math assessment continues to be required as part of NCLB.
- The WASL 3-8 becomes the MSP ... Measurements of Student Progress.
- OSPI is piloting on-line test taking and hopes to move 100% in that direction.
- 10th grade WASL becomes the HSPE: High School Proficiency Exam.
- End of Course math exams are currently scheduled to replace the 10th grade HSPE in the 2010-11 school year.
- Collection of Evidence alternative has been discontinued.
- OSPI is working on a series of diagnostic, on-line assessments
- New Accountability Index going to legislature
- Higher education and TMP working on a common placement test
- \$350 million toward Balanced Assessments which would measure Common Core Standards.

State requirements and resources

Curriculum –

- OSPI rate textbook matches against alignment with the state standards; most in the 70-80% range.
- The state has also reviewed supplemental materials.
- Documents help show where additional coverage is needed beyond the adopted texts.
- The state has also increased the state graduation requirements
 - All students need three credits of math to graduate (2013);
 - All students will need to complete algebra II or equivalent
 - All students need to take math in their senior year;
 - All students who have not passed the state exam need to take math each year in their junior and senior years.

State requirements and resources

Instruction –

- The PESB has increased the qualifications for newly certificated teachers.
- NCLB requires that districts hire “highly qualified” teachers.
- The state pays a premium for National Board Certified teachers.

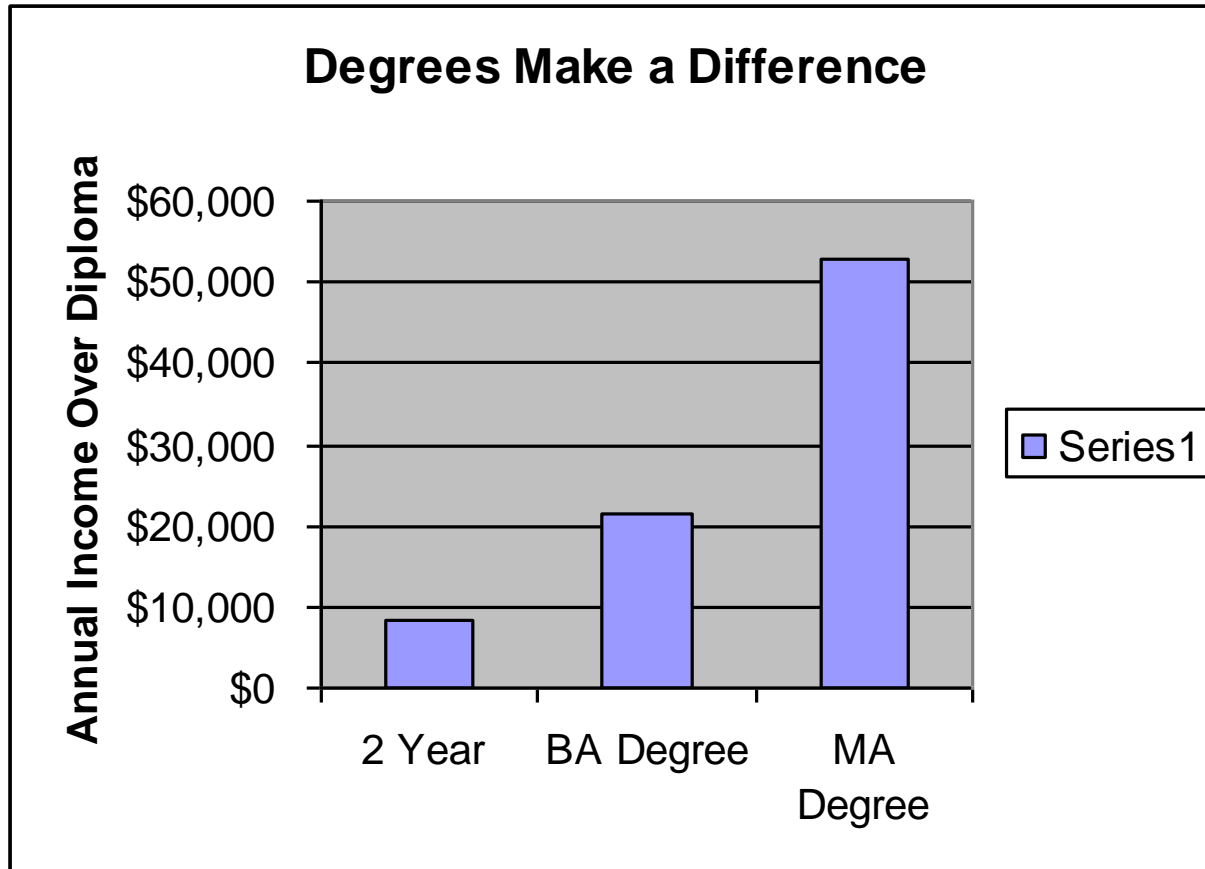
Why Math

- Important life skill
- Needed for college and career
- Job opportunities in WA
- Living wage jobs
- Equity

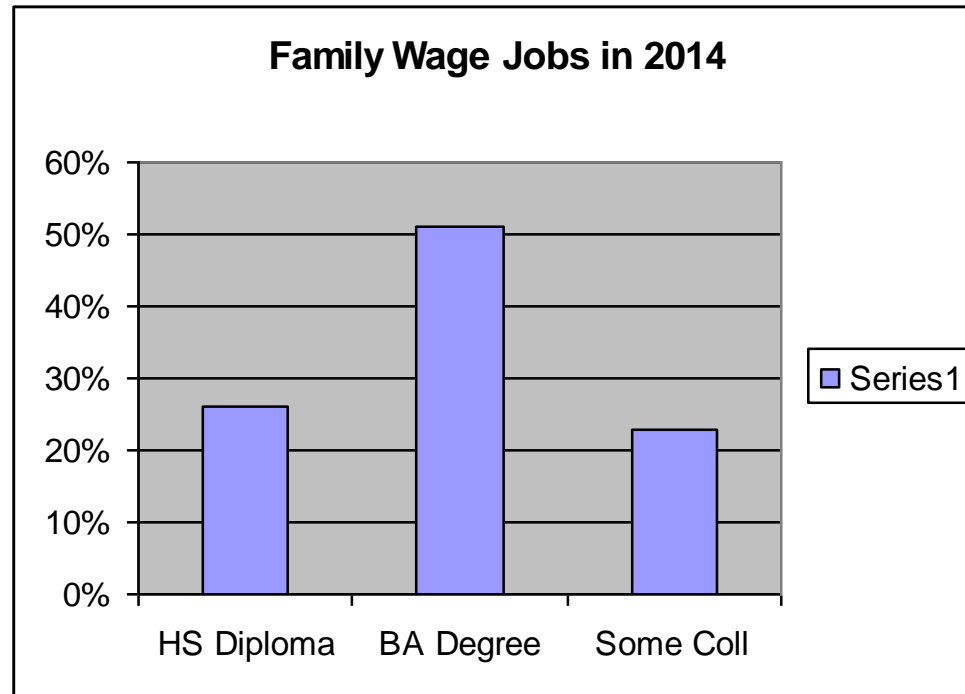
Leaving Too Many Behind

- Select year: 2008-09 WASL Results
(Administration Info) **Grade**
Level Reading Math Writing Science 3rd Grade
71.4% 66.3% 4th Grade
73.6% 52.3% 60.4% 5th Grade
74.0% 61.9% 44.9% 6th Grade
72.0% 50.9% 7th Grade
59.3% 51.8% 69.8% 8th Grade
67.5% 50.8% 51.1% 10th Grade
81.2% 45.4% 86.7% 38.8%

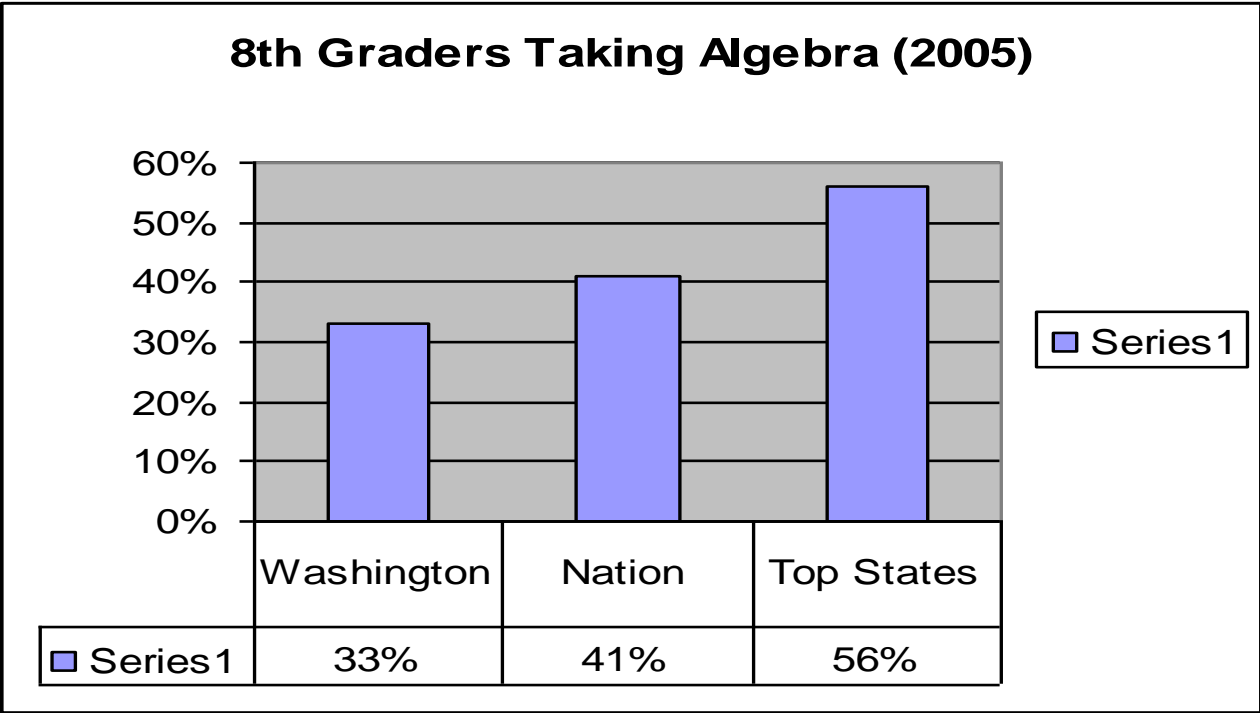
Missed Opportunity



77% of Jobs Require Some College



Algebra: Gateway to Future

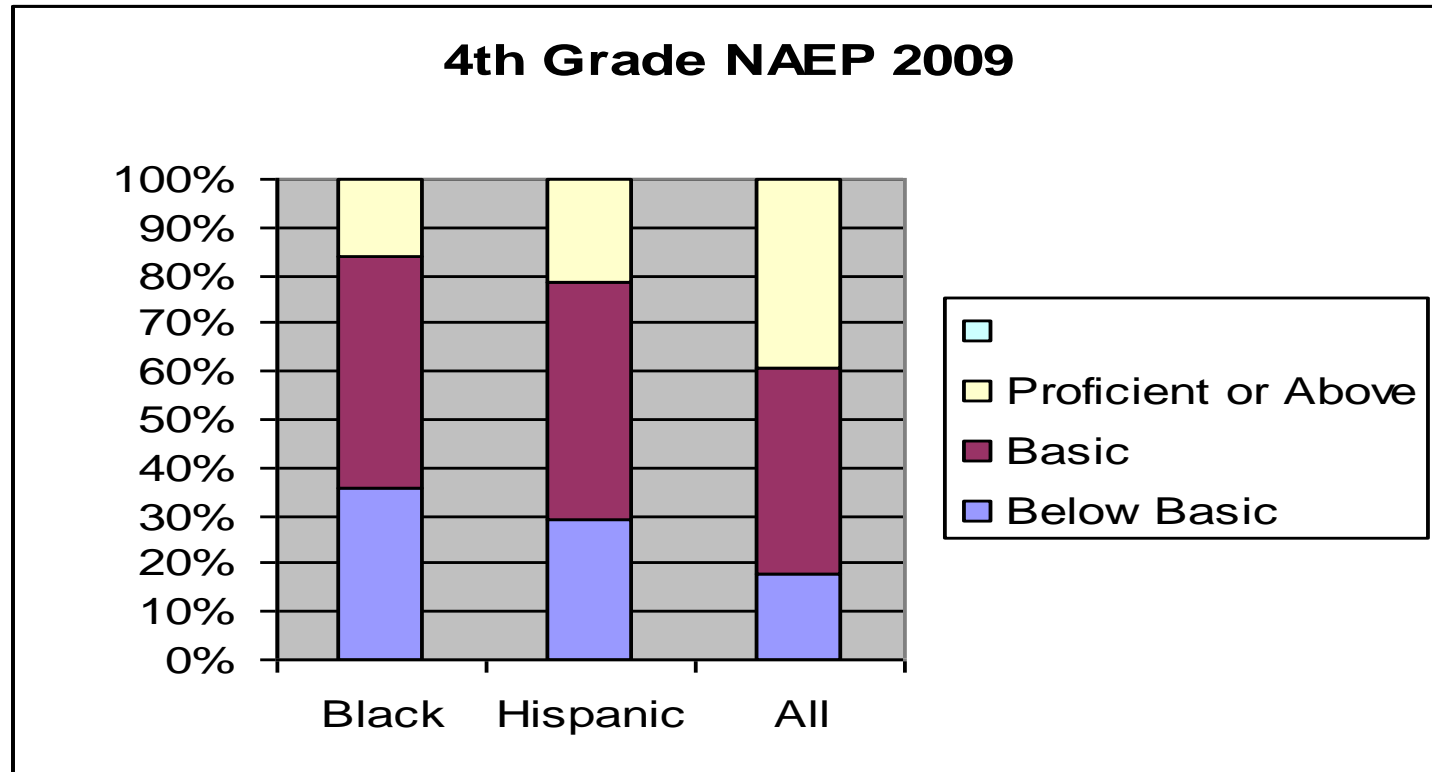


BERC Analysis of data from Nation's Report Card
Nyland - WERA 2009

Opportunities

- Washington ranks 4th in the nation for employment of science and engineering work force.
- Washington ranks 36th in the nation in producing science and engineering degrees.
- Washington ranks 4th in the nation for in-migration of college degree holders

2009 NAEP Grade 4 Math by Race/Ethnicity, Nation



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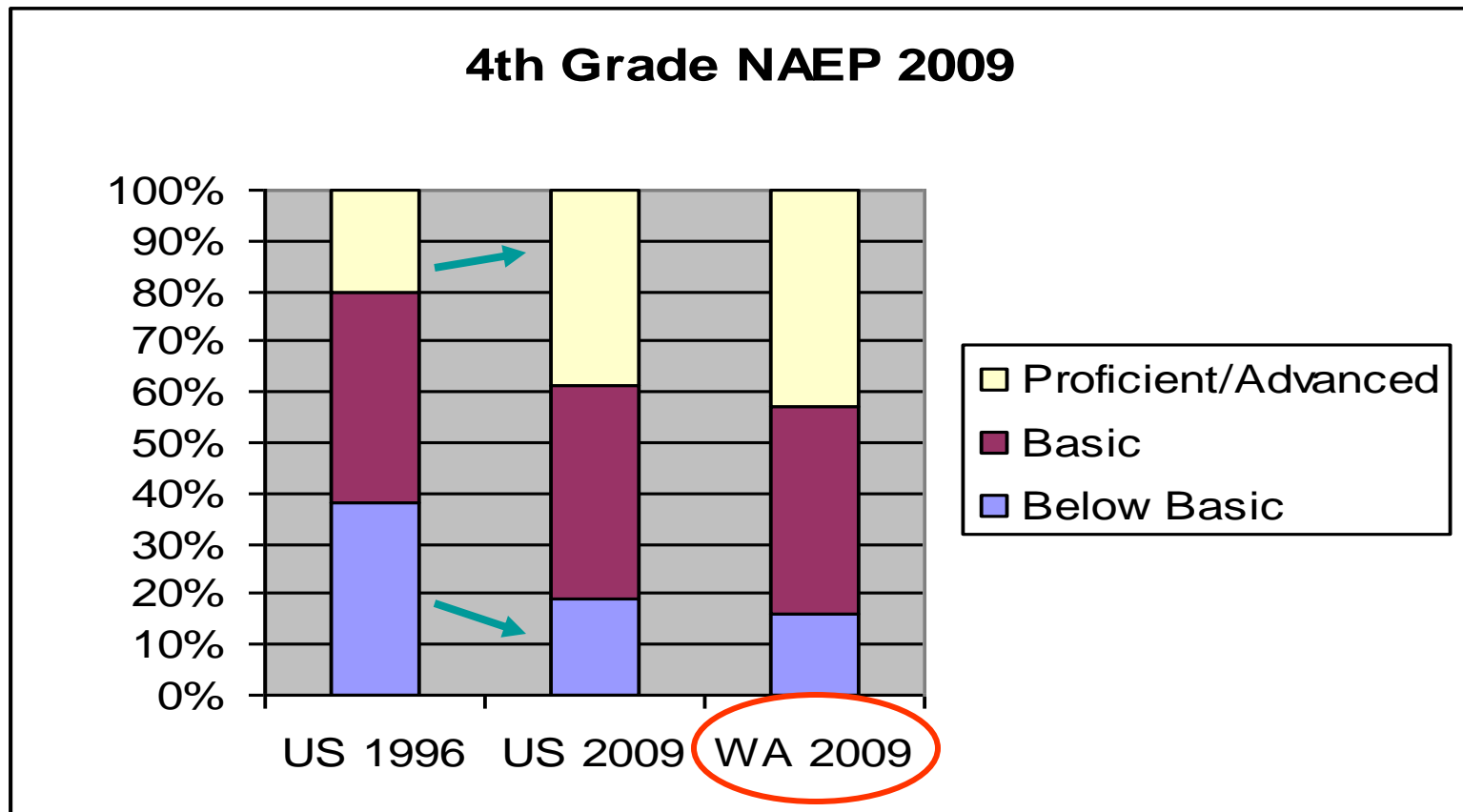
Math Effectiveness

- Noyce Foundation Rubric
- Rate your district
 - Challenges (goals)
 - Indications of success

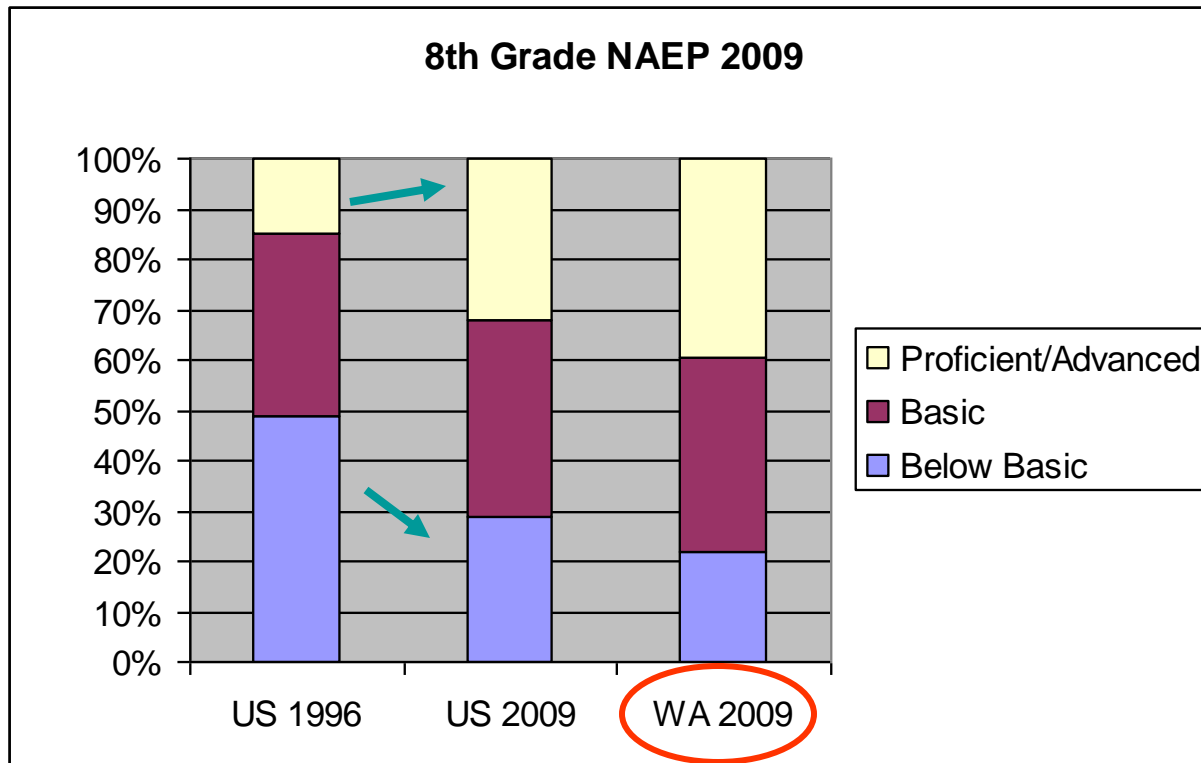
A Note of Encouragement

- NAEP Scores
- TIMMS Scores
- Urban Scores
- Exemplars
- Reading

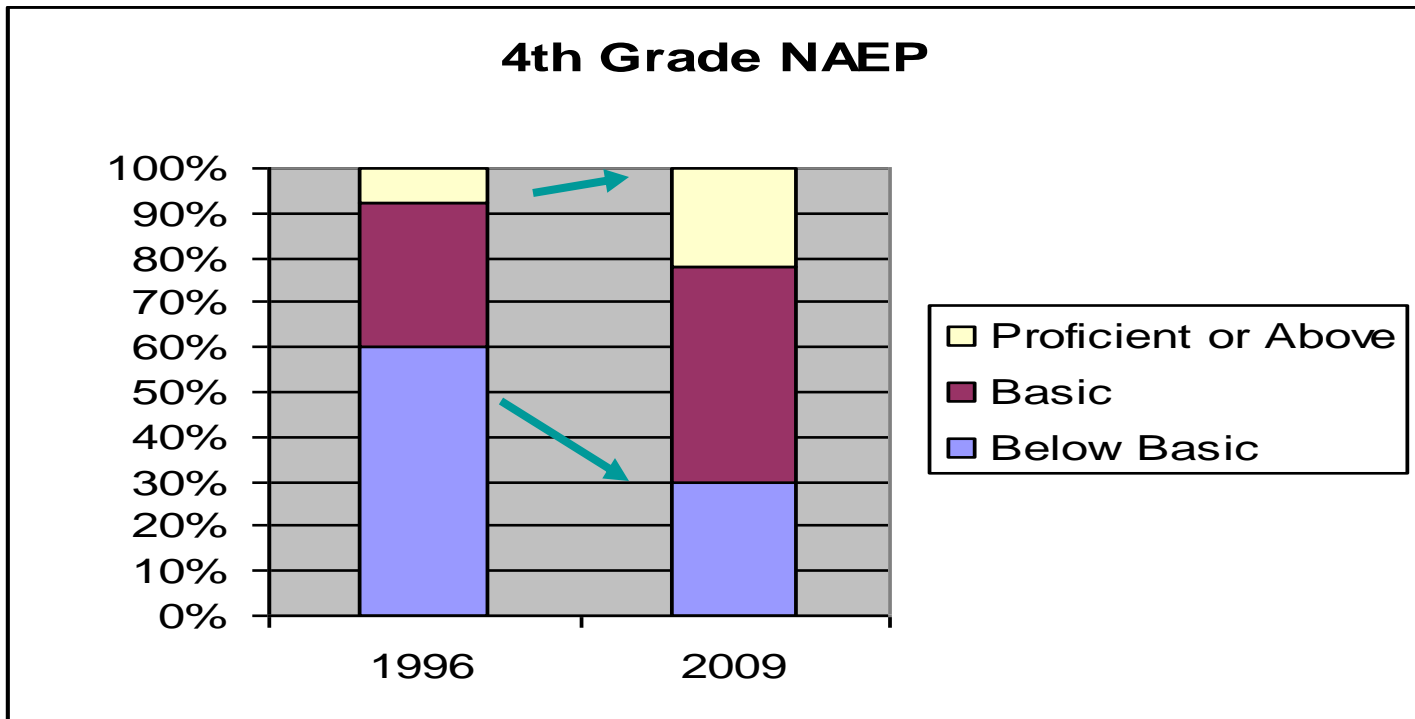
NAEP Grade 4 Math Low-Income Students, Nation 1996 compared to 2009



NAEP Grade 8 Math Low-Income Students, Nation 1996 compared to 2009

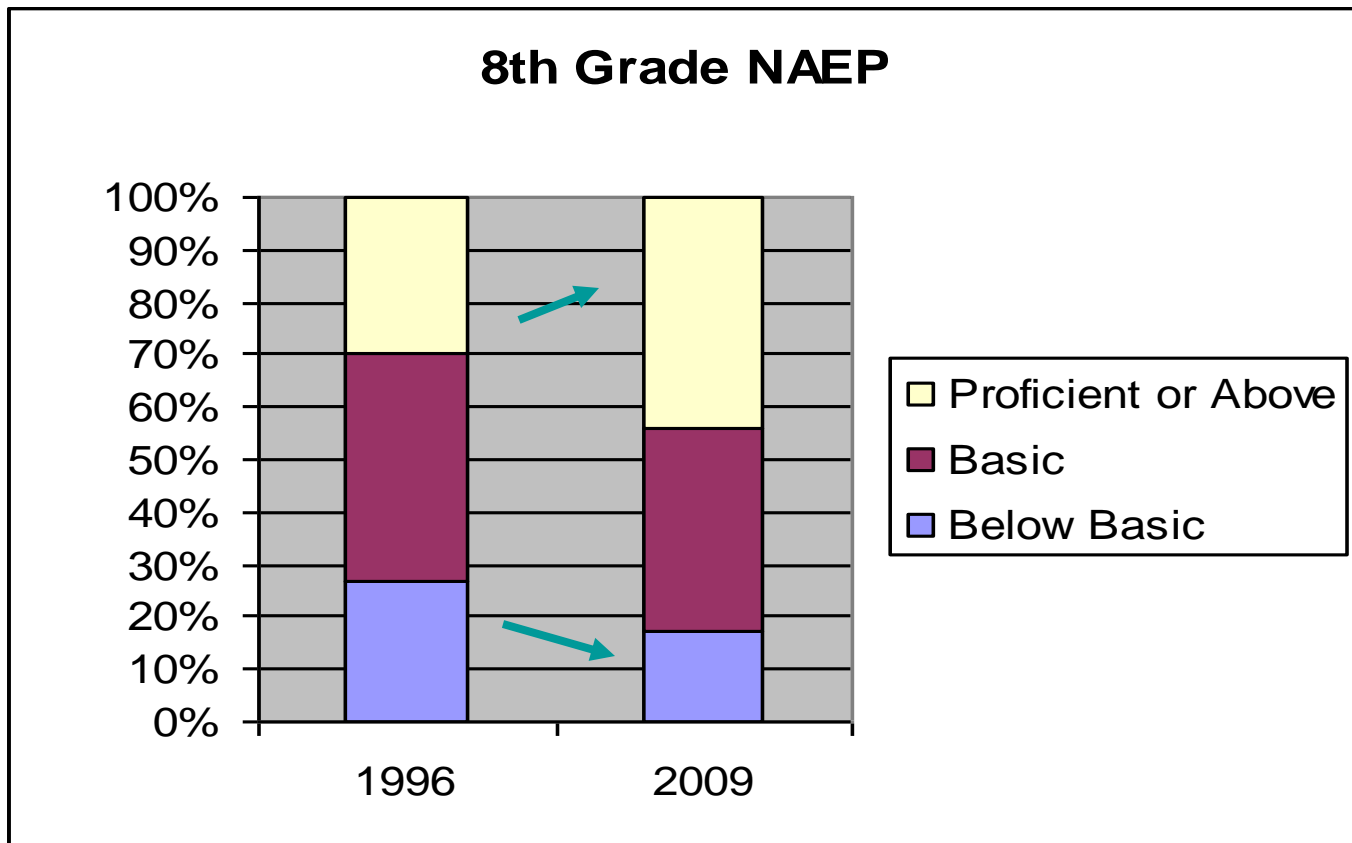


NAEP Grade 4 Math Low-Income Students, Nation 1996 compared to 2009



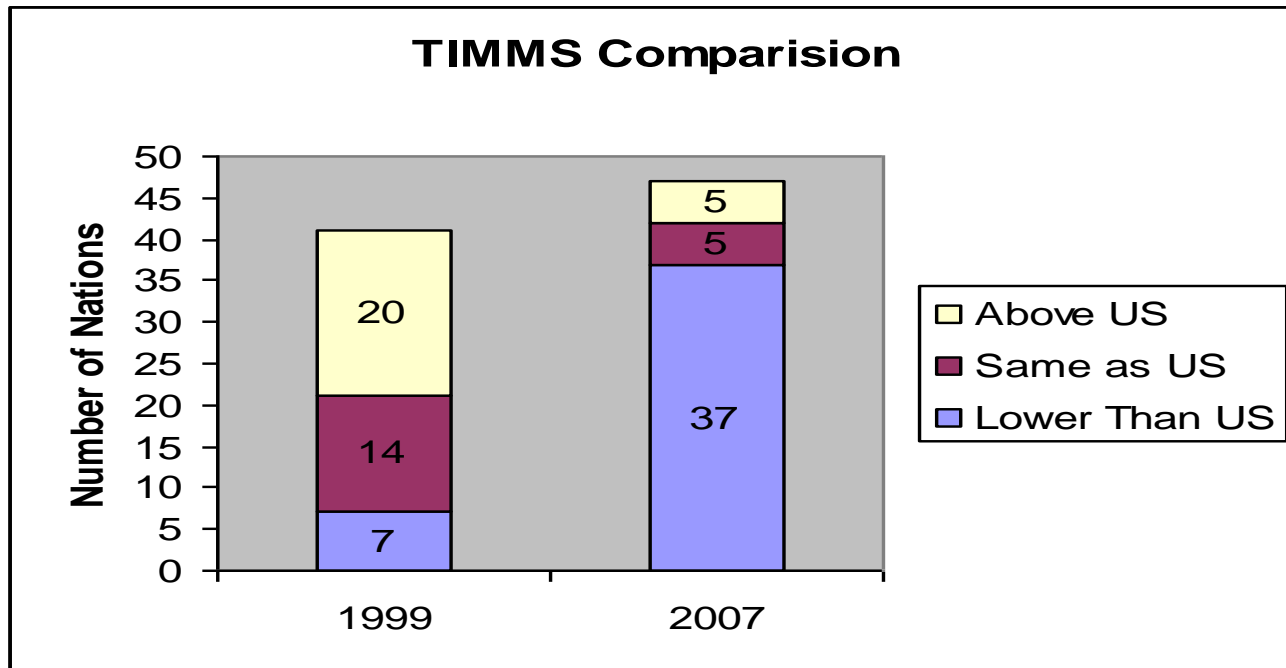
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NAEP Grade 8 Math Ethnic Students, Nation 1996 compared to 2009



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Other nations' average math performance compared with the U.S. TIMMS – 8th Grade Math



Highlights from TIMMS 2007 – National Center for Educational Statistics – September 2009

<http://nces.ed.gov/pubs2009/2009001.pdf>

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2007 NAEP Trial Urban District Assessment Mathematics 4th Grade Average Scale Score

White		Black		Hispanic	
Atlanta	266	Charlotte	230	Houston	234
Austin	263	New York City	227	Charlotte	234
Houston	263	Boston	226	Austin	233
District of Columbia	262	Austin	226	Boston	230
Charlotte	261	Houston	225	New York City	230
San Diego	252	Nation	222	Nation	227
Boston	250	San Diego	222	San Diego	223
New York City	249	Atlanta	217	Atlanta	223
Nation	248	Los Angeles	216	District of Columbia	220
Los Angeles	247	Chicago	213	Chicago	219
Chicago	244	Cleveland	210	Los Angeles	217
Cleveland	233	District of Columbia	209	Cleveland	215

2007 NAEP Trial Urban District Assessment Mathematics 8th Grade Average Scale Score

White		Black		Hispanic	
Austin	308	Charlotte	267	Charlotte	267
Houston	308	Houston	265	Houston	265
Charlotte	308	Austin	265	Austin	265
Boston	305	Boston	263	Boston	263
San Diego	294	Nation	259	Nation	259
National	290	San Diego	258	San Diego	258
New York City	289	New York City	258	New York City	258
Chicago	287	Atlanta	253	Atlanta	253
Los Angeles	285	Cleveland	253	Cleveland	253
Cleveland	269	Chicago	248	Chicago	248
Atlanta	a	District of Columbia	245	District of Columbia	245
District of Columbia	a	Los Angeles	245	Los Angeles	245

Exemplars

- Whatcom Middle: Bellingham
 - Nooksack Middle: Nooksack
 - Madison Elementary: Spokane
 - Highland Elementary: Montgomery Co.
 - Bellevue School District
-
- What do you notice, wonder?

Emerging Research ... on Teaching Moves for ... Improving Math Success

Disadvantaged Students

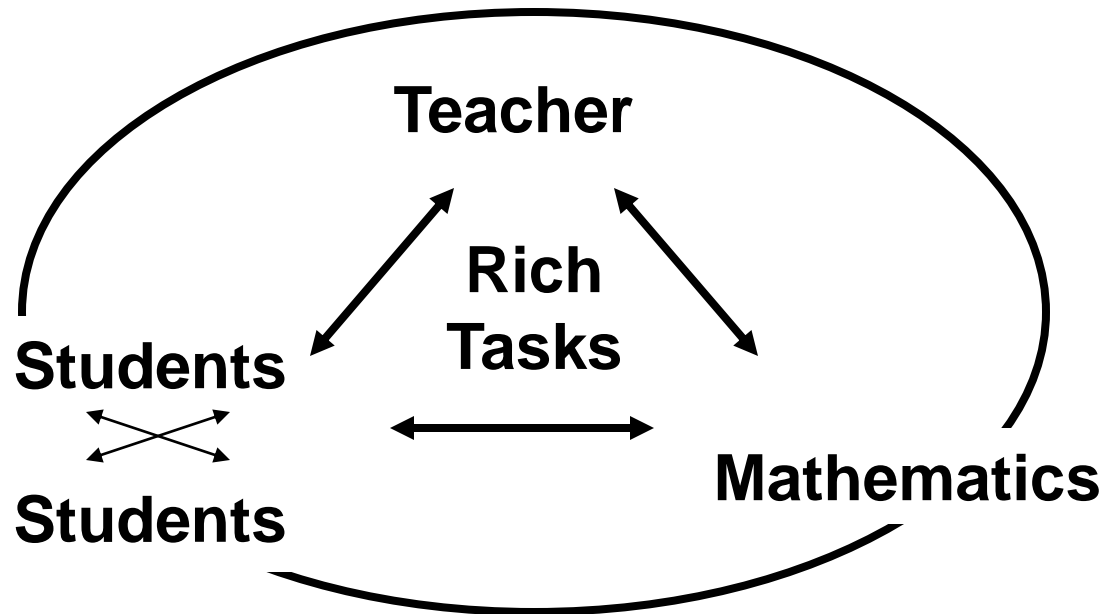
Did substantially better in classrooms where:

- “Teachers used multiple representations of mathematical ideas to support understanding,
- focused on non-routine problems to strengthen application of concepts,
- emphasized multiple solutions to problems to develop computing fluency, and
- held classroom discussions requiring logical reasoning that
- explored alternative solutions or meanings of mathematical procedures or results.”
– ***Helping Children Learn Mathematics.***

High Quality Math Instruction

- Gets students engaged in *doing* math
- Offers positive feedback to students
- Gives opportunities to explore options
- Holds everyone accountable
- Uses a variety of strategies
- Checks frequently for understanding
- Seeks advice from colleagues
- Uses assessment to guide instruction

The Instructional Core



Source: Cited in Adding It UP as adapted from Cohen and Ball, 1999

Elmore: Nothing happens in the core unless everything happens in the core

Time = Opportunity To Learn

- “Opportunity to learn is the single most important predictor of student achievement.” Classes of 60 minutes per day may deliver 50% more instructional time than classes of 45 minutes per day. – ***Adding it Up***
- “Time and opportunity to learn are essential for successful learning. An hour each school day ... should be apportioned so that all the strands of mathematical proficiency receive adequate attention.” – ***Helping Children Learn Mathematics***

Rich math tasks and real-world contexts.

- There is “growing evidence that students learn best when they are presented with academically challenging work that focuses on sense-making and problem solving as well as skill building.” – Adding It Up
- “Students who are given opportunities to work on their problem solving enjoy the subject more, are more confident and are more likely to continue studying mathematics.
– *University of Cambridge*

Rich Math Tasks ...

Keep levels of cognitive demand high:

- Memorization is lowest level;
- Procedures [formulas] without connections to concepts, meaning, understanding are second;
- Procedures with connections [multiple representations] are third, and
- Doing math [multiple methods, PS, thinking] is 4th. Moves from concrete to conceptual.
- Mary Kay Stein

Deliberate Lesson Planning

- Teachers most often plan for *activities*; seldom the *content* they wish students to learn.
- Needed are plans with:
 - a specific content focus, (I can statements)
 - well thought out but flexible tasks and approaches
 - based on what they know of student skills.
- Planning needs “continual adjustment ... informed by ... what happens as the lesson unfolds.” – ***Adding it Up***

Teacher Expectations

- Teachers working with low achievers often ...
 - call on them less ...
 - give less wait time ...
 - give these students the answer ...
 - criticize them more frequently ... and
 - praise them less frequently ... and
 - give them less demanding questions and tasks.”
- Teachers ask more from students when they feel confident and competent. They feel more confident and competent when they “know the mathematics ... their students’ current mathematical thinking, and strategies for representing mathematics.”
 - ***Adding it Up***, pages 338-339.

Motivation

- Students need to see math as ... sensible, useful, and doable.
- Find challenging work students can do ... without lowering cognitive load.
- Use group work, eye contact, student voice, display of student work, co-constructed visuals.
- Teach the focused effort matters.

Students with differing needs

- Identify those at risk for difficulties and provide interventions (moderate research evidence).
- Provide explicit instruction, guided practice, corrective feedback and frequent cumulative review; model problem solving, and thinking processes (strong research evidence).
- Interventions should include instruction on solving word problems that is based on common underlying structures (strong research evidence).
- Teachers and students should be proficient in using visual representations (moderate research evidence).
- Interventions at all grade levels should devote about ten minutes per session to building fluent retrieval of basic arithmetic facts (moderate research evidence).
 - Doing What Works

Teach students to work together in Communities of Learners

- For cooperative groups to be effective:
 - Students need to be taught how to work in this mode” and
 - Teachers need to select tasks that are well suited to students and content.
- Teaching and learning mathematics with understanding is supported by four classroom structures:
 - Ideas and methods of each student are valued as a contribution to the learning of the class;
 - Student autonomy in choosing and sharing their methods of problem solving;
 - An appreciation of the value of mistakes as learning opportunities; and
 - Recognizing logic (rather than the power of the teacher) as the final authority in making meaning.
 - ***Adding It Up***, page 349

Discuss multiple solutions to build discourse.

- “Encourage students to generate and share solution methods. Questioning and discussion that elicit students’ thinking lead to greater clarity. – HCL
- When you ask for explanations: you notice student thinking and errors, you can ask students to explain their thinking, you can ask other students to help. - Leinwand
- Students who struggle with math benefit from “student think alouds” and “systemic and explicit” development of academic language. The research for both is strong. – NCTM Research Brief
- Develop questions in advance, anticipate student responses, listen to student responses, keep the student thinking. – Deborah Ball
- 80/20 – Engage students 80%; Teacher only 20%.

De-Tracking and Heterogeneous Grouping

- “The evidence does not support grouping Pre-K to Grade 8 students according to their supposed mathematical abilities.” ***Adding it Up***, page 347
- “Grouping by achievement tends to be self-perpetuating. Students in lower groups receive fewer opportunities, have a less demanding curriculum, less capable teachers and few strong peer models. As a result, achievement gaps grow and racial and ethnic disparities widen.” - ***Helping Children Learn Mathematics***
- Tracking is a psychological prison. 88% never get out of their track. – Boaler, ***What’s Math Got To Do With It?***

Daily Cumulative Review and Reinforcement

- Practice for automaticity in addition, subtraction, multiplication and division. ***Adding It Up***, page 351.
- Start each day with a six question review of math students should already know: number fact of the day; estimate of the day; term of the day; skill of the day; picture of the day; measurement of the day. Within minutes you have reinforced mastery, determined who still needs help, and rewarded progress. -Leinwand
- *Interventions* at all grade levels should devote about ten minutes per session to building fluent retrieval of basic arithmetic facts (moderate research evidence).
– Doing What Works

Homework Should Be Used Intentionally

- Realistic in length and difficulty and designed for success.
- Give fewer, easier questions and focus on justification of answers.
- Short / frequent homework assignments most effective.
- Mixing hard and easy material increases accuracy and completion.
- Feedback – grades or comments – increases value of homework.
- Practice of past lessons or preparation for future lessons – are more effective than same day content.

Formative Assessment and Feedback FOR Learning

- Unpacking student thinking and misperceptions is essential to student understanding.
- When students know the goal and the assessment criteria, low performing students achieve at the same levels as high achievers.
- Feedback comments are more effective than grades or grades and comments.
- Use journals, RYG indicators, student talk, tasks, conferences to see student needs.

Multiple Representations Help Students Build Understanding

- Multiple representations support understanding.
- Abstractions work for some students but must be grounded in pictures and models for others.
- Rarely do 50% of students process math ideas as the teacher does. Drawing out alternative ways gathers important information on how students are thinking. – Leinwand
- Concrete materials should always be a means and not an end.
- Students who have difficulty in learning mathematics benefit from “visual and graphic depictions of problems.” – ***NCTM Research Brief***,
- Multiple representations - formulas, tables, graphs, verbal descriptions and concrete or pictorial representations – give more opportunities to make connections and build understanding.

One Dozen ... Educated Guesses ... on District Moves for ... Improving Math Success

- Uri Treisman, Mary Kay Stein, Richard Elmore, Bob Marzano, Doug Reeves
- Recent mathematics reports ... SBE math panel ... WSECC
- Everett ... Bellevue ... Montgomery County (MD) ... Dana Center Reports

Agree on Common Interim Assessments for All Math Courses

Make time for high school teachers to work together on ...

- Writing math assessments that parallel the new math standards.
- Calibrate work with each other and standards.
- Reeves says this is the best way to reduce drop outs ... by creating fair and consistent standards.

Create a Reliable, Consistent Curriculum with Guaranteed Fidelity

- Adopt research based text materials aligned to the new math standards.
- Decide what is most important, what to leave out, and what to supplement.
- Invest heavily in training teachers to use the materials in the way they were intended.
- Use the materials district wide, for supplemental services as well as regular education classes.

Increase the Time Spent on Math ... Especially for Students Who Struggle

- Reeves recommends that you double the amount of time you spend on math.
- Many recommend 60 minutes / day – more for students who need to catch up.
- Everett received recognition from the Governor for their “double dip” program giving students two math periods per day.

Accelerate Learning - Push Students Up Into More Challenging Courses

- Students can do more difficult work with success.
- Pre-load students for success (AVID, MESA, AYD, Step Up to HS).
 - Pre-teach skills and attitudes
 - Build relationships
 - Students start ahead of their peers often for the first time ever

Teach Academic Vocabulary Using Research Based Methods

- Even if students know how to do the math they may not get credit on state tests if they don't know the terminology.
- Tier II, academic vocabulary are terms used in school but not used frequently in non-school settings.
- Using research based methods to help students understand academic terms is recommended by Marzano and others and has been used with success in Boston.

Frequent Formative Assessment with Specific Advice on What to Improve

- Formative feedback improves learning by an effect size of 0.4 to 0.7 (Black).
- The more frequent the feedback, the larger the effect (Marzano).
- Provide clear targets and rubrics (Marzano)
- Have students chart their own progress (Stiggins)

Use Data to Identify and Act on Individual Student Needs

- Use data to target individual student needs
 - Everett uses data to place students in double dip classes, reduce F's.
 - Montgomery County identifies individual students (20%) that need help in taking tougher math classes.
- Meet regularly to see how students are progressing. (Bill)
 - Until we see student faces in data, teaching won't change
 - Examine individual student data and chart strategies for success

Ask teacher teams to work together on solving problems of practice

- Create a collaborative culture in which teacher teams learn, plan and work together to analyze student achievement on common assessments, develop strategies to improve student learning.
- Ask them to score student work together, develop common lessons, watch each other teach, and talk about what they see.
- Action research, publicly reported, has the highest rate of sustainability (Reeves).

Assign Teachers Intentionally to Meet Student Needs.

- Assign and support teachers based on student needs and teacher abilities.
- Build a safety net for new teachers.
- Strengthen elementary mathematics
 - Some advocate for elementary math specialists.
 - Some recommend respectful training.
 - Some recommend stronger certification.

Raise Standards ... to Make Every Student College Ready.

- Raise the bar for all students.
- Eighty percent of future living wage jobs will require at least some college
- Career jobs will require the same type of college ready skills.
- When we ratchet up performance nearly all students respond and we set a new norm.
- Montgomery County uses 5th grade pre-algebra, 8th grade algebra, and SAT college ready benchmarks.

Average first-year college GPA for Texas Advanced Placement students

Subpopulation	GPA for 1st-year college students passing an AP exam*	GPA for 1st-year college students taking, did not pass an AP exam*	GPA for 1st-year college students not taking an AP exam*
White (47,647 students)	3.18	2.78	2.40
Hispanic (19,868 students)	2.89	2.50	2.09
African American (7,813 students)	2.94	2.57	2.01
Low Income (22,028 students)	2.94	2.53	2.08

*AP Exams in core academic subjects of English, Math, Science, and Social Studies

Based on group of students taking 8th-Grade Texas Assessment of Academic Skills in 1994, graduating in 1998, and enrolling in a Texas public college or university (78,079 students).

Source: National Center for Educational Accountability

Grow Great Teachers Who Grow Great Students

- This is humbling work. None of us has the answer for reaching all students.
- The above steps will help move us in the right direction.
- Greater success depends on great teachers,
 - who know and understand math deeply
 - use multiple methods of pedagogy
 - know their students and use data to inform teaching
 - build mathematical thinking /discourse
- We get there with teams, action research, coaches

Instructional Strategies:

How do teachers learn a variety of instructional strategies?

	Rarely	Sometimes	Frequently
Teacher uses multiple strategies for describing a problem	1%	33%	65%
Students reflect on their progress and set goals for learning	72%	21%	7%
Students explain their reasoning to the class	30%	53%	17%
Students work on an individual project that takes several days	87%	12%	1%
Teacher presents mathematical ideas using visual formats	6%	42%	53%
Students explain their answers using more than one approach	27%	52%	21%

Source: Center for Strengthening the Teaching Profession: Improving High School Math Performance: Solutions for a Vexing Problem.

What Works

Two things ... collaboration and manipulatives.

- Collaboration ... a common plan ... time to work and plan together ... and share ideas ... has been invaluable.
- Manipulatives ... have really helped all kids but especially our lower students and ELL students who are challenged by the reading level of CMP2.
 - Chris Bickford

What Works

- Summer school students have made gains in their math skills this year. These students were incredibly low in skills coming into summer school. Their gains are attributable to my personal connections with them as well as the concrete learning experiences from summer school.

What Works

- “In this first few months of school, Gerald has learned more than he's ever learned. It is because of the hands-on math, concrete learning experiences that he hadn't been receiving previously.”
– Gerald’s Mom

What Works

- My struggle was to give up control, relax, and let my teaching be driven by present student needs. Students are talking and up out of their seats more - using math manipulatives and debating mathematics.
- Janis Heigl has changed my paradigm. Math manipulatives have been the key!
 - Arlana Juarez

What Works

- I can't remember in my last 17 years of teaching when I have been more inspired or supported to make changes in my teaching.... I am exhausted but I can push on because I can see results every day as kids are "turning on to math" ... gaining confidence ... I think because they feel supported and because I am learning who they are.
 - Kathy White

What Works

- Beth (ELL) struggled with basic facts and had no idea how to number a graph. She was quiet, never asked questions. She looked like she was working diligently ... but I realized she had learned to fake it by showing she was trying. Her self-esteem was low and she felt dumb ... not smart enough to contribute. ...

What Works

- By the end of summer school Beth was starting to ask for help, she was able to make a coordinate graph and tell the story of what it represented. She was actively sharing and presenting with her group work and proud that she could do it. Her smile warmed my heart. I could see in her eyes and smile that she wanted the success she felt in summer school to continue as much as I did.
– Kathy White

Professional Interaction

- “The magnitude of the change that teachers of mathematics are being asked to make requires substantive professional interaction ... team teaching, peer observations, videotapes, common planning, grade-level meetings, study groups, or informal research.
- Principals can rearrange schedules to provide common planning time so that teachers can work collaboratively and share ideas, experiences and collective wisdom.” - Leinwand
- “Common problems are solved” collectively rather than individually. Scope and Sequence. Assessments. Student work.

Lead the Way in Setting Benchmarks and Figuring Out to Reach Them

- None of the above are “set it and forget it” solutions.
- All require leadership and a cycle of inquiry (Copland):
 - Clear problems of practice / learning
 - Common planning for success
 - Regular follow through during the year
 - Mid course adjustments
 - Institutionalized learning

Saving Math Lives

- Goal, one stop web site for finding what works in math: research, case studies, reports.
- Protocols for school district success.
- Send information on promising practices to: Larry_Nyland@msvl.k12.wa.us

The End

Thank you for your participation.