The Algebra Crisis

David Foster
Silicon Valley Math Initiative
Twelve Years of a Comprehensive Approach to Improving Student Learning
From 1996-97 to 2008-09

Supporting 40 School Districts with Technical and Financial Resources
Factors that Correlate to Student Achievement Rates

• Parent Education
• Economics (poverty - affluence)
• Language Acquisition
• Ethnicity
Efforts to Improve Student Learning

- Class Size Reduction
- Whole School Reform (School Governance, Small Schools, etc.)
- Re-vamp Class time (varied bell schedules, year around schools, block schedules, etc.)
- Innovative Curriculum
- Traditional Curriculum (Back to Basics)
- Remediation Programs (tracking, two-year algebra, etc.)
- Standards Based Education (Pacing Guides, Benchmark Test, Data Driven, etc.)
- High-stakes Accountability (rewards/sanctions)
- Choice (charter schools, magnet schools, etc.)
- Centralize Leadership and Policies (state or national)

Not one of these strategies, in and of itself, has shown to have significant impact on student achievement!
Teaching

The most significant factor in student learning
Improving something as complex and culturally embedded as teaching requires the efforts of all the players, including students, parents and politicians. But teachers must be the primary driving force behind change. They are the best positioned to understand the problems that students face and to generate possible solutions.

James Stigler and James Hiebert,

*The Teaching Gap*
Good Instruction Makes A Difference

Good teaching can make a significant difference in student achievement, equal to one effect size (a standard deviation), which is also equivalent to the affect that demographic classifications can have on achievement.

Paraphrase Dr. Heather Hill, University of Michigan
Our research indicates that there is a 15% variability difference in student achievement between teachers within the same schools.

Deborah Loewenberg Ball
Documenting Uneven Instruction

2007 CST Math Scores - Proficient and Advanced
“What Matters Very Much is Which Classroom”

If a student is in one of the most effective classrooms he or she will will learn in 6 months what those in an average classroom will take a year to learn. And if a student is in one of the least effective classrooms in that school, the same amount of learning take 2 years.

*Most effective classes learn 4 times the speed of least effective.*

Dylan Wiliams, University of London
We were led to teacher professional development as the fundamental lever for improving student learning by a growing research base on the influences on student learning, which shows that teacher quality trumps virtually all other influences on student achievement.

(e.g., Darling-Hammond, 1999; Hamre and Pianta, 2005; Hanushek, Kain, O'Brien and Rivken, 2005; Wright, Horn and Sanders, 1997)
California has aligned state standards to textbooks, state tests and state sponsored p.d. More students are taking algebra earlier. How successful is the California experiment?
The longer we teach them, the worse they perform.
Algebra for All or Algebra Forever

“We have made significant gains in enrolling students in Algebra I in eighth grade in recent years, surpassing other state in the U.S. But we must set our goal higher.”

Arnold Schwarzenegger
July 8, 2008

We have also made more significant gains in FAILING students in Algebra I in eighth grade in recent years, surpassing other state in the U.S.
California Algebra – How are we doing?

3 out of 4 Fail

<table>
<thead>
<tr>
<th>Algebra CST</th>
<th>Students Passing Prof or Adv</th>
<th>Students Failing Basic or Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>106K</td>
<td>400K</td>
</tr>
<tr>
<td>506,000 students</td>
<td>21% meet standards</td>
<td>79% of students failed the test in 2003</td>
</tr>
<tr>
<td>2008</td>
<td>187K</td>
<td>560K</td>
</tr>
<tr>
<td>747,000 students</td>
<td>25% meet standards</td>
<td>40% more students failed in 2008 than in 2003</td>
</tr>
</tbody>
</table>

In 2008 more students failed the Algebra CST than took it in 2003!
Algebra for All or Algebra Forever

“I have strong reservations about requiring all eighth grade students to take Algebra I within 3 years … I also reached my conclusion after seriously considering the available data. It is important to note that a little less than half of eighth grade students in California currently take General Mathematics. For that roughly half of the eighth grade population, a disturbingly low 23 percent is proficient or advanced on what amounts to seventh grade standards.”

Jack O’Connell – July 8, 2008

The Los Angeles Times, in a multi-year longitudinal study, reported that a leading cause for increasing high school drop-out rates in Los Angeles County was the pattern of repeated failure in Algebra.

In some California schools, about 1 in 3 Grade 11 students are still taking Algebra – sometimes for a fourth year in a row!
Does Having Students Take Algebra More Times Increase District Performance?

Average # of Years Students Take the Algebra CST

Algebra CST (Mean Scale Score)

R² = 0.73

Copyright Tucher
General Math is Not the Answer

45% of Eighth Graders took the General Math Exam

Only 23% of those students met standards

Tracking is not a Solution
The Dilemma
Algebra for All versus Tracking

• How are students placed in Middle School math classrooms?
• How are students placed in Algebra 1?
• How are teachers assigned to classes?
• What are the pathways through math course?
• Which students get which teachers?
• How is time protected for teacher collaboration and p.d.?
“I see trouble with algebra.”
What Happens in High School?
Unfortunately an all too typical pathway through secondary education

It is not Algebra for ALL its is Algebra FOREVER
# Placement into High School

All 8th grade students took a full year of Algebra 1

<table>
<thead>
<tr>
<th>CST Level</th>
<th>Skills</th>
<th>Algebra A</th>
<th>Algebra 1</th>
<th>Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>7%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Proficient</td>
<td>(7%)*</td>
<td>21%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>3%</td>
<td>7%</td>
<td>21%</td>
<td>3%</td>
</tr>
<tr>
<td>Below Basic</td>
<td>3%</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
<tr>
<td>Far Below Basic</td>
<td>3%</td>
<td></td>
<td></td>
<td>3%</td>
</tr>
</tbody>
</table>

* Took simultaneously with Algebra 1

Courses where students were placed in 9th grade
How Well Does 6th Grade Math Performance Predict Success on the Algebra CST?

$R^2 = 0.85$
Findings from Data

• Understanding and being successful in mathematics up through 6th grade is most powerful predictor of success in algebra/college prep math.
• A large percentage of districts are not thoughtful about how students are assigned courses and classes.
• Tracking is detrimental to students.
• Failing Algebra 1 is detrimental to students.
• Multiple years of Algebra 1 (two year algebra) is detrimental students.
• Early access and success in Algebra 1 is most beneficial to students future in math.
• A policy that put everyone into Algebra 1 in 8th grade without sufficient preparation and support has produced the greatest failure rate California has ever known!
• It is our moral obligation to make sure all students have a positive and successful experience in Algebra 1!
Making Sense & Worthwhile Tasks

What are our Kids really being asked to do?

Keeping up with Cognitive Demand
Intertwined Strands of Proficiency

Conceptual Understanding

Strategic Competence

Productive Disposition

Adaptive Reasoning

Procedural Fluency

---

*Adding It Up: Helping Children Learn Mathematics, NRC, 2001*
Teaching for Meaning
Depth of Knowledge

Level 1: Recalling and Recognizing:
Student is able to recall routine facts of knowledge and can recognize shape, symbols, attributes or other qualities.

Level 2: Using Procedures:
Student uses or applies procedures and techniques to arrive at solutions or answers.

Level 3: Explaining and Concluding:
Student reasons and derives conclusions. Student explains reasoning and processes. Student communicates procedures and findings.

Level 4: Making Connections, Extending and Justifying:
Student makes connections between different concepts and strands of mathematics. Student extends and builds on knowledge to a situation to arrive at a conclusion. Students use reason and logic to prove and justify conclusions.

Adapted from the work of Norman L. Webb
“... understanding should be the most fundamental goal of mathematics instruction, the goal upon which all others depend.”

Making Sense, p. 18
Cognitive Demand:
The kind and level of thinking required of students to successfully engage with and solve a task.
Consider these two Measurement Problems

Martha’s Carpeting Task
Martha is re-carpeting her bedroom, which is 15 feet long and 10 feet wide. How many square feet of carpet will she need to purchase, and how much baseboard will she need to run around the edge of the carpet? Explain your thinking.

The Fencing Task
Ms. Brown’s class will raise rabbits for their science fair. They have 24 feet of fencing with which to build a rectangular pen. If Ms. Brown’s students want their rabbits to have as much room as possible, how long should each of the sides of the pen be? Explain your thinking.

For each problem, what kind of thinking is required? How are they Alike and how do they Differ?
Martha’s Bedroom vs. Rabbit Pens

**ALIKE**

- Both require Area and Perimeter calculations
- Both require students to “explain your thinking”
- Both are word problems, set in a “real world” context

**NOT ALIKE**

- Rabbit Pens requires a systematic approach
- Rabbit Pens leads to generalization and justification
- The “thinking” in Rabbit Pens is complex - requires more than applying a memorized formula
Cognitive Demand Spectrum

Memorization

Tasks that require memorized procedures in routine ways

Procedures without connections to understanding, meaning or concepts

Procedures with connections to understanding, meaning or concepts

Doing math

Tasks that require engagement with concepts, and stimulate students to make connections to meaning, representation, and other mathematical ideas

Smith, Stein, et al.
Memorization

• What are the decimal and percent equivalents for the fractions: \( \frac{1}{2} \) and \( \frac{1}{4} \)
Procedures Without Connections

• Convert the fraction $\frac{3}{5}$ to a decimal and a percent.
Procedures With Connection

• Using a 10x10 grid, identify the decimal and percent equivalents of $\frac{3}{5}$.
Doing Mathematics

• Shade 6 small squares in a 4 x 10 rectangle. Using the rectangle, explain how to determine each of the following:
  a) the percent of area that is shaded.
  b) the decimal part of area shaded.
  c) the fractional part of area shaded.
Cognitive Demand Framework

1. Tasks as they appear in curricular/instructional materials
2. Tasks as set up by the teacher
3. Tasks as implemented by students
4. Student Learning
Assessment

Summative
- Assessments to Rank, Certify, or Grade.
  - High-Stakes Tests
  - State Tests
  - HS Exit Exams
  - SAT, ACT
  - Norm-Reference
  - Final Exams

Formative
- Benchmarks
- Interim
  - Tests
  - Quizzes
  - Assignments
  - To inform instruction

Formative meaning during instruction to inform instruction
- Unit/Chapter Tests
- Semester/Quarter Tests
- Computer-based exams
- Benchmark Tests

Students comments, explanations, questions and/or work in class
The Need for Multiple Measures

What You Test is What You Get!

Hugh Burkhardt, University of Nottingham
Veronica can type 28 words per minute. At this rate, how many words can Veronica type in 5.5 minutes?

A 154
B 157
C 159
D 162
Candies

This problem gives you the chance to:
• work with fractions and ratios

1. This is Amy’s box of candies.  
   She has already eaten 6 of them.  

   What fraction of the candies has Amy eaten?  

2. Valerie shares some of the 12 candies from this box.  
   She gives Cindy 1 candy for every 3 candies she  
   eats herself.  

   How many candies does she give to Cindy?  
   Show how you figured this out.  

3. In a packet of mixed candies there are 2 fruit centers for every 3 caramel centers.  
   There are 30 candies in the packet.  

   How many caramel centers are there?  
   Show how you figured this out.  

4. Anthony makes candies.  
   First, he mixes 1 cup of cream with 2 cups of chocolate.  
   In all, he uses 9 cups of these two ingredients.  
   How many cups of chocolate does he use in this candy recipe?  

   Explain how you figured this out.
The design of a MARS task

Access             Core              Ramp
48. Which best represents the graph of \( y = -x^2 + 3 \)?

A sample CST item from Algebra 1
Functions
This problem gives you the chance to:
• work with graphs and equations of linear and non-linear functions

On the grid are eight points from two different functions.
• four points fit a linear function
• the other four points fit a non-linear function.

For the linear function:
1. Write the coordinate pairs of its four points.

__________
__________
__________
__________

Draw the line on the grid.

2. Write an equation for the function.
   Show your work.

For the non-linear function:
3. Write the coordinate pairs of its four points.

__________  __________  __________  __________

Draw the graph of the function on the grid.
4. The non-linear function is quadratic

The non-linear function is exponential

Chris

Who is correct? ________________________

Explain your reasons.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Alex

5. Write an equation that fits the non-linear function. Show your work. ____________________________

Access Core Ramp
Dimensions of Balance

• Mathematical Content
• Process Dimension: Modeling and Formulating, Transforming and Manipulating, Inferring and Drawing conclusions, Checking and Evaluating, Reporting
• Task Type: Non-routine, design, plan, evaluate and make a recommendation, review and critique, representation of information, technical exercise, definition of concepts
• Openness
• Reasoning Length
The MAC - MARS - Balanced Assessment Math Performance Assessments

• The Balanced Assessment - Mathematics Assessment Resource Service (MARS) is an NSF funded collaboration between U.C. Berkeley, Michigan State and the Shell Centre in Nottingham England.
• The Assessments target grades 3-10 and are aligned with the NCTM National Math Standards.
• The MAC develops a second grade exam, each school year since 1998-99, 50,000 - 80,000 student papers are scored by teams of teachers.
### 2008 Comparison Between CST & MARS

#### Fourth Grade

<table>
<thead>
<tr>
<th>CST Level</th>
<th>MARS Levels</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Far Below</td>
<td>0.8%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Below Basic</td>
<td>4.4%</td>
<td>3.8%</td>
<td>0.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Basic</td>
<td>3.8%</td>
<td>9.7%</td>
<td>3.0%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Proficient</td>
<td>1.1%</td>
<td>9.8%</td>
<td>11.8%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Advanced</td>
<td>3.0%</td>
<td>3.6%</td>
<td>15.5%</td>
<td>27.6%</td>
</tr>
</tbody>
</table>

#### CST Level

<table>
<thead>
<tr>
<th>CST Level</th>
<th>Below Std</th>
<th>Meet Std</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Std</td>
<td>22.7%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>17.5%</td>
<td>58.4%</td>
</tr>
</tbody>
</table>
# Trends Grade to Grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>CST Level</th>
<th>MARS Level</th>
<th>Below Std %</th>
<th>Meet Std %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>20.3%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>8.4%</td>
<td>63.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>23.6%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>13.7%</td>
<td>57.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>22.7%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>17.5%</td>
<td>58.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fifth Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>28.7%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>12.1%</td>
<td>51.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sixth Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>36.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>10.4%</td>
<td>47.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seventh Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>38.2%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>9.8%</td>
<td>43.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eighth Grade</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>57.4%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>28.6%</td>
<td>12.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>42.1%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>14.7%</td>
<td>37.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td>Below Std</td>
<td>MARS Level</td>
<td>17.4%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Meet Std</td>
<td>37.1%</td>
<td>45.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cohort of Students (8th Grade Graduates in 2008) Who Met Standards on Math Exams - Comparing Students from FiMC, SVMI and Across California

Year Grade Level/Course

Percent Meeting Standards

FiMC MARS
FiMC CST
SVMI MARS
SVMI CST
Calif CST
Why Students Struggle in Math Class?
Understanding the Challenge

• ‘low achievers’ are not slow learners they are learning a different mathematics

• The mathematics they are learning is ‘a more difficult form of mathematics’

Gray & Tall
Compression

“low achievers”

“high achievers”

Dr. Jo Boaler
Mathematics is amazingly compressible: you may struggle a long time, step by step, to work through the same process or idea from several approaches. But once you really understand it and have the mental perspective to see it as a whole, there is often a tremendous mental compression. You can file it away, recall it quickly and completely when you need it, and use it as just one step in some other mental process. The insight that goes with this compression is one of the real joys of mathematics.

W. T. Thurston
They become further apart from the flexible thinkers

“ Their persistence in emphasizing procedures leads many children inexorably into a cul-de-sac from which there is little hope of future development.”
Sheer imitation, dictation of steps to be taken, mechanical drills may give results most quickly and yet strengthen traits likely to be fatal to reflective power.

John Dewey, 1910
Where do misconceptions come from?
7th Grade Geometry Task

This problem gives you the chance to:
• reason about similar figures and scale factor

Here are some right triangles.

1. Which of the triangles on the opposite page are congruent to triangle A?

Explain your reasons.

2. Which of the triangles on the opposite page are similar to triangle A?

Explain how you decided.

3. If triangle A is enlarged by a scale factor of 3, what will the area of the new triangle be?

Show your work.

MARS 2003
Score Distribution for 7th Grade Similar Triangles

![Bar chart showing the distribution of scores for 7th grade similar triangles. The x-axis represents the points awarded (0 to 8), and the y-axis represents the percentage of students per score. The chart indicates that the majority of students received scores around 1, with a significant drop off for higher scores.]
Misconception students illustrated in their work on Similar Triangles

• Students thought the orientation of the figure mattered in whether figures were similar (they both face the same way).
• Students believe that all triangles are similar or all rectangles are similar.
• Students misinterpreted how to measure length of figures on graph paper.
• Students added the scale factor, instead of multiplying to find proportional enlargements of the lengths.
• Students seldom identified that a similar figure could be smaller in size. (go from large triangle to small triangle)
Similarity

Goal Using Properties of Similar Figures

If the corresponding angles of two figures are congruent and the ratio of the lengths of their corresponding sides are equal, the figures are similar. Similar figures are the same shape, but are not necessarily the same size. So, two congruent figures are always similar but two similar figures are not necessarily congruent. In the diagram below, quadrilateral \( ABCD \) is similar to quadrilateral \( EFGH \). You can write this statement as \( \text{quadrilateral } ABCD \sim \text{quadrilateral } EFGH \).

**Example** Properties of Similarity

\( \triangle ABC \sim \triangle DEF \). Describe the relationships among the angles and sides of the triangle.

**Solution**

Corresponding angles are congruent. That is, \( \angle A \cong \angle D \), \( \angle B \cong \angle E \), and \( \angle C \cong \angle F \).

The ratio of the lengths of corresponding sides are equal. The lengths of corresponding sides \( BC \) and \( EF \) are given, so this ratio is \( \frac{3}{5} \).

\[
\frac{BC}{EF} = \frac{AB}{DE} = \frac{AC}{DF} = \frac{3}{5}
\]

Find the length of RS.

**Solution**

Because two angles of \( \triangle RST \) are congruent to two angles of \( \triangle UVW \), \( \triangle RST \sim \triangle UVW \) by the AA similarity postulate. Write and solve a proportion to find the length of RS.

\[
\frac{RS}{UV} = \frac{ST}{VW}
\]

Substitute:

\[
x \cdot \frac{5}{3} = 30
\]

Cross product property

\[
x = \frac{30 \cdot 3}{5}
\]

Divide each side by 3.

\[
x = 3.75
\]

**Answer** The length of RS is 3.75 units.

If two polygons are similar, the ratio of the lengths of two corresponding sides lengths is called the scale factor. In the triangles above, the scale factor of \( \triangle RST \) to \( \triangle UVW \) is \( \frac{3}{5} \).

**Example 2 Using a Scale Factor**

You are designing a poster to advertise the next meeting of the Space Club. You begin by sketching the design shown at the right. The scale factor of the actual poster to your sketch is 4:1. Find the height and the width of the actual poster.

**Solution**

Use the scale factor to find the height \( h \) and the width \( w \) of the poster.

**Poster height**

\[
\text{Sketch height} = \text{Scale factor} \times \text{Actual height}
\]

\[
\frac{4}{1} \times 7 \text{ inches} = \frac{4}{1} \times 7
\]

\[
h = 28
\]

**Poster width**

\[
\text{Sketch width} = \text{Scale factor} \times \text{Actual width}
\]

\[
\frac{4}{1} \times 5 \text{ inches} = \frac{4}{1} \times 5
\]

\[
w = 20
\]

**Answer** The poster has a height of 28 inches and a width of 20 inches.
Supporting Struggling Students
Bell and Swan study
“I’m farther along on that continuum towards student-centered instruction. Why do we engage in instruction? Because we enjoy presenting? No, because we want students to learn. Therefore we need to be focused on students”

Paraphrase Tom Carpenter, 2008
Building Conceptual Understanding

Malcom Swan
Balanced Assessment,
Shell Centre Nottingham, England
Problem: Number line

Where are $a+b$, $b-a$ and $a-b$?

What can you say about where $a/b$ is?
Always, Sometimes, or Never True

A.

If you double the numerator of a fraction, you double the size of the fraction.

\[
\frac{a}{b} \rightarrow \frac{2 \times a}{b}
\]
Always, Sometimes, or Never True

C.

When you add the same number to the numerator and denominator of a fraction, the fraction becomes greater in value.

\[
\frac{a}{b} \rightarrow \frac{a + 1}{b + 1}
\]
I'll never be able to understand math!

Earliest Record of Math Phobia
Model of the Program

Academic Youth Development

11 day Summer Course → Academic Year Kickoff

Community of learners

Metacognitive strategies

Classroom Culture of Respectful Engagement

Academic Year Gatherings

Academic Year Integration and Application

Classroom Culture of Respectful Engagement

The Charles A. Dana Center
at the University of Texas at Austin
Overview

Are there people you think of as naturally smart? It may seem to you that everything comes easily to them or that they always get good grades without even trying. Have you ever wondered whether or not you were smart? Perhaps you've really struggled with something in school and felt you just weren't smart enough to learn it.
Overview

Just as an athlete develops her muscles to become a stronger and better player by working hard, you develop your brain to become smarter when you concentrate.
Complex Instruction
No one of us alone is as smart as all of us together

Designing Groupwork:
Strategies for the Heterogeneous Classroom

Elizabeth G. Cohen
Teacher College Press
Copyright 1994
ISBN 0-8077-3331-8
Promising Intervention Practices

- Extra Time (Double periods/block, full year course)
- Best teachers working with struggling students
- Teach for conceptual understanding
- Teachers attend to students’ self-image, productive disposition and status
- Pre-teach instead of remediate
- Arithmetic through the lens of algebra
Transforming Math Departments and Grade Spans into LEARNING COMMUNITIES

Focus on Learning
Culture of Collaboration
Focus on Results

Research in Math Education to reference:
Railside Study, Jo Boaler
Grant High School, Portland, Ore.
Columbus Ohio, PWA - Dana Center
Measured Progress, John Hopkins
Highlands School, documented Mills College

Dufour
Math Department as PLC
The Real Change Agent

P.D. & Content Providers
Provide tools, PD for teachers, coaches, principals, and facilitation & technical assistance.

Leadership Team
Guide the work of the district & provide a forum to share challenges & solutions.

Curriculum & Instruction
Collaborate with stakeholders & support the work within the district.

Key Math Teachers: Target Group
Attend PD, implement strategies and work within department to create a PLC.

Math Coaches
Support the work of teachers and the development of the PLC.

Math Departments
Collaborate to improve math learning for all students

Classroom Instruction
Conceptual understanding
Procedural fluency
Productive Disposition
Strategic Competence
Adaptive Reasoning

Interventions
During year one, develop plan for interventions.

Student Success in Math
Knowledge
Proficiency
Understanding
Disposition

Principal
Set expectations for math department and support their work.
Collectively score and analyze student work

Administer quality assessment tasks

Cycle of Formative Assessment to Inform and Improve Learning

Document student thinking to inform instruction.

Leads to improved teaching and learning in the classroom

Drives the professional learning communities of the teachers.

TOOTHPICK SHAPES
Tom uses toothpicks to make the shapes in the diagram below.

1. How many toothpicks make shape 3? __________________
2. Draw shape 4 next to shape 3 in the diagram above.
3. Tom says, “I need 36 toothpicks to make shape 12.” Tom is not correct. Explain why he is not correct.
   How many toothpicks are needed to make shape 12?
Learning from Student Work
Lesson Study

1. STUDY
2. PLAN
3. DO RESEARCH LESSON
4. REFLECT

- A team of teachers research and plan a lesson.
- The lesson is taught and observed by team members - focusing on student thinking.
- Team reflects, revises, sometimes reteaches
- Teams share findings with entire staff and through school network
- Focus for the further work evolves from the learning that is shared among individuals and the team.
Strategies to Improving Teaching
Using Student Thinking to Inform Instruction.

Focusing on students’ thinking is the key to teaching for understanding.

Teachers need to use student work, thinking, understanding and misconceptions to tailor instruction and improve student learning.
Maintaining Cognitive Demand in Mathematics Lessons.

The results of the TIMSS Video Study showed that although U.S. teachers used many tasks that could have required a high cognitive demand from students, the actual implementation always lowered the cognitive demand of the tasks.
Addressing Access and Status for Students

“All students can learn mathematics” has to be more than a nice slogan. Teachers must employ strategies to provide access and equity for all students. This includes paying attention to the role of status in the classroom and creating a community of learners.
Engaging Teachers in Productive Professional Development

Engage teachers in experiences that build teachers’ content knowledge, confidence and instructional strategies while developing a mutual relationship of trust and collaboration.
Enhancing Teacher Knowledge

It is widely accepted that we must support teachers in gaining mathematical content knowledge, pedagogical content knowledge, and developing an ongoing cycle of reflective learning.
Supporting Collegial Professional Learning Communities

Teachers must work together and learn from one another in a professional learning community. This requires a structured program of reflection and attention to students’ thinking and their work.
Strategies to Improving Teaching

• Using Student Thinking to Inform Instruction.
• Maintaining Cognitive Demand in Mathematics Lessons.
• Addressing Access and Status for Students.
• Enhancing Teacher Knowledge.
• Engaging Teachers in Productive Professional Development.
• Supporting Collegial Professional Learning Communities.
"Don't be encumbered by history-- go off and do something wonderful."

Dr. Robert N. Noyce
Inventor of the Silicon Chip
Co-founder of Intel