Supporting Teachers in their Classrooms to Increase Student Achievement

David Foster, Director
Silicon Valley Math Initiative
CMC-N Admin. Conference
Asilomar, Dec. 2006
Why Can’t Johnny Add?

Quest for Improving Math Instruction

- 1957 Sputnik
- 1960’s New Math
- 1970’s Individualized Instruction
- 1983 A Nation at Risk
- 1989 NCTM Standards
- 1995 Math Wars
- 1999 TIMSS
- 2001 NCLB
- 2006 National Math Panel
The world has been flattened.

The number of jobs requiring science and engineering skills in the US labor force is growing almost 5 percent per year.

Two-thirds of the nation's mathematics and science teaching force will retire by 2010.

The number of Americans who graduate with just engineering degrees is 5 percent, as compared to 25 percent in Russia and 46 percent in China.

In the fiscal 2005 budget passed by the Republican Congress in November 2004, the budget for the National Science Foundation was actually cut by 1.9 percent.

The brain gain started to go to brain drain around the year 2000.

It is a truism, but the more educated you are, the more options you will have in the flat world.
“Kevin will be giving my report on outsourcing.”
Competing successfully in this new global environment is essential for our national and economic security and to ensure that the U.S. is able to create high-value jobs and maintain a vital national engineering capability.
To compete in the global economy of the 21st century, knowledge of math is critical. Today's high school graduates need to have solid math skills whether they are proceeding directly to college, or going straight into the workforce. In today's changing world, employers seek critical thinkers and practical problem-solvers fluent in today's technology.

Secretary of Education Margaret Spellings
Comparing Mathematics Instruction between the USA and other High Performing Countries
### Student Achievement on 8th Grade TIMSS (math)

<table>
<thead>
<tr>
<th>Country</th>
<th>Average scores</th>
<th>1995¹</th>
<th>1999²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (AU)</td>
<td></td>
<td>519</td>
<td>525</td>
</tr>
<tr>
<td>Czech Republic (CZ)</td>
<td></td>
<td>546</td>
<td>520</td>
</tr>
<tr>
<td>Hong Kong SAR (HK)</td>
<td></td>
<td>569</td>
<td>582</td>
</tr>
<tr>
<td>Japan (JP)</td>
<td></td>
<td>581</td>
<td>579</td>
</tr>
<tr>
<td>Netherlands (NL)</td>
<td></td>
<td>529</td>
<td>540</td>
</tr>
<tr>
<td>Switzerland (SW)</td>
<td></td>
<td>534</td>
<td>—</td>
</tr>
<tr>
<td>United States (US)</td>
<td></td>
<td>492</td>
<td>502</td>
</tr>
<tr>
<td>International average</td>
<td></td>
<td>—</td>
<td>487</td>
</tr>
</tbody>
</table>

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Mathematics Teaching in the United States Today (and Tomorrow): Results from the TIMSS 1999 Video Study, Hiebert, et. al
Absence of Mathematical Reasoning

…the U.S. was the only country in which no lessons contained instances of developing a mathematical justification or generalizing from individual cases.”

Mathematics Teaching in the United States Today (and Tomorrow): Results from the TIMSS 1999 Video Study, Hiebert, et. al
Problem Type Presented
Average Percent of Problems

Percentage of problems per lesson

Country
AU  CZ  HK  JP  NL  US

Making connections
Stating concepts
Using procedures
How U.S. Lessons are Different

That although the U.S. doesn't look that different in types of problems worked on (or their frequency), in the U.S., none of the problems maintained cognitive demand or relationships".

James Hiebert
Making Connections
Problems Solved by Explicitly Using Processes

<table>
<thead>
<tr>
<th></th>
<th>AU</th>
<th>CZ</th>
<th>HK</th>
<th>JP</th>
<th>NL</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giving Results Only</td>
<td>38</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Using Procedures</td>
<td>31</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>19</td>
<td>59</td>
</tr>
<tr>
<td>Stating Concepts</td>
<td>23</td>
<td>24</td>
<td>31</td>
<td>29</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>Making Connections</td>
<td>8</td>
<td>52</td>
<td>46</td>
<td>48</td>
<td>37</td>
<td>0</td>
</tr>
</tbody>
</table>
Lowering the Cognitive Demand

In the U.S., none of the connections problems maintained a high level of cognitive demand in their enactment during the lesson.
Summary

The individual findings relating to mathematical challenge accumulate to portray U.S. lessons as presenting less of a challenge than lessons in other countries.

Mathematics Teaching in the United States Today (and Tomorrow): Results from the TIMSS 1999 Video Study, Hiebert, et. al
Examination of the California’s STAR Program and Accountability System
Student Achievement increased on the SAT-9 during the first 5 years of the STAR Program.

Students, no matter which county or even over the entire state, demonstrate dramatic growth (10%-20% increase) over the five years.
But, when the test was changed between 2002 and 2003, all the student achievement gains were lost.

So the gains were about test-taking not learning
Gap in Performance

In 2005, nearly 30% of the fourth grade students who were proficient or advanced on the CST Math Test, did not meet standards on NAEP. Passing standardized test does not necessarily equate to learning.

For the 2005-06 school year, 121 schools exited Program Improvement and 320 California schools were newly identified for a net increase of 199 schools. The number of PI schools keep rising.
Mathematics Performance Discrepancies in 2005: State Test Performances Versus NAEP Performances

- There were only three states in which the NAEP\(^1\) performance percentage was higher than the state performance percentage: Hawaii (1 percent); Massachusetts (9 percent); and Wyoming (4 percent).

- For the remaining 42 states, the discrepancies in the two percentages, with the state percentages being equal to or greater than the NAEP percentages, ranged from 0 percent (Maine) to 60 percent (Colorado and Mississippi). The grade 4 performance discrepancy gaps were grouped as follows.
  - 0 to 10 percent: 2 states (ME, SC)
  - 11 to 20 percent: 7 states (AR, KY, MO, MT, NM, RI, WA)
  - 21 to 30 percent: 5 states (CA, FL, NV, OH, PA)
  - 31 to 40 percent: 10 states (AK, CT, IN, KS, LA, MD, MI, MN, NJ, WI)
  - 41 to 50 percent: 14 states (AZ, DE, GA, ID, IL, IA, NE, NY, OK, OR, SD, TX, VA, WV)
  - 51 to 60 percent: 4 states (AL, CO, MS, NC)

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\(^1\) NAEP 2005 4th Grade

Primary Progress, Secondary Challenge: A State-by-State Look at Student Achievement Patterns
The Education Trust American Association for Higher Education, 2006
The Drop-Out Disaster

1. Nationally, about one-third of all high school students fail to graduate with their class.

2. For whites and Asian students, the graduation rate is about 75 percent; for minority students (African-American, Hispanic, Native American), the rate is about 50 percent.

3. In 2003, there were 3.5 million Americans aged 16 to 25 who had not graduated from high school and who were not enrolled in school.
In 1998, California defined Algebra 1 as the math content for all 8th Graders. Under the pressure of high-stakes testing and severe sanctions the experiment is failing.

Despite the State push toward 8th grade Algebra, only 44.7% of 8th graders took the Algebra I CST in 2005 and only 15% of the 8th graders met standard on the exam.

Then in 2006, 49% of 9th graders were enrolled in a beginning algebra course and 21% took geometry. At the end of that year, only 9% met standard in algebra and 9% in geometry. The failure rate is clearly very high.
## College Prep Mathematics in California

<table>
<thead>
<tr>
<th>Year</th>
<th>Course Enrolled</th>
<th>Alg 1</th>
<th>Geom</th>
<th>Alg 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Eighth Grade</td>
<td>32%</td>
<td>2%</td>
<td></td>
<td>34%</td>
</tr>
<tr>
<td>2004</td>
<td>Ninth Grade</td>
<td>43%</td>
<td>17%</td>
<td>3%</td>
<td>63%</td>
</tr>
<tr>
<td>2005</td>
<td>Tenth Grade</td>
<td>28%</td>
<td>29%</td>
<td>17%</td>
<td>74%</td>
</tr>
<tr>
<td>2006</td>
<td>Eleventh Grade</td>
<td>16%</td>
<td>18%</td>
<td>23%</td>
<td>57%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>119%</td>
<td>66%</td>
<td>43%</td>
<td></td>
</tr>
</tbody>
</table>

## Accumulated Results over 4 Years

<table>
<thead>
<tr>
<th>Class of 2007</th>
<th>% of Std</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met Standard Alg 1</td>
<td>21%</td>
</tr>
<tr>
<td>Met Standard Geom</td>
<td>14%</td>
</tr>
<tr>
<td>Met Standard Alg 2</td>
<td>10%</td>
</tr>
</tbody>
</table>
Sorry, Bob. We need someone who thinks outside the box.

Bobby's Standardized Test #3297:

1. [X] [X] [X]
2. [X] [X] [ ]
3. [ ] [X] [X]
4. [ ] [X] [ ]
The Solution to Improving Student Achievement?

Teacher Proofing Instruction
The Deficit Model of Intervention for Teachers

Unfortunately state and federal approaches to improving instruction centers on a belief that too many teachers can’t teach well, so the aim is to neutralize poor instruction by limiting curriculum/textbook options, providing scripts and pacing guides, assigning benchmark tests, focusing on merely basic procedures and skills, and punishing low test scores.
Teaching to the Test

"The drill and kill curriculum that accompanies high-stakes, one-size-fits-all testing programs undermines rather than improves the quality of education. Intensified testing has especially hurt education for low-income, African American and Latino students."

Monty Neill, Ed.D., National Center for Fair & Open Testing.
## Comparison of Student Performance on the MARS and CST 2006

<table>
<thead>
<tr>
<th>Grade</th>
<th>MARS Below Standards</th>
<th>MARS Above Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seventh Grade</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CST Below Standards</td>
<td>42.8%</td>
<td>4.6%</td>
</tr>
<tr>
<td>CST Above Standards</td>
<td>20.0%</td>
<td>32.6%</td>
</tr>
<tr>
<td><strong>Eighth Grade</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CST Below Standards</td>
<td>52.1%</td>
<td>10.1%</td>
</tr>
<tr>
<td>CST Above Standards</td>
<td>12.4%</td>
<td>25.5%</td>
</tr>
<tr>
<td><strong>Algebra One</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CST Below Standards</td>
<td>48.5%</td>
<td>6.2%</td>
</tr>
<tr>
<td>CST Above Standards</td>
<td>10.1%</td>
<td>35.2%</td>
</tr>
</tbody>
</table>
Testing ≠ Learning

“Once again, independent data demonstrate that the nation cannot test its way to educational quality. It's time to abandon the failed test-and-punish quick fix and get on with the hard work of identifying the real causes of student learning problems, then addressing them effectively."

Monty Neill, Ed.D., National Center for Fair & Open Testing.
Video of our
Teacher’s Dilemma
Teaching Matters

To Really Improve Student Learning - Invest in Teachers
Intertwined Strands of Proficiency

Adding It Up: Helping Children Learn Mathematics, NRC, 2001
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
Grappling with Teacher Knowledge

“Teaching mathematics requires an appreciation of mathematical reasoning, understanding the meaning of mathematical ideas and procedures, and knowing how ideas and procedures connect.”

Ball, 1990
Traditional Approach to Preparing Teachers

- Content
- Pedagogy
- Assessment
- Professional Development
Effective Teaching is at the Intersection

Content

Pedagogy

Assessment

Effective Teaching
Teacher Knowledge

- Cognitive
- Practice
- Moral

The Classroom
Teacher Knowledge

Cognitive

Practice

Moral

The Classroom
Teacher Knowledge

The Classroom
Teacher Knowledge

The Classroom
Teacher Knowledge

Cognitive

Practice

Moral

The Classroom
Teacher Knowledge
The Challenge of Teaching

Mathematics is perceived as a body of knowledge.

Yet,

Mathematics is a practice of problem solving.

A central practice of teaching is also problem solving.

Paraphrase Hy Bass
Sixth Grade Math Class

• Students are working on making sense of decimals.
• The class has in the past used benchmark numbers to make sense of other numbers; such whether a number is greater than or less than a benchmark such as 1/2 or 0.5.
• The class has found the decimal 0.166̅ to represent 1/6.
• Their task is to determine decimal equivalence for 2/6, 3/6, 4/6 and 5/6.
What knowledge does a teacher need in making real time decisions?

<table>
<thead>
<tr>
<th>Cognitive</th>
<th>Practice</th>
<th>Moral</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Did the students make valid math argument?</td>
<td>• Was the student’s explanation clear to the class?</td>
<td>• Which students understand?</td>
</tr>
<tr>
<td>• What is correct and what is incorrect in students understanding?</td>
<td>• Should I repeat it, correct it, or comment about it?</td>
<td>• What should I do for the students that don’t?</td>
</tr>
<tr>
<td>• How might 6th grade students understand repeating decimals?</td>
<td>• Should I ask another student to clarify?</td>
<td>• How do I get Dylan to engage?</td>
</tr>
<tr>
<td>• How does that student’s explanation relate to the math goals of the lesson?</td>
<td>• Should I ask another student for a different explanation?</td>
<td>• If I asked Juanita to present, would that cause embarrassment?</td>
</tr>
<tr>
<td></td>
<td>• Should I ask the groups to discuss it?</td>
<td>• Am I honoring everyone’s ideas?</td>
</tr>
</tbody>
</table>
“One thing is to study whom you are teaching, the other thing is to study the knowledge you are teaching. If you can interweave the two things together nicely, you will succeed...Believe me, it seems to be simple when I talk about it, but when you really do it, it is very complicated, subtle, and takes a lot of time. It is easy to be an elementary school teacher, but it is difficult to be a good elementary school teacher.”

Quote from Tr. Wang, Ma 1999
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.
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.
“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.
Summary Thoughts

• Unfortunately K-12 math instruction has a well too recognized *Signature Pedagogy*... that needs to be changed.

• Teacher Knowledge involves more than content - - cognitive, practice and moral.

• Teacher Knowledge should be measured by *flexibility* (reactive to concepts, responsive to students’ thought, sensitive to students’ needs).

• Building Teacher Knowledge is a life-time, ongoing process of growth and learning - which is a dramatic shift in thinking, policy and resource allocation.
For a copy of the PowerPoint, download from:

www.noycefdn.org/math/resources.html