Still At Risk

Mathematics in the US
A Nation At Risk

“We are at risk of becoming a nation divided both economically and racially by knowledge of mathematics.”

Source: National Research Council, 1989
“By the year 2000, United States students will be first in the world in mathematics and science achievement.”

–National Education Goal #5
Achievement In K-12
Results on International Assessments
TIMSS Nations’ Average Mathematics Performance Compared With the US

Nations Scoring

<table>
<thead>
<tr>
<th>Grade 4</th>
<th>Grade 8</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below the US</td>
<td>Same as the US</td>
<td>Higher than the US</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: NCES 1999-081R, Highlights From TIMSS
*US students with pre-calculus, calculus, analytic geometry or AP calculus instruction, representing about 14% of the US cohort. Of the higher-performing countries, all but four include more of their age cohort in this category.

Nations’ Average Mathematics & Science Performance Compared With the US on PISA

Nations Scoring

<table>
<thead>
<tr>
<th></th>
<th>Math</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below the US</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Same as the US</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Higher than the US</td>
<td>15</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: Organization for Economic Cooperation & Development, Programme for International Student Assessment, 2000
One measure on which we’re near the top on PISA?

Inequality!
Performance Of US 15 Year-Olds Highly Variable

<table>
<thead>
<tr>
<th></th>
<th>PISA 5&lt;sup&gt;th&lt;/sup&gt;-95&lt;sup&gt;th&lt;/sup&gt; Gap Rank*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading (interpreting texts)</td>
<td>3</td>
</tr>
<tr>
<td>Mathematical Literacy</td>
<td>6 (tie)</td>
</tr>
<tr>
<td>Science Literacy</td>
<td>7</td>
</tr>
</tbody>
</table>

*Of 27 OECD countries

Inside the US

... a look at NAEP results
Results Up at All Grade Levels
National Mathematics Scale
Score Results: 1990-2000
4th Graders Show Most Gains

Unlike in previous decades, when minorities made greater gains, gaps remained wide during nineties.
Gaps Narrow, Then Hold Steady or Widen: NAEP Math Scores, 13 Year-Olds

Gaps Narrow, Then Hold Steady or Widen: NAEP Math Scores, 17 Year-Olds

Despite progress, few students proficient or advanced... and too many performing below even the basic level.
NAEP Mathematics Performance 2000

8th Graders Performing Below Basic in Mathematics 2000

12th Graders Performing Below Basic in Mathematics 2000

High schools a special problem
Students Make More Growth In Grades 5-8 Than 9-12, Class of ‘00

Value Added Declining in High School Math

Age 13-17 Growth

<table>
<thead>
<tr>
<th>Math</th>
<th>Scale Score Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>34</td>
<td>29</td>
</tr>
</tbody>
</table>

Skills at end of high school?
## Too Few 17 Year-Olds Demonstrate Strong Math Skills

<table>
<thead>
<tr>
<th>Category</th>
<th>African American</th>
<th>Latino</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Step Problem Solving, Algebra</td>
<td>1%</td>
<td>3%</td>
<td>10%</td>
</tr>
<tr>
<td>Moderately Complex Procedures</td>
<td>27</td>
<td>38</td>
<td>70</td>
</tr>
<tr>
<td>Numerical Operations</td>
<td>89</td>
<td>94</td>
<td>99</td>
</tr>
</tbody>
</table>

*Source: USDOE, NCES, 1999 NAEP Summary Data Tables*
African American and Latino 17 Year Olds Do Math at Same Levels As White 13 Year Olds

Source: NAEP 1999 Long Term Trends Summary Tables (online)
Achievement in Higher Education
Many College Graduates Demonstrate Weak Quantitative Literacy Skills

<table>
<thead>
<tr>
<th></th>
<th>Grads: 2 Yr. Colleges</th>
<th>Grads: 4 Yr. Colleges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 5: High</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Level 4</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Level 3</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>Level 2</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Level 1: Low</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: USDOE, NCES, National Adult Literacy Survey, 1992, in Literacy in the Labor Force: Results from the NALS, September 1999, p. 61.
Description: Quantitative Literacy Level 2

• **CAN** Calculate postage and fees for certified mail
• **CAN** Determine difference in price between tickets for two shows
• **CAN’T** Calculate difference between regular and sale price from an advertisement using a calculator
• **CAN’T** Plan travel arrangements for meeting using flight schedule

Source: USDOE, NCES, National Adult Literacy Survey, 1992, in Literacy in the Labor Force: Results from the NALS, September 1999, p. 15.
Description:
Quantitative Literacy Level 3

• CAN Determine correct change using information on a menu

• CAN Use information stated in news article to calculate amount of money it takes to raise a child

• CAN’T Determine shipping and total costs on an order form for items in a catalog

• CAN’T Use information in news article to calculate difference in time for completing a race

Source: USDOE, NCES, National Adult Literacy Survey, 1992, in Literacy in the Labor Force: Results from the NALS, September 1999, p. 61.
Gaps between groups?
Colleges Don’t Close Gaps

<table>
<thead>
<tr>
<th>Quantitative</th>
<th>Highest Education</th>
<th>White Black Gap</th>
<th>White Hispanic Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS Diploma</td>
<td>47</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>2 Year Degree</td>
<td>46</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>4 Year Degree</td>
<td>49</td>
<td>43</td>
<td></td>
</tr>
</tbody>
</table>

Source: USDOE, OERI, Adult Literacy in America: A First Look at the Results of the Results of the National Adult Literacy Survey (NALS), 1992, September 1993, p. 36.
How do our skills compare internationally?
Almost Half of US Adults Perform at Lowest Literacy Levels in All Areas

<table>
<thead>
<tr>
<th>Literacy Scale</th>
<th>Level 1 (0-225)</th>
<th>Level 2 (226-275)</th>
<th>Level 1 + 2 (0-275)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prose</td>
<td>21%</td>
<td>26%</td>
<td>47%</td>
</tr>
<tr>
<td>Document</td>
<td>24%</td>
<td>26%</td>
<td>50%</td>
</tr>
<tr>
<td>Quantitative</td>
<td>21%</td>
<td>25%</td>
<td>46%</td>
</tr>
<tr>
<td>Composite</td>
<td>20%</td>
<td>25%</td>
<td>45%</td>
</tr>
</tbody>
</table>

(score range in parenthesis)

College Degrees Don’t Fix the Problem: US Adults Rank Poorly Among 20 High-Income Countries

<table>
<thead>
<tr>
<th>Educational Attainment</th>
<th>Quantitative Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-School Grad/GED, no college</td>
<td>19th</td>
</tr>
<tr>
<td>1-3 yrs of college</td>
<td>17th</td>
</tr>
<tr>
<td>Bachelor’s degree or higher</td>
<td>13th</td>
</tr>
</tbody>
</table>
Mathematics Education
“Mathematics and science education will be strengthened throughout the system, especially in the early grades.

—National Education Goal #5, Objective 1
CURRICULUM:
K-12
8th Grade: A lot of cross-national information because of TIMSS
Quality of Mathematical Content of 8th Grade Lessons

Average Grade Level of Content in 8th Grade Lessons, by International Standards

Algebra In 8th Grade Text Books

% Of Space Devoted To Algebra In 8th Grade Mathematics Textbooks

Math Emphasis Favors Routine Skills Over Understanding

United States 8th Grade Math Teachers

High School: Moving More Students into College-Prep Math Sequence
High School Graduates Taking More Mathematics

Source: HS&B, HSTS, NELS data, in NCES Digest of Education Statistics, 2000, Table 140.
Percentage of High School Graduates Completing Algebra II, 1998

Percentage of High School Graduates Completing Pre-calculus, 1998

Percentage of High School Graduates Completing Calculus, 1998

CURRICULUM: Higher Education
Enrollments in mathematical sciences courses doubled in the 70s and 80s, but the increases were all at the lower levels, with remedial enrollments leading the way.

Undergraduate Mathematics Course Enrollment

• Even at top rated doctoral granting public universities*, nearly 20% of total student enrollment in mathematics is at the Remedial or Precalculus levels.

*Group IA

### Many Freshmen Must Take Remedial Math Courses, 1995

<table>
<thead>
<tr>
<th>Institution Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All institutions</td>
<td>24%</td>
</tr>
<tr>
<td>Public 2 year</td>
<td>34%</td>
</tr>
<tr>
<td>Public 4 year</td>
<td>18%</td>
</tr>
<tr>
<td>High Minority Enrollment</td>
<td>35%</td>
</tr>
<tr>
<td>Low Minority Enrollment</td>
<td>21%</td>
</tr>
</tbody>
</table>

**Source:** USDOE, NCES, PEQUIS, Remedial Education at Higher Education Institutions in fall 1995 (1996), in The Condition of Education 1999, p. 88
TEACHERS: K-12
“The number of teachers with a substantive background in math and science will increase by 50%”

–National Education Goal #5, Objective 2
How Far Have We Come?
Percentage Public High School Math Teachers With a Major or Minor in Field

International Problem?
Who Teaches Grade 8 Mathematics?

If teachers without sufficient content are a problem, that problem affects different groups of students differently.
Percent High School Math Classes Whose Teachers Have No Major or Minor in Math

Percent Middle School Math Classes Whose Teachers Have No Major or Minor in Math

Teachers in general compared to other BA’s?
Math Literacy of Teachers Versus Other BAs

Description: Quantitative Literacy Level 3

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**Source:** USDOE, NCES, National Adult Literacy Survey, 1992, in Literacy in the Labor Force: Results from the NALS, September 1999, p. 61.
TEACHERS:
Higher Education
### Who Is Teaching Remedial Mathematics?

<table>
<thead>
<tr>
<th>Category</th>
<th>Research Univ.</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenured/Eligible</td>
<td>1%</td>
<td>26%</td>
</tr>
<tr>
<td>Other Full Time</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>TA/Part Time</td>
<td>87%</td>
<td>62%</td>
</tr>
</tbody>
</table>

**Source:** Fall 1995 Conference Board Mathematical Sciences Survey
Who’s Teaching Freshman Mathematics In Research Universities?

- Remedial: 1%
- Precalculus: 18%
- Calculus: 62%

Source: Fall 1995 Conference Board Mathematical Sciences Survey
Where are the Math Majors?
“The number of US undergraduate and graduate students, especially women and minorities, who complete degrees in mathematics, science, and engineering, will increase significantly.”

—National Education Goal #5, Objective 3
Junior/Senior Mathematical Sciences Majors Declining

72,000 >> 56,200 = -22%

Math Degrees Declining, 1971-2000

1997-98 Bachelor’s Degrees Awarded In Mathematics

1997-98 Master’s Degrees Awarded In Mathematics

- White: 59%
- Black: 29%
- Hispanic: 6%
- Asian/Pacific/Islander: 2%
- Non-Resident: 4%

1994-95 Doctor’s Degrees Awarded In Mathematics

- White: 45%
- Black: 0%
- Hispanic: 1%
- Asian/Pacific Islander: 8%
- Non-resident: 46%

MATH TEACHER DEMAND
Shortage of Certified and Fully Qualified Math Teachers

Distribution of middle and high school math and science positions filled in 1993-94.

Demand is Far Outpacing Supply

• An estimated 240,000 middle and high school mathematics and science teachers will be needed over the next 10 years.

• Of this total, nearly 70% will be newcomers to the profession.

Over a Decade...

We might produce as many as 120,000 math MAJORS. BUT, we may have to fill upwards of 130,000 math teaching positions.
And in the 1990s, only about 29% of mathematics majors taught at either level, with only about 15% teaching at any time.

Source: American Mathematics Society, “Data from the National Science Foundation on Bachelor’s Degree Recipients,” 1993.
Ways OUT
1. Start with the data—especially YOUR data.
2. Provide Assistance to Current Teachers

- Identify most important standards;
- refocus curriculum, assessment and professional development on most important standards
3. Increase number of students studying mathematics at all levels.

- Make college prep curriculum the default curriculum for all students;
- Accelerate students with weak skills BEFORE they take the course, not after they fail;
- Raise requirements for teaching, especially at middle school level;
- Mine ALL sources for teachers with strong math background
• Enroll strongest students in college math, rather than AP;
• Teach “remedial” math in high school
4. In higher education?

- Goals, incentives, rewards for increased production of bachelors degrees in math;
- Engage mathematics faculties in strategizing about how to produce more and better teachers of mathematics;
- Work on the mathematical literacy of ALL college students.
The Education Trust

www.edtrust.org
202-293-1217