MATHEMATICS: A CASE STUDY

Administrative Committee on Academic Affairs
October 16, 2001

Adapted from presentation at Summer Institutes, July 2001, NASH/Education Trust
"WE ARE AT RISK OF BECOMING A NATION DIVIDED BOTH ECONOMICALLY AND RACIALLY BY KNOWLEDGE OF MATHEMATICS."

“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
Nations’ Average Mathematics Performance Compared With the US

Source: NCES 1999-081R, Highlights From TIMSS
Average Advanced Mathematics Performance of Advanced Mathematics Students in All Countries

*U.S. students with pre-calculus, calculus, analytic geometry or AP calculus instruction, representing about 14% of the U.S. cohort. Of the higher-performing countries, all but four include more of their age cohort in this category.

ACHIEVEMENT IN HIGHER EDUCATION
Many College Graduates Demonstrate Weak Quantitative Literacy Skills

<table>
<thead>
<tr>
<th>Level</th>
<th>2 Yr. Colleges</th>
<th>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 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.
Math Proficiency Gaps Persist: College Graduates

“Mathematics and science education will be strengthened throughout the system, especially in the early grades.”

--National Education Goal #5, Objective 1
CURRICULUM: K-12
Quality of Mathematical Content of 8th Grade Lessons

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

Math Emphasis Favor Skills Over Understanding

United States 8th Grade Math Teachers

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

- African American: 7.0%
- Asian: 18.0%
- Latino: 6.0%
- Native American: 6.0%
- White: 12.0%
CURRICULUM:
Higher Education
ENROLLMENTS IN MATHEMATICAL SCIENCES COURSES HAVE DOUBLED IN THE LAST 20 YEARS, BUT THE INCREASES HAVE ALL BEEN AT THE LOWER LEVELS, WITH REMEDIAL ENROLLMENTS LEADING THE WAY.

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>

Two thirds of all college mathematics enrollments are below the level of calculus.

96% of all college mathematics enrollments are in courses also taught in High School.

In America today, the profile of mathematics in higher education is not that much different from that of mathematics in high school.

1995 FALL ENROLLMENT IN MATHEMATICS COURSES

Source:
“The number of teachers with a substantive background in math and science will increase by 50%”

--National Education Goal #5, Objective 2
TEACHERS: K-12
How Far Have We Come?
Percentage Public High School Math Teachers With a Major or Minor in Field

Middle School Math Students Most Likely to have Underqualified Teachers

Percent of public secondary students taught by teachers without major or minor in math

Math & Science Classes With a High Percentage of Minority Students Are More Often Taught by Underqualified Teachers

Math Literacy of Teachers Versus Other BAs

**Description:**

Quantitative Literacy Level 3

- **CAN** Determine correct change using information on a menu
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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?

Source: Fall 1995 Conference Board Mathematical Sciences Survey
WHO’S TEACHING FRESHMAN MATHEMATICS IN RESEARCH UNIVERSITIES?

Source: Fall 1995 Conference Board Mathematical Sciences Survey
GRADUATE TEACHING ASSISTANTS

• Approximately half of the graduate mathematics students in the United States are nonresident foreigners.

• “Heavy reliance on the use of graduate teaching assistants, many of whom have limited experience or training for the responsibilities placed on them, has far-reaching consequences.”

“The number of U.S. 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 Majors Declining

<table>
<thead>
<tr>
<th></th>
<th>1990-91</th>
<th>1997-98</th>
<th>Percent Change, 91-98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor’s degrees awarded in</td>
<td>15,310</td>
<td>12,328</td>
<td>-19.5%</td>
</tr>
<tr>
<td>mathematics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of total</td>
<td>1.4%</td>
<td>1.0%</td>
<td>-28.6%</td>
</tr>
<tr>
<td>bachelor’s degrees awarded</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mathematics Degrees Awarded

Source: Tabulated by NSF Division of Science Resource Studies; Data from NCES/IPEDS and NSF/SRS, in Science and Engineering Degrees: 1966-98.
1997-98 BACHELOR’S DEGREES AWARDED IN MATHEMATICS

1997-98 MASTER’S DEGREES AWARDED IN MATHEMATICS

1994-95 DOCTORATES AWARDED IN MATHEMATICS

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

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.

MATH MAJORS IN THE WORKFORCE

- Mean Salary: $50,902
- (30% above mean for all with BA only)
  - 15% employed in Education
  - 64% in for profit sector
  - 3% in non profit sector
  - 8% self employed
  - 10% government

Source: Andrew Sum, Northeastern University
SOME RECOMMENDATIONS FOR THE ROLE OF ARTS AND SCIENCE FACULTY IN MATHEMATICS

• College faculty must become actively involved in the education of teachers if the teaching of mathematics in the schools is to improve significantly.
• Colleges and universities should assign significantly higher priority to mathematics teacher education.
• All college and university faculty members who teach mathematics or mathematics education should maintain a vigorous dialogue with their colleagues in schools, seeking ways to collaborate in improving school mathematics programs and in supporting professional development of mathematics teachers.