College and University Leaders Changing Science & Math Education

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Science Outreach – Appalachian Math Science Partnership
National Science Foundation

Alarms! 1959

• Increased Funding for Math/Science Education

• Improved Teacher Training

• Launching of “Learning Science By Doing Science”
Student Performances in Math and Science: 1996 - 2000

If There is a Problem......Where Does it Lie?
### Historical Perspective

#### Student Achievement in Science – A Comparison of Progress in the 1990’s

<table>
<thead>
<tr>
<th>Grade</th>
<th>1996</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Proficient</td>
<td>26%</td>
<td>29%</td>
</tr>
<tr>
<td>Basic</td>
<td>38%</td>
<td>37%</td>
</tr>
<tr>
<td>Below Basic</td>
<td>33%</td>
<td>34%</td>
</tr>
<tr>
<td><strong>Grade 8</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>3%</td>
<td>4%</td>
</tr>
<tr>
<td>Proficient</td>
<td>26%</td>
<td>29%</td>
</tr>
<tr>
<td>Basic</td>
<td>32%</td>
<td>28%</td>
</tr>
<tr>
<td>Below Basic</td>
<td>39%</td>
<td>39%</td>
</tr>
<tr>
<td><strong>Grade 12</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Proficient</td>
<td>19%</td>
<td>16%</td>
</tr>
<tr>
<td>Basic</td>
<td>36%</td>
<td>34%</td>
</tr>
<tr>
<td>Below Basic</td>
<td>43%</td>
<td>47%</td>
</tr>
</tbody>
</table>

* Significantly different from 2000.

**NOTE:** Percentages within each science achievement-level range may not add to 100, or to the exact percentages at or above achievement levels, due to rounding.

**SOURCE:** National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 and 2000 Science Assessments.
Performance Comparisons by Race/Ethnicity

Average Science Scores by Race/Ethnicity, Grades 4, 8, and 12: 1996–2000

Grade 4

Grade 8

Grade 12

- White
- Asian/Pacific Islander
- American Indian
- Hispanic
- Black

* Significantly different from 2000.

Special analyses raised concerns about the accuracy and precision of national grade 4 Asian/Pacific Islander results in 2000. As a result, they are omitted here. (See technical notes on the NAEP Web Site.)

Percentage of Students At or Above Basic or Proficient in Science – Grades 4-12

- **White**
  - Grade 4: '96 = 37, '00 = 38
  - Grade 8: '96 = 37, '00 = 41
  - Grade 12: '96 = 27, '00 = 23

* ★ Significantly different from 2000.
* ♦ Special analyses raised concerns about the accuracy and precision of national grade 4 Asian/Pacific Islander results in 2000. As a result, they are omitted here. (See technical notes on the NAEP Web Site.)

**SOURCE:** National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 and 2000 Science Assessments.
Percentage of Students At or Above Basic or Proficient – Grades 4-12

- % at or above Basic
- % at or above Proficient

- Significantly different from 2000.
- Special analyses raised concerns about the accuracy and precision of national grade 4 Asian/Pacific Islander results in 2000. As a result, they are omitted here. (See technical notes on the NAEP Web Site.)

Percentage of Students At or Above Basic or Proficient – Grades 4-12

**Black**

<table>
<thead>
<tr>
<th>Grade 4</th>
<th>Grade 8</th>
<th>Grade 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>'96</td>
<td>'00</td>
<td>'96</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>34</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>34</td>
<td>26</td>
<td>22</td>
</tr>
</tbody>
</table>

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Equality in Education
What Are We Doing to Assure Tomorrow’s Future

- Brown v. Board of Education – 1954
- Sheff v. O’Neill (Connecticut)
  - 1996-Present

- HOW CAN WE HAVE AN ISSUE Over 50 YEARS LATER?
From Sputnik to Inhabiting Space
The Future is At Stake

- The Goals and Objectives for Math/Science Education Remain Constant…..We KNOW What Needs to Be Done.
- Equal Opportunities in Math/Science Education Must Be a Priority.
- Effective Standards Based Instruction Must Be Innovative.
Complaining is Easy!

What is Needed in Mathematics and Science Education?
What We Say is Needed for Mathematics and Science Education?

- More emphasis on “reasoning out” rather than memorization.
- More attention to developing a “problem-solving attitude and a “problem-raising attitude” on the part of students.
- More applications of the subject to the everyday life of the pupil and the community…”
What We Say is Needed for Mathematics and Science Education?

- More emphasis on the incompleteness of the subject and glimpses into the great questions yet to be solved by investigators

- Less coverage of territory; the course should progress no faster than pupils can go with understanding.

- “Suggestions for the Improvement of Biology Courses” Central Association of Science and Mathematics Teachers.....1910.  Hurd, 1961; 25-26
Is Math/Science Education Doomed?
Perspectives on Current Student Performance

- Changing Population Demographics
- A Widening Achievement Gap Among Socioeconomic and Racial Groups
- Public Education Standards in Mathematics and Science Have Declined
- External Factors Reduce High Expectations of Students and Educators in Mathematics and Science.
21st Century Needs in Mathematics and Science Education

- Development of an *Adequate* and *Effective* Work Force in Science and Technology
- Providing Future Economic Growth of Urban and Rural America
- Development of a Scientifically Literate Public
- Closing the Gap Between Urban/Rural and Suburban Students in Scientific Literacy
Can We Establish High Standards for ALL Students in Math/Science Education at Struggling Schools?
The Greater Hartford Academy of Math and Science at the Learning Corridor

A Working Partnership of Parents, Neighborhoods, K-12 Schools and Higher Education
Establish an Educational Environment for Students to Learn “Science as Scientific Discovery is Conducted”.

Math and Science Content + Problem Solving Skills

Active Research Programs Faculty with Interests in Research

Laboratory Based Education + Applied Mathematics
STUDENT PROFILE

- Interest in Mathematics and Science
- Ability to Work as an Individual or in a Peer Group
- Directed and Motivated to Pursue Academics at a 4 Year College or University
- Students Accepted on a “Lottery” Basis
Creating Scientists for the 21st Century Curriculum

Tracks

Chemistry, Biochemistry

Math & Computer Science

Integrative Biology

Electronics & Engineering

Environ. Science, Physics, Astronomy

Laboratory Based Education
- Critical Thinking Skills
- Problem Solving Skills
- Data Analysis
Figure 3. Effect of Years at GHAMAS on Attitudes

<table>
<thead>
<tr>
<th>Attitudinal Target</th>
<th>Positive Attitudes after 1 year</th>
<th>Positive Attitudes after 2 years</th>
<th>Negative Attitudes after 1 year</th>
<th>Negative Attitudes after 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>Only a few</td>
<td>None</td>
<td>Quite a few</td>
<td>All or almost all</td>
</tr>
<tr>
<td>Black</td>
<td>About half</td>
<td>Only a few</td>
<td>Most</td>
<td>Only a few</td>
</tr>
<tr>
<td>Latino</td>
<td>Most</td>
<td>None</td>
<td>Most</td>
<td>Only a few</td>
</tr>
<tr>
<td>White</td>
<td>All or almost all</td>
<td>Only a few</td>
<td>All or almost all</td>
<td>None</td>
</tr>
</tbody>
</table>
Rural Students in Math and Science Share Many Common Challenges
The Issues

Feeling Like You Are Alone
Swimming In A
Sea of Sharks!
The Issues:

Feeling Like You Just Don’t Fit
And....... 
Will I EVER Fit????
The Feeling of Academic Equality...
The Issues:

Making Math and Science Relevant to OUR World
Wanted: Change Agents to Increase Student Learning...

- Policy
- Curriculum
- Instruction
- Standards
Policy

- Different Levels of Policy Implementation
  - Federal
  - State
  - District
  - Individual Schools
Policy

- Focus on What YOU Can Control
Policies That Impact Science and Mathematics Education

- Required Courses
- Exit Exams/Placement Exams
- Course Sequencing
- Requiring Mathematics and Science Each Year
Rigorous Instruction

- Empower Faculty to Determine the Meaning of Academic Rigor
  - Empowerment = Responsibility
- More Content = Academic Rigor?
  - The Easy Answer!
- Integration and Alignment of Curriculum
Outreach Professors
Connecting K-12 Schools with Colleges and Universities
Science Outreach
Current Activities That Connect AMSP Regions with College/University Resources

- Develop and Conduct Summer Math & Science Institutes
- Building IHE Collaborations for Partnership Enhancement Program (PEP)
- Development and Expansion of Inquiry Based Pre-Service Math & Science Education Courses
- Connecting Math & Science Excel to Colleges & Universities
Lewis County, KY PEP
Goals and Outcomes

- **Desired Outcomes:**
  - **Decreases in:**
    - student failures in science courses
  - **Increases in:**
    - student empowerment in learning science
    - student contact with university personnel
    - student enrollment in college
    - student achievement on course assessments
    - student achievement on CATS and ACT
    - student understanding of fundamental science concepts.
Step One: Curriculum Design and Development Through Monthly LCHS Science Staff/IHE Scientist Meetings
Step Two: Pilot Curriculum Program Interest with IHE Faculty and HS Students
Step Three: Implement Curriculum & Assess Student Achievement (Currently Being Conducted)
Promoting Student Access to College and STEM Careers

What obstacles do you face?
Some Common Ingredients

- Significant Senior STEM Faculty Involvement
- Leveraging Capacity from Previous Projects
- High level Communication
- Administrative and Staff Assistance
  - Writing, budgeting, travel to sponsors‘ meetings, etc.
Primary Development Tools

- Outreach Professors in Math and Science
- Partnership Development Through Small Grants
- Communications and Instructional Technology
- Partnership Institute
  - Operates the “nursery”, “archives”
  - “Sustainability”
  - Hosts inter-college programs
  - Provides administrative, technical support
The Outreach Professor

- **The UK Model**
  - Full professors, regular faculty
  - Top salaries,
  - Hired with tenure on basis of research credentials,

- **Math and Science in AMSP**
  - Internal competition among departments for positions

- **50% of Salaries paid by AMSP through 2007**
What Constitutes “Outreach”? 

- Build Partnerships with K-12 and Higher Education
- Connect K-12 Schools with Colleges and Universities
- Develop (non-career threatening) Opportunities for Other Faculty
- Model Alternate/Additional Career Components for Colleagues and Students
- Facilitate Proposal Development
- Foster Innovative Math/Science Curriculum Development K-16
- Provide University Courses Facilitating “Outreach”
Current Externally Funded Projects:
Four in two yrs totaling $6.9 M

- “Assessing How Distance Learning For Teachers Can Enable Inquiry Science in Rural Classrooms”, Jeffrey Osborn, Rebecca McNall, William Raynes, Joseph Straley, Kelly Bradley, (NSF) $1.998 M

- “Recruiting, Retaining, and Graduating University of Kentucky Appalachian Science, Technology”, Engineering, and Mathematics Majors, Robert Tannenbaum, Jeffrey Osborn, Carl Eberhart (NSF), $1.998 M
“Algebra Cubed”, Richard Millman, Jeffrey Osborn, Xin Ma, Gerald Lineberry, Paul Prater (NSF) $1.974 M

“Kentucky Science Alliance”, Kimberly Zeidler, Jeffrey Osborn, Diane Johnson (Ky Dept Ed), $570 K

“Investigating The Assessment Principle Into Math Content for Preservice Elementary Teachers”, Richard Millman, Xin Ma (Ky Ed. Standards Brd), $100K

The Future is At Stake

- The Goals and Objectives for Math/Science Education Remain Constant.....We KNOW What Needs to Be Done.
- Change Agents Are Required TODAY!