



“If we’re serious about building a stronger economy and making sure we succeed in the 21st century, then the single most important step we can take is to make sure that every young person gets the best education possible, because countries that out-educate us today are going to out-compete us tomorrow.”

President Barack Obama,  
September 2010

# What is PCAST?



- PCAST is an advisory group of the nation's leading scientists and engineers who directly advise the President and the Executive Office of the President.
- PCAST makes policy recommendations in the many areas where understanding of science, technology, and innovation is key to strengthening our economy and forming policy that works for the American people.



Obama's PCAST has produced two reports on STEM education:

Prepare and Inspire:  
K-12 Education in STEM for  
America's Future



REPORT TO THE PRESIDENT  
PREPARE AND INSPIRE:  
K-12 EDUCATION IN SCIENCE,  
TECHNOLOGY, ENGINEERING,  
AND MATH (STEM) FOR  
AMERICA'S FUTURE

Executive Office of the President  
President's Council of Advisors  
on Science and Technology

SEPTEMBER 2010





Obama's PCAST has produced two reports on STEM education:

Engage to Excel: Producing One Million Additional College Graduates with Degrees in STEM



REPORT TO THE PRESIDENT  
ENGAGE TO EXCEL: PRODUCING ONE MILLION  
ADDITIONAL COLLEGE GRADUATES WITH  
DEGREES IN SCIENCE, TECHNOLOGY,  
ENGINEERING, AND MATHEMATICS

Executive Office of the President  
President's Council of Advisors  
on Science and Technology

FEBRUARY 2012



# Engage to Excel:

Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Math

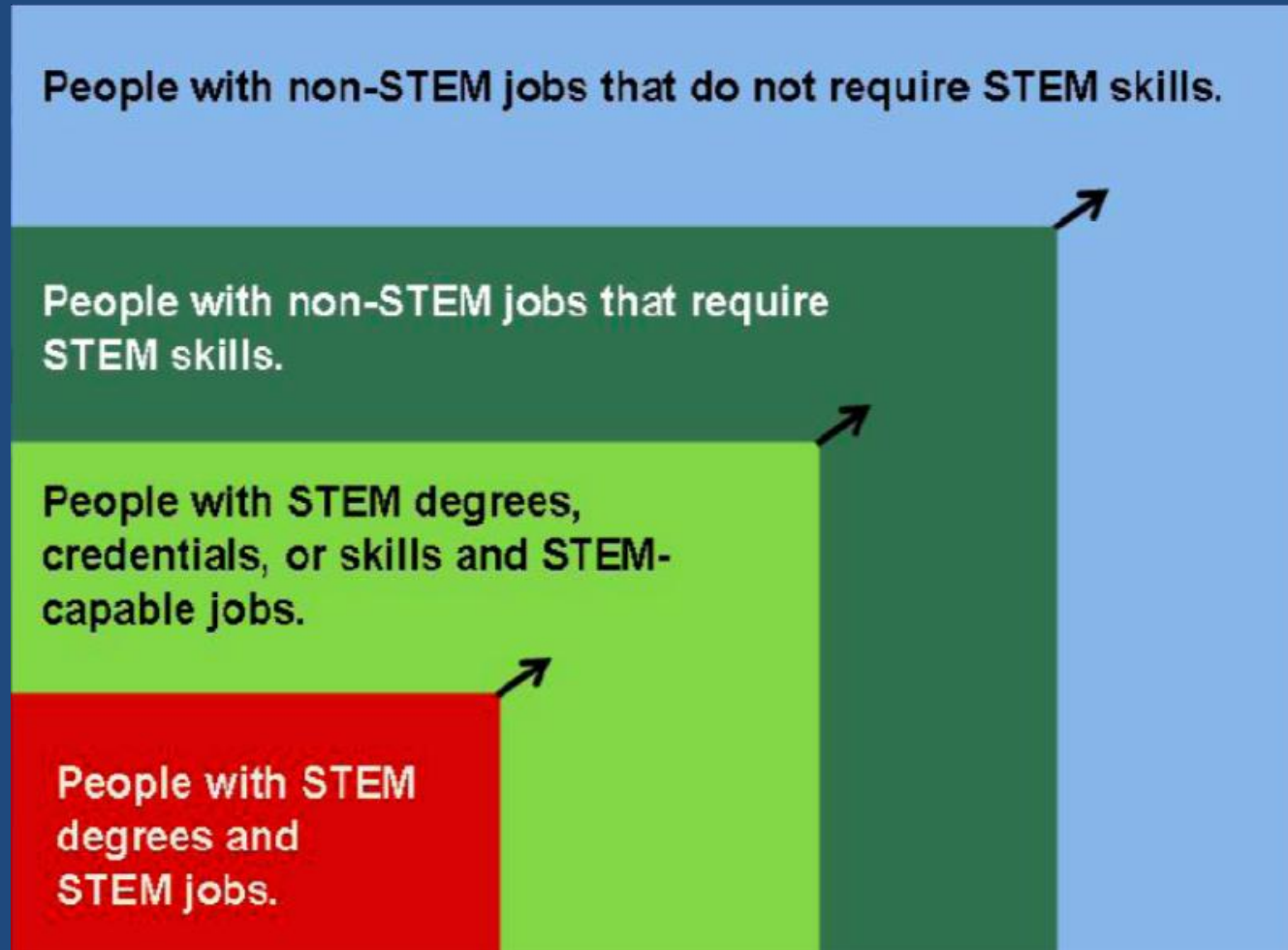
**The President's Council of Advisors on Science and Technology**

Public Release

Tuesday, February 7, 2012

# STEM Skills are Needed in a Growing Number of Occupations

Figure E-1 Total U.S. Workforce



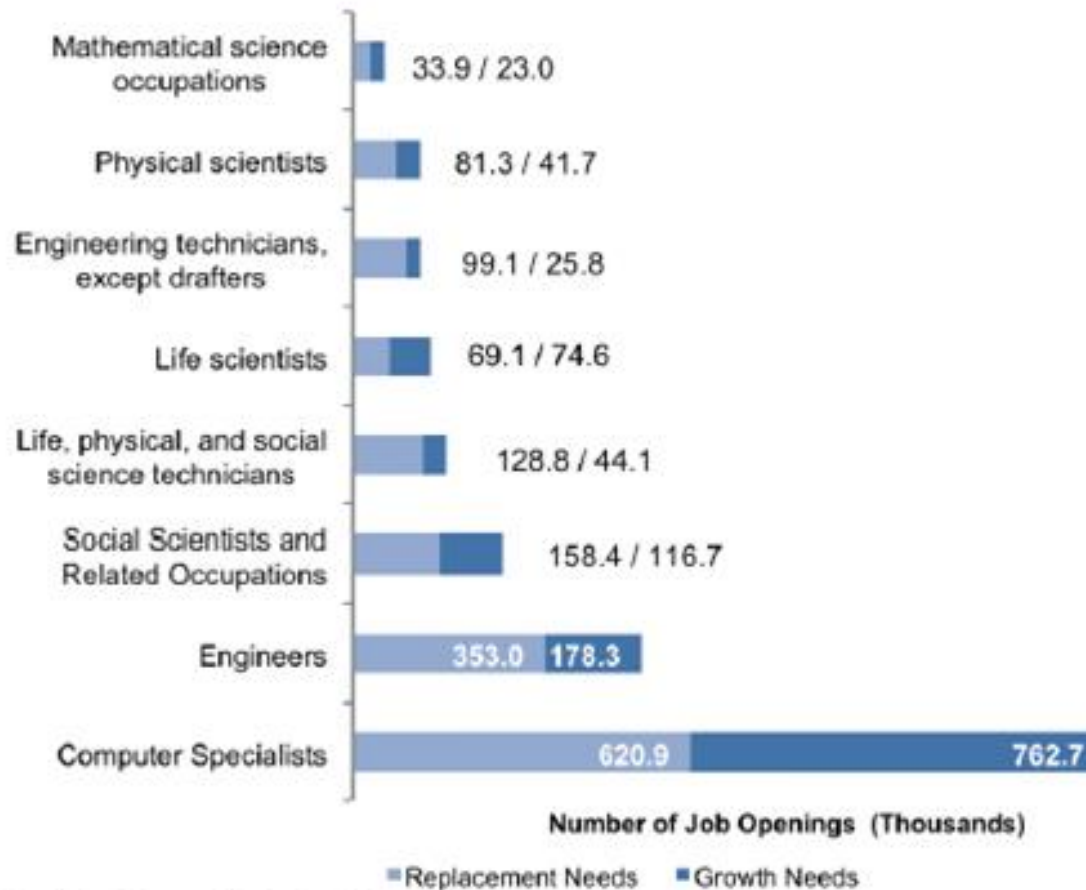
Some Postsecondary education

Need number of additional 4-year and 2-year Degrees and credentials

Need additional 4-year degrees in the next decade

# Projected Job Openings In STEM Occupations, 2008-2018

Figure D-7. Projected Job Openings in STEM Occupations, 2008-2018



Derived from: Bureau of Labor Statistics.

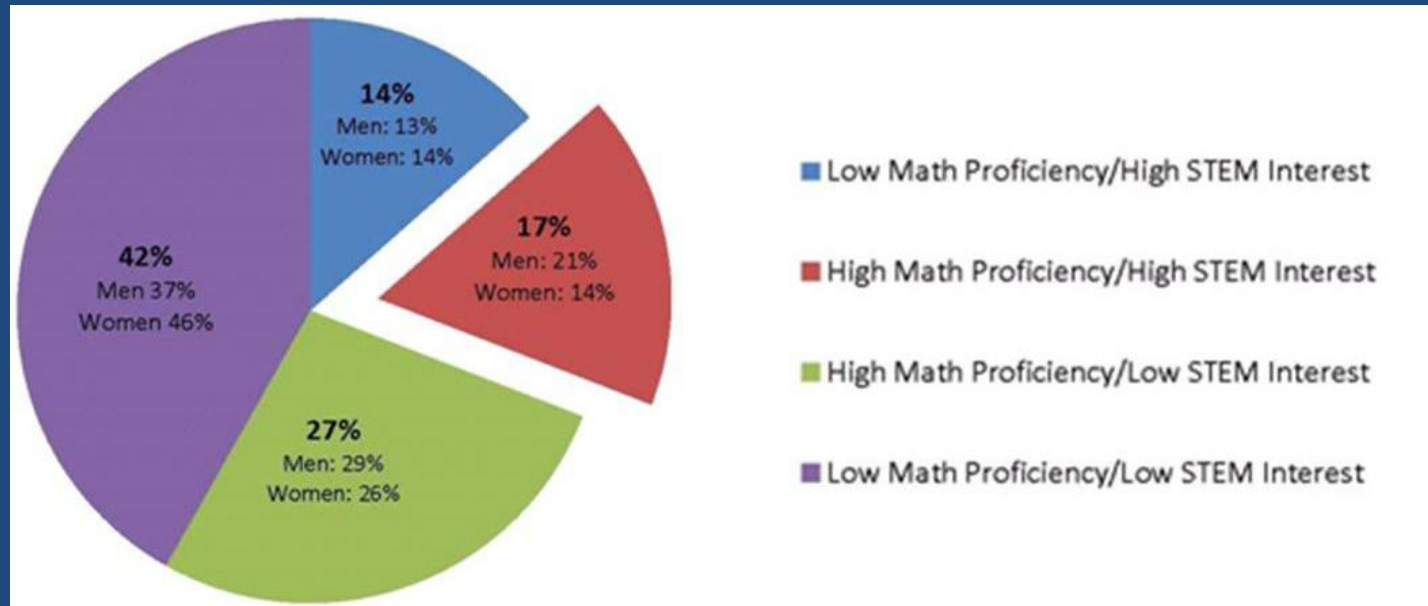
# Retention Problem in First Two Years of STEM College Education

- Fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree.
- High-performing students frequently cite uninspiring introductory courses as a factor in their choice to switch majors.
- Low-performing students with a high interest and aptitude in STEM careers often have difficulty with the math required in introductory STEM courses with little help provided by their universities.
- Many students, and particularly members of groups underrepresented in STEM fields, cite an unwelcoming atmosphere from faculty in STEM courses as a reason for their departure.
- Increasing retention from 40% to 50% would generate almost three-quarters of the one million additional STEM degrees needed in the next decade.



# Math-Preparation Gap Keeps Students from STEM Degrees

Figure E-1. 12th Grade Student STEM Interest and Mathematics Proficiency



Source: BHEF (2011). The STEM interest and proficiency challenge: Creating the workforce of the future.

- About 14% of 12th graders are interested in STEM fields but not proficient in math.

# Engage to Excel Findings

Need one million more STEM professionals than will be produced at current rates over the next decade.

- ◆ First two years of college do not inspire students to pursue STEM degrees.
- ◆ Improved teaching methods, including engaging students in active learning, will increase retention and improve performance in STEM courses.
- ◆ The current system pushes hands-on research and internship experiences for STEM majors off to the third and fourth year of college, when many of the students have already opted out.
- ◆ Closing the mathematics-preparation gap would enable many more students interested in STEM fields to attain STEM college degrees.
- ◆ Retaining more STEM majors is the lowest-cost, fastest policy option to provide the STEM professionals that the Nation needs for economic and societal well-being.
- ◆ Increasing the rate of STEM associate and bachelor degrees by 33% from 2 million to 3 million over the next decade will help satisfy the projected demand for STEM workers.

# Imperatives to Improve STEM Undergraduate Education

Based on extensive research about students' choices, learning processes, and preparation, three imperatives underpin this report:

- Improve the first two years of STEM education in college.
- Provide all students with the tools to excel.
- Diversify pathways to STEM degrees.

Our recommendations detail how to convert these imperatives into action.

# Engage to Excel

## Multipronged Solution

- ◆ Capture the thrill of discovery and inquiry in the first two years of college STEM courses.
- ◆ Address the gap in math preparedness.
- ◆ Provide diverse routes to STEM degrees.
- ◆ Galvanize leadership in academic science to foster change.

# Recommendation #1

**Catalyze widespread adoption of empirically validated teaching practices.**

**Diverse active learning methods enhance learning**

Case studies

Problem-based learning

Problem sets in groups

Concept mapping

Small group discussion & peer instruction

Analytical challenge before lecture

Computer simulations and games

Writing w/peer review

Testing

Clickers

Group tests

## Examples:

- One study found that, students in traditional lecture courses were twice as likely to leave engineering and three times as likely to drop out of college entirely compared with students taught using active learning techniques.
- Students in a physics class that used active learning methods learned twice as much as those taught in a traditional class, as measured by test results.

## Recommendation #1

**Catalyze widespread adoption of empirically validated teaching practices.**

### Premise:

Classroom practices that actively engage students promote learning better than lectures.

### Actions:

- ◆ Train current and future faculty in evidence-based teaching.
- ◆ Provide grants to enable campuses to adopt new teaching practices.
- ◆ Develop metrics by which institutions can gauge their progress toward excellence in STEM education.

## Recommendation #2

**Advocate and provide support for replacing standard laboratory courses with discovery-based research courses.**

### Premise:

Students who engage in research early college are more likely to persist in STEM majors.

### Example:

One study found that college sophomores who engaged in research projects with a professor were significantly less likely to leave STEM majors than those who did not.

### Actions:

- ◆ Fund implementation of research courses for students in the first two years.
- ◆ Establish collaborations between research universities and small colleges, such as community colleges, to provide all students access to research experiences.

## Recommendation #3

**Launch a national experiment in postsecondary mathematics education to address the math-preparation gap.**

### Premise:

Nearly 60% of students enter college without the math skills needed for STEM majors.

### Actions:

- ◆ Support a national experiment in mathematics undergraduate education aimed at developing new approaches to remove the math bottleneck.
- ◆ Identify most successful strategies and replicate.



## Recommendation #4

**Encourage partnerships among stakeholders to diversify pathways to STEM careers.**

### Premise:

STEM education needs to accommodate students who follow non-traditional trajectories.

### Actions:

- ◆ Foster partnerships between 2-year and 4-year institutions, high schools and colleges.
- ◆ Encourage public-private partnerships to support STEM programs and provide hands-on research and internships experiences.

## Recommendation #5

**Create a Presidential council on STEM education with broad leadership.**

### Premise:

Transformative and sustainable change requires leadership from industry, academia, and government.

### Actions:

- ◆ Address structural barriers to change.
- ◆ Identify new resources to support STEM education.

# Engage to Excel:

Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Math



**President's Council of Advisors on Science and Technology**

<http://www.whitehouse.gov/ostp/pcast>