

Engage to Excel:

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



President's Council of Advisors on Science and Technology (PCAST)

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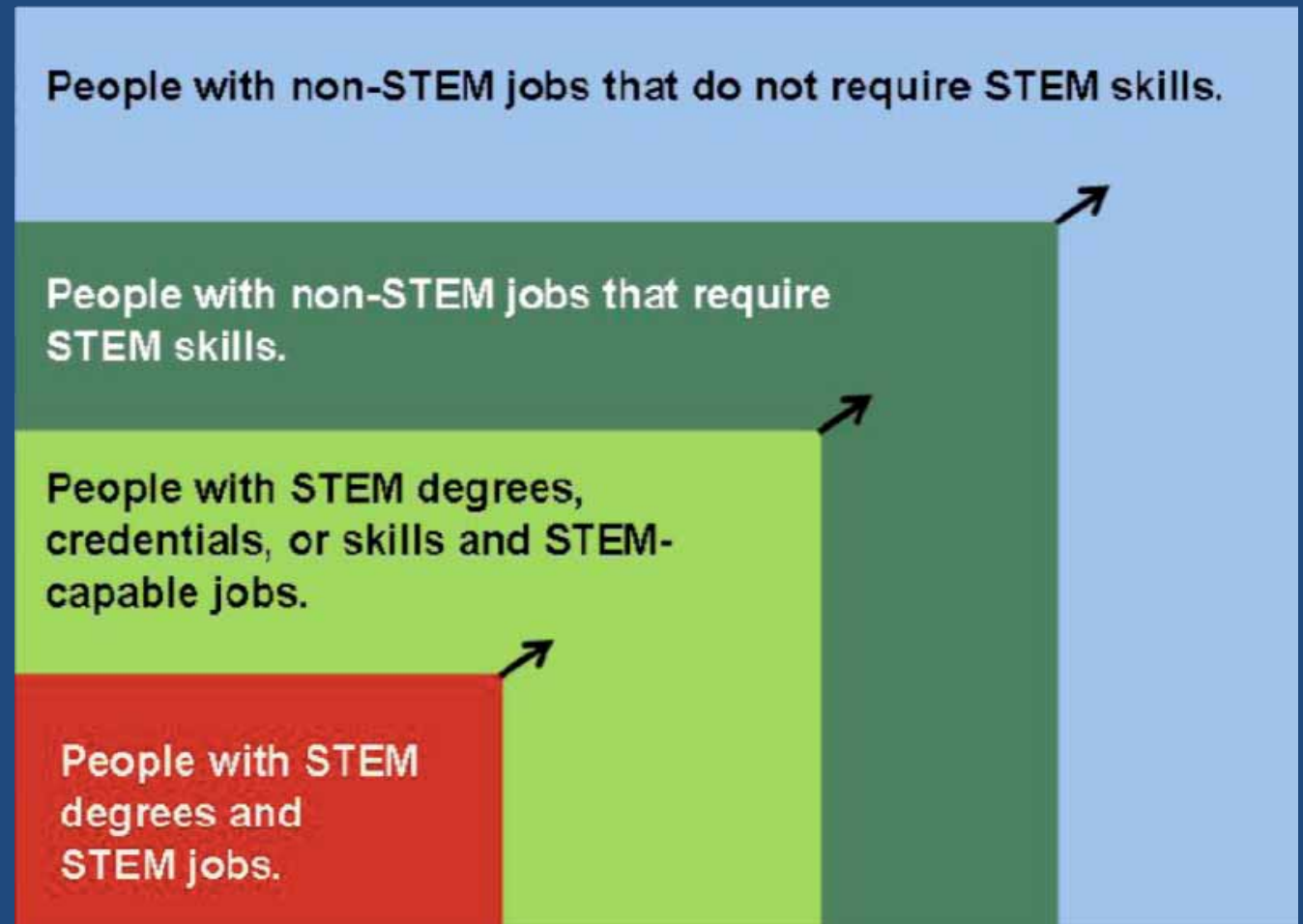
STEM Skills are Needed in a Growing Number of Occupations

Figure E-1 Total U.S. Workforce

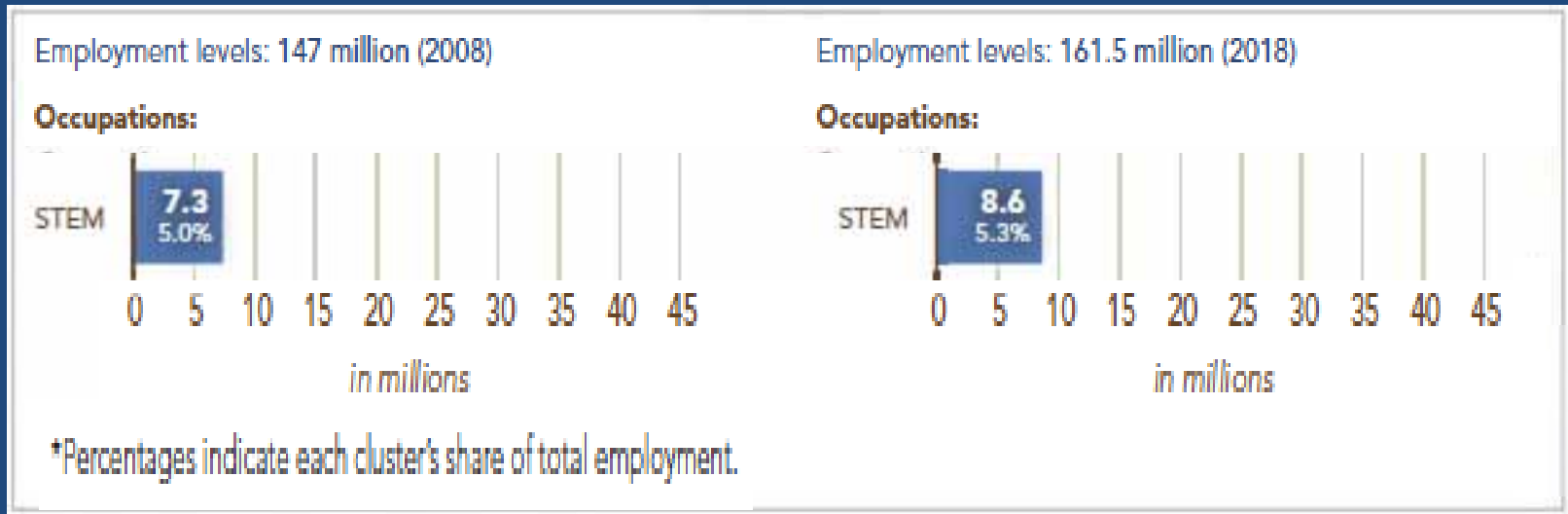
Some postsecondary education

Need additional 4-year and 2-year degrees and credentials

Need additional 4-year degrees in the next decade



Increasing Demand in STEM Occupations

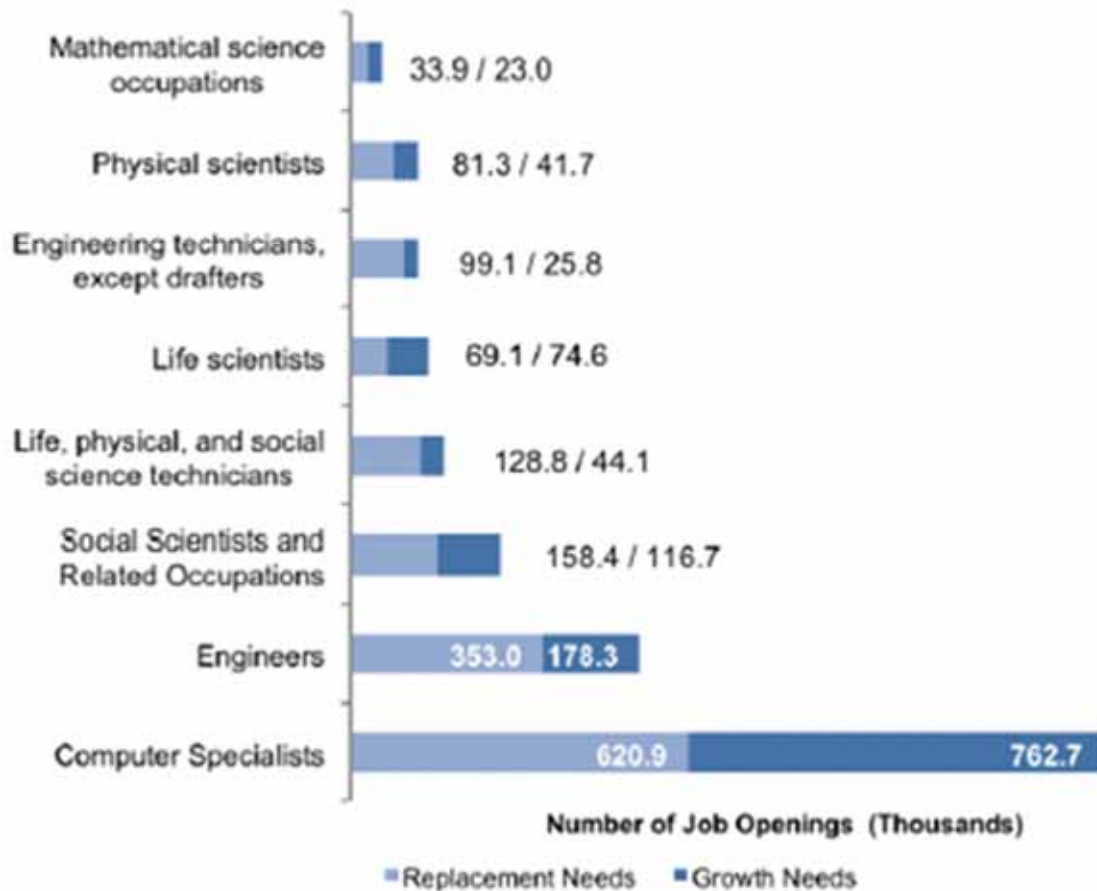


Source: Carnevale, et al. (2010). *Help Wanted: Projections of Jobs and Education Requirements through 2018*.

- Between 2008 and 2018, STEM occupations will increase from 5.0% of the jobs in the U.S to 5.3%, an increase that is equivalent to 1 million jobs.
- By 2018, 92% of STEM jobs will require at least some postsecondary education and training.

Projected Job Openings In STEM Occupations, 2008-2018

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



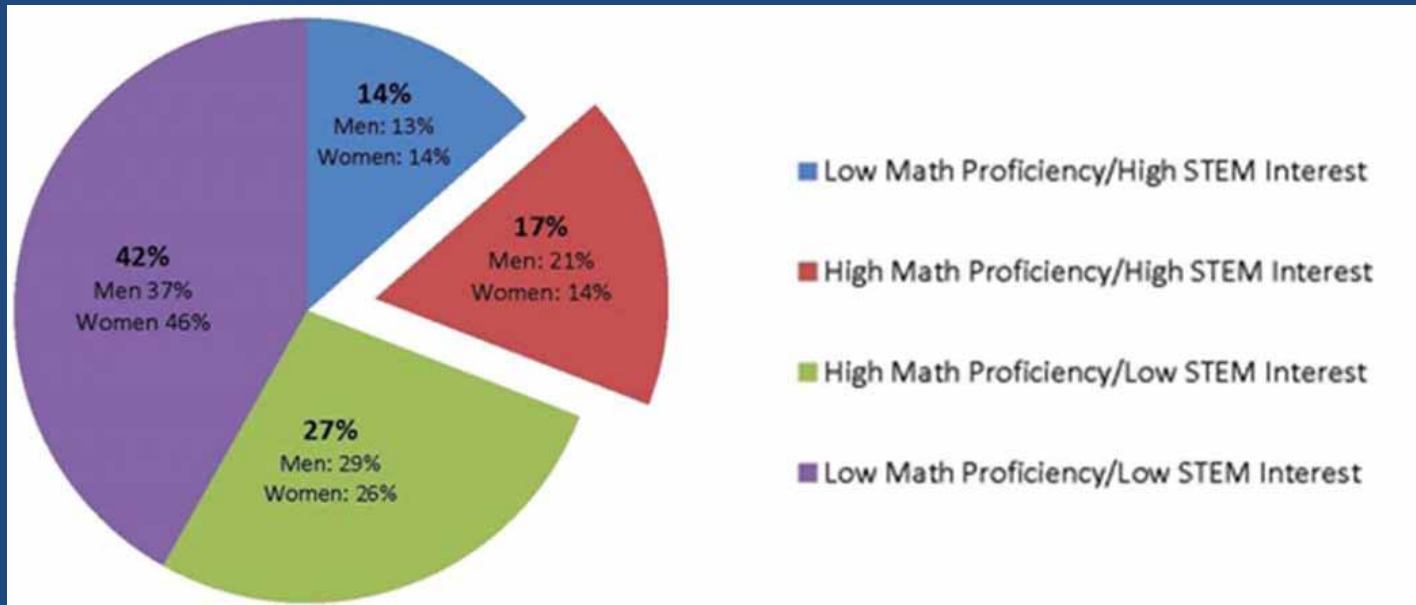
Derived from: Bureau of Labor Statistics.

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 reason for switching majors.
- Low-performing students with a high interest and aptitude in STEM face difficulty in introductory courses due to insufficient math preparation and help.
- Many students, and particularly members of groups underrepresented in STEM fields, cite an unwelcoming atmosphere from faculty teaching STEM courses as a reason for their departure.

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 rate over the next decade.

- ◆ Increasing the rate of STEM associate and bachelor degrees by 33% from 3 million to 4 million over the next decade will help satisfy the projected demand for STEM workers.
- ◆ First two years of college do not inspire students to pursue STEM degrees.
- ◆ Increasing retention from 40% to 50% would generate almost three-quarters of the one million additional STEM degrees needed in the next decade.

Engage to Excel – Findings (continued)

- ◆ Improved teaching methods, including engaging students in active learning, will increase student retention and improve performance in STEM courses.
- ◆ The current system delays hands-on research and internship experiences for STEM majors 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.

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 support replacing standard laboratory courses with discovery-based research courses.

Premise:

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

Example:

One study found that college sophomores who engaged in research projects 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 the expanding pool of students, such as adults, working students, and those with atypical backgrounds, by providing multiple pathways rather than a “pipeline” to a STEM career.

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.

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