

STEM Careers
Science Technology Engineering Math
Information for Students and Parents

Edited by

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About the Editor

Michael Erbschloe has worked for over 30 years performing analysis of the economics of information technology, public policy relating to technology, and utilizing technology in reengineering organization processes. He has authored several books on social and management issues of information technology that were published by McGraw Hill and other major publishers. He has also taught at several universities and developed technology-related curriculum. His career has focused on several interrelated areas:

- Technology strategy, analysis, and forecasting
- Teaching and curriculum development
- Writing books and articles
- Publishing and editing
- Public policy analysis and program evaluation

Books by Michael Erbschloe

Social Media Warfare: Equal Weapons for All (Auerbach Publications)

Walling Out the Insiders: Controlling Access to Improve Organizational Security (Auerbach Publications)

Physical Security for IT (Elsevier Science)

Trojans, Worms, and Spyware (Butterworth-Heinemann)

Implementing Homeland Security in Enterprise IT (Digital Press)

Guide to Disaster Recovery (Course Technology)

Socially Responsible IT Management (Digital Press)

Information Warfare: How to Survive Cyber Attacks (McGraw Hill)

The Executive's Guide to Privacy Management (McGraw Hill)

Net Privacy: A Guide to Developing & Implementing an e-business Privacy Plan (McGraw Hill)

Introduction

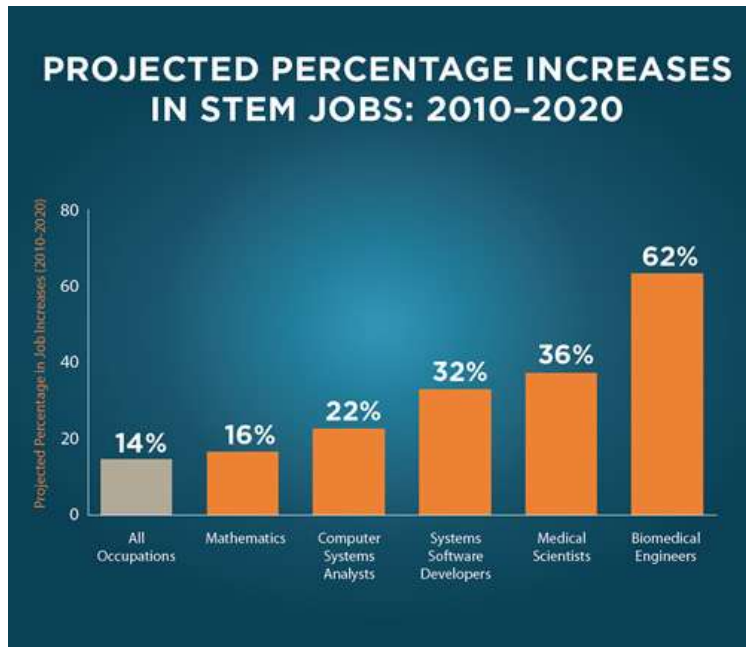
Science is more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world...

— President Barack Obama, March 23, 2015

The United States has developed as a global leader, in large part, through the genius and hard work of its scientists, engineers, and innovators. In a world that's becoming increasingly complex, where success is driven not only by what you know, but by what you can do with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. These are the types of skills that students learn by studying science, technology, engineering, and math—subjects collectively known as STEM.

Yet today, few American students pursue expertise in STEM fields—and we have an inadequate pipeline of teachers skilled in those subjects. That's why it is a high priority to increase the number of students and teachers who are proficient in these vital fields.

All young people should be prepared to think deeply and to think well so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. But, right now, not enough of our youth have access to quality STEM learning opportunities and too few students see these disciplines as springboards for their careers.



For example, we know that only 81 percent of Asian-American high school students and 71 percent of white high school students attend high schools where the full range of math and science courses are offered (Algebra I, geometry, Algebra II, calculus, biology, chemistry, and physics). The access to these courses for American Indian, Native-Alaskan, black, and Hispanic high school students are significantly worse. Children's race, zip code, or socioeconomic status should be determining their STEM fluency. We must give all children the opportunity to be college-ready and to thrive in a modern STEM economy.

We also know that only 16 percent of American high school seniors are proficient in math and interested in a STEM career. Even among those who do go on to pursue a college major in the STEM fields, only about half choose to work in a related career. The United States is falling behind internationally, ranking 29th in math and 22nd in science among industrialized nations. What's more, a recent survey revealed that only 29 percent of Americans rated this country's K-

12 education in STEM subjects as above average or the best in the world. In our competitive global economy, this situation is unacceptable.

President Obama articulated a clear priority for STEM education: within a decade, American students must "move from the middle to the top of the pack in science and math." The Obama Administration was also working toward the goal of fairness between places, where an equitable distribution of quality STEM learning opportunities and talented teachers can ensure that all students have the chance to study and be inspired by science, technology, engineering, and math—and have the chance to reach their full potential.

Specifically, President Obama called on the nation to develop, recruit, and retain 100,000 excellent STEM teachers over the next 10 years. He also has asked colleges and universities to graduate an additional 1 million students with STEM majors.

These improvements in STEM education will happen only if Hispanics, African-Americans, and other underrepresented groups in the STEM fields—including women, people with disabilities, and first-generation Americans—robustly engage and are supported in learning and teaching in these areas.

It is not clear what the new Administration will do because of its anti-science attitude.

Link: <https://www.ed.gov/stem>

The STEM Plan in Brief

The Committee on STEM Education (CoSTEM), comprised of 13 agencies—including all of the mission-science agencies and the Department of Education—are facilitating a cohesive national strategy, with new and repurposed funds, to increase the impact of federal investments in five areas: 1.) improving STEM instruction in preschool through 12th grade; 2.) increasing and sustaining public and youth engagement with STEM; 3.) improving the STEM experience for undergraduate students; 4.) better serving groups historically underrepresented in STEM fields; and 5.) designing graduate education for tomorrow's STEM workforce

Coordinated efforts to improve STEM education are outlined in the federal, 5-year Strategic Plan for STEM Education and concentrate on improving the delivery, impact, and visibility of STEM efforts. Additionally, the Department of Education, the National Science Foundation, and the Smithsonian Institution are leading efforts to improve outcomes for traditionally underrepresented groups.

The health and longevity of our Nation's, citizenry, economy and environmental resources depend in large part on the acceleration of scientific and technological innovations, such as those that improve health care, inspire new industries, protect the environment, and safeguard us from harm. Maintaining America's historical preeminence in the STEM fields will require a concerted and inclusive effort to ensure that the STEM workforce is equipped with the skills and training needed to excel in these fields. During President Obama's first term, the Administration used multiple strategies to make progress on improving STEM education:

- Making STEM a priority in more of the Administration's education efforts. The first round of the Department of Education's \$4.3 billion Race to the Top competition offered states a competitive preference priority on developing comprehensive strategies to improve achievement and provide rigorous curricula in STEM subjects; partner with local STEM institutions, businesses, and museums; and broaden participation of women and girls and other groups underrepresented in STEM fields. Other examples include STEM priorities in the Department of Education's Invest in Innovation and Supporting Effective Educator Development programs. Prioritizing STEM in existing programs at the Department of Education has the advantage of leveraging existing resources and embedding STEM within our overall education reform efforts.
- Setting ambitious but achievable goals and challenging the private sector. President Obama announced the goal to prepare 100,000 excellent STEM teachers over the next decade in his 2011 State of the Union Address. Answering this call to action, over 150 organizations led by the Carnegie Corporation of New York formed a coalition called 100Kin10. Members of the coalition have made over 150 commitments to support STEM-teacher preparation and have raised over \$30 million for this effort. In mid-March, the Howard Hughes Medical Institute announced a \$22.5M investment to support expansion of the successful UTeach program in support of this goal. Additional examples of this all-hands-on-deck approach to challenging companies, foundations, non-profits, universities, and skilled volunteers include Change the Equation, US2020, and the scaling up and expanding an AP program for children in military families.

- The first-ever White House Science Fair took place in late 2010 and the second in 2012, fulfilling a commitment made at the launch of the Educate to Innovate campaign to directly use the pulpit to inspire more boys and girls to excel in mathematics and science. A call to action was issued to the 200,000 Federal scientists and engineers to volunteer in their local communities and think of creative ways to engage students in STEM subjects. Improving STEM education will continue to be a high priority in President Obama's second term. Guided by the aims articulated in the February 2012 Progress Report and subsequent pre-final drafts of this Strategic Plan—as well by the President's desire to re-organize STEM-education programs for greater coherence, efficiency, ease of evaluation, and focus on his highest priorities—the Executive Office of the President recommended, and the President accepted, a FY2014 Budget Request for STEM education that would increase the total investment in STEM-ed programs by 6 percent over the 2012 appropriated level.
- The Department of Education was designated to play an increased role in improving P-12 STEM instruction by supporting partnerships among school districts and universities, science agencies, businesses, and other community partners to transform teaching and learning. It also invested an additional \$80 million in support of the 100,000 new STEM-ed teachers goal and \$35 million for the launch of a pilot STEM-ed Master Teacher Corps, as well as in creation of new STEM Innovation Networks to better connect school districts with local, regional, and national STEM resources. The Department also collaborated with all of the CoSTEM agencies to ensure that Federal scientific assets were utilized in the improvement of P-12 STEM education.

- The National Science Foundation increased its focus on improving the delivery of undergraduate STEM teaching and learning through evidence-based reforms, including a new \$123 million program aimed at improving retention of undergraduates in STEM fields. NSF also received \$325 million to expand and enhance its graduate fellowship programs, including creation of a new National Graduate Research Fellowship, using a common infrastructure at NSF to reach more students and offer a set of opportunities that address national needs and mission critical workforce needs for the CoSTEM agencies.
- The Smithsonian Institution received \$25 million to focus on improving the reach of informal STEM education by ensuring that materials are aligned to what students are learning in the classroom. The Smithsonian worked with NSF, ED, the other CoSTEM agencies including the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior (DOI), U.S. Department of Agriculture (USDA), National Institutes of Health (NIH), and other science partners to harness their unique expertise and resources to disseminate relevant, evidence-based materials and curricula, on-line resources, and delivery and dissemination mechanisms to reach more teachers and students both inside and outside the classroom.

All of the CoSTEM agencies continued to be key players in the re-organized effort. All of these agencies depend upon the cultivation of a talented and well-trained workforce in order to meet their STEM-related missions, and all of them play a critical role in inspiring and training the next generation of STEM workers. Whether it be through direct support, provision of expertise and

content, mobilization of talented STEM role models and mentors, or by exposing students to real-world learning opportunities at Federal STEM facilities, these agencies inspire and inform future scientists, engineers, innovators, and explorers.

The Strategic Plan complements the important steps already taken. The Plan begins by providing an overview of the importance of STEM education to American scientific discovery and innovation, the need to better prepare students for today's jobs and those of the future, and the importance of a STEM-literate society and also describes the current state of Federal STEM education efforts. The document then presents five priority STEM education investment areas where a coordinated Federal strategy can be developed, over five years, designed to lead to major improvements in key areas. This increased coordination is expected to bring significant gains in efficiency and coverage.

Also included in this plan are initial implementation roadmaps in each of the priority STEM education investment areas, proposing potential short-, medium-, and long-term objectives and strategies that might help Federal agencies achieve the outlined goals (section 5). Additionally, throughout the document, the plan highlights (1) key outcomes for the Nation and ways Federal agencies can contribute, (2) areas where agencies will play lead roles, thereby increasing accountability, (3) methods to build and share evidence, and (4) approaches for decreasing fragmentation. The Strategic Plan will allow us to better achieve a number of inter-related goals:

- It will help Federal STEM efforts reach more students and more teachers more effectively by reorienting Federal policy to meet the needs of those who are delivering STEM education: school districts, States, and colleges, and universities;
- It will help in reorganizing efforts and redirecting resources around more clearly defined priorities, with accountable lead agencies;
- It will enable rigorous evaluation and evidence-building strategies for Federal STEM-education programs;
- It will increase the impact of Federal investments in important areas such as graduate education by expanding resources for a more limited number of programs, while recognizing shortages in key disciplines and professions; and,
- It will provide additional resources to meet specific national goals, such as preparing and recruiting 100,000 high-quality K-12 STEM teachers, recognizing and rewarding excellence in STEM instruction, strengthening the infrastructure for supporting STEM instruction and engagement, increasing the number of undergraduates with a STEM degree by one million over the next decade, and broadening participation in STEM fields by underrepresented groups.

The STEM Strategic Plan sets out ambitious national goals to drive Federal investment in five¹² priority STEM education investment areas:

- Improve STEM Instruction: Prepare 100,000 excellent new K-12 STEM teachers by 2020, and support the existing STEM teacher workforce;
- Increase and Sustain Youth and Public Engagement in STEM: Support a 50 percent increase in the number of U.S. youth who have an authentic STEM experience each year prior to completing high school;
- Enhance STEM Experience of Undergraduate Students: Graduate one million additional students with degrees in STEM fields over the next 10 years;
- Better Serve Groups Historically Under-represented in STEM Fields: Increase the number of students from groups that have been underrepresented in STEM fields that graduate with STEM degrees in the next 10 years and improve women's participation in areas of STEM where they are significantly underrepresented; and,
- Design Graduate Education for Tomorrow's STEM Workforce: Provide graduate-trained STEM professionals with basic and applied research expertise, options to acquire specialized skills in areas of national importance, mission-critical workforce needs for the CoSTEM agencies, and ancillary skills needed for success in a broad range of careers.

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) advises the President on the effects of science and technology on domestic and international affairs. The office serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the Federal Government. OSTP leads an interagency effort to develop and implement sound science and technology policies and budgets. The office works with the private sector to ensure Federal investments in science and technology contribute to economic prosperity, environmental quality, and national security.

For more information, visit <http://www.ostp.gov>.

About the National Science and Technology Council

The National Science and Technology Council (NSTC) was established by Executive Order on November 23, 1993. This Cabinet-level council is the principal body within the executive branch that coordinates science and technology policy across the diverse entities that make up the Federal research and development enterprise. Chaired by the President, the membership of the NSTC consists of the Vice President, the Director of the Office of Science and Technology Policy, Cabinet Secretaries and Agency Heads with significant science and technology responsibilities, and other White House officials.

The NSTC is organized into five primary committees: Science, Technology, Engineering, and Mathematics (STEM) Education; Science; Technology; Environment, Natural Resources and Sustainability; and Homeland and National Security. Each of these committees oversees subgroups focused on different aspects of science and technology. One of the NSTC's primary

objectives is to establish clear national goals for Federal science and technology investments in an array of areas that span virtually all the mission areas of the executive branch. The Council prepares coordinated interagency research and development strategies to form investment packages that are aimed at achieving multiple national goals. For additional information concerning the work of the National Science and Technology Council, please visit the NSTC website.

About the Committee on Science, Technology, Engineering, and Mathematics (STEM) Education

The NSTC Committee on STEM Education (CoSTEM) coordinates Federal programs and activities in support of STEM education pursuant to the requirements of Sec. 101 of the America COMPETES Reauthorization Act (2010). CoSTEM addresses education and workforce policy issues; research and development efforts that focus on STEM education at the PreK-12, undergraduate, graduate, and lifelong learning levels; and current and projected STEM workforce needs, trends, and issues. CoSTEM performs three functions: review and assessment of Federal STEM education activities and programs; with the Office of Management and Budget, coordination of STEM education activities and programs across Federal agencies, and; development and implementation of a Federal STEM education 5-year Strategic Plan through the participating agencies to be updated every 5 years.

About the Federal STEM Education 5-Year Strategic Plan

The America COMPETES Reauthorization Act (2010) directs OSTP to create an interagency committee under the NSTC to develop a Federal STEM education 5-year strategic plan. In response to the Act, CoSTEM chartered the Federal Coordination in STEM Education (FC-

STEM) Task Force to develop the Federal STEM Education 5-Year Strategic Plan and to prepare this report with CoSTEM oversight. The FC-STEM includes members from the 12 Federal agencies represented on CoSTEM, and the Smithsonian Institution. Representatives from each of the agencies represented on CoSTEM made significant contributions to the plan. CoSTEM chartered the NSTC Fast-Track Action Committee on Federal Investments in STEM (FISTEM) to design and conduct an inventory of current Federal investments in STEM education. FI-STEM included members from the 12 Federal agencies represented on CoSTEM. The Federal Science, Technology, Engineering and Mathematics (STEM) Education Portfolio⁶, released in December 2011, provided the most-detailed overview of Federal STEM education activities to date, and guided the development of the Strategic Plan.

Link: https://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

Women in STEM

Supporting women STEM students and researchers is not only an essential part of America's strategy to out-innovate, out-educate, and out-build the rest of the world; it is also important to women themselves. Women in STEM jobs earn 33 percent more than those in non-STEM occupations and experience a smaller wage gap relative to men. And STEM careers offer women the opportunity to engage in some of the most exciting realms of discovery and technological innovation. Increasing opportunities for women in these fields is an important step towards realizing greater economic success and equality for women across the board.

The Office of Science and Technology Policy, in collaboration with the White House Council on Women and Girls, is dedicated to increasing the participation of women and girls — as well as other underrepresented groups — in the fields of science, technology, engineering, and mathematics by increasing the engagement of girls with STEM subjects in formal and informal environments, encouraging mentoring to support women throughout their academic and professional experiences, and supporting efforts to retain women in the STEM workforce.

STEM Depiction Opportunities: Inspiring a diverse generation of science, technology, engineering, and math (STEM) innovators.

Biases are destructive for those who apply them as well as those being judged based on stereotypes. Various experiments suggest that those who judge others through a biased lens can miss the chance to hire superior employees or appreciate the true talents of others, including their own children. For instance, parents rate the math abilities of their daughters lower than parents of boys with identical math performance in school. For example, college faculty are less likely to

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