STEM an Opportunity for Improving Maritime Education

2014 Maritime Education Summit
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My Background

Professor of Engineering at Maine Maritime Academy appointed in 1986

USCG certified Chief Engineer Steam/Motor/Gas Turbine/unlimited

Registered Professional Engineer (State of Maine)

First Class Stationary Engineer (State of Maine)

Co-Author “Fundamentals of HVACR”

AHRI Air-Conditioning, Heating, and Refrigeration Institute

Fundamentals of HVACR

Carter Stanfield and David Skaves

Second Edition

STEM

Science

Technology

Engineering

Mathematics

What Is STEM?

Whether it is visas for foreign workers, scholarships for STEM majors, or funding for scientific research, the question of what we mean by the term "STEM" is central to the federal policy conversation.

Some federal agencies, such as the NSF, use a broader definition of STEM that includes psychology and the social sciences (e.g., political science, economics) as well as the so-called core sciences and engineering (e.g., physics, chemistry, mathematics).

Others, including the Department of Homeland Security (DHS), U.S. Immigration and Customs Enforcement (ICE), use a narrower definition that generally excludes social sciences and focuses on mathematics, chemistry, physics, computer and information sciences, and engineering.

What Is STEM?

Some analysts argue that field-specific definitions such as these are too static and that definitions of STEM should focus on "an assemblage of practices and processes that transcend disciplinary lines and from which knowledge and learning of a particular kind emerges."

The Value of STEM Skills in the 21st Century Economy

The United States has traditionally produced the world's top research scientists and engineers, leading to breakthrough advances in science and technology.

The late 20th century ushered in vast improvements in computer and information technologies, as well as biomedical technologies. These innovations are changing the way we live, work, and play in marvelous and unforeseen ways.

This technological innovation has been a primary driver of U.S. economic growth, with studies showing that half or more of economic growth in the United States over the past fifty years is attributable to improved productivity resulting from innovation.

Fully capturing the economic benefits of existing and undiscovered technologies will require a steady stream of Americans equipped with science, technology, engineering, and math (STEM) knowledge, skills, and abilities.

STEM in the Maritime Industry

Maritime Administration Promotes Opportunities in Maritime Industry, Importance of STEM Education for Baltimore-Area Students Touring Modern Cargo Ship

MARAD 02-12
Wednesday, February 29, 2012

BALTIMORE – Maritime Administrator David Matsuda hosted approximately 125 area high school students onboard the Baltimore-based federal merchant ship, the *Cape Washington*, to highlight maritime career opportunities and the importance of a strong Science, Technology, Engineering and Mathematic (STEM) education in the field today. Students from Baltimore- and Washington, D.C.-area high schools toured the ship's bridge, engine room, decks, and cargo holds to learn about the industry and the many contributions made by African Americans in celebration of Black History Month.

STEM in the Maritime Industry

The U.S. focus has primarily been left to the k-12 grades to develop general STEM programs not necessarily with any specific maritime focus.

The U.K. is more active in aggressively recruiting students.

UK Maritime Industry

Introduction – Making waves

Although very few people are aware of it, over **90% of the UK's visible trade moves by sea.** Worldwide, the shipping industry continues to expand to meet the demands of globalisation – in the last 40 years the world's population has doubled yet maritime trade has quadrupled. Ships carry 77% of world trade and seaborne trade is forecast to almost double over the next 15 years. **With increasing world trade and growing maritime leisure interests, the range of supporting maritime activities is always growing.** Making Waves

The importance of STEM subjects

The maritime industry particularly looks for applicants with STEM-related qualifications to enable recruits to keep up with the ever increasing technological advances, or to have a sound understanding of mathematics for the marine financial area.

Representative examples are:-

a) Deck Officer

Responsible for controlling navigation and communications using the latest technological systems, including satellite communication with ships, ports and offices worldwide. Technical and mathematical ability is important, together with good team working, communication skills and self-reliance.

b) Engineer Officer

Operating and maintaining all the mechanical and electrical equipment throughout the ship – at sea, if equipment goes wrong you can’t just pull in to the nearest garage! A real interest in mechanical, electrical and electronic systems is important, together with a willingness to learn about new technology and adapt skills to its use.

c) Marine Contracting

Skills in engineering, science, IT or mathematics could provide the passport to opportunities such as constructing the next generation of offshore installations for the international oil and gas industry; working in a team operating technically advanced offshore construction, installation and support vessels or remotely operated vehicles; charting the sea and oceans; laying telecommunications cables; or playing a vital role as a life support technician to an offshore diving team.

Websites and links to Classroom Resources

Sea Vision UK – www.seavisionuk.org - Website which highlights what the wider maritime sector offers in terms of work, leisure and lifestyle opportunities

Sea Vision UK – www.seavisionuk.org/education/education_resources.cfm
Access to an exciting range of maritime-themed classroom materials

Sea Vision UK –
http://www.seavisionuk.org/_db/_documents/Maritime_08_20081106053755.pdf
The direct link to Maritime, the Sea Vision guide to careers in the maritime sector

Careers at Sea – www.careersatsea.org –
A website providing information about career opportunities in the Merchant Navy. Includes everything from different types of ships, training involved, sponsoring companies and colleges offering appropriate courses. Also includes details of the Careers at Sea Ambassadors, who are volunteers from the shipping industry who visit schools/groups and give a lively, informative presentation about the Merchant Navy

SEMTA – www.semta.org.uk – Sector Skills Council for Science, Engineering and Manufacturing Technologies including the Marine sector

The International Marine Contractors Association (IMCA) – www.imca-int.com - Roles and entry requirements within the maritime sector, including case studies

The Maritime Industry Foundation Knowledge Centre – www.maritimeindustryfoundation.com/index.htm - Includes a video Careers in international shipping and an interactive Kidzone

The Maritime Skills Alliance – www.maritimeskills.org – An alliance of maritime industries which focuses on the skills needs of the sector. Includes a Career Pathways link

The Marine Society & Sea Cadets – www.ms-sc.org –Help to promote maritime careers, with the Sea Cadets having 400 units in the UK with 15,000 young people learning nautical and life skills

Institute of Marine Engineering, Science and Technology –
www.imarest.org/Membership/Careers.aspx –
Includes a downloadable booklet Sea Your Future – A Guide to Marine Careers

About the Institute of Engineering, Science and Technology (IMarEST)

The IMarEST is an international membership body and learned society for all marine professionals. The IMarEST (a registered charity) is the first Institute to bring together marine engineers, scientists and technologists into one international multi-disciplinary professional body. It is the largest marine organisation of its kind with a worldwide membership of around 15,000 based in over 100 countries.

IMarEST, the international professional body and learned society for all marine professionals, and the first institute to bring together marine engineers, scientists and technologies into one international multi-disciplinary professional body, found that its 427 female members comprised just over 3% of the total IMarEST membership. Only 1.5% of members who are registered as Chartered Engineer (CEng) through the IMarEST are women, however around 35% of those registered as Chartered Scientist (CSi) through the IMarEST are women.

The Institute of Marine Engineering, Science and Technology (IMarEST) has submitted written evidence to the House of Commons Science and Technology Select Committee inquiry into Women in STEM (science, technology, engineering and mathematics) careers which has now been published on the House of Commons website, with a link from the IMarEST websitehttp://www.imarest.org/OurVoice/ConsultingOurMembers.aspx .

Innovative approaches to promoting maritime careers

- John Hepburn

John Hepburn - Promoting_Maritime_Careers.ppt

MARITIME PLYMOUTH

PROMARC
PROMOTING MARINE RESEARCH CAREERS

SEVENTH FRAMEWORK PROGRAMME

STEM

Science

Technology

Greek: Systematic treatment of an art or craft.

Engineering

The application of scientific knowledge especially to industrial or commercial objectives.

Mathematics

A capability given by the practical Application of knowledge.

Lately, technology has come to mean something different, in one respect the term has come to mean something narrower.

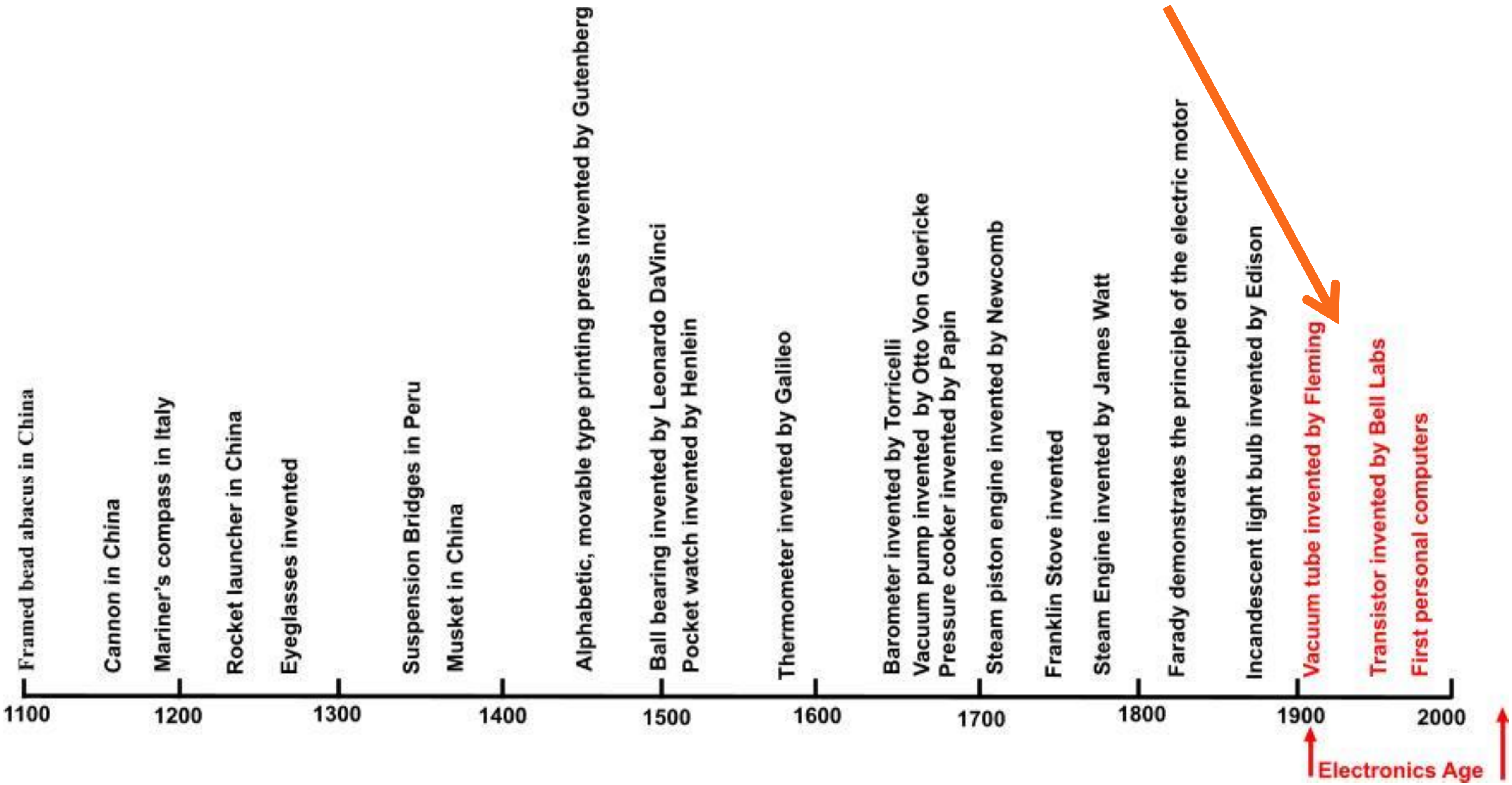
- Technology is the rational process of creating means to order and transform matter, energy, and information to realize certain valued ends.
- Technology is the set of means (tools devices, systems, methods, procedures) created by the technological process.

Technological objects range from toothbrushes to transportation systems.

Ken Funk: *Technology and Christian Values*, September 1999 Oregon State

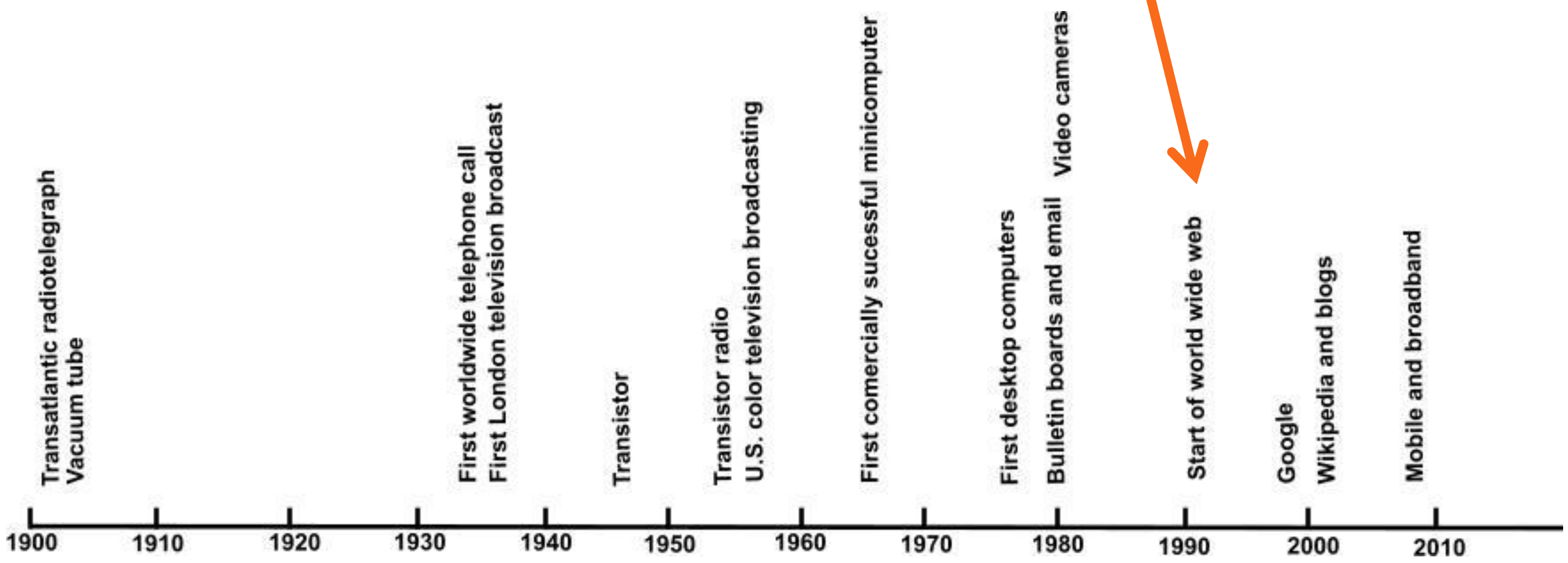
Technology Timeline

SO MUCH HAS HAPPENED SO QUICKLY

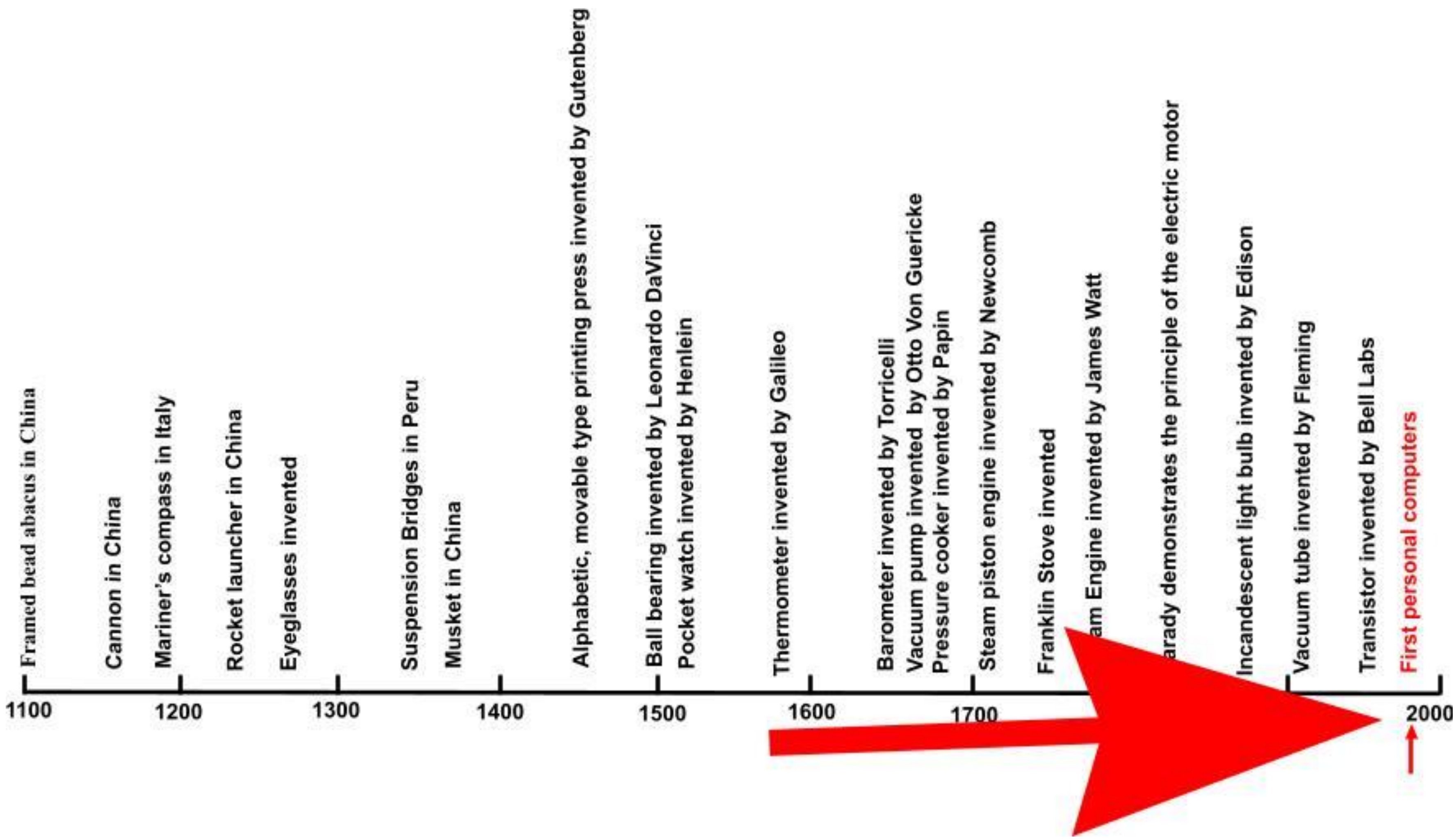


Electronics Timeline

COMPUTER APPLICATIONS AND THE INTERNET HAVE ONLY JUST BEGUN



Personal Computer Timeline



By the Year 2035

- <u>One-third</u> of the jobs that exist today will be EXTINCT

- <u>One-third</u> of the jobs that will exist then HAVEN'T EVEN BEEN THOUGHT OF YET

A goal should be to keep as many options open for your students as possible.

- Today’s students are generally proficient with computers and current technology.
- However many teachers complain that today’s students have no practical experience and have to be shown almost everything.

Many American high school graduates are unprepared for the work world or college

- Fewer than 25 percent of graduates feel they were significantly challenged in high school (according to Achieve Inc.'s recent survey).
- Two in five recent high school graduates say there are gaps between the education they received in high school and the skills, abilities and work habits that are expected of them in college and work.

Is the educational system emphasizing the wrong values?

- More than 20 percent of four-year college graduates are not able to compare ticket prices or calculate the cost of a sandwich, according to a new study published by the National Survey of America's College Students.
- Saundra McGuire, director of Louisiana State University's academic success center, said classes are more focused on memorization and regurgitation than understanding the underlying concepts of the lessons.

U.S. Congress Joint Economic Committee

STEM Education:
Preparing for the Jobs of the Future

A Report by the Joint Economic Committee Chairman's Staff
Senator Bob Casey, Chairman

April 2012

Order Code RL33434

CRS Report for Congress

Science, Technology, Engineering, and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Action

Updated March 21, 2008

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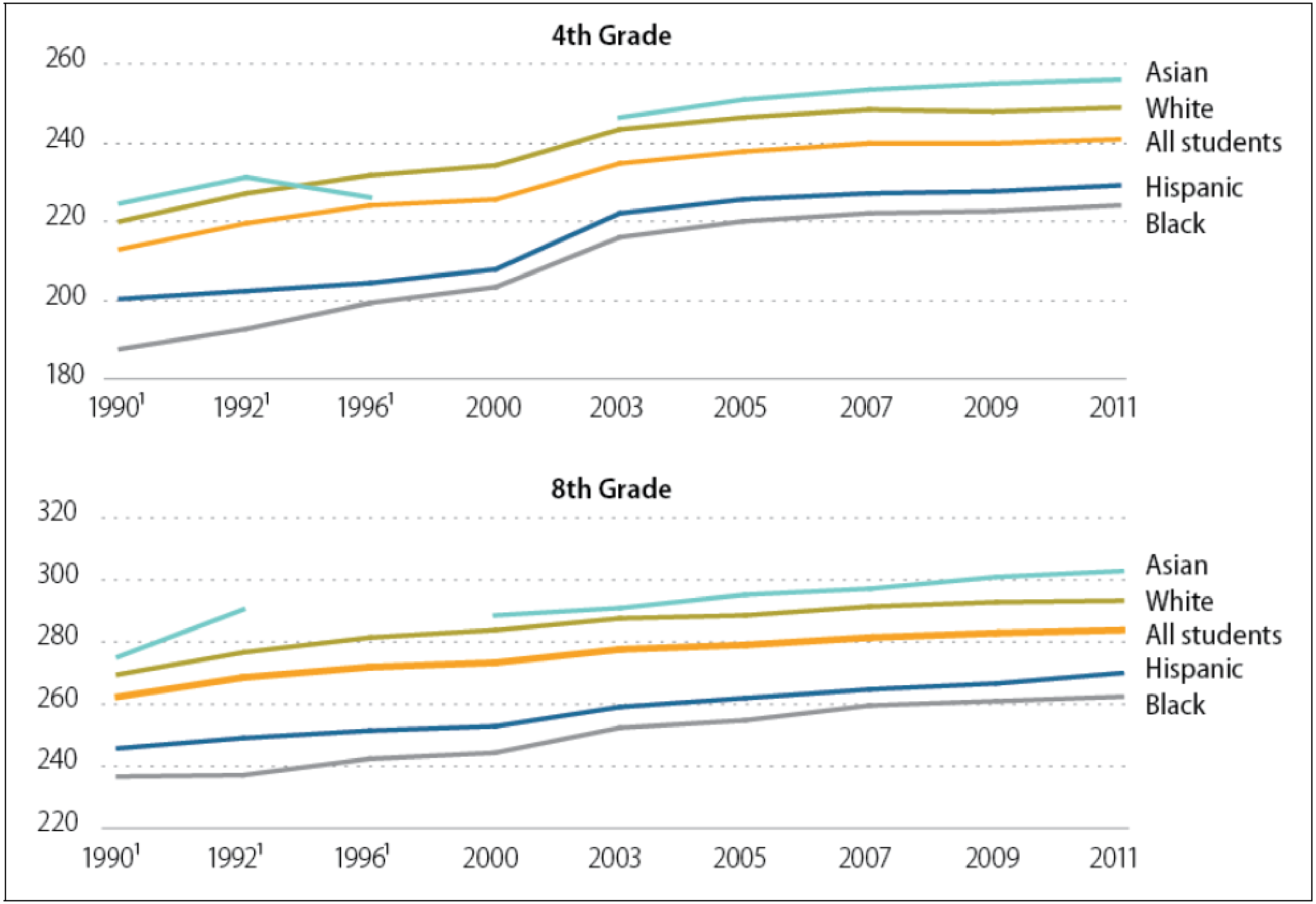
Specialist in Education Policy
Domestic Social Policy Division

Prepared for Members and Committees of Congress

Congressional Research Service

Figure 5. Trends in 4th and 8th Grade Average Mathematics Scores

Main NAEP, 1990 to 2011



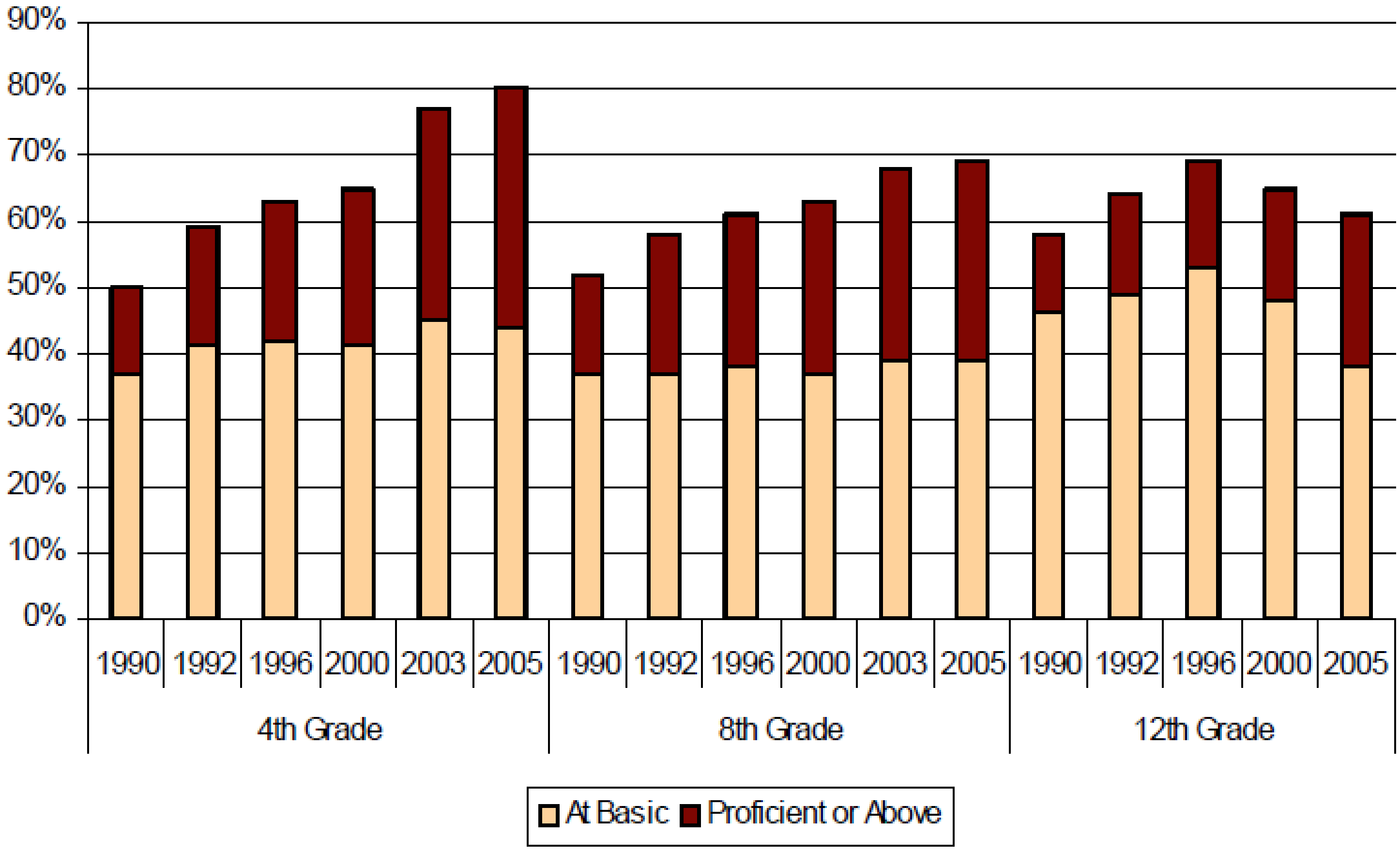
Source: CRS analysis of data from U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress, various years.

Notes: The NAEP Mathematics scale ranges from 0 to 500. Some apparent differences between estimates may not be statistically significant. Time series are broken for years in which sample size was insufficient.

[1]Accommodations for students with disabilities were not permitted prior to 1996.

National Assessment of Educational Progress (NAEP)

Figure 1. NAEP Math Scores, Selected Years: 1990-2005



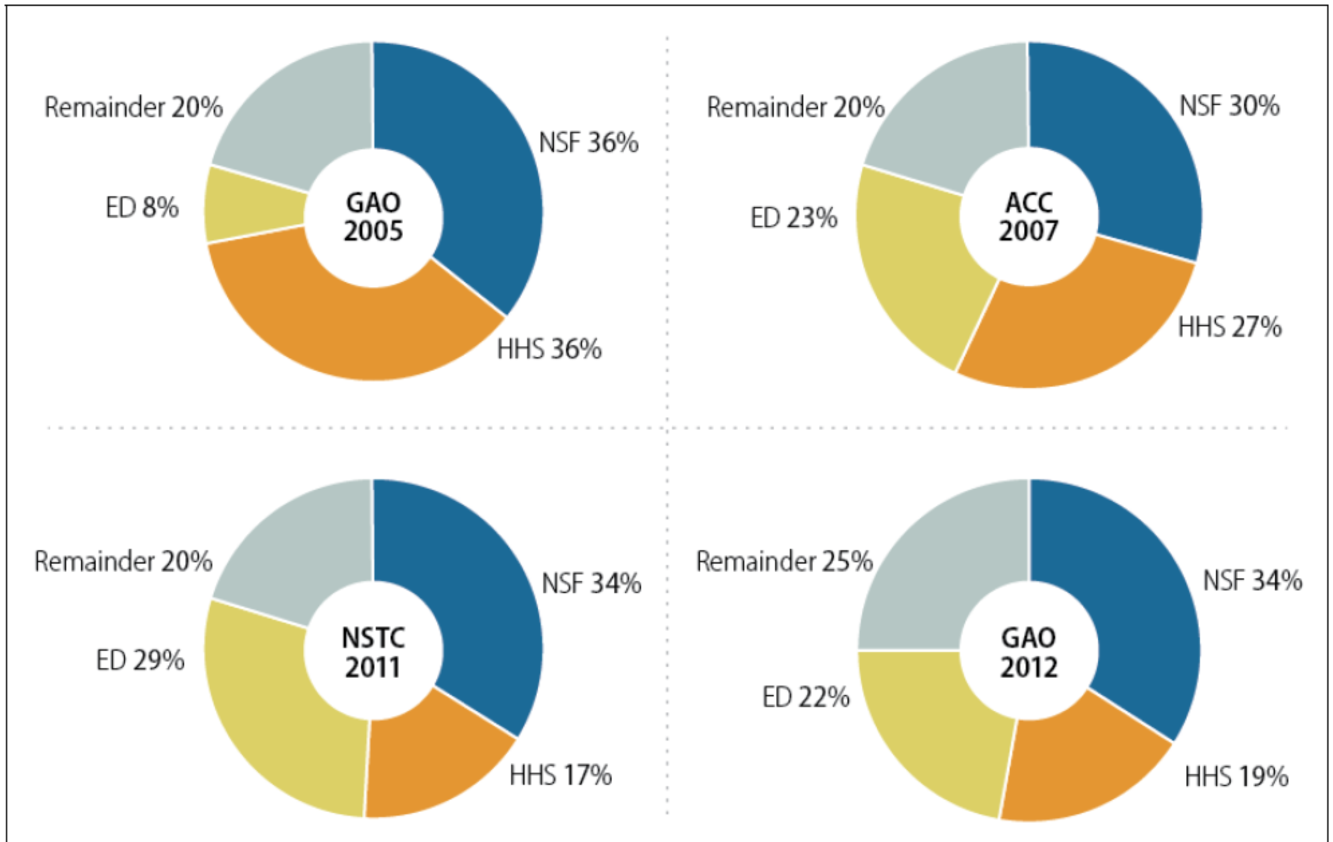
Source: U.S. Department of Education, National Center for Education Statistics, *The Nation's Report Card*, various years.

Federal Programs by Agency

Each of the four congressionally mandated inventories of the federal STEM education effort found that virtually all federal agencies administer STEM education programs. However, three agencies account for about four-fifths of federal funding for STEM education: the National Science Foundation (NSF) and the Departments of Education (ED) and Health and Human Services (HHS).

As **Figure 1** shows, all four inventories found that about one-third of the federal investment in STEM education is appropriated to the NSF.

Figure 1. Federal STEM Education Funding, by Agency



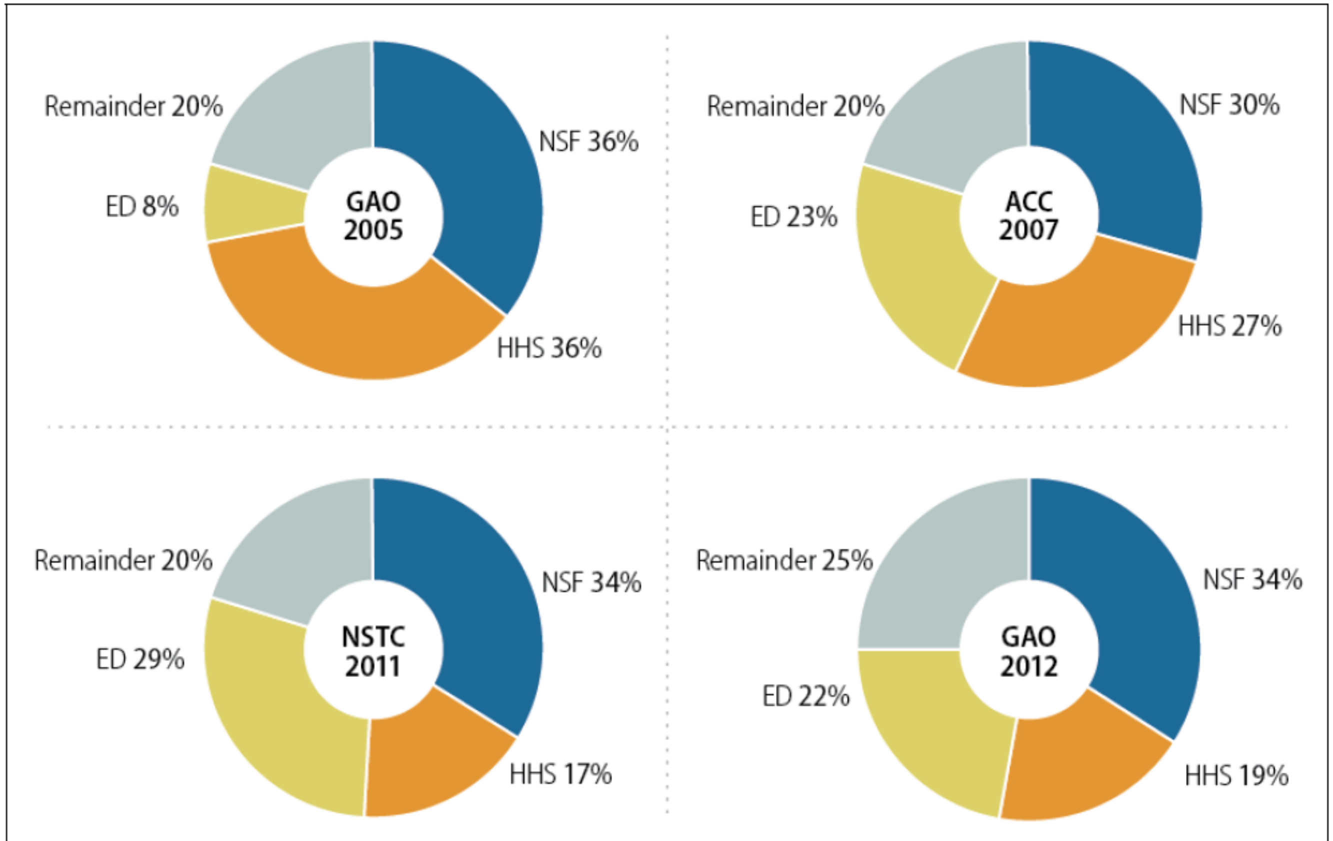
Source: CRS calculation based on GAO-2005, Figure 1; ACC-2007, Page 21; NSTC-2011, Figure 11; and GAO-2012, Appendix 2.

[11] The ACC was created by the Deficit Reduction Act of 2005 (P.L. 109-171) and charged with conducting a yearlong study to identify all federal STEM education programs. U.S. Department of Education, *Report of the Academic Competitiveness Council*, May 2007.

[12] President Bill Clinton established the NSTC by Executive Order 12881 on November 23, 1993. The NSTC aims to coordinate science and technology policy across the federal government. For more information on the NSTC, see CRS Report RL34736, *The President's Office of Science and Technology Policy (OSTP): Issues for Congress*, by John F. Sargent Jr. and Dana A. Shea.

[13] U.S. Government Accountability Office, *Federal Science, Technology, Engineering, and Mathematics Programs and Related Trends*, GAO-06-114, Washington, DC, October 2005.

Figure 1. Federal STEM Education Funding, by Agency



Source: CRS calculation based on GAO-2005, Figure 1; ACC-2007, Page 21; NSTC-2011, Figure 11; and GAO-2012, Appendix 2.

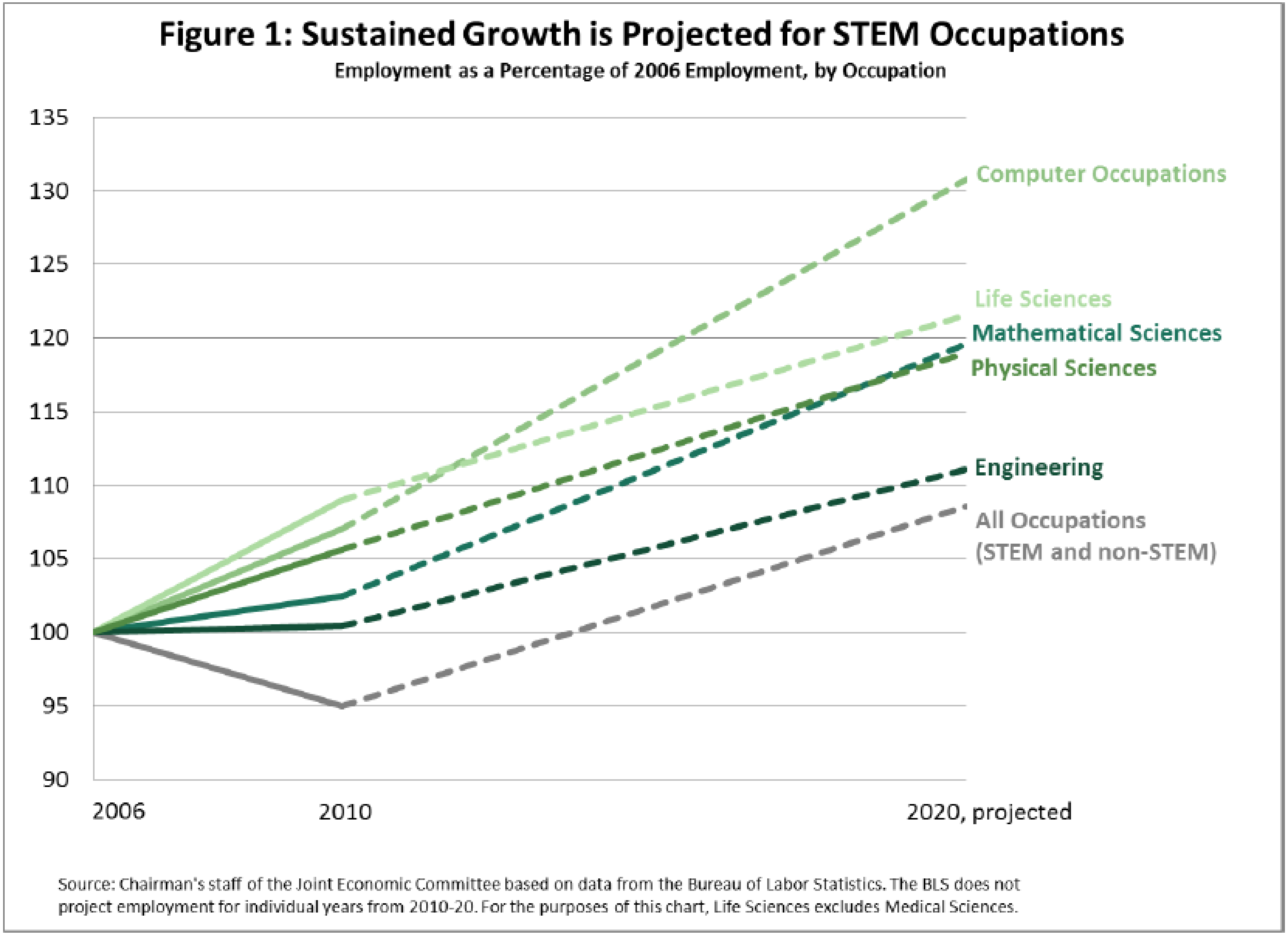
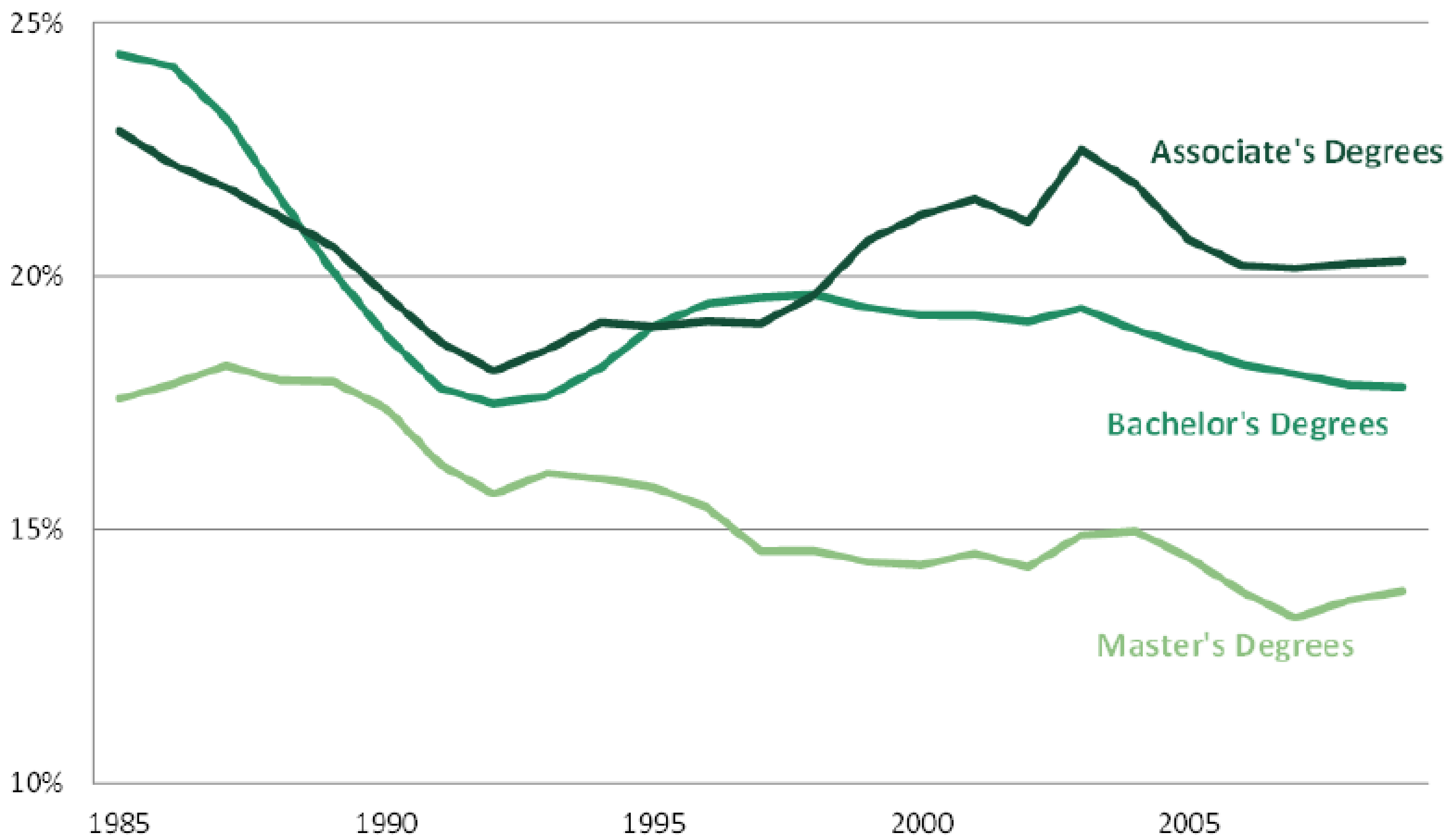


Figure 1: Sustained Growth is Projected for STEM Occupations
Employment as a Percentage of 2006 Employment, by Occupation
135
130
125
120
115
110
105
100
95
90
2006
2010
2020, projected
Computer Occupations
Life Sciences
Mathematical Sciences
Physical Sciences
Engineering
All Occupations
(STEM and non-STEM)
Source: Chairman's staff of the Joint Economic Committee based on data from the Bureau of Labor Statistics. The BLS does not project employment for individual years from 2010-20. For the purposes of this chart, Life Sciences excludes Medical Sciences.

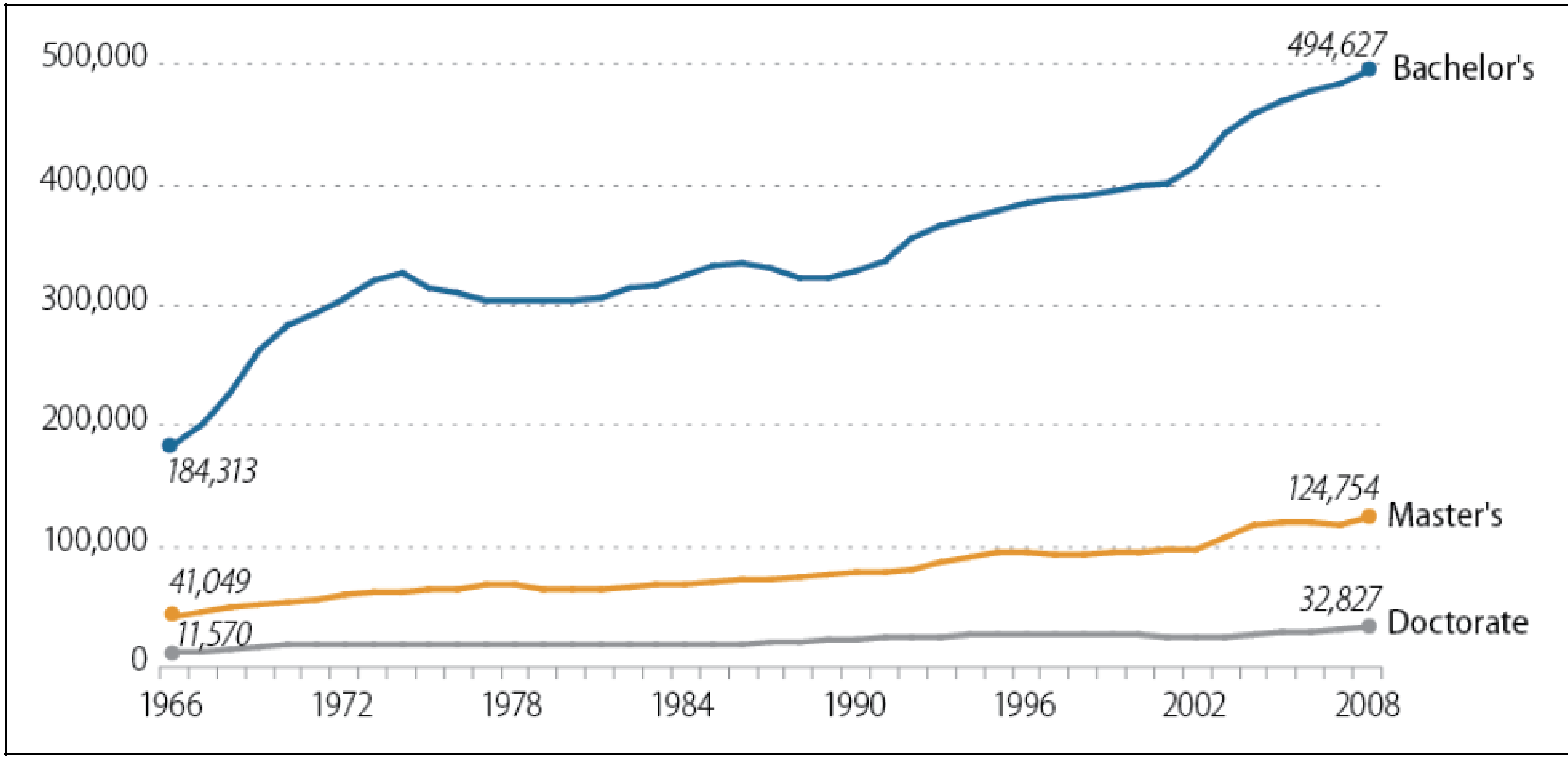
Figure 2: A Smaller Percentage of Degrees Are STEM Degrees

STEM Degrees as a Share of All Degrees Granted, 1985-2009



Source: Chairman's staff of the Joint Economic Committee based on data from the Department of Education's National Center for Education Statistics: Integrated Postsecondary Education Data. STEM Degrees include degrees in: Engineering, Physical Sciences, Geosciences, Math and Computer Sciences, and Life Sciences (except Medical Sciences).

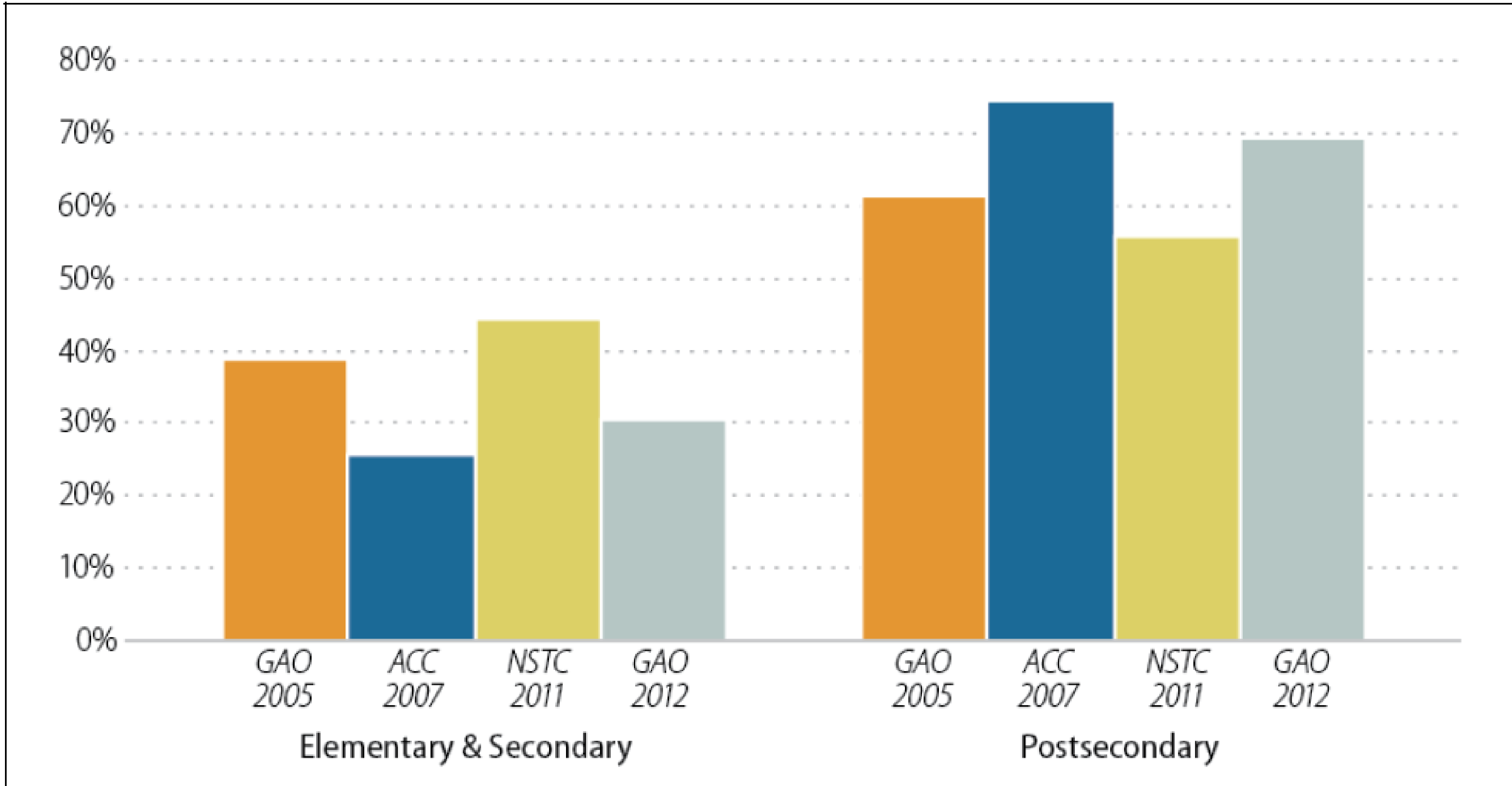
Figure 4. Number of S&E Degrees Awarded from 1966-2008, By Degree Level



Source: National Science Foundation, National Center for Science and Engineering Statistics, "Table 1. S&E Degrees 1966-2008," *Detailed Statistical Tables* (NSF 11-316).

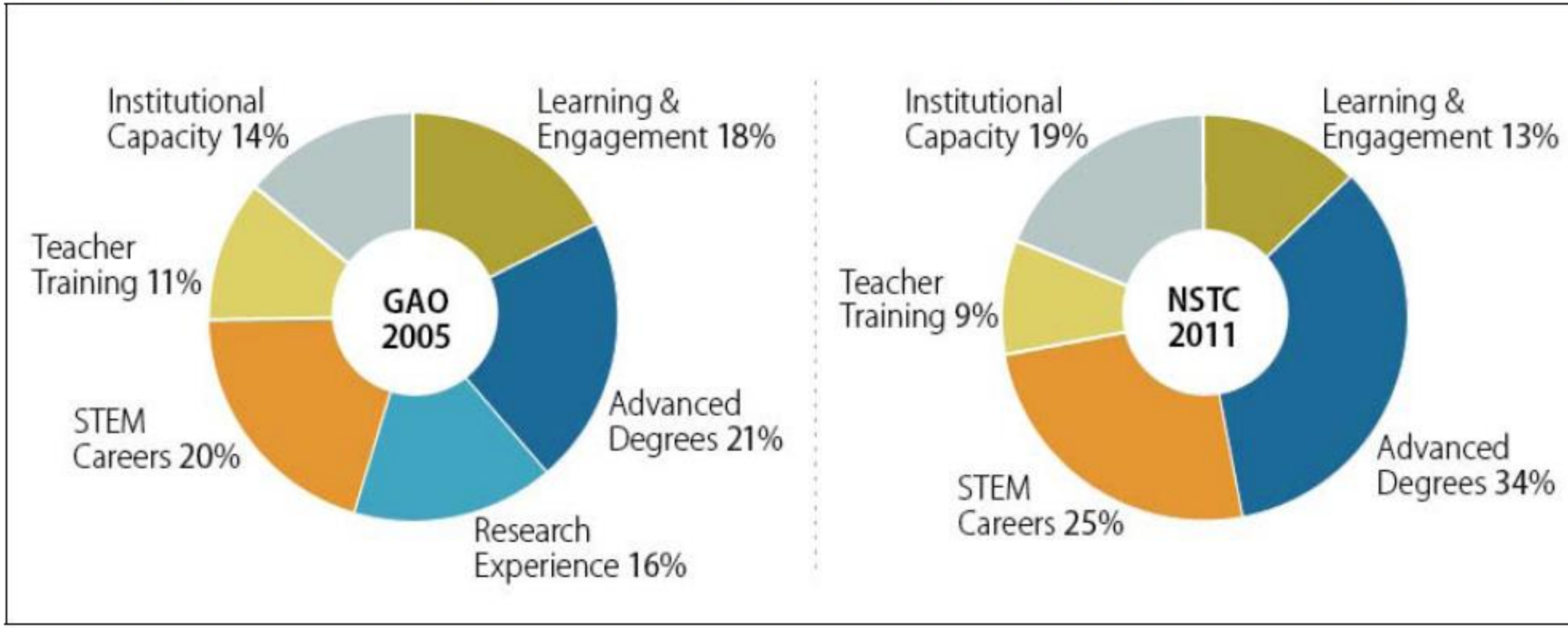
Notes: Includes only degrees where field of study is known. Includes degrees awarded in the social sciences and psychology.

Figure 2. Percentage of STEM Education Programs, by Education Level



Source: CRS calculation based on GAO-2005, Table 8; ACC-2007, Page 2; NSTC-2011, Table 6; GAO-2012, Page 15.

Figure 3. Percentage of STEM Education Programs, by Primary Objective



Source: CRS calculation based on GAO-2005, Table 6; NSTC-2011, Figure 7.

Technically Speaking

Why all Americans Need to Know More About Technology

The National Academy of Engineering

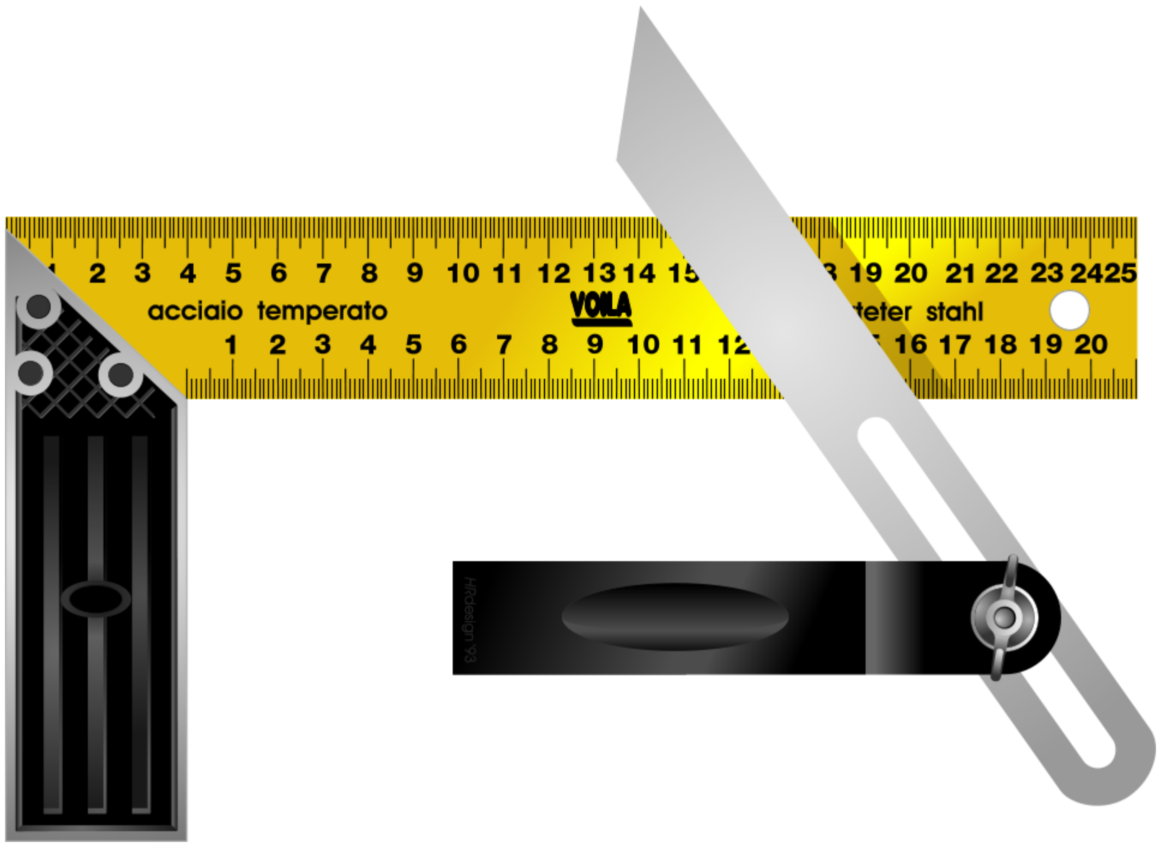
- Most Americans know little about the world of technology, yet from day to day they must make critical decisions that are technologically based.
- Learning about technology should begin in kindergarten and the connection between all subjects and technology should be emphasized throughout a student’s education.
- Many schools believe that because they offer computer classes, they are already teaching about technology.
- Schools need to move beyond the perception of technology as a separate subject to be taught in “shop class”.

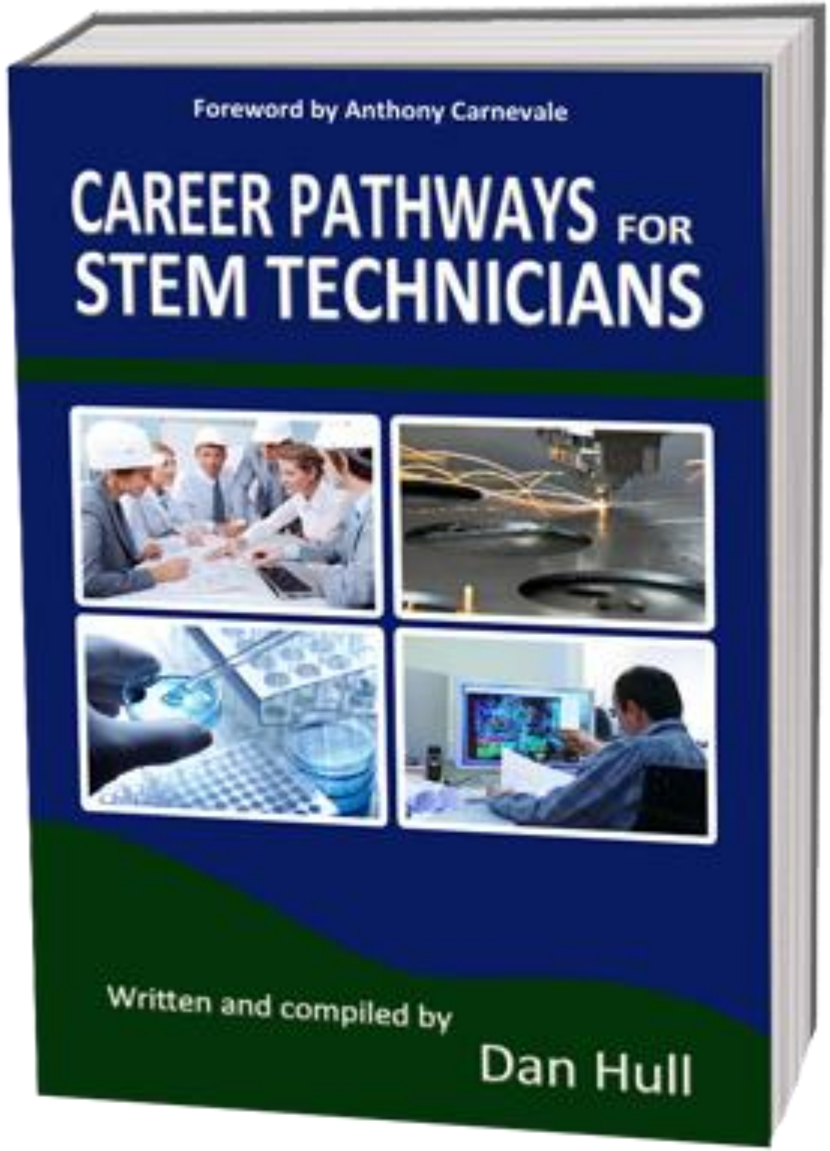
Lack of Technical Ability

Nick Zieminski

August 25th edition of Reuters

- Workers with specialized skills are in critically short supply.




Foreword by Anthony Carnevale
CAREER PATHWAYS FOR STEM TECHNICIANS
Written and compiled by
Dan Hull

The vast majority of STEM jobs require some form of postsecondary education or training

By 2018, roughly 35 percent of the STEM workforce will be composed of those with sub-baccalaureate training, including:

1 million associate degrees
745,000 certificates, and
760,000 industry-based certificates

We find that STEM wages are high and have kept up with wages as a whole over the last thirty years.

Two-thirds of STEM workers with an associates degree make more than the average for workers without an associate degree.

Wages for engineers and engineering technicians have grown 18 percent since the early 1980s. The average salary for engineers and engineering technicians ($78,000) is higher than salaries for all other STEM occupations.

What Are Technicians? Where Do They Come From?

First, let me explain what technicians are not. They aren't the "gofers" that only make coffee, run errands, or do manual labor in the shop.

The technicians that I worked with understood the technology and knew how to solve certain problems

—but they were also the "geniuses of the labs" and the "masters of equipment."

They were particularly good at hands-on technical tasks, and they had incredible spatial abilities.

They could see how things should fit together, and they knew how to make equipment work.

Today, technicians are working with a wide variety of emerging technologies, such as

photonics;

nanotechnology;

biotechnology;

information manufacturing;

advanced environmental monitoring;

communication technology;

biomedical equipment;

alternative energy fields,
nuclear, solar, wind.

So, Why Are Enrollments Low in AAS Programs that Prepare Technicians for These Rewarding and In-Demand Careers?

The problem is that our culture—
and our approach to educational reform over the last twenty-five years
—has fixated on *one single path* through higher education for *everyone*.

High school curricula and teaching strategies are almost totally focused on preparing students to enter and succeed in four-year baccalaureate programs.

Accordingly, high schools typically offer only one path toward higher education,

and this path requires students to take abstract math courses in their junior or senior year.

We have the tools and institutions in place.

Associate-degree technical-education programs.

- Our community and technical colleges offer these programs using curricula and teaching materials that have been specified by the industries and employers who want to hire technicians.
- They are taught by competent faculty members who have been trained in both the content and in the strategies that can help technical students succeed in their careers.

High School STEM programs and academies.

- Specialized STEM programs have been formed over the past decade to interest, attract, and cultivate students to enter postsecondary education in preparation for careers in engineering, science, and technology.

<u>The dilemma we face is this:</u>

Most of the colleges offering technician education in the new and emerging technologies *do not have an adequate number of capable students* enrolling in and completing their associate degree programs.

Most of the high school STEM program are *not attracting and serving the students who have the greatest potential to become the technicians we need.*

PATHWAYS

A pathway, by design, should prepare students for both college and career. The days are gone when someone could succeed with just a high school diploma. Everyone will need further education and career preparation.

A pathway should prepare students for the full range of postsecondary options. "College" no longer just means a four-year postsecondary opportunity. It also includes community college, apprenticeship, and formal employment training.

A pathway should connect challenging academics to the real world, helping students to better understand what they need to know and why they need to know it. Students deserve thoughtful and truthful answers when they ask, "Why do I need to know this?"

A pathway must produce significant growth in student achievement—in academics to be sure, but also in communications, critical thinking, problem-solving, technological literacy, and other cross-disciplinary areas needed for success in the modern world.[ix]

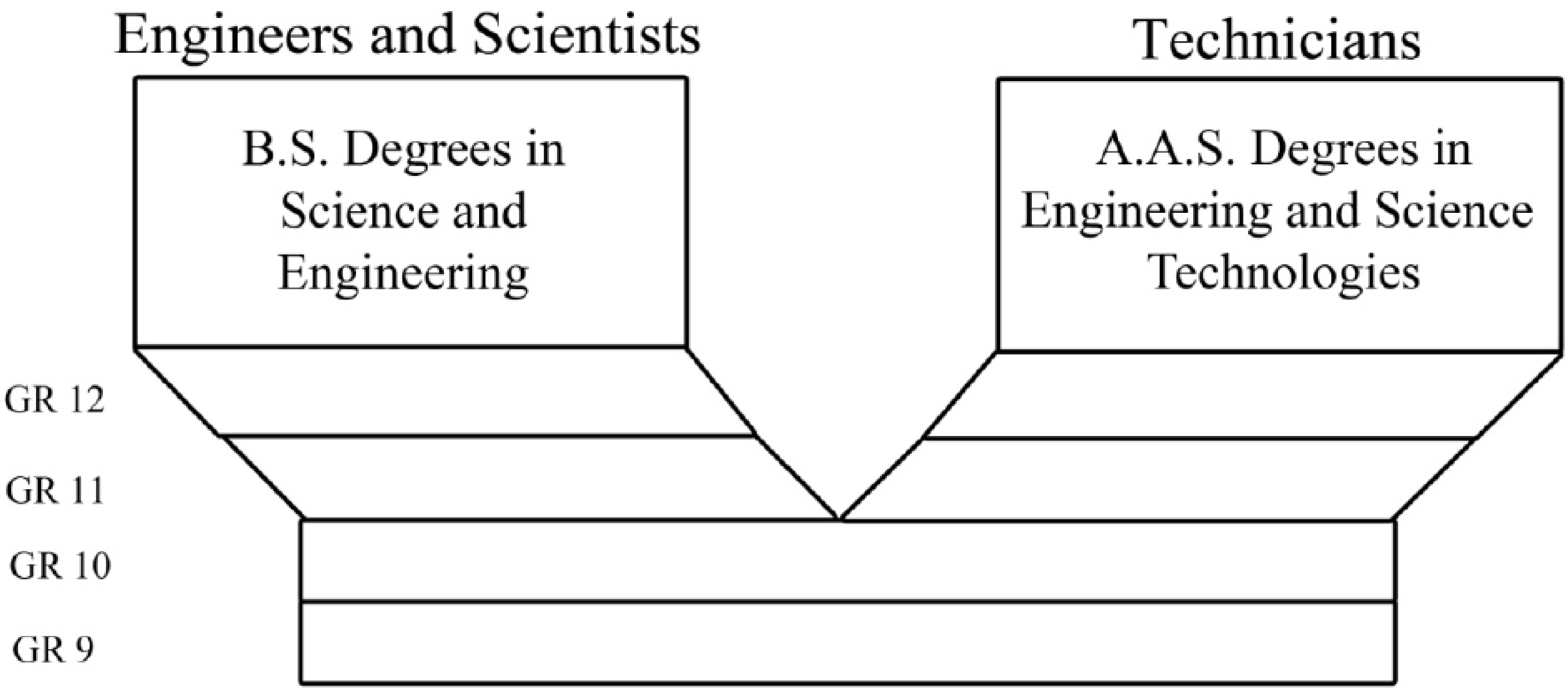


Figure 1. Alternative Curriculum Pathways for STEM High Schools

The Vision for STEM Education in Maine

It is estimated that in the next decade one in seven new Maine jobs will be in STEM-related areas, and these jobs will produce wages that are 58% higher Than wages for other occupations in Maine.

The Maine Office of Innovation has identified seven STEM occupational Clusters that are key areas for economic development:

Biotechnology
Composites
Environmental technology
Forest products and agriculture
Information technology
Marine technology
Precision manufacturing

Those involved in workforce development and STEM education are Appropriately concerned about the ability of Maine students to assume These jobs of the future.

The Vision for STEM Education in Maine

The Department of Education envisions an educational system in which all students:

- *Have equitable access to effective STEM instruction;*
- *Receive instruction in which STEM concepts are applied and integrated; and*
- *Understand the relevance of STEM to their communities and to their own career aspirations.*

Goal #1

Overall student achievement in science, mathematics, engineering and technology demonstrates a gain of 15 percentage points within four years as measured by the combined percentage of students who “meet” and “exceed” expectations on State assessments of science and mathematics.

Objectives:

1. Increase in-service teacher content knowledge, pedagogical knowledge, and pedagogical content knowledge in science, technology, engineering and mathematics
2. Increase teacher leadership in science, technology, engineering and mathematics
3. Increase pre-service teacher programming and recruitment

Goal #2

The number of students interested in pursuing STEM-related careers increases by 15 percentage points (from 33% to 48%) within four years, as reported on the PSAT and SAT student surveys; and the number of Maine students who graduate from two-year and four-year engineering and STEM-related programs statewide increases by 10%.

Objectives:

1. Improve student awareness of and participation in STEM-related pathways
2. Increase after-school programming that supports STEM learning
3. Increase internship opportunities that provide awareness of STEM opportunities

Goal #3

The STEM initiatives of the Department of Education and the STEM Collaborative, which includes governmental, non-profit and business partners, are coordinated and three million dollars in federal grants is secured by the Department of Education to support STEM learning and growth in the State.

Objectives:

1. Increase Maine Department of Education STEM integration and grant awards
2. Develop common STEM goals
3. Identify and scale up promising and proven STEM programs

STEM on-line course – David Skaves Spring 2014
HVAC

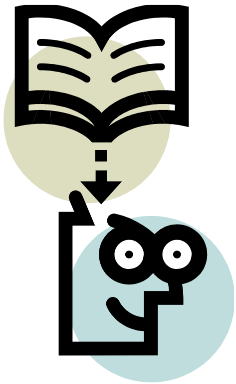
- The heating, ventilation, air conditioning, and refrigeration (HVACR) industry plays an important role in our society.
- There are many one year certificate and two year degree programs throughout the country for training certified technicians.
- The industry also employs many engineers and has strong support from professional societies such as ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers), RSES (Refrigeration Service Engineers Society), AFE (Association of Facilities Engineers), and AHRI (Air Conditioning, Heating, and Refrigeration Institute).
- A course in HVACR is ideal for STEM students. This is because it helps to explain the basic fundamentals of science as applied to practical working models.
- In addition, the most recent practice regarding sustainable systems is introduced.
- The course is delivered on-line.
- There are two fifty minute classes per week for fourteen weeks.

Course Outline and Daily Schedule

Course outline: STEM Course Outline 2014

Daily Schedule: Daily Schedule 2014

Thank you for Attending



I hope this presentation has provided you with some useful information and spurred Some new ideas.

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