Science, Technology, Engineering, & Math Skills The Foundation for a Highly Skilled Workforce

In the 21st Century, economic power will be derived from skills and innovation. Nations that don't invest in skills will weaken: it is that straightforward.

Louis Gerstner Jr., former Chairman and CEO, IBM, *Meeting the Challenge of a Changing World, Strengthening Education for the 21st Century,* U. S.Department of Education, January 2006

The Workforce Boards of Metropolitan Chicago have issued this publication for the purpose of providing specific information on the metropolitan Chicago region's growing need to increase the quality of science, technology, engineering, and mathematics (STEM) skills of its current and future workforce. Employment projections demonstrate that the jobs of tomorrow will require higher STEM skill levels supported with lifelong learning.

The Workforce Boards of Metropolitan Chicago (Workforce Boards) are a consortium of nine Workforce Boards that include the Chicago Workforce Board, Cook County Workforce Investment Board, DuPage Workforce Board, Grundy Livingston Kankakee Workforce Board,Lake County Workforce Investment Board, McHenry County Workforce Investment Board, River Valley Workforce Investment Board, The Workforce Board of Northern Cook County, and Workforce Investment Board of Will County. The Workforce Boards are responsible for workforce preparation and economic development activities in their respective local areas but, collectively as a consortium,work to address workforce issues on a regional basis. This consortium has adopted a regional approach recognizing that cross-geographic issues impact the economic vitality of each area.

Our Economy – Our Future

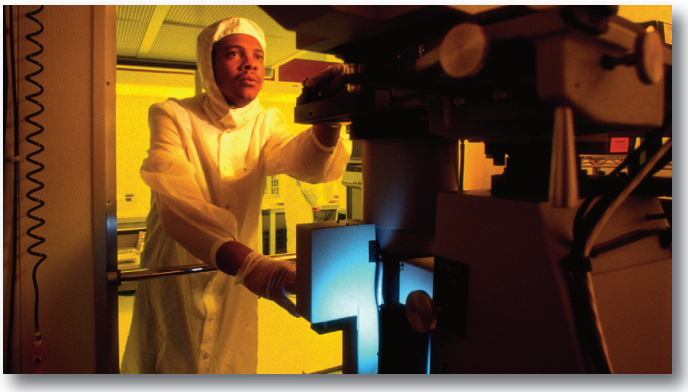
In recent years, economists and public policy experts have focused a great deal of attention on STEM. Their message has been that our country's future in a global economy is dependent on its ability to be innovative. Innovation in this context is defined as the ability to rapidly translate knowledge and insights into new high value products and services.[1] Innovation requires knowledge acquired through education or, more specifically, STEM skills.

America's educational system has received intense scrutiny as it relates to its ability to provide U. S. students with the science, engineering, technology and mathematic skills needed to support the innovation that our country requires. As stated in a report prepared by The National Commission on Mathematics and Science Teaching for the 21st Century:

…the Commission is convinced that the future well-being of our nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science specifically. From mathematics and sciences will come the products, services, standards of living, and economic and military security that will sustain us at home and around the world. From them will come the technological creativity American companies need to compete effectively in the global marketplace. [2]

Occupational Outlook

There is an increasing need for individuals in the region's workplace with strong STEM skills. As reflected in Figure 1, the nation's STEM workforce is expected to increase 8% between 2008 and 2013, the same as the metro Chicago region's projected growth and higher than Illinois's projected increase of 6%. In 2008, the region's STEM workforce represents 67% of the State's total STEM workforce.



[1] Council on Competitiveness, http://www.compete.org/explore/drive-innovation-entrepreneurship

[2] *Before It's Too Late, A Report to the Nation from The National Commission on Mathematics and Science Teaching for the 21st Century,* September 2000, page 4.

Currently the region's 468,128 STEM occupations represent 8.7% of the region's total labor force (5,393,308). That number is expected to increase to 504,789 by 2013 and represent 8.8% of the region's labor force (5,730,811).

Projected Job Growth/STEM Occupations Figure 1				
	2008 STEM Jobs	2013 STEM Jobs	Change	% Change
Regional Total	468,128	504,789	36,658	8%
Illinois Total	698,153	741,969	43,815	6%
National Total	17,540,463	18,911,170	1,370,70	38%

Source: Economic Modeling Systems, Inc.

In addition to 36,658 new jobs, over the next five years 39,516 skilled replacement workers will be needed for STEM jobs that are vacated by workers retiring or otherwise leaving STEM jobs. This number is reflective of the large number of Baby Boomers expected to retire in the coming years. It is particularly significant in terms of STEM occupations because as skilled Baby Boomers retire, an increasing proportion of the entering workforce will be from segments of the population that historically have lower levels of postsecondary education and are, therefore, less likely to acquire the skills needed to perform STEM occupations.[3]

The regional STEM occupations that will have the highest demand for new and replacement workers through 2013 are reflected in Figure 2. Of those twenty high demand occupations, one has a decrease in the number of new jobs. However the replacement number warrants inclusion on this table. Of the twenty jobs, the top high demand job classification is postsecondary teachers (9,972) followed by accountants and auditors (9,117), computer software engineers, applications (4,372), automotive service technicians and mechanics (4,231), and computer support specialists (4,231).

Metropolitan Chicago Region: Top Twenty High Demand STEM Occupations Figure 2						
Occupation	2008 Jobs	2013 Jobs	Change	% Change	New & Replacement	% New & Replacement
Postsecondary teachers	58,677	64,844	6,167	11%	9,972	17%
Accountants and auditors	59,612	64,701	5,089	9%	9,117	15%
Computer software engineers, applications	16,968	20,275	3,307	19%	4,372	26%
Automotive service technicians and mechanics	24,044	26,382	2,338	10%	4,231	18%
Computer support specialists	18,643	19,803	1,160	6%	3,788	20%
Computer systems analysts	14,836	16,672	1,836	12%	3,524	24%
Computer software engineers, systems software	14,843	16,836	1,993	13%	2,940	20%
Network and computer systems administrators	11,172	12,502	1,330	12%	2,501	22%
Computer specialists, all other	12,348	13,332	984	8%	2,403	19%
Network systems & data communications analysts	8,880	10,532	1,652	19%	2,252	25%
Computer programmers	22,881	22,599	(282)	(1%)	2,208	10%
Cooks, institution and cafeteria	9,469	10,279	810	9%	2,000	21%
Construction managers	17,821	19,491	1,670	9%	1,976	11%
First-line supervisors/managers of food preparation and serving workers	19,462	20,786	1,324	7%	1,967	10%
Computer and information systems managers	11,163	11,907	744	7%	1,568	14%
Cost estimators	7,040	7,761	721	10%	1,371	19%
Graphic designers	9,415	9,706	291	3%	1,317	14%
Industrial engineers	5,477	6,137	660	12%	1,309	24%
Civil engineers	8,193	8,525	332	4%	1,250	15%
Mathematical scientists, all other	2,952	3,592	640	22%	979	33%

Source: Economic Modeling Systems, Inc.

[3] *Keeping Illinois Competitive,* Northern Illinois University, June 2006, page 2.

A summary of the regional demand for all STEM occupations, in terms of new and replacement jobs, by major job category is reflected in Figure 3. The majority (34.9%) of the region's STEM occupations are in the Computer and Mathematical Science Occupations, followed by the Business and Financial Operations Occupations (14.5%) and Education, Training and Library Occupations (13.2%).

Metropolitan Chicago Region: STEM New and Replacement Jobs By Occupational Category 2008 - 2013 Figure 3

Occupational Categories	New and Replacement Jobs
Computer and Mathematical Service Occupations	26,557
Business & Financial Operations Occupations	11,032
Education, Training & Library Occupations	10,062
Architecture & Engineering Occupations	8,237
Life, Physical & Social Science Occupations	4,505
Installation, Maintenance, & Repair Occupations	4,231
Management Occupations	4,062
Food Preparation & Serving Related Occupations	3,967
Arts, Design, Entertainment, Sports, & Media Occupations	1,317
Production Occupations	1,304
Healthcare Practitioners & Technical Occupations	608
Transportation & Material Moving Occupations	143
Protective Service Occupations	23
Farming, Fishing, & Forestry Occupations	121

Source: Economic Modeling Systems, Inc.

While many STEM occupations require either a bachelor degree or master degree, there are a large number of occupations requiring other levels of education or training. Figure 4 demonstrates the range of training required for STEM occupations (Note: This chart is illustrative and does not include all regional STEM occupations.)

The O*NET system serves as the nation's primary source of occupational information and is supported by the U.S. Department of Labor (http://online.onetcenter.org/). For the purpose of occupational data presented in this report,STEM occupations are those identified on the online O*NET system. Disciplines include: Chemistry, ComputerScience, Engineering, Environmental Science, Geosciences,Life Sciences, Mathematics, and Physics/Astronomy. TheO*NET system classifies 129 occupations as STEMoccupations; 103 are represented in the regional labor force data.

Educational/Training Requirements: Figure 4

Computer support specialists	Associate's degree
Computer specialists, all other	Associate's degree
Civil engineering technicians	Associate's degree
Electrical and electronic engineering technicians	Associate's degree
Environmental engineering technicians	Associate's degree
Industrial engineering technician	Associate's degree
Mechanical engineering technicians	Associate's degree
Engineering technicians, except drafters, all other	Associate's degree
Construction managers	Bachelor's degree
Accountants and auditors	Bachelor's degree
Computer programmers	Bachelor's degree
Computer software engineers, applications	Bachelor's degree
Computer software engineers, systems software	Bachelor's degree
Computer systems analysts	Bachelor's degree
Database administrators	Bachelor's degree
Network and computer systems administrators	Bachelor's degree
Network systems and data communications analysts	Bachelor's degree
Computer and information systems managers	Degree.+work exp
Farm, ranch, and other agricultural managers	Degree.+work exp.
Engineering managers	Degree.+work exp
Actuaries	Degree.+work exp.
Computer and information scientists, research	Doctoral degree
Mathematicians	Doctoral degree
Biochemists and biophysicists	Doctoral degree
Microbiologists	Doctoral degree
Medical scientists, except epidemiologists	Doctoral degree
Postsecondary teachers	Doctoral degree
Farmers and ranchers	Long-term on-the-job training
Compliance officers, except agriculture, construction, health and safety, and transportation	Long-term on-the-job training
Numerical tool and process control programmers	Long-term on-the-job training
Chemical plant and system operators	Long-term on-the-job training
Operations research analysts	Master's degree
Statisticians	Master's degree
Mathematical technicians	Master's degree
Mathematical scientists, all other	Master's degree
Epidemiologists	Master's degree
Dietetic technicians	Moderate-term on-the-job training
Cooks, institution and cafeteria	Moderate-term on-the-job training
Chemical equipment operators and tenders	Moderate-term on-the-job training
Architectural and civil drafters	Postsecondary vocational award
Automotive service technicians and mechanics	Postsecondary vocational award
Cost estimators	Work experience in a related field
First-line supervisors/managers of food ipreparation and serving workers	Work experience in a related field

Source: Economic Modeling Systems, Inc.

As a group, STEM workers earned about 70% more than the national average in 2005, according to the Bureau of Labor Statistics.[4] The median hourly earning in the region for all STEM occupations is $30.32 as compared to $26.41 for the State and $25.29 for the nation. Figure 5 reflects the region's STEM occupations earning the highest average hourly rates.

Metropolitan Chicago Region
STEM Occupations with Highest Average Hourly Rate
Figure 5

Occupation	Average Hourly Rate
Petroleum engineers	$59.98
Biochemists and biophysicists	$58.44
Nuclear engineers	$55.78
Epidemiologists	$55.50
Zoologists and wildlife biologists	$54.06
Physical scientists, all other	$53.91
Mining & geological engineers, including mining safety engineers	$51.46
Hydrologists	$50.68
Computer and information systems managers	$50.46
Engineering managers	$49.69
Aerospace engineers	$49.49
Biomedical engineers	$49.33
Agricultural engineers	$48.41
Mathematicians	$47.91
Actuaries	$47.62
Computer and information scientists, research	$47.56
Chemical engineers	$47.21
Physicists	$46.73
Materials scientists	$46.65
Astronomers	$46.59
Natural sciences managers	$46.54
Computer software engineers, systems software	$44.25

More than half of the undergraduate degrees awarded in China are in the fields of science, technology, engineering and math, compared to16 percent in the U.S.

Meeting the Challenge of a Changing World,Strengthening Education for the 21st Century,
U. S.Department of Education, January 2006

Creating a Pipeline of STEM Workers

The publication *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* presents the following statistics:

- In 2005, only 36% of 4th grade students and 30% of 8th grade students who took the National Assessment of Educational Progress (NAEP) performed at or above the proficient level in mathematics.
- Only 29% of 4th grade students, 32% of 8th grade students and 18% of 12 grade students performed at or above the proficient level on the science 2000 NAEP.
- Our 4th grade students perform as well in mathematics and science as their peers in other nations, but in the most recent assessment 12th graders were almost last among students who participated in the Trends in International Mathematics and Science Study. Of the 20 nations assessed in advanced mathematics and physics, none scored significantly lower than the United States in either subject.
- Our 8th grade students did better on an international assessment of mathematics and science in 2003 than the same age group in 1995. However, in both cases they ranked poorly in comparison with students from other nations.
- A recent assessment by the OECD Programme for International Student Assessment revealed that U.S. 15 year olds are near the bottom worldwide in their ability to solve practical problems that require mathematical understanding.[5]

These statistics demonstrate that the K-12 educational system is failing to provide our youth with the foundational skills they will need for the future. This is in part attributed to the fact that 30% of high school math teachers and 60% of physical science teachers did not major in the subject in college or are not certified to teach it. Additionally, the science and math curricula in many schools are inadequate.[6]

And what about our top performing students? The U.S. ranks 16 of 17 nations in the proportion of 24 year olds who earn degrees in natural sciences or engineering as opposed to other majors and 20 of 24 when looking at all 24-year olds.[7]

[4] *Occupational Outlook Quarterly,* STEM Occupations, U.S. Bureau of Labor Statistics, Spring 2007, page 27.
[5] *Rising Above the Gathering Storm, Energizing and Employing America for a Brighter Economic Future,* Executive Summary, National Academy of Sciences, 2007, pages 94 and 95.
[6] Ibid, page 95.
[7] Ibid, page 98.

A recent study conducted by Northern Illinois University provides an assessment of Illinois' STEM education. That report reaffirms many of the findings presented in the national report and identifies the following challenges that will impact Illinois' future economic vitality:[8]

- Student Academic Achievement - More than half of Illinois high school students did not have the requisite mathematics and science skills for post-secondary education or jobs in the emerging new economy.
- Alignment of 21st Century Knowledge and Skills – State curricula, assessments, and pedagogy are not consistently aligned with the 21st Century knowledge and skills needed for the state's economy.
- Teacher Preparation – Many mathematics and science teachers do not have the proper qualifications to teach those subjects or access to ongoing professional development to improve their teaching.
- Investment in STEM Education – Strategies may not be adequate to recruit and retain the most qualified individuals for STEM professions and for research and development for innovation.
- Lifelong Learning – In the 21st Century, all citizens and workers will need increasing mathematics and science skills and opportunities for lifelong learning.

Investment in the Future

The America Creating Opportunities To Meaningfully Promote Excellence in Technology, Education and Science Act (American COMPETES Act), signed into law by President Bush on August 9, 2007, is the most recent federal legislation to address the nation's need to remain a leader in innovation and strengthen the STEM skills of its citizens. The America COMPETES Act provides a total of $33.6 billion in newly authorized spending levels for research and education programs.[9]

The Act focuses on three primary areas: 1) increasing research investment, 2) strengthening educational opportunities in science, technology, engineering, and mathematics from elementary through graduate school, and 3) developing an innovation infrastructure.[10] The Act proposes to strengthen educational opportunities in STEM and critical foreign languages by:

- Authorizing competitive grants to States to promote better alignment of elementary and secondary education with the knowledge and skills needed.
- Strengthening the skills of thousands of math and science teachers by establishing training and education programs.
- Expanding the Robert Noyce Teacher Scholarship Program at NSF to recruit and train individuals to become math and science teachers.
- Assisting states in establishing or expanding statewide specialty schools in math and science that students from across the state would be eligible to attend and providing expert assistance in teaching from national laboratories' staff at those schools.
- Facilitating the expansion of Advanced Placement (AP) and International Baccalaureate (IB) programs by increasing the number of teachers prepared to teach AP/IB and pre-AP/IB math, science, and foreign language courses in high need schools.
- Developing and implementing bachelor degree programs with concurrent teaching credentials and part-time master degree education programs for math, science, and critical foreign language teachers.
- Creating partnerships between national laboratories and local high-need high schools to establish centers of excellence in math and science education.
- Expanding existing NSF graduate research fellowship and traineeship programs as well as NSF's science, mathematics, engineering and technology talent programs.
- Providing Math Now grants to improve math instruction in the elementary and middle grades and provide targeted help to struggling students.
- Expanding programs to increase the number of students from elementary school through postsecondary education who study critical foreign languages and become proficient.[11]

The educational system is responsible fordeveloping a pool of technically adept and numerically literate individuals and a continual supply of highly trained mathematicians,scientists, and engineers.

Meeting the Challenge of a Changing World, Strengthening Education for the 21st Century,
U. S.Department of Education, January 2006

[8] *Keeping Illinois Competitive,* Northern Illinois University, June 2006, page 1.
[9] White House Press Release, President Bush Signs America COMPETES Act, August 2007, http://www.whitehouse.gov/news/releases/2007/08/20070809-3.html
[10] EdNews, Summary of the America COMPETES Act, http://www.ednews.org/articles/10558/1/SUMMARY-OF-THE-AMERICA-COMPETES-ACT/Page1.html
[11] Ibid

Summary

In fiscal year 2004, U.S. expenditures totaling $2.8 billion supported programs designed to increase the number of students in STEM fields and employees in STEM occupations and to improve related educational programs. According to testimony delivered to the Committee on Education and the Workforce in 2006, only half of those programs had been evaluated and there was limited coordination between programs.[12] Therefore, it was difficult to assess their impact.

This year, $33.6 billion in public funds will be available to address the nation's need for individuals with strong STEM skills. Is it enough?

In reviewing the STEM literature in the context of workforce development, there are three reoccurring themes:

- The need to improve teacher abilities to equip our youth with the mathematic and science skills needed for postsecondary education in preparation for STEM careers.
- The need to increase awareness of and interest in STEM career opportunities.
- The need to maximize the benefit of publicly funded programs and initiatives through increased collaboration and coordination between programs.

In an effort to address two of these points, The Workforce Boards of Metropolitan Chicago are compiling an inventory of STEM initiatives underway in the metro Chicago area and other STEM resources. More information regarding the inventory can be found on the Workforce Board's regional website at www.workforceboardsmetrochicago.com.

In conclusion, the metropolitan Chicago region's future economy is highly dependent on its ability to develop a STEM workforce that meets the needs of its employers. This will include jobs that can be foreseen – as well as those that will emerge as a result of future innovation. The choice is simple, either the region's citizens acquire the skills needed for these jobs or employers will find skilled workers elsewhere.

Thanks to globalization, driven by modern communications and other advances, workers in virtually every sector must now face competitors who live just a mouse-click away in Ireland, Finland, China, India, or dozens of other nations whose economies are growing.

Rising Above the Gathering Storm, Energizing and Employing America for a Brighter Economic Future,
Executive Summary, National Academy of Sciences, 2007

[12] *Science, Technology, and Mathematic Trends and the Role of Federal Government,* testimony before the Committee on Education and the Workforce House of Representatives, Statement of Cornelia M. Ashby, Director, Education, Workforce, and Income Security Issues, U. S. Government Accountability Office, May 2006.