STEM: A Foundation for the Future

Improving Student Skills in Science, Technology, Engineering, and Math

At Microsoft, our focus has always been on enabling people around the world to realize their full potential. An important part of that commitment has been helping individuals develop the skills necessary to succeed in a world—and workplace—that is increasingly complex, technologically advanced, and competitive.

These skills are predominantly concentrated in the fields of science, technology, engineering, and math (STEM). Gone are the days when a basic understanding of math or science was sufficient for most high school or college graduates. Today's students will need a strong foundation in these subjects regardless of their plans after high school, and such a foundation is essential for students to succeed in computer science. In fact, the vast majority of family-wage jobs in this country will require a range of technical skills and a capacity for lifelong learning.

Consider the many challenges identified nearly a decade ago in the United Nations Millennium Development Goals—including eradicating poverty, reducing hunger and child mortality, and combating diseases such as AIDS and malaria. STEM skills are central to addressing all of these issues—through development of new energy sources, medical breakthroughs, more effective agricultural practices, and innovations that drive economic prosperity.

For the U.S. to continue to play a leadership role in addressing these challenges—and to achieve the productivity and innovation needed to remain competitive in the global marketplace—we must do a better job of preparing and empowering educators who teach STEM subjects. We must also do more to engage students in these subjects and encourage them to pursue careers in STEM-related fields.

Addressing the STEM Gap

The U.S. Department of Labor has projected that by 2014, the U.S. will have more than 2 million job openings in STEM fields. But will we be able to fill them? Even amid the worst economic recession in decades, hundreds of thousands of technology-related jobs went unfilled in 2009 due to a lack of qualified workers, according to Labor Department estimates.

The fact is that the number of U.S. students graduating with degrees in STEM fields is declining. Fewer than 15 percent of current U.S. college undergraduates are pursuing degrees in science or engineering—compared to more than 30 percent in India and more than 40 percent in China.

Across the U.S., student performance in math and science lags behind that of students in other nations based on international benchmarks. Multiple studies have found that many students begin to lose interest in these subjects as early as middle school. During the past five years, the percentage of U.S. high schools offering Advanced Placement computer science courses declined dramatically. Meanwhile, colleges are finding too few students with the interest and preparation to pursue STEM degrees.

As Bill Gates noted in testimony before the U.S. House Committee on Science and Technology in 2008, "Too many of our students fail to graduate from high school with the basic skills they will need to succeed in the 21st-century economy…. Although our top universities continue to rank among the best in the world, too few American students are pursuing degrees in science and technology."

We must work especially hard to persuade young women and minority students—who are underrepresented in the STEM fields—that their contributions are needed and that exciting and rewarding career opportunities exist for them. Expanding the STEM talent pool to include more women and minorities is not simply a matter of ensuring that all members of society have access to educational opportunities. It requires even more significant and targeted investment.

As the world's largest software company, Microsoft is keenly aware of the importance of expanding the STEM talent pool. Not only is this important to our business, our partners, our customers, and the communities in which our 88,000 employees live, but it is crucial to the global standing of the U.S. economy. That's why we have invested significantly in tools and resources to enable effective teaching of STEM subjects and in programs that encourage young people to consider careers in STEM fields. Our commitment of cash, software, and employee volunteer time totals hundreds of millions of dollars per year.

As with any prudent investment strategy, we have diversified our efforts. Some of the programs we support, such as the Imagine Cup, help students and the public understand the transformational role that technology can play in our daily lives. Others, such as DigiGirlz, dispel stereotypes associated with careers in technology. Partners in Learning, the Microsoft Math Partnership, and Games4Learning provide educators and students with innovative new approaches to STEM education.

This paper offers a look at our business and citizenship programs that support STEM education. It also addresses the STEM challenge as a responsibility shared by both the public and private sectors, and we offer some ideas and recommendations that we hope government, educational institutions, and other stakeholders will consider as we work together to better prepare students and educators for the 21st-century economy.

K–12 Programs

Education is the foundation of our communities and a key to our country's ability to remain competitive in the global economy. Microsoft is working to strengthen K–12 education worldwide through a range of programs that support students, teachers, and school leaders.

Partners in Learning

Partners in Learning is a 10-year, nearly $500 million commitment to help schools increase their access to technology and use it more effectively in teaching. Since 2003, Partners in Learning has reached more than 177 million students, teachers, and education policymakers in 112 countries.

Through the Innovative Schools program, we are engaging deeply with 12 mentor schools and 31 Pathfinder Schools. The program pushes school leaders to think beyond the limits of the classroom and traditional educational models toward new approaches that make learning more engaging, inspiring, and relevant. The resulting educational tools and methods are available for other school districts to adapt and are being used by more than 1,600 school districts worldwide.

Our Innovative Teachers program is dedicated to helping educators develop and share successful teaching methods, lesson plans, practices, and professional development resources. Our Innovative Schools program

works with governments and schools to help deliver technology products and supporting curricula directly into the hands of students to enrich their learning. More than 2 million teachers and school leaders are currently active on the Partners in Learning Network, an online professional development network.

Club Tech at Boys & Girls Clubs of America

For more than a decade, Microsoft has partnered with Boys & Girls Clubs of America to teach essential digital literacy skills to children across the country and on U.S. military bases abroad. Club Tech uses fun, interactive lessons to give youth of all ages and backgrounds the skills they need to showcase their creativity, perform better in school, and eventually take their technology know-how into the workplace. To date, Microsoft's $150 million investment has reached 4.5 million children in 4,300 locations. We also provide local clubs with technology and support services to help run their operations, and many of our employees volunteer at Boys & Girls Clubs.

Microsoft Math Partnership

The Microsoft Math Partnership (MMP) works to raise middle school students' participation and achievement in math, science, and technology. Through partnerships with local school districts, universities, and other educational organizations in the Puget Sound area of Washington state, MMP provides professional development opportunities to teachers to increase the rigor of secondary and post-secondary math and science education. MMP also advocates for policy changes, with the ultimate goal of encouraging students to become critical thinkers who are proficient in mathematical skills and concepts, including numeracy, algebra, statistics, and problem solving. Over time, the plan is to expand MMP programs to other states and to work with school districts to improve science education.

Washington STEM Initiative

The Washington STEM Initiative, formed in 2010, seeks to improve student achievement and opportunity in science, technology, engineering, and math. The initiative provides technical assistance, teacher training, access to STEM curricula, and other resources to help spur innovation in Washington state's K–12 education system. Microsoft, the Bill and Melinda Gates Foundation, The Boeing Company, Battelle, the Washington Roundtable, and the Partnership for Learning are providing the critical initial support for these efforts. The goal is to improve teacher effectiveness and significantly increase the number of high school graduates who are prepared to succeed in STEM degree programs in college, with a particular emphasis on accelerating the achievement of low-income and minority students.

DigiGirlz

The Microsoft DigiGirlz program, which started in 2000, helps dispel stereotypes associated with careers in technology. DigiGirlz Days and DigiGirlz High Tech Camps give high school girls a chance to learn about careers in technology, connect with Microsoft employees, and participate in hands-on computer and technology workshops hosted on many of Microsoft's campuses around the world. Participants receive career planning assistance, explore technology and business roles, engage in thought-provoking exercises, and become familiar with the latest software developments.

Imagine Cup software design competition winners.

Higher-Education Programs

Microsoft-sponsored competitions and technology access programs are designed to help young people develop collaboration and problem-solving skills that will be useful in any work environment, while inspiring them to pursue opportunities in STEM fields.

Imagine Cup

The Imagine Cup 2010 competition encourages students to "imagine a world where technology helps solve the toughest problems." Specifically, the competition calls on student programmers, designers, and technologists to take on the global challenges identified in the United Nations Millennium Development Goals. More than 300,000 students from 142 countries participated in the 2009 Imagine Cup. The competition helps students strengthen technical, problem-solving, and communication skills that can aid them in a future career.

Imagine Cup video link:
www.imaginecup.us/Faculty/Index.aspx

Students to Business

The Microsoft Students to Business (S2B) program helps university students who are pursuing technology careers to connect with Microsoft partners and customers for entry-level and internship positions. Microsoft S2B provides training and certification opportunities as well as other resources that fuel innovation and help students gain the skills required to become more employable. It also connects students with jobs at Microsoft and Microsoft partner companies. Since 2006, the program has provided more than 300,000 students with new career skills and has led to internships and jobs for 15,000 students.

DreamSpark

To support advanced technical learning and unlock students' creative potential, the Microsoft® DreamSpark™ program offers university and high school students free downloads of professional Microsoft developer, designer,

and gaming software. Since 2007, Dream-Spark has provided more than 2.5 million such downloads. The program also o ffers online instructional resources, training videos, special offers on Microsoft Certified Technology Specialist exams, and access to Microsoft IT Academy learning opportunities.

MSDN Academic Alliance

To help improve teaching and learning, the MSDN® Academic Alliance provides accred-ited universities, technical schools, and high schools with access to professional-level soft-ware development and design tools. Students enrolled at a school with an MSDN Academic Alliance subscription can also obtain free Microsoft software with a license that never expires. The program is designed to give stu-dents a head start toward a career in technol-ogy by familiarizing them with the tools and practices that employers will expect them to use. In the eight years since it launched, the MSDN Academic Alliance has distributed more than 5 million downloads of software and other resources.

Microsoft IT Academy

Microsoft IT Academy provides comprehen-sive information technology (IT) training curricula and resources, as well as Microsoft certification opportunities, to help prepare students for the workplace and encourage lifelong learning. The program gives educa-tors the tools they need to deliver technology courses that align with industry hiring needs and offer dynamic learning experiences to a diverse community of students. The program is available in thousands of locations in more than 100 countries.

For additional information about the broad range of tools available to higher education faculty and students, visit the Microsoft Higher Education Academic Resource Center.

Personal robots are being used to make introductory computer science courses more relevant and engaging.
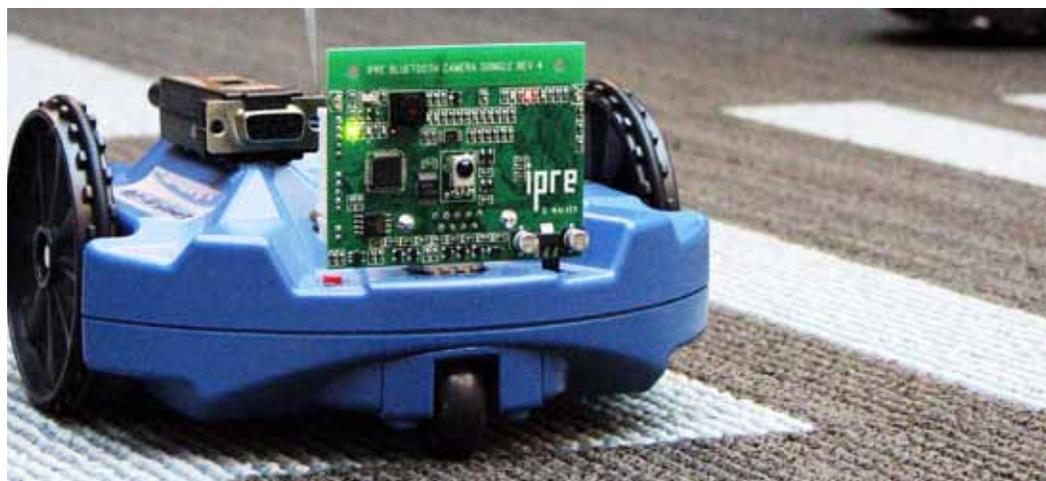
Tools for Engaging Student Learning and Improving STEM Instruction

In education, there's nothing more valuable than hands-on experience. Microsoft is working with education and research partners around the U.S. to develop tools that make STEM education more engaging and relevant for students of all ages.

Robotics

Hands-on learning using robots and other devices is an effective way to get students excited about STEM-related subjects. Over the past five years, Microsoft External Research has sponsored more than a dozen robotics research and education projects at universities around the United States. In many of these projects, educators and students have used Microsoft Robotics Developer Studio (RDS), an advanced general-purpose software toolkit that can be used to run everything from educational toys to industrial robots. An academic edition of RDS is available at no cost to students through the DreamSpark program and to academic institutions through the MSDN Academic Alliance program.

In 2006, Microsoft External Research co-founded the Institute for Personal Robots in Education (IPRE) in collaboration with researchers at the Georgia Institute of Technology and Bryn Mawr College. Now predominantly supported by the National Science Foundation, IPRE uses personal robots to make introductory computer science instruction more relevant and engaging for both students and professors. The project's initial focus was on undergraduate students, but IPRE's ultimate mission is to employ robots in STEM education at all levels—from middle school to graduate school. To ensure broad access to the program, IPRE's technology is robust, easy to use, and affordable—with a target price equivalent to that of a college textbook. IPRE's early results have shown that when each student purchases a personal robot with the class textbook, attraction and retention of students to computer science improves—sometimes dramatically.

Microsoft has also sponsored leading educational robotics competitions, including Dean Kamen's FIRST Robotics Competition for K–12 students and RoboCup, an international robotics competition for both K–12 and university students.

Games for Learning

Another approach to engaging students in STEM learning experiences is through the use of computer gaming. For more than five years, Microsoft External Research has worked with a number of universities to produce gaming kits and assessment studies and has supported research in this area by award-

Kodu screen shots.

ing academic funding and helping to launch initiatives such as the Foundations of Digital Games conference series.

In 2008, Microsoft co-founded the Games for Learning Institute (G4LI), a collaborative research endeavor undertaken by Microsoft Research, New York University, and a consortium of other universities in New York state. G4LI researchers are working to identify how computer gaming can be used to more effectively teach science, math, literacy, and other academic skills. In particular, the researchers are working to identify which qualities of computer games engage students and how to use them in developing relevant,   personalized teaching strategies. The initial research focuses on evaluating computer games as potential learning tools for STEM subjects during the middle school years (grades 6–8). The institute is working with a broad range of student populations, with particular attention paid to underrepresented middle school students such as girls and minorities. All research results will be shared widely with educators, software and game developers, and other researchers who are interested in developing games that are useful as educational tools.

Kodu

Microsoft is finding ways to engage even young children in the basic concepts of computer programming. One example is Kodu, a new icon-based visual programming language that enables kids to create their own games for the Microsoft Xbox® gaming console. A PC version is available for beta testing in schools.

More information about these and other tools is available at the free download site that Microsoft Research set up in recognition of National Computer Science Education Week.

Teaching Tools and Curricula

Microsoft is developing tools and curricula that will open vast new opportunities for teaching and learning science. One example is Microsoft Research's WorldWide Telescope, which compiles enormous amounts of image data from land- and space-based observatories. Through a Web-based browser, users can pan across the night sky or zoom in on galaxies, stars, and planets. Since its launch in 2008, the WorldWide Telescope has been downloaded more than 2 million times in research facilities, classrooms, and homes around the world.

Another exciting exploratory tool is a new Web site called Be A Martian!, a joint effort of NASA and Microsoft. Using Microsoft's new Azure™ platform, which allows information to be stored in the cloud, the site allows students to view hundreds of thousands of images of the Red Planet. One of the primary objectives is to spur interest in science and technology among students.
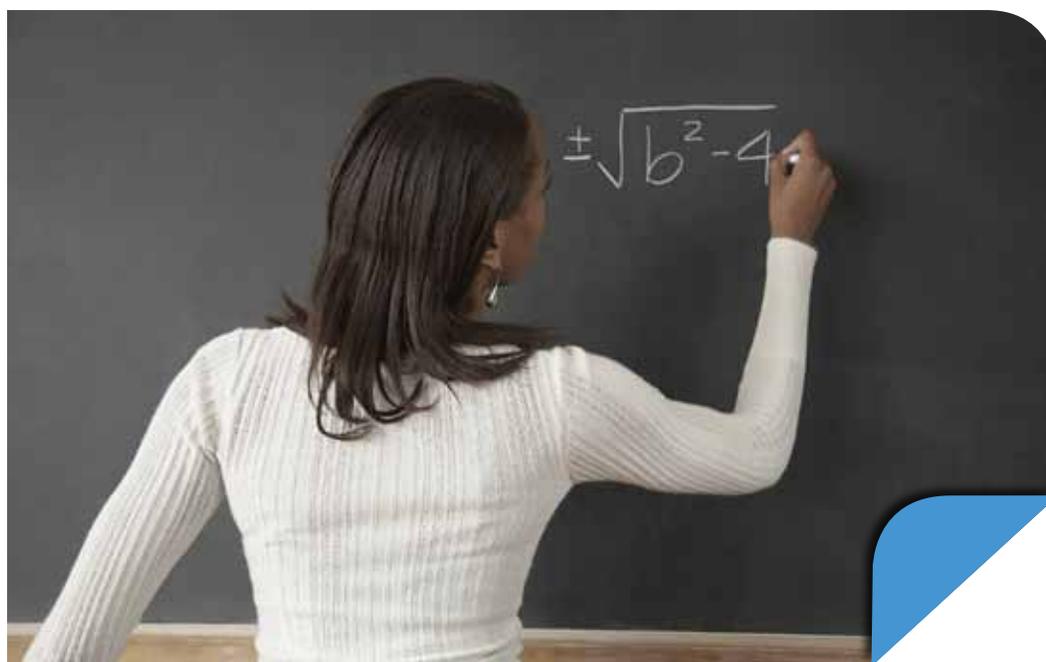
Policy Recommendations

Improving math and science education and inspiring young people to study and pursue careers in STEM fields will require vision and commitment by government and education leaders and support from industry. Here are some ideas and recommendations that we believe are essential to improving STEM education in the United States:

- As a society, we need to increase our investment in education systems that enable students to gain a solid foundation in STEM subjects as well as in STEM-related disciplines such as computer science.

- Public and private sector stakeholders should work together to enhance existing investments in STEM education. We encourage public-private partnerships such as the Washington STEM Center, a new nonprofit effort that aims to accelerate improvements in the state's K–12 education system and dramatically increase the number of graduates ready to enter STEM post-secondary degree programs and careers.

- Governments should use core standards and assessment programs to stimulate development of consistent and aligned STEM and workforce education at the primary, secondary, and post-secondary levels.

- We need to foster a strong pipeline of educators who are effective at teaching STEM subjects and are skilled at using technology by taking measures such as the following:

  ◦ Putting greater emphasis on providing professional development opportunities and establishing evaluation systems that help and reward teachers who are dedicated to improving their instructional practice.

  ◦ Making it easier for professionals with expertise in STEM fields to become certified teachers.

  ◦ Supporting the National Science Foundation's effort to put an additional 10,000 new computer science teachers into the field by 2015.

  ◦ Allowing for differential compensation structures that make it easier for schools to recruit and retain top-quality STEM teachers.

- We need to place greater emphasis on encouraging and helping more women, low-income individuals, and minorities to pursue careers in STEM fields. These efforts should start early. For example, by recruiting and training more women and minorities to teach math and science, we can engage and inspire more girls and minority students in those subjects.

- Our current approach to computer science education must be revamped, especially at the high school level. For example, computer science courses could be classified as math or science so students can gain academic credits that count toward graduation requirements. Computer science curricula and assessments, including Advanced Placement, should also be revised to better prepare students for the broad range of computing environments in the real world.

- Education leaders can increase the odds of STEM success by encouraging formation of innovative new school models and school networks that partner with museums, research centers, and STEM-based industry partners. Such new models can help provide students with an enriched, engaging, and challenging STEM education.

- Workforce training systems must be improved and expanded to meet the needs of all workers—including the underemployed, the unemployed, and students who lack requisite skills. Everyone entering or already in the workforce should have access to the resources they need to become a lifelong learner who can adapt to an ever-changing workplace. We currently do not have the resources as a society to meet those needs. Technology will be the critical ingredient in helping to scale employment services to millions of workers through increased use of "virtual" one-stops and industry-recognized online certification programs.

Conclusion

Social trends and global competition have created challenges as well as opportunities for U.S. businesses and the U.S. workforce. The good news is that this country is still a leader in scientific and technological innovation, and jobs in STEM fields will continue to be available for those who are qualified. But to maintain the country's position as an innovation leader, we must address the shortcomings in our STEM education.

In comments recognizing President Obama's leadership in making STEM a national priority, Microsoft CEO Steve Ballmer said, "Public and private partnerships to promote STEM are critically important. We all have a vested interest in advancing our country's proficiency in the disciplines of science, technology, engineering, and math as a means to driving innovation and jobs—which are key to fueling our economic growth and global competitiveness."