Woodrow Wilson
International
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Science, Technology, America and the Global Economy

STAKEHOLDERS IN STUDENT SUCCESS:

PUBLIC-PRIVATE PARTNERSHIPS STRENGTHENING K-12 EDUCATION

A Report by Jacqueline Nader
Edited by Kent Hughes

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Available from :

Science, Technology, America, and the Global Economy
Woodrow Wilson International Center for Scholars
One Woodrow Wilson Plaza
1300 Pennsylvania Avenue NW
Washington, DC 20004-3027

www.wilsoncenter.org/stage

ISBN 1-933549-47-5

December 2008

Cover Photo:

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ACKNOWLEDGEMENTS

The Program on Science, Technology, America, and the Global Economy especially thanks the Petrie Foundation for making the program's focus on education and the completion of this report possible.

The conferences held by the STAGE Program over the last year were made successful by its dedicated speakers. We extend our appreciation to all our panelists, especially those that traveled long distances in order to participate. Special thanks goes to the Albert Einstein Distinguished Educator Fellows of 2007-2008, who provided essential insight and commitment to our program and to these events.

We would also like to thank the co-sponsors of the conferences, including the Wilson Center's Asia Program, the U.S. Department of Education, the National Center for Women & Information Technology, the Association for Computing Machinery, and the Computing Research Association.

A number of people at the Wilson Center were instrumental in the preparation of the conferences and of this report, including Jane Mutnick, Amy Wilkinson, Susan Nugent, Elizabeth Byers, Sarah Eversman, Nicholas Mills, Andrew Polk, and Timothy Valley. Thank you all for your extensive time and effort.

INTRODUCTION

Ensuring that every child grows up with a strong education is a deeply rooted American value. Over time, however, the basic preparation that American students need to succeed in the world has changed. Now, with a competitive global economy and the importance of technology in the fields of health, energy, and engineering, the United States must improve its education system to give all students, regardless of ethnic or economic background, the skills to face these challenges and seize the opportunities available to them. With this objective in mind and with a generous grant from the Petrie Foundation, the Program on Science, Technology, America, and the Global Economy (STAGE) has brought together leading thinkers from the worlds of business, government, and the classroom in order to discuss the best possible ways to move the U.S. education system forward. Giving special attention to math and science subjects as essential for the development of critical-thinking and problem-solving skills, the program's education project has highlighted some of the most successful initiatives and best new ideas to give every American student a world-class education.

THE CHALLENGES AT HAND

There are many different groups with high hopes for American students and great expectations for their educational progress—the parents that raise them, the companies that want to employ them, and, indeed, all American citizens that hope for a prosperous, productive, and well-informed populous. All parties have reasons to be concerned: twenty-four percent of all students do not complete high school, the education gap between minority and non-minority students is high and stagnant, and the scores of U.S. students on international tests are well below those of other industrialized nations. Furthermore, the United States lags behind other countries in producing high-performing students—thirteen countries had higher percentages of top scorers on the 2006 PISA science assessment test* than the United States, including Germany, Japan, and the United Kingdom.[1]

* According to the Organisation for Economic Co-operation and Development (OECD), the Program for International Student Assessment (PISA) is "a triennial survey of the knowledge and skills of 15-year-olds. It is the product of collaboration between participating countries and economies through the Organisation for Economic Co-operation and Development (OECD), and draws on leading international expertise to develop valid comparisons across countries and cultures." An analysis of the 2006 PISA results can be found here: "http://www.oecd.org/document/2/0,3343,en_32252351_32236191_39718850_1_1_1_1,00.html#Vol_1_and_2" http://www.oecd.org/document/2/0,3343,en_32252351_32236191_39718850_1_1_1_1,00.html#Vol_1_and_2

There have been some notable K-12 education successes in the United States, including the improvement of socio-economic conditions for students from disadvantaged backgrounds, the expansion of early childhood education, and the establishment of charter schools and magnet schools. Still, there is no single solution that can push our education system forward, and a lot of work remains to be done in creating an innovative, flexible system that better reflects the reality of the twenty-first century world.

Preparing students to excel in higher education and live, work, and compete in a very technological and globalized world requires strong math and science courses at every level. Though the United States was the first country to establish a universal education system, giving every American citizen the opportunity for a bright future, other countries are now succeeding in educational innovation in ways that this country is not. Concerns over this trend are not new. They have come from such reports as *A Nation at Risk* (1983)[2] and, more recently, *Rising Above the Gathering Storm* (2007).[3] As further evidence of the need for innovation in math and science education, several information-technology, manufacturing, and engineering firms have been vocal in their inability to find well-prepared, high-tech employees. How, then, will our education system progress in order to offer all students the education they need and to guarantee that our strong economy will not be undermined?

INNOVATIVE EDUCATIONAL INITIATIVES AND POLICIES

This report is a resource for educational stakeholders, presenting a collection of initiatives and policies that have been making gains in student achievement and can be expanded to improve the U.S. education system, especially if they continue to engage all segments of the population—from the government to the private sector to teachers and parents.

The first section describes two multi-panel conferences, which were held at the Wilson Center with a follow-up session on Capitol Hill, to outline some of the most innovative and measurably-successful educational programs across the country. As partnership initiatives between businesses, schools, and universities, these programs have motivated both students and teachers and have ensured that even the most disadvantaged students are ready for college and the workforce. The first conference, held on February 27, 2008, focused on programs that have created new approaches to in-class instruction and after-school activities, with the goal of inspiring students and bringing their knowledge into the 21st century. The second conference took place on May 6, 2008, with a complementary Hill discussion the next day, to examine initiatives aimed at teacher support, including excellent undergraduate degree programs and professional development opportunities. This series of events demonstrated eye-opening successes in improving student performance and teacher preparedness. The

programs it highlighted form a set of promising models from which large-scale change in U.S. education could be possible.

The next section of the report summarizes the key findings of additional conferences and seminars, which were held to address national education issues and possible areas of reform. The first of these was in November of 2007, sponsored by the STAGE Program and the Wilson Center's Asia Program, to compare mathematics and science education in the U.S. with that of Japan, China, and Korea. Then, in April of 2008, three members of the U.S. Department of Education's National Mathematics Advisory Panel came to the Center to present their report on the current status of and need for reform in K-12 mathematics education, especially in the approach to pre-algebra and algebra subjects. Finally, in June 2008, the STAGE Program partnered with the National Center on Women in Information Technology, the Computing Research Association, and the Association of Computing Machinery to examine the role that a stronger K-12 computer science focus could play in preparing students for the future economy. These seminars had the combined effect of presenting possible system changes in education, including the implementation of national benchmarks, more in-depth textbooks, more effective teacher certification, and a greater commitment to the research of how various policies and administrative decisions affect student outcomes. They also questioned the traditional teaching of core K-12 subjects and pushed for more applicable and substantive classes that are cross-disciplinary in nature and more connected to the real world.

This report also includes a section on the experiences and perceptions of dedicated leaders in education, who give significant insights into how this country might improve its schools. These include former Congressman Sherwood Boehlert, former Chairman of the U.S. House Science Committee, Congressman Brian Baird, Chairman of the U.S. House Subcommittee on Research and Science Education, the Business Roundtable, the Business-Higher Education Forum, and the Albert Einstein Distinguished Educator Fellows. Together, their perspectives represent leading ideas in education, including the importance of a strong education system for a prosperous economy, the effect that U.S. culture has on student learning, and the need to support our teachers as the most fundamental way to improve student performance. Their experiences demonstrate the important role that government officials, business executives, teachers, and individuals can play in moving U.S. education forward.

Finally, the report details the STAGE Program's future plans to continue to act as a forum for an ongoing dialogue on national education. While continuing to highlight new programs and ideas focused on student learning and teacher support, it will also widen its reach to examine other forms of innovation in education. In addition to helping organize a regional competition of the "For Inspiration and Recognition of Science and Technology" (FIRST) organization in the District of Columbia in 2009, and following the ambitious reforms of the D.C. Public Schools Chancellor Michelle Rhee, it will examine the educational experiences of other parts of the country and

the world. The school system in New Orleans, which was restructured almost entirely after Hurricane Katrina, and the educational systems in European countries that perform well on international assessments can offer insights into what elements of schools, teaching, and school systems work best. The STAGE Program will also explore the achievements of educational entrepreneurs—inventive individuals, businesses, organizations, and foundations that are looking past the status quo to make gains in student achievement. Moving forward, the STAGE Program will continue to focus on bringing the discussion of these topics to congressional audiences, especially through the *Wilson Center on the Hill* initiative, which it also directs.

In these ways, the STAGE Program will continue to create an open dialogue on the challenges and successes of education in this country, highlighting innovative initiatives and perspectives in order to provide insight into the development of a U.S. education system that gives all students the best opportunity to learn, for their futures and the strong future of this country.

PART I: MODELS OF OUTSTANDING EDUCATIONAL PROGRAMS: PARTNERSHIPS TO IMPROVE STUDENT PERFORMANCE AND TEACHER PREPAREDNESS

While national progress in education has lagged behind the needs of our students, especially in a time of globalization and technological innovation, several cutting-edge programs have sprung up in individual communities, sometimes expanding into nationwide networks, to take on educational problems from the bottom up. These initiatives have formed as a result of partnerships between schools, businesses, non-profits, and universities, who share a common goal of ensuring that our nation's students are all well-prepared for higher education and the workforce. They have recognized the importance of closing the achievement gap between minority and non-minority students, of ensuring that all students are taught necessary hands-on, critical thinking, teamwork, and communication skills, and of inspiring students to aim high. Their work has been important both in improving the lives of individual students and in strengthening the foundations of our nation's economy and society.

Several of these programs have focused directly on current students and how learning can be improved. Their achievements have been remarkable. Vast numbers of students, most of them from disadvantaged backgrounds, who had been several grade levels behind in math and science, are heading off to college. And, students who never would have thought of math and science as exciting subjects are now motivated to learn and excel in these fields.

Other initiatives have worked to advance teacher preparation and development, with the idea that just a few great teachers can change the lives of hundreds of students. Undergraduate math and science majors are being attracted to the field of teaching and are experiencing the classroom and the techniques of master teachers long before graduating into the teaching workforce. Meanwhile, current teachers across the country are taking part in professional development opportunities to keep their knowledge and skills on track with top-of-the-line instructional methods and global workforce needs.

A FOCUS ON THE STUDENTS

A conference on Wednesday, February 27th, 2008 brought together representatives of some of the most impressive initiatives across the country that are focusing on

our students and raising their academic performance. The discussion, entitled *Building Blocks: How Schools and Businesses Can Partner to Improve American Education,* featured the Knowledge is Power Program, the Cristo Rey Network, the NativityMiguel Network of Schools, Project Lead The Way, FIRST, and Make the Connection. **Kent Hughes**, who moderated the conference, described the key elements of these programs that have led to their success in improving student learning: high expectations, constant improvement of school instruction, effective outreach to communities and parents, school flexibility, and longer school days, weeks, and years. He went on to stress the element of inspiration, which runs through all six programs, and the role that businesses can play: "We need to motivate young people and we need to bring the real world into the classroom. To that end, corporate support is essential—in providing funding, volunteers, and role models."

THE KNOWLEDGE IS POWER PROGRAM (KIPP)

The Knowledge is Power Program is a public charter school network that has raised the nation's perceptions and expectations of what low-income and minority students are capable of achieving. Its creativity in educational instruction and flexibility in running schools have fostered students that are engaged in academics and performing at very high levels. Currently, its 66 schools across the country serve 16,000 students—80 percent of which are low-income and 90 percent of which are African-American or Latino.[4]

Allison Fansler, President and Chief Operating Officer of KIPP DC, gave some background on the nationwide program. She explained that KIPP schools have an extended day, week, and year with a focus on the usual academic subjects, plus extracurricular activities. The KIPP website gives a transparent and public account of its success: nationwide, only about twenty percent of low-income students continue on to higher education, while "more than 80 percent of KIPP alumni have gone on to college." In a commentary for *Forbes*, Mike Feinberg, one of the two founders of KIPP, explains that success: "From Day One, the basic premise has been that there are no shortcuts to academic success. KIPP schools are primarily public charter schools, where principals receive less funding than traditional public schools but greater freedom to hire

"KIPP schools are primarily public charter schools, where principals receive less funding than traditional public schools but greater freedom to hire the best teachers, manage the budget and extend the school day, week and year."

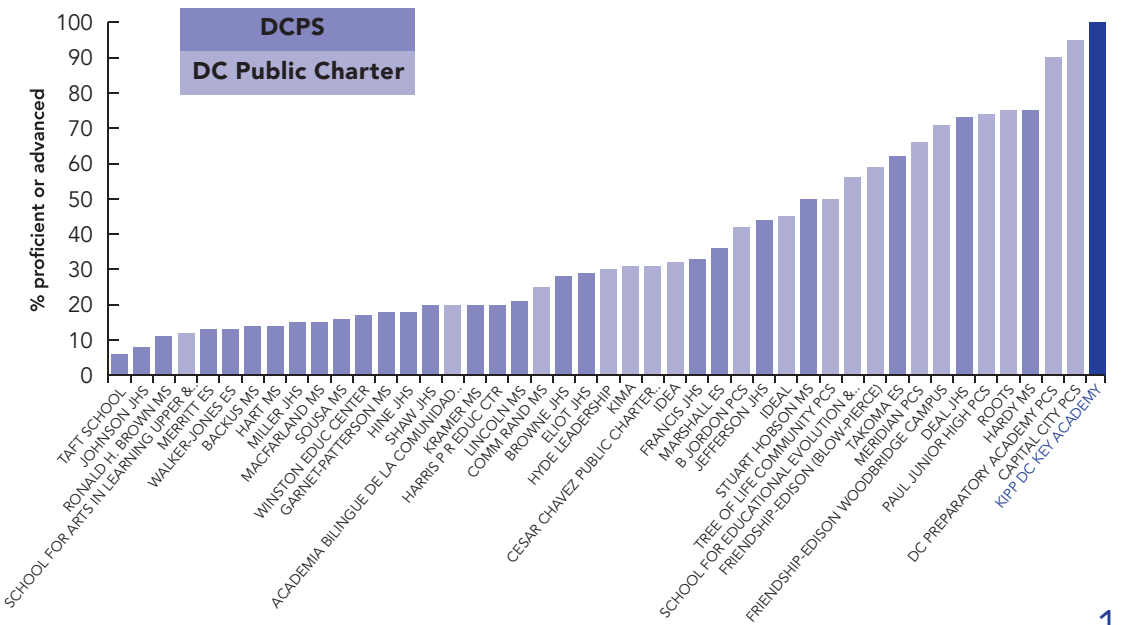
—Mike Feinberg, co-founder of KIPP

the best teachers, manage the budget and extend the school day, week and year."[5]

Within the District of Columbia, KIPP DC runs four schools—KEY Academy, AIM Academy, WILL Academy, and LEAP Academy—and has plans to open two more in the next few years. Fansler described the current student body: more than 75 percent of its students are eligible for free or reduced lunch and 99 percent are African-American. The KIPP schools in the District have been very successful, forming the "highest performing network of charter schools in D.C.," said Fansler. Additionally, the District of Columbia Comprehensive Assessment System (DC-CAS), which is administered each April to assess students in math, reading, science, and writing, shows that 80 percent of 8th grade KEY Academy students are proficient in reading and 100 percent of them are proficient in math. This makes KEY Academy "the highest performing middle school in the District of Columbia."[6]

A key factor instrumental to KIPP's success is the involvement of corporate partners that support its teachers and administrators. **Brittany Lothe**, director of Corporate Citizenship at SAP Americas and a KIPP DC board member, spoke about one such partnership. SAP, the third-largest software company in the world, works nationwide with eighteen communities that have KIPP schools, focusing on math and science. Not only does it commit to multi-year funding of the program

MATH: PROFICIENT & ADVANCED - DC CAS SPRING 2007 - 8TH GRADERS



Source: Data provided by OSSE Office of Accountability & Assessment 2/13/2008

and contribute computer lab and software equipment to the schools, but its employees also serve as mentors and tutors for the students. That direct relationship builds teamwork and connects the students to real-world opportunities in the fields of math and science.

Both Fansler and Lothe stressed that the partnership is very important. Fansler emphasized that its effectiveness is a result of the fact that the businesses are willing to work very closely with the schools, with great respect for the KIPP teachers and the organization's expectations. Lothe added that she and her colleagues treat the partnership like a product launch—with a timeline and assessments of progress. According to Lothe, SAP benefits from the partnership in several ways: a more developed workforce, a national presence, and an "association with excellence." Ultimately, open and honest communication and clear expectations strengthen the school-business bond and make the schools more effective.

THE CRISTO REY NETWORK

The Cristo Rey Network is equally progressive in its approach to student learning. A nationwide network with 19 high schools serving 4,200 students[7], this program combines a traditional education, a religious education, and a corporate work study program. This innovative educational design has attracted national attention—from the Bill and Melinda Gates Foundation, which has invested more than $15 million in the network[8], and from *Newsweek*, CBS' 60 Minutes, and the U.S. Department of Education, which have all publicized success stories from the Cristo Rey schools.

The schools are located in urban areas throughout the country and generally use federal reduced lunch guidelines to give preference to low-income students. Minority students tend to form the majority of the Cristo Rey student body. For example, **Fr. Steve Shafran**, president of the Don Bosco Cristo Rey High School, explained that his school, which is located in Takoma Park, Maryland, opened in August 2007 with a student population that is about 50 percent Latino and 50 percent African-American.

Shafran presented the network's accomplishments: 93 percent of its corporate sponsors renew each year and 99 percent of its students go on to college. What has created the considerable success of the network's students? **Alicia Bondanella**, executive director of the Corporate Work Study Program at the school, described how the program works.

Bondanella explained that all students of the Cristo Rey Network perform entry-level jobs for local companies in addition to attending all their required classes. The program works because students can attend a longer school day for four days a week, and then work at a business for one day a week, plus one extra day per month. In this way, four students can share one job, which is normally an administrative temporary

position at a local company. The nationwide network has 700 corporate sponsors—utilizing "businesses as educative partners."

This arrangement originally began as a way for students to pay most of their way through high school. In fact, the students earn about 65 percent of the cost of their education through the corporate work study program.[9] However, the value of the program is much greater, as it has also grown to be a strong element of the students' education. They learn all aspects of the business world: how to dress professionally, how to communicate, and how to work in teams. One student explained the benefit she gets from working for a prominent company through a school that motivates her to succeed: "They make you believe that you're somebody and that you can achieve anything. They believe in us so much that they send us to the outside world to learn all we can."

One student explained the benefit she gets from working for a prominent company: "They make you believe … that you can achieve anything. They believe in us so much that they send us to the outside world to learn all we can."

According to Robert Birdsell, President of The Cristo Rey Network, "The Cristo Rey model is the most exciting innovation there is in high school education. Every one of our students is an inspiration. By working, they're gaining tremendous insights that will serve them for the rest of their lives."[10]

THE NATIVITYMIGUEL NETWORK OF SCHOOLS

The NativityMiguel Network of Schools also focuses on working with urban, minority students and preparing them for college, but they do so at a middle school level, which is a very critical developmental age for students. The network has 64 schools across the country, with a total of 4,400 students, and is hard at work in its mission to break the cycle of poverty.

Like KIPP and Cristo Rey, the NativityMiguel schools have a lengthened school day and year. **Joseph Powers,** Headmaster at Washington Jesuit Academy (WJA), which is located in Washington, D.C., explained how the school gives students much more than a basic education: the school itself provides breakfast, lunch, dinner, and extracurricular activities. The school day is a whopping 9.5 hours long.[11] Further, local professionals step in to provide tutoring and homework help.

The longer day and the school's requirements of the students "move the bar up [and] move the floor up too." In other words, students are held to high expectations, but are also given a solid foundation and the resources they need to achieve academically. Powers stressed that the school is an ongoing support system for its students, as it

tracks them through high school, keeps up with their future grades, and holds college nights to continue to motivate them.

The results are clear. According to the NativityMiguel Network website, "nearly 90 percent of our alumni graduate high school—that's 39 percent more than comparable students in other schools."[11]

Greg Naleski, the vice president of development at the NativityMiguel Network, said that the national organization provides the schools with professional development for its teachers and college visits for the students, but not funding—the schools themselves raised $52.8 million from corporations in 2007.

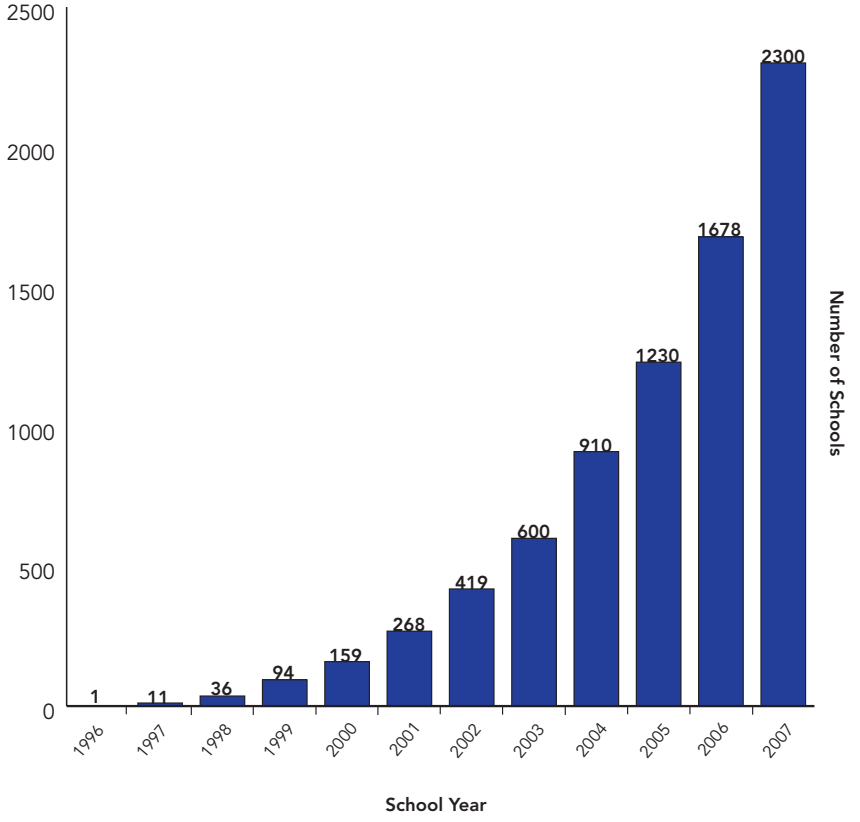
PROJECT LEAD THE WAY

Project Lead The Way (PLTW) is a nationwide non-profit organization, which takes another approach to engaging and motivating students—working in existing schools of all kinds to enhance engineering, biomedical, and agricultural curricula, with an extra effort to reach out to girls. **Niel Tebbano**, vice president for operations at PLTW, explained that the program was founded in 1996 by industry leaders in order to meet workforce needs and, today, it is in over 2,300 schools across the nation, reaching more than 200,000 students. The *Rising Above the Gathering Storm* (2007) report cites it as a model for how to adapt curriculum materials to real-world needs and standards. Tebbano emphasized the strength of the program is its "rigorous, relevant curriculum."

Tebbano explained that Project Lead The Way coordinates with middle schools and high schools to create opportunities for students to take in-depth engineering coursework on top of their required core curriculum. In the high school program, called "Pathway to Engineering," students take such classes as "Principles of Engineering" and "Digital Electronics," all of which are project-based and foster higher order


Photographer: Adrianna Groismann

GROWTH IN NUMBER OF SCHOOLS WITH PLTW ENGINEERING CURRICULUM



Source: Niel Tebbano, Vice President at PLTW

thinking. This type of learning is supported by the strong skills of the teachers, which are developed through ongoing professional development opportunities.

The outcome of the program is that the students gain skills in critical thinking, problem resolution, and group collaboration. For example, Tebbano shared the story of one student in Saratoga Springs, NY, who worked with local Amtrak engineers to program her cell phone so that it could start her car engine and turn on the heat before she had to leave her house in cold winter months.

Tebbano emphasized that "partnerships are key" to the program's success in reaching out to students and showing them where their academic success can take them. He believes that the PLTW experience can be used as a "guidebook…for the efficient use of professional mentors in the classroom."

Steve Smalley, an advisory engineer at Northrop Grumman, represents one of those key partners. "Getting the engineers in the classrooms is a very important piece," he said. A company such as his, he explained, which will need to hire about 17,000 qualified technical graduates next year, must be invested in the educational needs of American students. In addition to PLTW, Northrop Grumman also provides funding, support, and mentors to educational programs such as the Mathematics, Engineering, Science Achievement (MESA) Program, DiscoverEngineering, and For Inspiration and Recognition of Science and Technology (FIRST), among others.

FOR INSPIRATION AND RECOGNITION OF SCIENCE AND TECHNOLOGY (FIRST)

FIRST is a program that takes the students out of the classroom and into fun and exciting tournaments to learn about science and technology. In after-school hours, teams of students are paired with engineer mentors to build robots they later take to compete at regional, national, and even international competitions. The idea behind FIRST is to motivate students and take them out of the mindset that science has to be boring and difficult. How? It infuses learning with both teamwork and competition, or "coopetition."

Paul Gudonis, FIRST president, explained that most students think that math and science are "important, but not for me." The FIRST Robotics Competition and FIRST Lego League are changing that. They model the learning experience after sporting events, with the idea that "kids look up to adults doing cool things."

Started by Dean Kamen, who invented the Segway and a host of other innovations, the FIRST Robotics Competition alone involves about 40,000 high school students and 64,000 volunteers annually. Some 9,000 middle schools now participate in FIRST Lego League and a version has also been developed for elementary

Photographer: Adrianna Groismann

schools. For the program to affect all U.S. students and the culture of math and science education as a whole, however, it has to grow further still. According to Gudonis, only 5 percent of all U.S. grade schools currently participate in FIRST.

Surveys of students and coaches at the competitions demonstrate the effect that the program has on the students' interest in the fields of science and technology. In the opinion of the coaches, more than 85 percent of the students want to learn more about computers, robotics, science, and technology. Of the students themselves, about 90 percent stated that they see the usefulness of school subjects to solve real-world problems and said that they are interested in science and technology careers.

FIRST is a program that takes the students out of the classroom and into fun and exciting tournaments to learn about science and technology.

The effort that the students and mentors put into the competitions is huge, but Gudonis explained that the cost of the program is only about $400 per student at the high school level, which is less than the cost of a typical sports uniform.

Picking up the costs and the scientific brainpower are the corporate sponsors, whose employees get involved as mentors, advisors, judges, and coordinators. One of these sponsors is BAE Systems, which is the third-largest aerospace corporation in the world. **Len Hawkins**, a vice president at BAE, explained that the company has supported FIRST since the early 1990s and, in 2008, it directly supported more than 60 teams.

He described the benefits to both the students and the business partners. Though most students look up to athletes and Hollywood stars as their role models, Hawkins gives them a different message at the FIRST competitions: "If you are a young person aspiring to be a mathematician or scientist, your chances of success are 100 percent." FIRST shows students that engineering and science are fun, exciting, and valuable in the real world, so that they are motivated to gain the academic skills that will give them those career opportunities. For companies, the program "represents [an] investment in a future high tech workforce."

MAKE THE CONNECTION

Make the Connection is inspiring students in another way—by changing girls' perceptions of mathematics, science, and technology and exposing them to careers in these fields. The program brings together teenage girls and corporate mentors in a series of events, which not only give the girls an up-close look at real jobs, but also foster the development of teamwork and leadership skills. So far, it has involved 180 mentors and has reached 555 girls, at least 30 percent of which are from low-income families and 40 percent of which are racial or ethnic minorities.

The program was created about three years ago by **Rebecca Patton**, who works at Booz Allen Hamilton as a technical leader on environmental projects and is a member of the Women's Advisory Board of the Girl Scout Council of the Nation's Capital (GSCNC). She brought the company and GSCNC together to run the program, following from the Girl Scout mission to give girls "courage, confidence, and character" and the Booz Allen Hamilton philosophy of global citizenry and creating social change.

Patton's aim was to bridge the gap between the image girls have of math and technical jobs and the real success that they could have with careers in these areas. She said, "there are lots of myths we get to bust" in the program, like the idea that all mathematicians become accountants.

The program is comprised of four events throughout the school year, with activities designed for groups made up of six girls and three mentors. At the first, girls are introduced to the career world—they get to play with new, high-tech gadgets at a technology petting zoo, speak about personal topics with a group of professional women, and make a career inventory based on their interests. At the second and third events, they discuss balancing school with friends and parental expectations, they learn how to write a résumé and present themselves professionally, and they work as teams to complete a challenge course. The final event is a celebration with an inspirational speaker. As the girls get to know their mentors and take part in these real-world tasks, they are able to see more clearly what the corporate world of technology, science, and math is all about.

Patton explained that the mentors have a challenging task, as the "hardest thing [they will] ever do is try and explain to a 13-year-old what they do for a living." But, it pays off, because the girls see how far their female mentors have gone in the world of science and technology—and can begin to picture themselves there too.

A FOCUS ON THE TEACHERS

Excellent teachers are at the core of any successful education system. Today, science and math teachers have significant opportunities and challenges in the classroom—preparing students for the globalizing world, handling diversity and closing the achievement gap, incorporating technology into learning, and inspiring young people through discovery and innovation. Their work shapes students' minds, and, in turn, the future of our American citizenry and workforce.

From an understanding of the great importance of teachers, a conference was held at the Woodrow Wilson Center on Tuesday, May 6, 2008, with a corresponding event on Capitol Hill the following day, to discuss new initiatives in teacher education and support. **Kent Hughes**, moderator of the program, explained its focus: "how pragmatic partnerships, involving business, government, universities, and other

institutions, can have a very positive impact on preparing teachers for science, technology, engineering, and mathematics (STEM) subjects when they are *all* pulling in the right direction."

NATIONAL MATH AND SCIENCE INITIATIVE & EXXONMOBIL

The National Math and Science Initiative (NMSI) is a public-private partnership between some of the most dedicated schools and universities in the country and numerous private entities, including the ExxonMobil Corporation, the Bill and Melinda Gates Foundation and the Michael and Susan Dell Foundation. It works towards transforming K-12 math and science education in the United States in two ways. First, it is funding and spreading the Advanced Placement (AP) course program and, second, it is duplicating undergraduate teacher education programs that are proven to work.[12]

Why have these universities and businesses taken up the work of improving U.S education and better preparing its teachers? The NMSI website points out that U.S. students are lagging behind their international counterparts on math and science tests. Further, "about a third of high school math students and two-thirds of those enrolled in physical science have teachers who did not major in the subject in college or are not certified to teach it." Not only does this affect the students' futures, but also the future of our country.

Additionally, NMSI is responding to a race gap in these fields: "In 2000, only 4.4 percent of the science and engineering jobs were held by African Americans and only 3.4 percent by Hispanics."

Gerald McElvy explained that the shortcomings of the U.S. education system make up a "quiet" crisis, because it takes time and understanding to demonstrate how drastically America's poor education performance will affect future innovation and long-term U.S. competitiveness.

Gerald McElvy, president of the ExxonMobil Foundation, spoke at the Wilson Center and on Capitol Hill about the foundation's involvement in education and its $125 million commitment to NMSI. Mentioning the *Rising Above the Gathering Storm* report, he explained that the shortcomings of the U.S. education system make up a "quiet" crisis, because it takes time and understanding to demonstrate how drastically America's poor education performance will affect future innovation and long-term U.S. competitiveness.

In response to this crisis, one of the main objectives of NMSI is to spread "proven-effective" teacher education programs across the country. Its model is the UTeach program of the University of Texas at Austin, which has had ten years of evident success. McElvy explained that NMSI began supporting 13 UTeach-type programs across the country in its first year, after having received 52 preliminary proposals. It

hopes to increase the number of grantees to 55 in the next five years—leading to 5,000 new teachers.

In closing, McElvy emphasized the substantial positive impact that added government support could make in furthering NMSI's goal of stronger U.S. math and science education. He stressed that appropriations under the America Competes Act*, along with the commitment of state education authorities, will be "very important" in helping these effective teacher education programs to grow further.

UTEACH AT THE UNIVERSITY OF TEXAS, AUSTIN

Why was UTeach chosen as a model example of teacher education, to be replicated across the country by the National Mathematics and Science Initiative? UTeach is a program at the University of Texas at Austin that was established to respond to the shortage of excellent math and science teachers in the country. Its aim is to attract math and science undergraduate students to the field of teaching and, in their four years at the university, give them a strong education in both content knowledge and effective teaching methods.

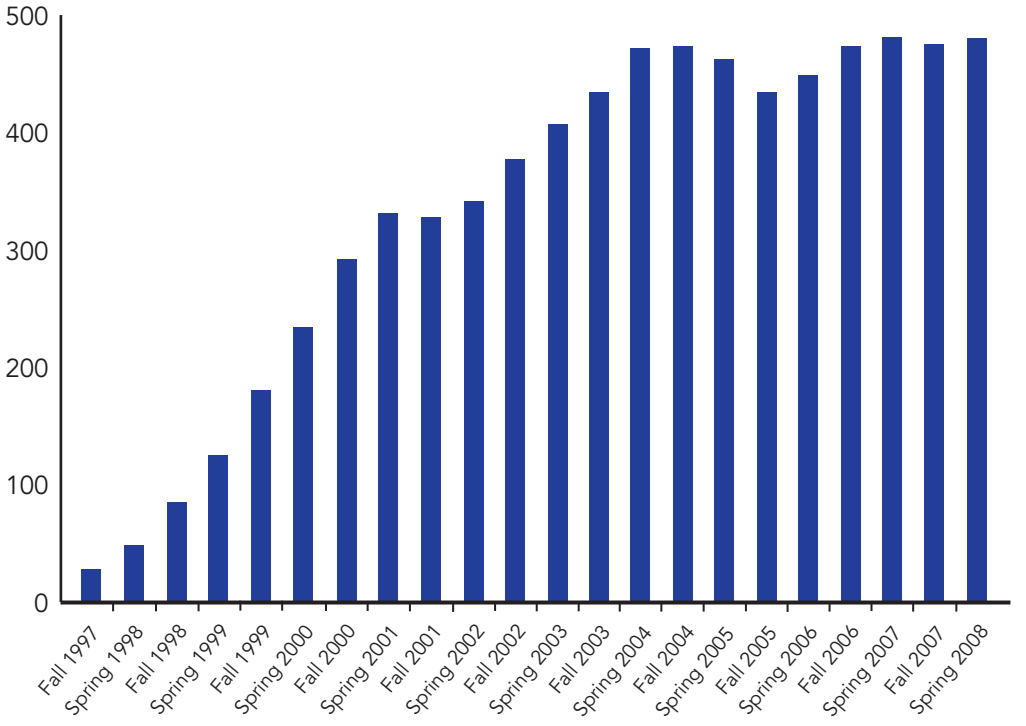
Mary Ann Rankin, dean of the College of Natural Sciences at the university, described the program's success. She explained that, since the creation of UTeach in 1997, enrollment in teacher preparation among the undergraduates has risen sharply. In fact, the UTeach website shows an increase in enrollment from less than 50 students in 1997 to almost 500 students in 2007.[13]

Not only are more undergraduates, and particularly math and science majors, getting interested in the teaching field, but a large majority of them are graduating into the teaching profession. According to Rankin, over 85 percent of UTeach graduates become teachers. Moreover, 92 percent of those that begin teaching are currently teaching, and 70 percent are still teaching even 5 years after graduation. About half of them teach in schools that are generally hard to staff, where a majority of students receive a free or reduced-price lunch. In the context of a national problem of teacher attrition, these are very striking numbers.

Rankin described the key elements that make the program so successful at bringing math and science majors into teaching and then preparing them adequately for a teaching career. Because students at research universities tend to be discouraged from teaching, UTeach attracts students by offering the first two courses tuition-free—

* According to the official website of the White House, in August 2007, "President Bush signed into law the 'America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act' (America COMPETES). This bill shares the goals of the President's American Competitiveness Initiative (ACI), a comprehensive strategy to keep America the most innovative nation in the world by strengthening our scientific education and research, improving our technological enterprise, attracting the world's best and brightest workers, and providing 21st century job training." More information can be found at: http://www.whitehouse.gov/news/releases/2007/08/20070809-6.html

UTEACH ENROLLMENT



Source: Michael Marder, November 2007 Brief UTeach Overview

courses that actually allow them to try teaching in the classroom. Further, the program aggressively recruits students, offers field experience at every level, makes it possible for students to complete the program along with another major in just four years, and then continues to support students post-graduation.

Rankin attributes the "life of the program," however, to its "master teachers." From the College of Natural Sciences, the College of Education, and local high schools, these expert practitioners have worked together to develop innovative content and pedagogy courses, reflecting modern knowledge of how students learn best. She added that the College of Natural Science has taken a leading role, which is necessary for stronger math and science teacher education.

Moving forward with the process of replicating UTeach, Rankin pointed out that most universities are accustomed to getting grants for their own new program ideas, rather than copying a model that works. For university education programs across the country to experience the success that UTeach has seen, however, they should work to maintain its key ingredients.

SCIENCE AND MATHEMATICS INITIATIVE AT THE UNIVERSITY OF CALIFORNIA SYSTEM

The University of California (UC) system is also involved in new teacher education programs, attracting math and science undergraduates to the teaching profession and ensuring that they have the right experiences and knowledge to do the job well. While a couple of the California universities are implementing the UTeach program under NMSI grants, a system-wide program has also been developed to involve all of the UC campuses, with plans to incorporate the California State University (CSU) system in the future. Called the Science and Mathematics Initiative (SMI) or "Cal Teach," this statewide effort was launched by Governor Arnold Schwarzenegger, former UC President Robert C. Dynes, and CSU Chancellor Charles Reed in 2005, and is backed by the state's key industries.[14]

Patrick Callahan, the executive director of SMI, explained that California, with 10 percent of the nation's students, has a significant interest in improving teaching. The goal of the program is to increase the number of new science and math teachers graduating from the UC campuses each year to from 250 to 1,000. Its slogan, "One Thousand Teachers, One Million Minds," demonstrates the rippling effect that this achievement could have on the students and the whole education system.

According to Callahan, part of the solution to the lack of qualified teachers is "changing the culture." He explained that most people think students have no interest in teaching, but, in fact, the UC Berkeley branch of SMI received 100 student applications just after its start. Callahan emphasized that science and math majors are motivated to teach when they see other students struggling with the subjects and when they recall their own past experiences with teachers who *didn't* succeed in inspiring them.

The Cal Teach program is honing in on that interest and working to attract first-year undergraduates and math and science majors to the field of teaching. Callahan explained the key elements that make Cal Teach appealing from the start: early field experiences, networking opportunities, and financial incentives. He emphasized that early classroom experience is the best way for students to know if they will like teaching.

Indeed, the relationships between the universities, community colleges, and K-12 schools, and the resulting field experiences, are a crucial part of the Cal Teach program. Callahan cited, "UC SMI students have worked with a total of 771 mentor teachers in 261 schools, working in classrooms a total of 25,374 times." Working in the field, undergraduate pre-teachers are able to observe, assist, and sometimes develop and teach lessons.

Callahan pointed out the benefit that K-12 schools see from the Cal Teach program right now. He quoted one mentor teacher as saying, "Young students always enjoy having

college students in the classroom. For some students, this is their first experience of 'seeing' a college student. It may help some elementary students see the option of university as a reality."

The Cal Teach program is strengthened by its commitment to self-evaluation and data collection, surveying both the undergraduate students and the K-12 mentor teachers. Callahan listed the continued development and refinement of a "robust quality indicator system," as a top priority as the program grows. Moving forward, he also hopes to better institutionalize the program and make connections with other university systems.

TEACHERS FOR A NEW ERA & THE CARNEGIE CORPORATION AT MICHIGAN STATE UNIVERSITY

The national Teachers for a New Era (TNE) project, supported by the Carnegie Corporation of New York and the Ford, Rockefeller, and Annenberg Foundations, is also a far-reaching public-private partnership focused on strengthening undergraduate schools of education. The program aims to refine and polish teacher education programs at universities that have deep roots in graduating excellent teachers. In addition, it seeks to stress to policymakers the importance of teacher preparation for a strong education system.

Robert Floden, a professor of teacher education at Michigan State University (MSU), and **Joan Ferrini-Mundy,** the associate dean of the Division of Science and Mathematics Education at MSU and currently the director of the National Science Foundation's Division of Research on Learning in Formal and Informal Settings (DRL), together co-chair the TNE program at MSU.

The nationwide program, they explained, is broad in its support for university schools of education. It gives grants to a "range of institutions, driven by promising ideas" rather than replicating one successful model across the country. Essential to the program and its participating universities, however, are three main principles: making decisions based on sound evidence, fostering engagement of the arts and sciences in teacher education, and supporting teaching as a profession.

Floden and Ferrini-Mundy pointed out a significant challenge in the evaluation of the success of the TNE program, and indeed of any teacher education program in the United States: the process of gathering evidence is made more difficult by a lack of state data directly linking teacher skills and knowledge to student performance.

The Teachers for a New Era program has made grants to eleven universities, all of which were already prestigious for the quantity and professionalism of the teachers they have graduated in the past. One of these is MSU, which alone produces about 75 secondary and 300 elementary school teachers each year.

Floden explained that MSU faculty members from the College of Education and the College of Natural Science have always worked together, but are doing so even more now.

As teams, they have studied teaching methods and looked at the importance of developing reasoning skills among K-12 students, which has led to stronger content and pedagogy courses for the pre-teachers. Floden emphasized that extra support from the NSF in assessing new objectives for student learning would be very beneficial in the development of even better teacher preparation.

Ferrini-Mundy added that the teams have developed "teacher knowledge standards" in mathematics, which emphasize that teachers should know the origins of mathematical concepts, use visuals and representation methods in class, and focus on the applications of mathematics.

The teaching program at MSU is also very concerned with gathering useful evidence, which could be used to improve teacher education across the country. It researches international comparisons in teaching methods, collects comprehensive data on the content knowledge of their graduating teachers, and is hoping to work with the state of Michigan to develop better data tying teacher excellence to student outcomes.

THE CENTER FOR SCIENCE AND MATHEMATICS EDUCATION AT STONY BROOK UNIVERSITY

At Stony Brook University, a less institutionalized approach is taking form, with the establishment of its own Center for Science and Mathematics Education to better prepare teachers and support them through every step of their education and career. **R. David Bynum,** a professor and director of the Center, explained that, without a school of education, the university has had to find innovative ways to do that.

This new program has focused on building a network to bring current teachers, pre-teachers, community colleges, and university faculty and students together. With support from the National Institutes of Health, the National Science Foundation, and the Petrie Foundation, the university has been able to offer teaching labs and workshops for undergraduate education students, graduate students of education, and current teachers. Moreover, it offers fellowships to teachers who have committed to teaching in high-needs schools.

One of the unique elements of the Center's professional development opportunities is that it puts in-service teachers in the lead, offering exactly the kind of support they want.

TRIANGLE COALITION FOR SCIENCE AND TECHNOLOGY EDUCATION

Several programs to enhance teacher education and support have been launched by non-profit organizations directly, rather than through universities or the private

sector. The first to be presented at the Wilson Center conference was the Triangle Coalition for Science and Technology Education. With members from the worlds of business, education, and scientific societies, the Coalition is a multidimensional organization. From this strength, it organizes conferences for teachers directly, along with other meetings and programs for representatives from the Department of Energy, Congress, the White House offices, and other policymaking bodies in order to discuss education issues.

Executive director **Vance Ablott** pointed out that most people underestimate the difficulties of teaching, thinking the solution to low educational performance is as simple as "if the teachers did a better job, the students would learn better." The Triangle Coalition, on the other hand, recognizes the complexities of education and student learning. It brings together teachers and other key stakeholders in education to focus on "providing a common view of where education is going."

Among the Triangle Coalition's key activities is the coordination of the Department of Energy's Albert Einstein Distinguished Educator Fellowship Program, which gives outstanding K-12 teachers the opportunity to work in a Congressional or executive agency office for a year.

It also sponsors programs to give teachers networking opportunities and experience in how education policies are made. Among the Triangle Coalition's key activities is the coordination of the Department of Energy's Albert Einstein Distinguished Educator Fellowship Program, which gives outstanding K-12 teachers the opportunity to work in a Congressional or executive agency office for a year. The fellowship pulls together the voices of teachers and policymakers, so that policy is better informed by real classroom experiences and teachers can understand the public policy process that underlies the education system.

DEPARTMENT OF ENERGY WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

Karen Stiner, a middle school teacher from Oregon and an Albert Einstein Distinguished Educator Fellow herself, explained the work of the office to which she was assigned for her fellowship year: the Department of Energy office of Workforce Development for Teachers and Scientists (WDTS).

Stiner explained that the WDTS program utilizes the vast resources of the Department of Energy's National Laboratories, which are all across the country, to offer professional development opportunities to pre-teachers and teachers. Its

objective is to help train the future workforce of the Department of Energy and that of the private sector and to give K-16 teachers the skills to add creativity and experience-based learning to their math and science classes.

Two of its main teacher professional development programs are the Pre-Service Teachers (PST) Program and the Academies Creating Teacher Scientists (ACTS) Program. The former, PST, is a ten-week summer opportunity for future teachers to work in a National Laboratory, giving them both added content knowledge and a firm grasp of hands-on learning to augment their education.

The ACTS program, on the other hand, allows current teachers to do research in a National Laboratory for four to eight weeks during the summer as a three-year commitment. The program gives them the opportunity to collaborate continually with both an experienced "master" teacher and a scientist mentor. Through their work at the laboratories, these teachers gain the focused, hands-on knowledge and the research experience to restructure K-12 math and science classes in order to give their students the same applied learning. As one ACTS teacher expressed, "I have learned so much and am excited to share my experiences with my students. In the classroom I encourage my students to ask questions, ponder new thoughts and ideas to construct their knowledge—to broaden and bring depth to their understandings."

AMERICAN SOCIETY OF ENGINEERING EDUCATION'S ENGINEERINGK12 CENTER

Another program offering support for current teachers and their continued learning is the American Society of Engineering Education (ASEE). **Kristen Farole**, the K12 Coordinator for the ASEE EngineeringK12 Center, explained that the ASEE has 500 member institutions and includes 80 percent of all engineering universities and colleges in the country. The EngineeringK12 Center was established in response to a call from the deans of those universities for ASEE to become more involved in K-12 teacher education and professional development.

The EngineeringK12 Center is essential for teachers looking for classroom resources, new technology, and a network for correspondence with other teachers. Its website explains that teachers can use engineering in their classrooms as the "academic glue" that holds concepts of math and science together and shows students how academic knowledge is applied in the real world.[15]

According to Farole, one of the many resources it offers teachers is Teachengineering.org, which provides free engineering curriculum modules, developed by five research universities to be most effective and also mapped to state and national standards.

Additionally, Farole mentioned that a new tool called "Engineering Go For It!" will be published soon as a handbook that high school teachers can give to their students to better connect them to engineering in the real world. The book will be something

that students can relate to, addressing "what engineering can do to shape the world" and what students should start to do now in order to pursue these important careers later on. It will show, for example, how engineering can help tackle climate change, a key topic on the news and in students' minds.

Farole explained that the Center also holds annual engineering education workshops, attended by about 200 teachers on average. An opportunity for teachers to see how they can best incorporate technology into the classroom, these workshops also create an ongoing network of high schools that teachers can rely on for advice and shared information.

Through these resources and networks, the EngineeringK12 Center "seeks to identify and gather in one place the most effective engineering education resources available to the K-12 community." Indeed, its website is a comprehensive display of information, links, and tips that are immediately accessible: www.engineeringk12.org.

PART II: SPECIAL TOPICS IN EDUCATION: INTERNATIONAL COMPARISONS, RESEARCH ON MATHEMATICS EDUCATION, AND THE IMPORTANCE OF INFORMATION TECHNOLOGY IN K-12 SCHOOLS

Beyond the STAGE Program's look at the exceptional new approaches to motivating students and supporting teachers, it has also examined cross-cutting topics in U.S. education. These separate sessions held at the Wilson Center ranged from an examination of Asian education systems in comparison with that of the United States, a discussion with members of the National Mathematics Advisory Panel on their recent report with recommendations to strengthen K-12 math classes, and a roundtable on how to put computer science education on every student's path to high school graduation. These conferences mirrored various elements of the two larger ones by emphasizing the need to rethink how students learn best and how the school system and its teachers could be most effective.

Ultimately, all of these conferences shed light on the features of the institution of U.S. education—how classes tend to be taught, which topics are covered, and what is expected of students. Then, they gave insights into which policies created the system as we know it and what could be done to tweak the system to better prepare students for a highly-globalized and technological world.

INTERNATIONAL COMPARISONS: WHAT THE UNITED STATES CAN LEARN FROM MATH AND SCIENCE EDUCATION IN ASIA

As educators and policymakers work to refine elements of the U.S. educational system, one way to test the effectiveness of new ideas or of traditional methods is to look at the experiences of other countries. In a conference on math and science education in China, Japan, and Korea, several panelists discussed differences from the United States system and compared its relative strengths and weaknesses. Held on November 14, 2007 by the Asia Program and STAGE Program at the Wilson Center, the event featured several experts on Asian education systems as well as U.S. Deputy Secretary of Education **Raymond Simon**, who discussed the problems and progress of math and science teaching in the United States. The panelists reiterated common concerns that U.S. students perform below average on international tests and asserted that this country could learn a lot from the successes that Asian educational systems have achieved.

Raymond Simon, who spoke both from his experience as a former high school math teacher and from his time at the U.S. Department of Education, explained the possible future direction of U.S. education. As the scores of U.S. students on international tests lag far behind those of many other countries, it is time for an adjustment in U.S. education, he said. Some change is already beginning to occur, with the passage of the No Child Left Behind Act and the establishment of the National Mathematics Advisory Panel, which could help set important standards in mathematics learning. However, Simon described another important challenge: the number of math and science teachers in the United States leaving the profession is greater than the number entering. He asserted that more respect and support needs to be given to our teachers and that high quality teaching should be distributed equally to all, including the poor. More broadly, the culture of the United States should place a higher value on education.

Vivien Stewart, vice president for education at the Asia Society, began the comparison of U.S. education with Asian education systems by explaining the Chinese system. With a population of 360 million students, China lacks the necessary resources to extend an upper secondary education system to many rural areas. In spite of this challenge, however, the Chinese Ministry of Education plays a key role in the education of all students: it sets clear national standards, and "everything aligns to that." This national continuity is in stark contrast to the United States, where states set the standards, resulting in a wide variety of teaching and learning methods across the country.

Furthermore, Stewart noted, the Chinese standards are set high. The core curriculum in China includes algebra, geometry, biology, chemistry, and physics, whereas general biology is the most challenging science course ever taken by 40 percent of U.S. high school students. Chinese schools also have longer days and years than do American schools, such that the average Chinese student spends the equivalent of two more years in school. Stewart also explained that, when compared with American teachers, more Chinese teachers of math and science, including teachers of very young students, have a degree in the subject that they teach.

The experiences of Japan and South Korea reiterate the importance of national direction. **Tadanobu Watanabe**, an associate professor of mathematics education at Kennesaw State University, explained that the Japanese ministry of education establishes a national course of study for all subjects and approves textbooks. In this sense, U.S. schools are at a disadvantage, because they use textbooks that are written to meet all the requirements and course topics of several states, resulting in books that are only loosely aligned with specific student needs. Watanabe also demonstrated that Japanese textbooks are more focused by holding up six Japanese mathematics textbooks, which combined were the size of just one common U.S. textbook.

Hyunjoon Park, assistant professor of sociology at the University of Pennsylvania, pointed out the success of South Korean students on international science and math tests and attributed that success to centralized standards, uniform teaching methods,

and standardized textbooks. He explained that Korean students on both ends of the curve do well: both top-scoring and low-scoring students do better than their international counterparts. Korean students even perform better than those of other countries on tests that evaluate problem-solving skills, countering the notion that Korean students test well only because of a system of rote learning and memorization.

As the successes of other countries, particularly Korea, Japan, and China, become more well-known to U.S. policymakers and education practitioners, perhaps the push towards setting high national standards or guidelines, combined with Simon's emphasis on teacher support and recognition, will gain momentum.

RESEARCH ON MATHEMATICS EDUCATION: THE FINDINGS OF THE NATIONAL MATHEMATICS ADVISORY PANEL AND THE POTENTIAL FOR CHANGING U.S. MATHEMATICS CLASSES

On April 3, 2008, the STAGE Program and the U.S. Department of Education co-sponsored a discussion with members of the U.S. Department of Education's National Mathematics Advisory Panel to discuss their recent report, "Foundations for Success." The panel was established under a Presidential Executive Order in 2006, charged with studying proven-effective mathematics curricula and teaching methods in order to suggest effective reform. It was made up of 25 diverse members, who surveyed teachers and reviewed over 16,000 research studies in order to pool knowledge on best practices in learning processes, curriculum, instruction, teaching, and assessment methods.

The members present to discuss their experiences on the panel included **Irma Arispe**, Assistant Director for Life Sciences and Acting Assistant Director for Social and Behavioral Sciences in the Office of Science and Technology Policy (OSTP) of the Executive Office of the President, **Vern Williams**, mathematics teacher at Longfellow Middle School in Fairfax, Virginia, and **A. Wade Boykin**, Professor and Director of the Graduate Program in the Department of Psychology at Howard University.

Irma Arispe outlined the main goal of the panel: to provide the U.S. President and the Secretary of Education with the optimal methods to advance the teaching and learning of mathematics, with a specific focus on preparation for and success in algebra. All three speakers emphasized the importance of learning algebra for students to later excel in college. According to the report, "students who complete Algebra II are more than twice as likely to graduate from college compared to students with less mathematical preparation."[16]

Williams explained that examining some of the newer mathematics programs used in schools today led him to "wonder where the algebra went." In turn, Boykin asserted that there should be better definitions of "authentic algebra courses." Williams added that math should be streamlined from kindergarten to 8th grade, a

practice used in many other countries that score well on international mathematics assessments. More specifically, students need critical foundations for algebra. The way to achieve this is by creating national benchmarks that guide curricula, textbook development, and state assessments.

Next, Boykin brought attention to the report's findings of how socioeconomic backgrounds and views on learning affect student performance. Low-income students tend to lag behind their peers, in part because children from families with low incomes, low levels of parental education, and single parents often begin school with less mathematical knowledge than children from more advantaged backgrounds. Additionally, a student's views about math are strongly related to performance. Experiential studies have demonstrated that reversing a student's belief in the importance of ability over effort can increases his or her engagement in mathematics learning, which in turn improves mathematics outcomes. Therefore, teachers and other educational leaders should consistently help parents understand that an increased emphasis on effort can help improve math grades.

According to Williams, students need critical foundations for algebra. The way to achieve this is by creating national benchmarks that guide curricula, textbook development, and state assessments.

Another component of mathematics performance relates to the education of teachers. Williams found that, "there is research to support the idea that teacher knowledge does have a positive effect on student learning." He emphasized the need for more research on the possible benefits of full-time math teachers in elementary schools. In terms of the materials that math teachers use to structure their lessons, it was found that U.S. textbooks are far too long, which, according to Williams, "tends to undermine coherence and focus."

Boykin emphasized the need to better prepare teachers to be consumers of high-quality research and to apply best practices, noting that "a lot of the [available] research has not yet come to inform practices in math classrooms." Furthermore, he called for additional and more holistic research, which should focus more on the world of the teacher—its traditional methodologies and practical challenges—rather than solely on the psychological elements of how students learn.

The discussion closed with specific recommendations for improving the system of mathematics education in K-12 schools. In addition to earlier suggestions of creating national benchmarks and structuring all math classes and textbooks towards preparing students for algebra, Arispe commented that, "the National Assessment of Educational Progress and states should focus on the mathematics that students should learn, with [assessment] scores reported and tracked over time."

THE IMPORTANCE OF INFORMATION TECHNOLOGY IN K-12 SCHOOLS AND HOW TO INCORPORATE COMPUTER SCIENCE LEARNING INTO THE HIGH SCHOOL CURRICULUM

In a broad roundtable event held to address issues in the information technology (IT) sector, several participants discussed the importance of promoting the field in K-12 schools, both for students' futures and for the creation of a skilled workforce. On June 19, 2008, the "IT Business Advocacy Roundtable" at the Wilson Center featured panelists **Lucy Sanders**, CEO and Co-founder of the National Center on Women in Information Technology (NCWIT), **Peter Harsha**, Director of Government Affairs at the Computing Research Association (CRA), and **Cameron Wilson**, Director of Public Policy Affairs at the Association of Computing Machinery (ACM).

Peter Harsha stressed that "IT drives our economy." Thus, a strong IT sector, supported by public interest, more federal funding of research and development, and a growing IT workforce, is crucial to the country. Cameron Wilson explained that, between 2006 and 2016, six of the top ten jobs available in the job market will involve computer science.

But, according to Wilson, these jobs are not getting filled and the industry is facing a workforce shortage. A key leakage in the IT workforce pipeline comes from the inadequate preparation of students in primary and secondary schools. Guidance counselors often discourage high school students from considering IT careers, portraying them as unstable by pointing to the bursting of the "dot-com bubble." More importantly, students do not receive adequate early exposure to computer science, as most grade school courses cover only rudimentary topics such as the use of software applications and the development of keyboarding skills.

Sanders argued that as IT job projections continue to grow, the industry must make a concerted effort to attract minorities and women. In addition to alleviating the shortage, a more diverse workforce can improve the performance of the industry.

Wilson argued that computer science classes should be more rigorous, requiring the use and development of problem-solving skills and algorithmic thinking. Indeed, it should be treated as a hard science, rather than an elective. Peter Harsha noted that the ACM has already developed a computer science curriculum with various standards that emphasize important learning objectives.

Lucy Sanders of NCWIT added that women and minorities are under-represented in the IT industry, which adds to the shortage. This trend also begins at the high school level: the College Board reported that only fifteen percent of those who took the AP Computer Science Exam were female. Sanders argued that as IT job projections continue to grow, the industry must make a concerted effort to attract minorities and women. In addition to alleviating the shortage, a more diverse workforce can

improve the performance of the industry, as studies have shown that diverse work groups produce better results than do homogenous ones.

Participants in the roundtable also brought up the important issue of a lack of K-12 student interest in computer science. Many agreed that this could be partially explained by an image problem. Lucy Sanders remarked that most children perceive computing to be "nerdy, geeky." **Susan Baker** of the Information Technology Association of America suggested that the IT sector should take the opportunity to revamp its image and "re-brand" computer science. **Chris Mustain** of IBM added that one way to redefine computer science is to place more emphasis upon the human element of computing, that is, the improved human performance that stems from the implementation of computer systems. IBM, for example, calls their computer systems engineering division "Service Science."

In advancing computer science in high schools, not only in the curriculum but also in students' minds, teachers may be at the heart of the matter. Wilson made the point that a significant barrier to the success of any national computer science curriculum appears to be insufficient training for teachers. Both Lucy Sanders and **Amy Burke** of Texas Instruments Inc. stressed the importance of funding for teacher training programs. Several individuals emphasized that state and local action should not be neglected in the effort to improve the computer science curriculum nationally.

Lucy Sanders remarked that many individual firms and organizations are attempting to address these important issues, but that greater coordination must take place among these related entities in order to achieve progress. **Sylvia Palm** of BAE Systems remarked that both private corporations and K-12 schools have immediate needs, and that better collaboration between these two groups could result in attracting more workers to the IT sector. **John Palafoutas** of the American Electronics Association noted that German engineering firms have begun their workforce development recruitment as early as the kindergarten level.

In addition to more cooperation between business and the schools, stronger government support is needed—yet many participants in the discussion reported that policymakers, in general, are unaware of key issues facing the IT sector. **Bill Kamela** of Microsoft stressed that, in order to better inform the public and future policy, the entire IT sector should identify and get behind two or three central goals.

PART III: INSIGHTS OF KEY LEADERS IN EDUCATION

In addition to focusing on innovative programs in education and exploring some of the most pressing issues in the field of education today, the STAGE Program has worked with prominent leaders in education—those that serve in the government, in the private sector, and in the classroom. All of them represent essential stakeholders in our country's K-12 schools and, together, they describe the elements that can push math and science learning forward.

In the following sections, two Congressional representatives put math and science education into the context of globalization and national objectives, two business supporters of education explain the role the private sector can play, and some of our nation's top educators describe education reform as it is seen in the classroom.

Together, their perspectives demonstrate how collaborative involvement in education—from government at all levels, from businesses, from teachers, and from individuals—will be necessary to improve our schools and give every student the preparation needed to succeed in the twenty-first century world.

Former Congressman **Sherwood Boehlert**, former Chairman of the U.S. House Science Committee—*Science, Technology, Engineering, and Mathematics Education and the Future of Our Country*

Emphasizing the importance of Science, Technology, Engineering, and Mathematics (STEM) education for the future of our country, former Congressman **Sherwood Boehlert**, former Chairman of the U.S. House Science Committee, shared his own experiences and perspective. Boehlert served in the U.S. House of Representatives for twenty-four years and also served as a public policy scholar at the Wilson Center.

The United States "has a monumental challenge on its hands—that is not being adequately addressed," said Boehlert. He spoke not of the Iraq War or the current state of the economy, but rather of STEM education and its importance for our future competitiveness in the world. He listed the low rankings of United States students on international assessments, the call that U.S. companies are making for more qualified engineers, and the fact that many U.S. teachers in STEM subjects do not have degrees in either math or science.

Speaking of his time on the House Science Committee, Boehlert discussed his work with the National Academies, which led to the "history-making" report, *Rising Above the Gathering Storm*, and his meetings with former Director of the Office of Management and Budget (and White House Chief of Staff for the George W. Bush Administration) Josh

Bolten to outline the need for a significant increase in spending on research and development and STEM education. He pressed that our action in these areas will determine the future global position of the United States and addressed an issue on everyone's mind: "To fill [future] jobs—if we want to fill them here instead of outsourcing them or out-shoring them—we've got to do a better job in STEM education."

> "To fill [future] jobs—if we want to fill them here instead of outsourcing them or out-shoring them—we've got to do a better job in STEM education."
>
> —Former Congressman Sherwood Boehlert

Finally, he asserted that it is time that we had "an open and national dialogue" to produce real results. He called all of us to get involved—by writing letters to our congressional representatives or publishing opinion articles in our local newspapers. "You can't just wish for action, you've got to *work* for action."

Congressman **Brian Baird,** Chairman of the U.S. House Subcommittee on Research and Science Education—*Current Policy Initiatives and Moving Education Forward*

Congressman **Brian Baird,** Chairman of the U.S. House Subcommittee on Research and Science Education, put the importance of STEM education, both for students and for the economy, into the context of current legislation and public debate. His commitment to education is evident: "on average, once a week I'm in a classroom."

In a discussion of current policy, he began by explaining the America Competes Act, whose primary House author was Congressman Bart Gordon, Chairman of the House Committee on Science and Technology. The act aims to foster a multidisciplinary, collaborative environment at universities and increase the experience and preparedness of K-12 educators. According to Baird, there is some concern that the America Competes Act will not be adequately funded, as a result of current government deficits. He explained the negative rippling effect that would have: taking away funding from developing high skills in math and science is like eating your seed corn, pulling away investment from the foundations of the economy.

As the effort to strengthen STEM education continues, Baird stressed that we need stronger career and technical education, not just high-level classes in science, math, and engineering. Most importantly, we need an education system that encourages hands-on, life-applicable learning. While the government should expand

* The H-1B is a nonimmigrant classification used by an alien who will be employed temporarily in a specialty occupation or as a fashion model of distinguished merit and ability. Further information can be found through the office of U.S. Citizenship and Immigration Services at: http://www.uscis.gov/portal/site/uscis/menuitem.5af9bb95919f35e66f614176543f6d1a/?vgnextoid=c487d92e8003f010VgnVCM1000000ecd190aRCRD

the H-1B visa program*, businesses that employ workers from overseas should also be required to "show a commitment to educating the American workforce."

In terms of additional government involvement, Baird explained that the public will probably support increased funding for education, as it is crucial both for American students and the prosperity of the country. He laid out several reforms that would be successful in changing the culture of education and improving student learning.

Congressman Brian Baird stressed that we need stronger career and technical education, not just high-level classes in science, math, and engineering.

The first concerns teachers and increasing their prestige: we should implement pre-screening, make it easier to remove ones that are not effective, and give successful ones rewards for their achievements. Along the same lines, principals should be empowered to run their schools in the most effective way possible. Finally, Baird expressed his support for a voluntary national curriculum. He explained that all the countries with higher student performance in math and science have one.

Susan Traiman, Director of Education and Workforce Policy, the Business Roundtable—*Business Commitment to Education and Changing Student Culture*

Susan Traiman, director of Education and Workforce Policy at the Business Roundtable, explained the high stakes that businesses have in the future of education and how connected business leaders are to reform and improvement. The CEOs of major corporations are looking towards the long-term economy and know it is important "to help in areas where they can make a difference."

The Business Roundtable facilitates their role. It has succeeded in mobilizing its members, which include CEOs of large corporations from many different sectors, to influence both state and national policy. Further, one of its main goals is to change the culture of students, increasing the prominence of math and science in their lives.

Yet, Traiman explained that the prevailing stereotypes of math and science in the minds of students can present a challenge. High school students seek social connections, concrete accomplishments, belonging, and freedom. Actors and sports stars are "cool," whereas science and math are "nerdy."

So, she continued, in order to inspire the students' education, we have to connect their academics to their aspirations. The message to send is that "math and science power virtually everything exciting in your life." By making young people more aware of how math and science are all around them—especially in things they care about, like music and television—and responding to their individual needs, we can break the stereotypes and give meaning to their education. Traiman calls it "connecting the dots."

Ultimately, that can breathe new life into the culture of math and science in America. It can inspire young people to take up the challenges and job opportunities presented by today's fast-paced world.

Brian Fitzgerald, Executive Director of the Business-Higher Education Forum—*Community Support for Teachers as the Core of Math and Science Education*

Brian Fitzgerald is the executive director of the Business-Higher Education Forum (BHEF), an organization that brings together prominent CEOs and university leaders in order to promote educational excellence, with a particular focus on how that success can translate into economic prosperity. It has been a leader in producing reports on U.S. competitiveness, including some of the first on the subject.

According to Fitzgerald, the "quality of math and science teaching is the single most important factor" in the future of science, technology, engineering, and mathematics (STEM) education. William Swanson, co-chair of the initiative and CEO of Raytheon, has developed a systems-dynamic model for STEM education, which demonstrates the complexity of all the factors that contribute to student success—with "teachers at the heart of it."

A BHEF report focused on educators, *An American Imperative: Transforming the Recruitment, Retention, and Renewal of Our Nation's Mathematics and Science Teaching Workforce*, makes clear recommendations to address teacher under-preparedness and high attrition rates. Fitzgerald explained that we need to improve content and pedagogy courses in teacher education and address job dissatisfaction through the "creation and maintenance of learning communities" for teachers to network with one another and continue their professional development.

Fitzgerald stressed that there are "two different worlds"—suburban schools and urban schools—with urban students being much less prepared.

One BHEF program, the STEM initiative, is working to create a "community of practitioners and researchers" to improve teaching in individual localities. Fitzgerald stressed that there are "two different worlds"—suburban schools and urban schools—with urban students being much less prepared. An important focus, then, is to better align curriculum, adequately train teachers, and raise expectations.

The work called for by the BHEF, including stronger teacher preparation and life-long community support for teachers, is a necessary element to improving math and science education in K-12 schools, which would then benefit the prosperity of our country.

The Albert Einstein Distinguished Educator Fellows—*Top Teacher Perspectives on the Challenges of the Classroom and the Potential for Stronger U.S. Schools*

The **Albert Einstein Distinguished Educator Fellows** are outstanding K-12 teachers, selected from around the country by the U.S. Department of Energy to spend a fellowship year in the policy world of Washington. They are chosen for their excellence in teaching in the subjects of math, science, or technology.

Having spent time both in K-12 classrooms and with public leaders, including those at the Department of Energy, Congressional offices, the National Science Foundation, the National Institute of Standards and Technology, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration, they are in a unique position to share their insights about the current state of STEM education in the United States. Their perspectives and ideas can shed light on the system as a whole and the challenges of individual classrooms, informing our future education initiatives and reforms to make them as successful as possible.

Keeping in close contact with the STAGE Program over the last year, the 2007-2008 Einstein Fellows have discussed such topics as the need for stronger teacher support, the possibilities of future educational policy, the role that businesses and universities can play in K-12 education, and the efforts the Fellows have made in their own classrooms to give their students a world-class education, in spite of significant challenges.

One issue repeatedly emphasized by the Fellows is the need for stronger teacher support in the United States, towards the creation of a more enjoyable working environment. They explained that most teachers leave the profession due to poor working conditions. Teachers face the challenges of large class sizes, hours of grading, and isolation from other teachers, giving them little time to individually or jointly prepare lessons, create innovative lab experiments, or take part in professional development.

One issue repeatedly emphasized by the Fellows is the need for stronger teacher support in the United States, towards the creation of a more enjoyable working environment.

Several programs launched by businesses, non-profit organizations, and government entities have focused on giving extra support to teachers, but they have not always taken these challenges into account. It is difficult for teachers to participate in professional development activities when they are not incorporated into the school day, when they cost extra money, or when they are sporadic rather than continuous tools for teachers to rely upon. One event or workshop is not enough—teachers need ongoing expertise and support in order to implement innovative, hands-on projects in their classrooms. Although some programs donate supplies for teachers in addition to training, schools generally have to compete with each other for access to technology, and the tools they do receive are often out-of-date. According to the Fellows, for teacher support and professional development activities to be most effective, they

need to take into consideration the challenges that teachers face, including time and budget constraints.

With regard to governmental support for education, the Fellows explained that current education policies and programs vary widely depending on location. Curricula and textbooks vary from one district to another and so does the amount of spending per student. This unevenness makes the work of teachers more difficult, especially when students move across state lines and data systems are not in place to track progress and standards between states.

According to the Fellows, one event or workshop is not enough—teachers need ongoing expertise and support in order to implement innovative, hands-on projects in their classrooms.

The federal government could support teachers more in several ways. First, if teachers are to be innovative in the classroom, focusing on depth and how to "work together, think outside the box, problem-solve" rather than just memorize factual content, the federal government needs to set the tone. Additionally, it should play a larger role in compiling and showcasing best practices, so that teachers can more easily try new methods. Finally, the Fellows asserted that a national curriculum may result in a loss of diversity in understanding and expertise, but that some national direction would be beneficial. National benchmarks and general guidelines of topics to be covered in each grade level, such as those suggested by the National Mathematics Advisory Panel, would be most effective.

As for private sector involvement, the Fellows all pointed to the very substantial role that businesses can play in improving math and science learning. Several of the Fellows have been able to connect their students to science and business leaders through site visits, mentorships, and business-sponsored contests. Businesses can provide examples of how math and science are applied in everyday life and, in some cases, can help teach hands-on math and science. But just putting a mentor in a school is not enough—a real role for businesses requires "resources, money, and support."

Indeed, there is no easy guide for how teachers and businesses can collaborate. Rural areas have only a small, resource-scarce business sector, making collaboration between businesses and schools difficult. In these areas, distance learning, internet connectivity, and virtual field trips are areas in which businesses could be more involved and successful. Ultimately, if businesses work closely with educators to develop real insight into the world of education, teachers can benefit substantially from the collaboration. Understanding how school skills translate into employment opportunities allows teachers to connect math and science classes to today's global and technological world, engaging students and inspiring them to seek careers in these fields.

The Fellows expressed that the involvement of community colleges and universities in middle schools and high schools would also be beneficial—as long as there is a reliable, long-term commitment.

After describing these issues in public and private support for teachers, the Fellows presented some of the national programs that are advancing math and science education and demonstrating progress in student learning. Initiatives include the FIRST Robotics Competition, the NASA explorer schools, the Cisco Academies, and alternative schools such as the NativityMiguel Network, the Cristo Rey Program, the Learn to Work (LTW) Program, and the Knowledge is Power Program (KIPP).

The Fellows also stressed that a lot of work needs to be done to continue to improve education in the United States. Ideally, it should focus on the real problems and limitations that teachers face. According to the Fellows, the programs that are most successful are those that make use of local resources and adapt to particular circumstances, rather than seeking a one-size-fits-all model for nationwide education reform.

PART IV: RECURRING THEMES AND IDEAS FOR EDUCATIONAL PROGRESS

The programs and initiatives that the STAGE Program has highlighted over the last year have all focused on the same goal—making our nation's schools work for our nation's students. They make it clear that giving our students a strong education is essential for the future prosperity of this country and the economy. They point to one of the nation's greatest challenges: working to develop a world-class educational system to ensure that all American students are prepared for higher education and the global workforce.

Moreover, they describe ways that all education stakeholders and education communities can—and should—get involved in making U.S. schools and students more successful. Businesses, universities, the federal government, state and local governments, non-profit organizations, school administrators, teachers, and parents all have a role. Each can make a significant difference in the lives of students in surrounding communities and in the national education discussion and policy-making process, especially if they collaborate in their efforts.

Some of the ideas and initiatives that have been successful have focused on motivating students, emphasizing their effort over ability, giving them more time in school, setting high expectations and strong support for their success, providing them with role models, and connecting their academic problem-solving and critical thinking skills to the real world. Others have emphasized the role of teachers, and what businesses, universities, and the government can do to better support them—from stronger undergraduate preparation, to practical and continuous professional development, to the placement of mentors in the classroom, to reforming the structure of schools to allow for a better working environment, and, finally, to increasing the value and prestige of the teaching profession. Still others have looked at possible progress at the state and national level, through developing national benchmarks, adapting the teaching profession to better support students, setting guidelines for textbooks, giving schools and their principals more autonomy, improving data collection to tie teaching skills to student performance, and creating a resource that compiles best practices and research to better inform classroom instruction.

From these current insights for reform, new ones will invariably arise. While the many programs and initiatives presented at the STAGE conferences do not converge on a single method or policy that can improve the performance of all

students in all schools across the country, they do demonstrate the successes that innovative thinking can achieve when it is backed by a committed, continuous effort from many different individuals, organizations, and public and private entities. They show that to push the U.S. education system forward, to give all U.S. students the opportunities to learn, a unified and collaborative approach, involving practical business sense and substantial public discussion, will be necessary.

PART V: THE CONTINUED EFFORT TO DRIVE NATIONAL EDUCATION INNOVATION WITH THE CABINET, THE CONGRESS, AND THE COUNTRY

As the STAGE Program continues to work on furthering the national discussion of educational challenges, progress, and new ideas, it will continue to highlight outstanding student and teacher programs across the country, current topics and research on the strengths and weaknesses of the education system, and the forward-thinking perspectives of strong educational leaders. Currently, it is working to expand its focus and collaborate with additional programs and individuals in order to bring new developments and projects into the dialogue. Some of these include the work of the FIRST organization, the reforms and initiatives of D.C. Public Schools Chancellor Michelle Rhee, the comparison of U.S. education to that of Europe as well as Asia, the experiences of the schools in New Orleans and surrounding areas, and the educational entrepreneurs that are working to spread programs like Teach for America and non-profit and for-profit charter schools.

One of the excellent organizations whose work was discussed at earlier STAGE conferences is "For Inspiration and Recognition of Science and Technology" (FIRST), a program that will continue to play an important role in attracting students to the fields of science, technology, engineering, and mathematics and encouraging them to aim high in their future career goals. The participation of students and business mentors in the program is on the rise and national awareness of the program is growing. In 2009, FIRST will hold one of its regional competitions in the District of Columbia. Bringing the tournament to D.C. will get students in the area involved and can also lead to increased support for the city government and the D.C. public school system. As the local school district and the FIRST organization come together, the Wilson Center will report on the shared interests of the two and the potential for them to work together more in the future.

The District of Columbia public school system will continue to be important and interesting for another reason as well: Chancellor Michelle Rhee, superintendent of the public schools, has been given wide-reaching authority by the mayor to turn the schools upside down in order to raise student achievement. Typically, students in D.C. public schools perform poorly on national assessments, and the schools have made little progress in past decades.[17] Rhee, who founded The New Teacher Project in 1997 in order to attract teachers to high-needs schools and transform urban public school systems, was appointed as Chancellor by Mayor Adrian Fenty in June of 2007.[18] Now, with an unwavering commitment to the city's students, she is working for strong and

innovative reform to make sure they have the best opportunities to learn. In Rhee's words, "People say that kids are disadvantaged because they come from poor homes or whatever… But the bottom line is that, if kids have teachers with extraordinarily high expectations of them, if they work hard and do the right things, they can absolutely achieve at the highest levels."[19]

In addition to this local focus, the STAGE Program will also continue its examination of school systems nationally and internationally. These days, post-Katrina New Orleans has come to be known as an "educational laboratory," because much of its current education system is new and strikingly different from the rest of the country. With such an innovative approach to education—as a large number of students are enrolled in public charter schools and the superintendent of the Recovery School District has a great degree of autonomy[20]—the experiences of New Orleans will be studied and evaluated in years to come.

"But the bottom line is that, if kids have teachers with extraordinarily high expectations of them, if they work hard and do the right things, they can absolutely achieve at the highest levels."

—Chancellor Michelle Rhee

Kent Hughes, director of the STAGE Program, made two separate visits to New Orleans in 2008 in order to discuss education in the post-Katrina period with local political leaders, school officials, non-governmental organizations, and a leading education reporter. One institute particularly active in educational issues is the Scott S. Cowen Institute for Public Education Initiatives at Tulane University, which produced a report entitled *The State of Public Education in Orleans*.[21] This report examines public opinion and quantitative data to highlight successes as well as remaining challenges in New Orleans education. It describes the current situation: Hurricane Katrina destroyed what was already a struggling school system and, now, the emerging system has many different parts. The State of Louisiana has established the Recovery School District (RSD) to take control of more than 100 public schools that had been performing below the state average before Katrina. As of 2008, "eighty public schools are run by 29 different operators including the Orleans Parish School District, the RSD, and 27 charter school operators." The Louisiana Governor and the state legislature have also added a voucher program to the educational mix that included private and parochial schools. In addition to following educational change and progress in the area, the Cowen Institute has also responded to the situation with a number of initiatives. One of these is to act as an incubator for planned charter schools that are waiting for schools to be physically restored and for more students to return to New Orleans.

Sarah Carr, the lead education reporter for *The Times Picayune*, is covering some ongoing challenges that the schools in New Orleans face. Students are returning to the area, but many of them lack even a basic education, which they should have received

in earlier years. She reports that some are being assigned to special education classes simply because they are an appropriate age for middle school but cannot read.[22]

The STAGE Program plans to continue to study the K-12 education system in New Orleans as it continues to develop and respond to these challenges. With plans for Hughes to make additional trips in 2009, the STAGE Program will get a better sense of which charter schools are most successful, how broader communities of businesses and universities are becoming engaged in the schools, and what lessons learned in the New Orleans schools may useful for other urban districts around the country.

In comparing the experiences of different education systems, some of the most enlightening insights into how to improve U.S. schools might come from abroad. Indeed, several countries in Europe perform at the very top in international assessments of math and science. While each country faces unique challenges and has its own answers, they all have useful experiences with improving student learning, which U.S. educators and policymakers could take into account as they work to improve the U.S. school system.

Beyond comparing different education programs and approaches across geographical areas, the STAGE Program also plans to look at ways that additional scientific research could demonstrate the relative success of differing education methods. The creation of the National Mathematics Advisory Panel of the U.S. Department of Education is one example of a research-based approach to the evaluation of math and science education that could inspire similar work in the future.

Finally, the STAGE Program is beginning to work more closely with educational entrepreneurs in the United States—those non-profit organizations, businesses, foundations, and individuals that are thinking outside the box and developing cutting-edge programs for educational progress. These programs, such as Teach for America and innovative charter schools, demonstrate which features of schools and teaching help students succeed the most. In the future, they can be scaled up to reach more of the nation's students or used as examples that can be adapted into other kinds of educational reform.

With these projects, the STAGE Program will continue to act as a forum for the inventive educational programs in this country and the exemplary educational progress in other countries, all of which can better inform educational policymaking and decision-making towards improving U.S. schools.

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"Education…is a branch of that general work enabling a great country to use its energies to the best advantage and to lift itself from generation to generation through the stages of unbroken progress." Woodrow Wilson was speaking to the annual convention of the Western Association of Princeton Clubs in Cleveland, May 19, 1906.

The full speech can be found in Arthur S. Link, Editor, The Papers of Woodrow Wilson, Princeton University Press, Princeton, New Jersey, 1973.

Education…is a branch of that general work of enabling a great country to use its energies to the best advantage and to lift itself from generation to generation through the stages of unbroken progress.

Woodrow Wilson, May 19, 1906, Cleveland, Ohio

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