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STEM Education in Washington State: The Facts of the Matter




Summary of the Proceedings of a Symposium,
Rising Above the Gathering Storm: STEM Education in Washington State

Held as Part of the 2011 Annual Meeting of the
Washington State Academy of Sciences

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Held as Part of the 2011 Annual Meeting of the
Washington State Academy of Sciences
September 22, 2011, Museum of Flight, Seattle, WA

Summarized by

R. James Cook

Dean and Professor Emeritus, Washington State University

Immediate Past President, Washington State Academy of Sciences

Earll M. Murman

Ford Professor of Engineering Emeritus, Massachusetts Institute of Technology

President, Washington State Academy of Sciences

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About the Washington State Academy of Sciences

The Washington State Academy of Sciences (WSAS) is an organization of Washington State's leading scientists and engineers dedicated to serving the state with scientific counsel. Formed as a working academy, not an honorary society, WSAS is modeled on the National Research Council. Its mission is two-fold:

> To provide expert scientific and engineering analysis to inform public policy making in Washington State, and
>
> To increase the role and visibility of science in the state.

WSAS was formed in response to authorizing legislation signed by Governor Gregoire in 2005. Its 12-member Founding Board of Directors was recommended to the governor by the presidents of Washington State University and the University of Washington and duly appointed by the governor. In April 2007, WSAS was constituted by the Secretary of State as a private, independent 501(c)(3).

Symposium Materials

Source material for the 4th Annual Symposium may be found on the WSAS website, including

- Opening greeting by Governor Gregoire
- Speaker's slides
- Videos of the invited speaker's presentations
- After dinner talk by Brad Smith, Senior VP and General Counsel of Microsoft
- Symposium handouts
- Symposium pictures

Washington State Academy of Sciences
410 11th Avenue SE, Suite 205
Olympia, WA 98501
programs@washacad.org
http://www.washacad.org
(360) 534-2338

EXECUTIVE SUMMARY

Following the lead of the National Academies' 2010 report to the nation, Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5 (RAGS, Revisited), the Washington State Academy of Sciences (WSAS) used its 2011 annual meeting symposium to (1) document the reality of the current state of STEM (Science, Technology, Engineering, Math) education in Washington State, (2) showcase the latest research on teaching math and science and (3) set a course for the WSAS to partner in effecting change at both the grass roots and policy levels. The 125 people attending the symposium included eleven elementary-through-high school teachers and principals; eleven 8th to 12th grade students; five directors of science and engineering fairs; representatives from Washington STEM, the Pacific Science Center and other organizations; speakers; WSAS members; and guests.

Following a video greeting by Governor Christine Gregoire, Dr. Dan Mote opened the symposium with his talk, Five Years of Rising Above the Gathering Storm. He was one of 20 authors of the original 2005 National Academies' RAGS report that led to the 2005 America COMPETES Act, and also one of the 17 authors of the 2010 RAGS, Revisited follow-up report. He described the committee's 2010 findings as "chilling," and that "current trends affecting America's future competitiveness are sharply negative." While the U.S. has made gains in global competitiveness over the past five years, our competitor technology nations are making gains faster than us, with the result that the United States is falling behind. He stated during the discussion that we, the American people "don't get it," that "public opinion must be galvanized," that "you cannot fix a problem unless you know you have a problem."

Dr. Edward D. Lazowska, Bill & Melinda Gates Chair in Computer Science & Engineering, University of Washington, provided an analysis of STEM education in Washington relative to other technology-dependent states (technology peer states), similar to the facts and conclusions reported in RAGS for America relative to other nations. He pointed out that Washington ranks 2nd among the ten technology peer states in intensity of its scientific and engineering workforce, 2nd in intensity of engineers, and 5th in intensity of computer specialists. But then he adds, "It turns out that they [this high-tech workforce] are not our own children." Washington ranks second among the ten technology peer states, and first on a per capita basis, in the importation of 22- to 39-year olds with a bachelor's degree or higher. Washington's pipeline between 9th grade and completion of a college degree is the leakiest of the ten technology peer states: for every 100 students that enter high school, only 18 complete a college degree within 150% of the time normally required.

Senator Rosemary McAuliffe, Chair of the Washington State Senate Committee on Early Learning and K-12 Education, emphasized the importance of partnerships and the need to convince the public that we have a problem. She called attention to the Washington STEM Program as one of the "legislative highlights" that seeks to improve student achievement and opportunity in STEM subjects, describing the program as mobilizing "education, business, and civic leaders to fulfill shared responsibility to improve STEM instruction throughout the state."

Dr. Andrew Meltzoff, Job and Gertrud Tamaki Endowed Chair and Co-Director of the Institute for Learning and Brain Science at the University of Washington, addressed how children's interest in math is shaped in early childhood through societal stereotypes. In particular, young girls sense already in 2nd grade that boys do math and girls do reading, and consequently conclude by 2nd or 3rd grade that they don't like math.

Dr. Tamara Homlund Nelson, Associate Professor in Science Education at Washington State University, Vancouver, brought findings from STEM research to the symposium audience. She explained how the conventional linear one-way teacher-to-student model needs replacement with a "circular model of learning" in which teachers and students develop the learning content in an iterative, interactive way. This was one of three interactive components of teaching for understanding, the other two being disciplinary knowledge and knowledge of pedagogy.

Dr. George "Pinky" Nelson, Director of Science, Mathematics and Technology Education and Professor of Physics and Astronomy at Western Washington University spoke about their program for educating "tomorrow's" math and science teachers, and his work with schools in Whatcom and Skagit Counties as well as the Makah reservation at Cape Flattery. His data on inverse correlation of proficiency outcomes with student's economic levels as measured by percentage of students receiving free or reduced-price lunches in the respective schools was both sobering and consistent with other findings on academic performance and poverty.

WSAS members attending the symposium were introduced to the important topic of science and engineering fairs by inclusion of science and engineering fair directors, students and their advisors and mentors. Feedback and follow-up interactions captured a significant amount of audience input. Further analysis after the symposium revealed that Washington is far behind other states in the level of student participation in science and engineering fairs. For example, in the 2011 Intel International Science and Engineering Fair, the state's student participation per capita ranked 44th out of 47 participating states.

As the after-dinner speaker, Mr. Brad Smith, Microsoft General Counsel and Senior Vice President for Corporate and Legal Affairs, echoed the dire situation for STEM education in Washington. Pointing out that Washington has a "skills gap," he stated that Washington bachelor degree production in STEM-related fields needs to grow by 40% in the next seven years. Sharing lessons he learned as Chair of Governor Gregoire's Higher Education Funding Task Force, he emphasized the need "to meet in the middle" in solving the issues, but that "it is not realistic for people within government to meet in the middle if everyone outside of government stays in their respective corners." It must start with individuals and groups outside government working together and standing behind a common proposal.

WASHINGTON STATE FACTOIDS

- Washington ranks 2nd in the Kauffman Foundation New Economy Index of "leaders of innovation" states (2010). Only Massachusetts ranked higher than Washington[i]. Ten of the top twelve states form a technology peer group: California, Colorado, Connecticut, Maryland, Massachusetts, New Jersey, New York, Utah, Virginia, Washington.
- In the 2011 Intel Science Talent Search – the "Junior Nobel Prize" – only two of the 300 semifinalists were from Washington, putting it in 8th place among 10 technology peer states. Top participating state New York had 101 semifinalists[ii].
- Employment in Washington private sector technology industries quadrupled from 1974 to 2009, reaching almost 400,000 employees[iii].
- 80% of all new U.S. jobs in STEM fields are projected to be in computer science and other fields of engineering[iv].
- Washington produces 29.8 engineers for each 1000 engineering employees, and 21 computer scientists for every 1,000 computer science employees, ranking 9th and 7th respectively among the 10 technology peer states (2005)[v].
- Due to capacity constraints, the University of Washington College of Engineering is able to accommodate only half of its applicants – enrolled college students who have successfully fulfilled the Engineering pre-requisites. Computer Science & Engineering can accommodate only one quarter of its applicants[vi].
- For every 100 Washington students that enter 9th grade, only 18 receive a bachelor's degree within 150% of time. Washington ranks 10th – last – among the technology peer states in this metric[vii].
- In 2007, the rate of job growth in Washington was about 3% for both the life sciences sector and total employment. Life science sector job growth increased to 8% by January 2011, compared with a negative 3% for total employment[viii].
- Washington 4th graders achieved 44% proficiency in mathematics skills (2007) and 28% in science skills (2005), ranking 4th and 7th, respectively, among its technology peer states[ix].
- Washington 8th graders achieved 36% proficiency in mathematics skills (2007) and 33% proficiency in science skills (2005), ranking it 6th and 7th, respectively, among its technology peer states [x].
- In 2007, Washington spent an average of $8,524 per elementary and secondary school student in public schools, ranking 8th among the 10 technology peer states. Top ranked New Jersey spent $16,163. The Washington expenditure increased 48.7% from 1997-2007, compared to the average increase for the technology peer states of 67.8%[xi].

- Washington ranks 47th when public school financing is compared to personal income, with $40.98 per $1,000 in 2007-08, a $2 decrease from 2005-06 (best state: Alaska, $78.08; national average, $49)[xii].
- Washington ranked 44th out of 47 states on per capita participation in the 2011 Intel International Science and Engineering Fair (ISEF) with only 10 of 988 US participating students[xiii].
- Washington ranks 2nd among the 50 states in the percent of its workforce who are engineers, surpassed only by Michigan (2008)[xiv].
- More than 40% of the students that the UW College of Engineering is unable to accommodate, and more than 60% of the students that the UW Department of Computer Science & Engineering is unable to accommodate, have college grade point averages of 3.25 or above (2011)[xv].
- Washington is the second largest importer of bachelor's degree recipients among its technology peers (4th among all 50 states), and first on a per capita basis (2007)[xvi].
- For every 100 bachelor's degrees awarded by one of Washington's universities, another 76 are imported. For every 100 graduate or professional degrees awarded, Washington imports another 125[xvii].
- Washington ranks 30th in state financial support for higher education when compared to personal income, with $5.62 per $1,000 in 2010, a $1.40 decrease from 2008 (best state: New Mexico, $13.23; national average: $6.18)[xviii]
- Washington ranked 38th in on-time high school graduation rates with 71.9% in 2007-08, below the national average of 74.9%[xix].
- Almost half (48%) of all Washington high school graduates enrolled in community and technical colleges take remedial math courses (2008-09)[xx].
- Societal stereotypes about STEM are absorbed in childhood and begin to sculpt interests and aspirations. As early as 2nd grade, Washington girls think that "math is for boys, not for girls"[xxi].
- In 2010, Washington spent $850 million on 18,000 criminal inmates – a cost of $47,222 per inmate – an amount that tripled from 1982 to 2008[xxii].
- The average Washington public school teacher's salary in 2007 was $47,882, 7th among the 10 technology peer states. California spent an average of $63,840. The average Washington teacher salary increased 26.5% from 1997-2007, compared to the average increase for its technology peer states of 28.2%[xxiii].
- Every dollar spent on early learning can generate returns of up to $10 in savings from reduced crime, corrections and other costs[xxiv].

- 11,274 eligible low-income Washington preschoolers (36% of those eligible) were unserved by existing pre school programs in 2010[xxv].
- Math proficiency rates for White (51%) and Asian/Pacific Islander (56%) Washington fourth graders are more than double the rates for African American (24%), Latino (20%), and Native American (21%) students[xxvi].
- Washington's Latino population increased 70% from 2000 to 2010 and constitutes 11% of the population[xxvii].
- High school dropout rates in Washington for Native American (10.1%), African American (7.8%), and Latino (7.2%) students were nearly double the rates for White (4.5%) and Asian/Pacific Islander (3.3%) students in 2008-09[xxviii].
- A variant on the 80-20 rule – In Skagit & Whatcom counties and Cape Flattery 5th to 10th grades, 80% proficiency on standard science exams are achieved for classes where 20% of the students qualify for free or reduced lunches, while only 20% proficiency is achieved for classes with 80% of the students qualifying for free or reduced lunches (2009-10)[xxix].
- In 2010, 18.2% of Washington residents under 18 years old were in households with incomes below the national poverty level[xxx].
- More than 47 percent of single mothers with children under 5 in Washington were living in poverty in 2010[xxxi].

[i] http://www.kauffman.org/newsroom/2010-ranking-of-new-economy-states-highlights-leaders-and-laggers.aspx

[ii] http://www.societyforscience.org/document.doc?id=264

[iii] Technology Alliance: The Economic Impact of Technology Based Industries in Washington State, 2010

[iv] Bureau of Labor Statistics

[v] NCH National Center for Higher Education Management Systems/U.S. Census Bureau

[vi] University of Washington College of Engineering and Computer Science and Engineering Department

[vii] NCH National Center for Higher Education Management Systems/U.S. Census Bureau

[viii] Washington Research Council, Trends in Washington's Life Science Industry 2007-2011 www.washbio.org

[ix] National Assessment of Educational Progress (NAEP), 2009

[x] National Assessment of Educational Progress (NAEP), 2009

[xi] National Science Foundation http://www.nsf.gov/statistics/seind10/tables.htm#c8

[xii] League of Education Voters http://www.educationvoters.org/2011-report-card/invest-in-what-works/

[xiii] Data provided by Gary Foss, private communication. Participant list at http://www.societyforscience.org/document.doc?id=295

[xiv] National Science Foundation http://www.nsf.gov/statistics/seind10/tables.htm#c8

[xv] University of Washington College of Engineering and Computer Science and Engineering Department

[xvi] National Center for Higher Education Management Systems/U.S. Census Bureau

[xvii] Sam Smith, "Washington higher education: When should we schedule the last Apple Cup?" Seattle Times, Nov 28, 2010

[xviii] League of Education Voters http://www.educationvoters.org/2011-report-card/invest-in-what-works/

[xix] League of Education Voters http://www.educationvoters.org/2011-report-card/prepare-all-children/

[xx] League of Education Voters http://www.educationvoters.org/2011-report-card/focus-on-math-science-and-engineering/

[xxi] Cvencek, Meltzoff, & Greenwald, Child Development (2011)

[xxii] Seattle Times, October 15, 2010, "Invest in youngest citizens to reduce burgeoning crime costs."

[xxiii] National Science Foundation http://www.nsf.gov/statistics/seind10/tables.htm#c8

[xxiv] Seattle Times, October 15, 2010, "Invest in youngest citizens to reduce burgeoning crime costs." Also see James J. Heckman, "Skill formation and the economics of investing in disadvantaged children", Science Vol 312, pp 1900-1902, June 30, 2006

[xxv] League of Education Voters http://www.educationvoters.org/2011-report-card/invest-in-early-learning/

[xxvi] National Assessment of Educational Progress (NAEP), 2009, League of Education Voters http://www.educationvoters.org/2011-report-card/focus-on-math-science-and-engineering/

[xxii] Seattle Times, Oct 6, 2011 "Washington's redistricting commission should ensure people of color have more influence"

[xxviii] League of Education Voters http://www.educationvoters.org/2011-report-card/prepare-all-children/

[xix] George "Pinky" Nelson, "Preparing Teachers for Tomorrow's Schools", WSAS 2011 Symposium, Sep 22, 2011

[xxx] Seattle Times, Sep 21, 2011 "Census: More residents sinking into poverty"

[xxxi] Seattle Times, Sep 21, 2011 "Census: More residents sinking into poverty"

RECOMMENDED WSAS ACTIONS

Symposium participants were asked: Consistent with its charter, what can the WSAS do as an organization to help improve STEM education in Washington; and what can WSAS members do as individual volunteers to help improve STEM education in Washington? Responses to these questions, the content of the talks, comments during each sessions, and informal input formed the basis for these recommendations.

- The WSAS should take a proactive role in informing the public on "The Facts of the Matter" about STEM education in Washington State by:
- Informing the State's Legislators;
- Speaking out in public;
- Bringing attention through the media; and/or
- Informing WSAS members who can carry the message to their colleagues and constituencies.

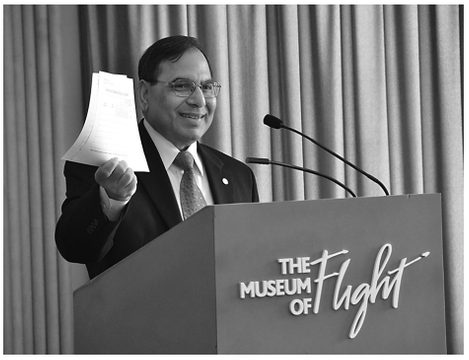
The WSAS can help to provide a forum for teachers to share best practices and findings from classroom teaching as well as learning of the latest findings from STEM research. There are pockets of excellence throughout the state, but not adequate mechanisms for diffusion across school boundaries. The forum might be online, a workshop/conference similar to the annual meetings of American Society of Engineering Education, or a combination of these. The WSAS should partner with other organizations to accomplish this goal.

The WSAS should continue its program enabled by member-donated funds to sponsor one or more students to attend and represent Washington State at the annual meeting of the American Junior Academy of Sciences. Two awards were announced at the 2011 Annual Meeting for students attending Duvall and Odessa high schools, respectively, to attend the 2012 meeting of the AJAS in Vancouver, BC.

The WSAS should also take a proactive role in increasing the participation of Washington's K-12 students in science fairs and competitions. Specific actions could include:

- Encouraging WSAS members to participate as mentors, judges, speakers and donors;
- Nurturing the establishment of additional science and engineering fairs;
- Sponsoring a Junior Academy of Sciences; and/or
- Developing or contributing to an online mentoring resource for student projects that would encompass not only WSAS members, but their peers, employees and/or students.

The WSAS has limited financial and human resources and cannot carry through on all of the above actions. The WSAS Board needs to prioritize these actions based upon which would add the most value to improving STEM education in the State. WSAS should seek to partner with other organizations whenever possible and avoid duplication of efforts.



Subhash Singhal, WSAS Board Member, introducing American Academy of Junior Sciences Award Winners

Bonnie Dunbar, WSAS Board Member, with AJAS Award Winners Katie McClintic (l) and Kira Powell (r)

Senator Rosemary McAuliffe and Subhash Singhal with students

Nick Vergara, Cedarcrest HS, asks a question

New WSAS member Sarah Keller (l) talks to WSAS Board member Kristina Katasaros (r)

INTRODUCTION

Following the lead of the National Academies 2010 report to the nation, Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5, the Washington State Academy of Sciences used its 2011 symposium to (1) document the chilling reality of the current state of STEM (Science, Technology, Engineering, Math) education in Washington State, (2) showcase the latest science and methods of teaching math and science to better understand and deal with the challenges and (3) set a course for its members and as the State's premiere scientific society, partner in effecting change at both the grass roots and policy levels.

The National Academies 2010 report was a follow-up to its 2005 report, Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. This report was produced by a blue-ribbon committee of university presidents, Nobel laureates, and corporate CEOs in response to a request by a bipartisan group of senators and members of congress to answer two questions:

> What are the top 10 actions, in priority order, that federal policy makers could take to enhance the science and technology enterprise so the United States can successfully compete, prosper, and be secure in the global community of the 21st century?
>
> What strategy, with several concrete steps, could be used to implement each of these actions?

The conclusions and recommendations in the 2005 report were based on the premise that "Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living." The gathering storm metaphor was used to convey the threatening situation facing the United States if it continues on its present course of falling behind other developed and some developing countries in the training of scientists and engineers.

The 2010 report, Rising Above the Gathering Storm, Revisited: Approaching Category 5, was requested by the leaders of the National Academies and written by the original committee minus two members that had since gone on to cabinet posts and one who had deceased. Their goal was to evaluate progress over the past five years since the original report was released. The report concludes that the United States made no progress since the 2005 report in ability as a nation to "successfully compete, prosper, and be secure in the global community of the 21st century," that, instead, America had actually lost ground relative to its global peer technology nations. Below are factoids included in the 2010 report that refer specifically to the declining status of STEM education in the United States.

> Sixty nine percent of United States public school students in fifth through eight grades are taught mathematics by a teacher without a degree or certificate in mathematics.

> Ninety three percent of United States public school students in fifth through eight grades are taught physical sciences by a teacher without a degree or certificate in the physical sciences.
>
> The United States ranks 27th among developed nations in the proportion of college students receiving undergraduate degrees in science or engineering.
>
> The United States ranks 20th in high-school completion rate among industrialized nations and 16th in college completion rates.
>
> China's Tsinghua and Peking Universities are the two largest suppliers of students who receive PhD's—in the United States.
>
> The United States has fallen from first to eleventh place in the OECD in the fraction of 25-34 year olds that has graduated from high school. The older portion of the U.S. workforce ranks first among OECD populations of the same age.

Unlike the previous two annual meeting symposia that were open to members only, the WSAS opened registration for the 2011 symposium to anyone interested in STEM education. Of the 125 attendees, more than half were guests including eleven K-12 science teachers and eleven students grades 8 to 12 from across the state, ranging from small rural to large metropolitan schools. Travel expenses and registration fees for these teachers and students were paid with generous donations/sponsorships provided by the Apex Foundation in Bellevue, Boeing, Microsoft Research Connections, Pacific Northwest National Laboratory operated by Battelle, and Schweitzer Engineering Laboratories in Pullman.

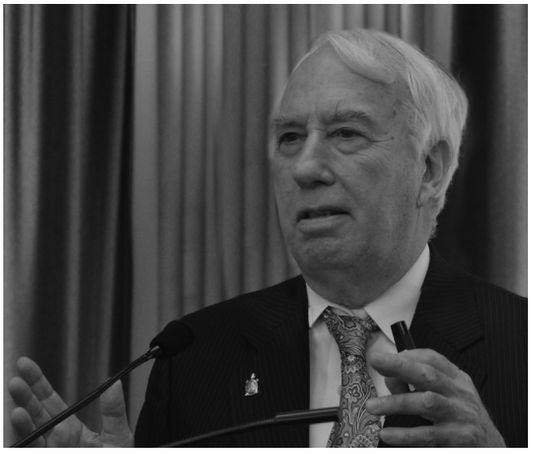
Four of the students exhibited posters of prize-winning projects previously presented at science fairs. Two of these were honored during a noon ceremony with awards that include all expenses to represent Washington State at the 2012 annual meeting of the American Junior Academy of Sciences in Vancouver, BC Canada. Also attending the symposium and invited to speak during the noon program were the directors of five of the seven science fairs held annually across the state for Washington grade-school and high-school students to exhibit their science projects and compete for the right to move on to national and international science fair competitions.

The Academy's 2011 symposium was the second symposium since its first (founding) annual meeting in 2008 with a focus on the education. The other symposium, held as part of the 2010 annual meeting at the Woodmark hotel in Kirkland, WA, was on the topic, The Science for Early Childhood Development: Learning for Life. The 2011 symposium takes this topic to a discussion of K-12 with a focus on STEM education more specifically. The Museum of Flight was a perfect backdrop for the 2011 symposium focused on STEM education in Washington State.

PART I: THE GATHERING STORM

Five Years of Rising Above the Gathering Storm

Dr. C.D. (Dan) Mote, Regents Professor and President Emeritus, University of Maryland.



Following a video greeting and charge to the symposium by Governor Christine Gregoire, Dr. Dan Mote opened the symposium with his talk, Five Years of Rising Above the Gathering Storm. Dr. Mote is a member of the National Academy of Engineering. He was also one of the 20 authors of the original 2005 National Academies' report, Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future[1] and one of the 17 authors of the 2010 …Approaching Category 5[2] follow-up report.

Dr. Mote opened his talk by complimenting the WSAS for connecting teachers, students, policymakers, STEM education leaders, and university faculty as done for the symposium, stating that "this is exactly what the country needs" to move ahead in STEM education.

He then turned his attention to the Gathering Storm report, boiling its recommendations for actions down to steps required to assure high-paying quality jobs for Americans and a plentiful supply of clean affordable energy for America. He made it clear that STEM education is fundamental to achieving both of these goals.

He pointed out that the 2005 report with its recommendations led to the America COMPETES Act, approved almost unanimously by both houses of congress and signed into law by President George W. Bush, and that the 2010 follow-up report was instrumental in getting congressional approval for renewal of the America COMPETES Act in December 2010. In fact, he said that without the 2010 follow-up report, renewal of the American COMPETES Act almost certainly would have failed.

Dr. Mote described their findings five years after the release of the 2005 report as "chilling," and that "current trends affecting America's future competitiveness were sharply negative." He pointed out, for example, that federal support in science and engineering had dropped from 0.76% of GDP in 2004 to 0.24% of GDP in 2008. A significant part of the U.S. workforce in science, technology, engineering and mathematics today consists of foreign nationals, many of them educated in, and who then have stayed in the United States on green cards or have become U.S. citizens. Brad Smith, Microsoft's General Counsel and Vice President, Legal and Corporate Affairs,

[1] Rising above the Gathering Storm Energizing and Employing America for a Brighter Economic Future. 2007. National Academy Press. 564 pp

[2] Rising Above the Gathering Storm, Revisited—Rapidly Approaching Category 5. 2010. National Academy Press, 85 pp.

made the point in his after-dinner talk that Microsoft has employees from 150 different countries. However, continuing to build our scientific and engineering work force with foreign nationals may not be sustainable as more and more of these students return to their homeland where opportunities are greater. Dr. Mote reported that 56% more Chinese nationals returned to their homeland in 2009 compared with 2008 and that 33% more returned to their homeland in 2010 compared with 2009.

The World Economic Forum 2010-2011 evaluation of global competitiveness for 139 countries showed

U.S ranked 4th in global competitiveness

- Down from 2nd in 2009-2010
- Down from 1st in 2008-2009

U.S. Education ranked

- 34th in primary education quality
- 52nd in math and science education quality (below the 40th percentile)
- 26th in higher educational systems

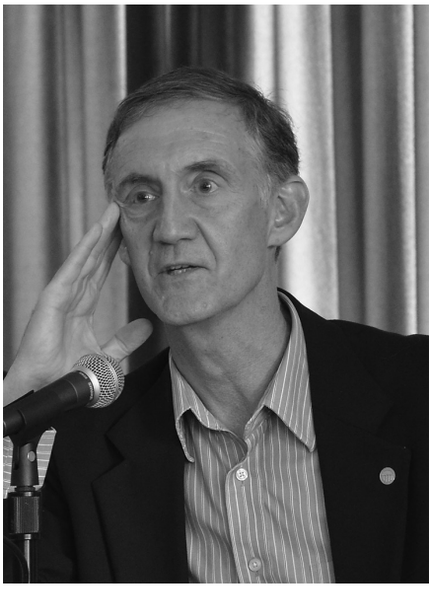
Dr. Mote was clear that the U.S. has made gains in global competitiveness over the past five years. The problem, he pointed out, is that our competitor technology nations are making gains faster than us, with the result that the United States is falling behind some of them. On a more positive note, Dr. Mote stated that actions recommended in the 2005 report and reconfirmed in the 2010 report, if implemented, "will help the United States achieve prosperity in the 21st century." Unfortunately, the trend is in the opposite direction. On the day of the symposium, the Seattle Times ran a front page story based on the 2010 U.S census—**Poverty growing in state: incomes shrink, fewer people have health insurance, more households live below the poverty line.**

A consistent message throughout the symposium and Brad Smith's after-dinner talk was that it is not members of congress or the Washington legislature that don't get it. As Dr. Mote stated during the discussion, we, the American people "don't get it," that "public opinion must be galvanized," that "you cannot fix a problem unless you know you have a problem."

Slides and a video for this talk are available at www.washacad.org.

STEM Education in Washington: The Facts of the Matter

Dr. Edward D. Lazowska, Bill & Melinda Gates Chair in Computer Science & Engineering, University of Washington.



The second speaker was Dr. Edward D. Lazowska, member of the National Academy of Engineering and secretary of the Washington State Academy of Sciences. Dr. Lazowska's task was to shift the focus of the symposium to realities in Washington State – to provide an analysis of STEM education in Washington relative to other technology-dependent states similar to the facts and realities reported in Rising Above the Gathering Storm for America relative to other nations. Dr. Lazowska acknowledged the invaluable help of Kristin Osborne, Director of Policy and Communications, Washington Technology Alliance, for pulling much of the data together for his presentation. Because of its central relevance to the symposium, the title his talk, STEM Education in Washington State, the Facts of the Matter, is the title chosen for this report.

Dr. Lazowska's overall message for the education system of Washington was just as chilling as was Dr. Mote's for the nation's education system: Washington "lags behind [other tech states] in most quantitative measures of student preparation and opportunity." This is not to say that there are not outstanding individual examples of excellence. But for all of the presented metrics, as well as others not presented, Washington does not rise above average, and for many metrics it is well below average within its technology peer-group of states and often among all 50 states.

Lazowska pointed out that, by any measure, Washington is a leader in America's innovation economy. Washington ranks 2nd among the top 12 states in technology enterprises as determined by the 2010 Kaufmann Foundation New Economy Index, and growth in private-sector technology employment has quadrupled during the period of 1974 to 2009. Technology industries are a major driver of Washington trade, with 75% of all technology sales going out-of-state in 2010. Ten of the top 12 states in the New Economy Index represent a "technology peer group" for Washington. The other nines states are California, Colorado, Connecticut, Maryland, Massachusetts, New Jersey, New York, Utah, and Virginia. Comparisons with this peer group are more meaningful than with all 50 states.

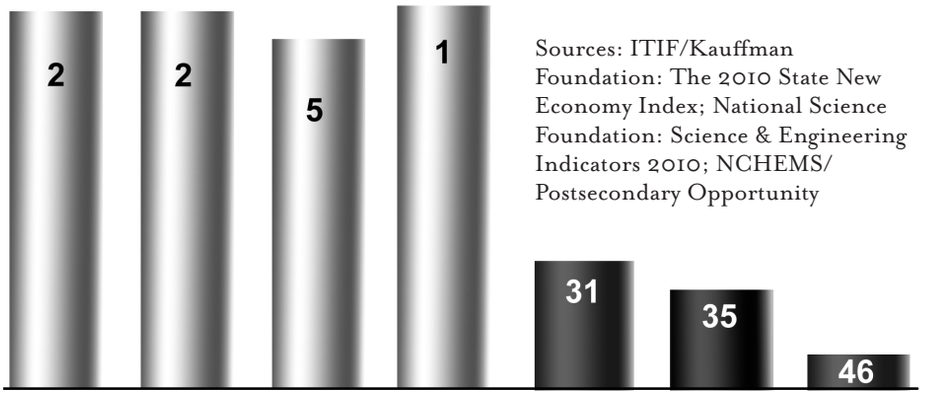
Kaufmann Foundation Methodology
Overall, the 2010 State New Economy Index uses 26 indicators, divided into five categories that best capture what is new about the New Economy:

1) Knowledge jobs
2) Globalization
3) Economic dynamism
4) Transformation to a digital economy
5) Technological innovation capacity

Source: http://www.kauffman.org/

As an economy driven by a highly educated innovative workforce, Washington ranks 2nd among the top ten tech states in intensity of it scientific and engineering workforce, 2nd in intensity of engineers, and 5th in intensity of computer specialists. But he then adds, "It turns out that they [this high tech workforce] are not our own children."

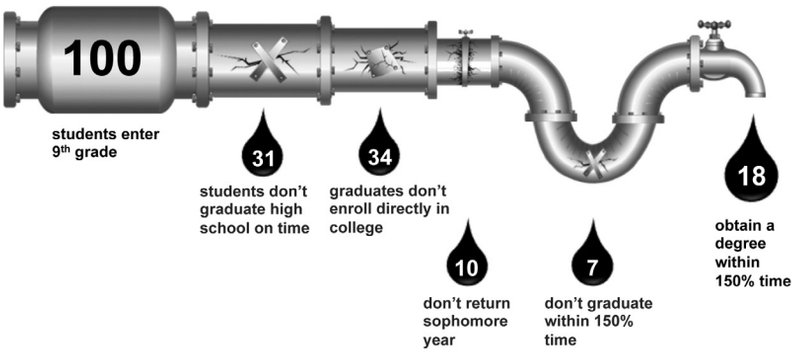
A mismatch between economic opportunity and our educational output.



Sources: ITIF/Kauffman Foundation: The 2010 State New Economy Index; National Science Foundation: Science & Engineering Indicators 2010; NCHEMS/ Postsecondary Opportunity

Washington ranks second among the ten technology peer states, and first by far, among all states on a per capita basis in the importation of 22- to 39-year olds with a bachelor's or higher degree. The state ranks second from last among the ten technology peer states in production of engineering degrees (29.8) per 1000 engineering occupations, and seventh in production of computer science degrees (21.0) per 1,000 computer science occupations. Lazowska then documented the mismatch between employment opportunity and educational output; while ranking 2nd in intensity of its science and engineering workforce, 2nd in intensity of its engineering workforce, and 5th in intensity of its computer science workforce among the ten technology peer states, Washington ranks 31st among all states in production of bachelor's degrees in the natural sciences and engineering, 35th in production of bachelor's degrees in engineering, and 46th in science and engineering graduate program participation. Washington ranks last among the ten technology peer states in science and engineering graduate program participation.

Washington State's Pipeline from 9th Grade to Higher Education Completion

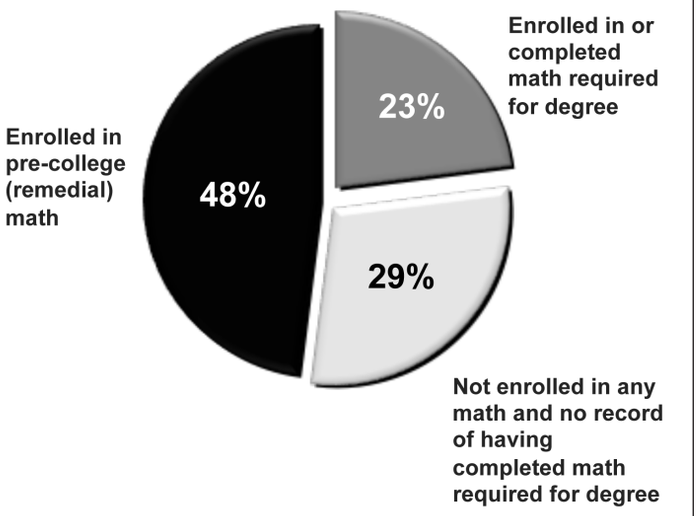


Source: NCHEMS. Note: Data for high school graduation doesn't account for transfers to private high schools and out-of-state. The calculation for college graduation doesn't account for transfers across institutions.

One problem is the state's leaky pipeline from when students enter 9th grade until they complete a two-year or four-year college degree. For every 100 students that enter high school, only 18 complete a college degree within 150% of the time normally required. Of the 100 students entering high school in 9th grade, 31 do not graduate from high school within 150% of the normal time, another 34 do not enroll directly in a college or university, 10 do not

return for their sophomore year, and 7 do not graduate within 150% of the normal time. Overall, Washington's pipeline between 9th grade and completion of a college degree is the leakiest of the ten technology peer states. Washington is also last among the ten technology peer states in proportion of high school graduates that go directly to a college or university. Of those that enrolled in a 2-year college directly out of high school, only 23% enrolled in college-level math or had the math required to complete their degree. Forty eight percent enrolled in pre-college remedial math and 29% were not enrolled in math, but had no record of having completed the math requirement for their degree.

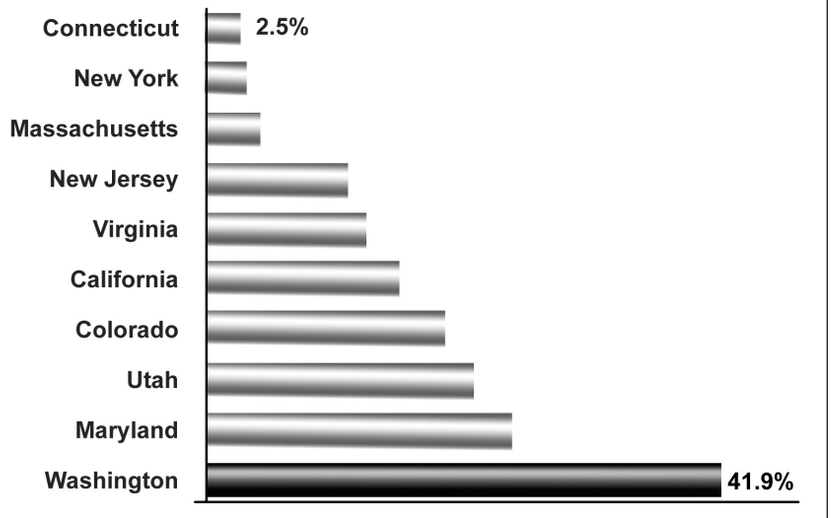
Washington higher education math enrollment



Source: Washington State Board for Community & Technical Colleges: Role of Pre-College (Developmental and Remedial) Education for Recent High School Graduates Attending Washington Community and Technical Colleges, 2009

Lazowska cited a 2009 National Education Progress report showing that, as a nation, we are not adequately preparing K-8 students for high school math. Even in Massachusetts, the top performing technology state, only 57% and 51% of 4th and 8th grade students, respectively, were at or above proficient in math. The corresponding numbers for Washington's 4th and 8th grade students was 43% and 40% respectively. Similarly in science proficiency, 48% and 43%, respectively, of 4th and 8th grade students in Massachusetts were at or above proficient, compared to 35% and 35%, respectively, of 4th and 8th grade students in Washington that were at or above proficient in science. These numbers are averages across all ethnic groups. When sorted according to white, Hispanic, and black, the numbers were even more troubling; for both math and science and both the 4th and 8th grades, the percentages of Hispanic and black students that were proficient were only a fourth to half of the percentages of white students that were proficient in these subjects.

% Change in skills mismatch index by state (2007-2010)



Source: Marcello and Tsounta. International Monetary Fund, courtesy of Drew DeSilver, Seattle Times.

Lazowska concluded his Facts of the Matter talk with information on the growing mismatch between the educational attainment required for Washington jobs

and the educational attainment of those seeking work. This "Skills Mismatch Index" was recently defined by the International Monetary Fund. Between 2007 and 2010, Washington's Skills Mismatch Index grew by 41.9% – more than all but one other of the 50 U.S. states. In plain language, "The people that held the jobs we are losing are not going to obtain the jobs we are creating."

Lazowska cited data provided by the Bureau of Labor Statistics indicating that, nationally, 80% of all STEM jobs over the period 2008 to 2018 are projected to be in fields of engineering, including computer science. Similarly in Washington, Lazowska showed data indicating that the engineering fields have the largest gap between supply and demand, followed by medical professionals, while business and management has the smallest gap between supply and demand. Washington's universities do not have the capacity to increase the number of engineering baccalaureates. Lazowska stated, "In the most recent year, more than 500 undergraduates seeking to major in a UW engineering program had to be turned away. More than 40% of the students that the College of Engineering was unable to accommodate, and more than 60% of the students that the Department of Computer Science & Engineering was unable to accommodate, had college grade point averages of 3.25 or above."

Slides and a video for this talk are available at www.washacad.org.

The Legislative Perspective

Senator Rosemary McAuliffe, Chair of the Washington State Committee on Early Learning and K-12 Education.

The WSAS was honored to have Senator Rosemary McAuliffe add a legislative perspective of STEM education in Washington State. In addition to her commitment to innovative education "that prepares all children for life and a career as a global citizen," Senator McAuliffe was co-sponsor of Senate Bill 5351, which established the Washington State Academy of Sciences in 2005.

She began her presentation by recognizing the teachers and students attending the meeting as guests and complimented them for making a difference in STEM education, noting that "teachers and students like these are examples of what we can achieve in our schools." She then asked the students and teachers to stand and be recognized with applause "for all their great work."

Senator McAuliffe called attention to the Washington STEM Program as one of the "legislative highlights" that seeks to improve student achievement and opportunity in STEM subjects. She described the program as mobilizing "education, business, and civic leaders to fulfill shared responsibility to improve STEM instruction throughout the state." She emphasized the critical importance of public/private partnerships such as Washington STEM in assisting school districts with the implementation of an inquiry-based science program aligned with the Washington State science grade level expectations.

In 2010, the Legislature passed HB 2621 to recognize STEM "lighthouse" schools and promote best practices in STEM education in Washington State. A total of $150,000 was allocated from the general fund for 2011 to designate up to three high schools and three middle schools in Washington as STEM lighthouse schools to identify, share, and promote best practices in STEM education. Updates from the selected schools are now pending.

Senator McAuliffe noted that teacher education on how to best teach a STEM curriculum is critical to the success STEM education in schools. One key to this effort has been the work with leading teachers such as James Sullivan at Brier Terrace Middle School who has grown the number of STEM-certified teachers from five to 300. She announced her support for a continuation of scholarships for teachers to obtain STEM certification each summer.

Washington STEM's foundation is built upon four core strategies that are catalysts to accelerate change and generate results:

- Discover and develop promising practices
- Engage families and communities
- Advocate for effective policies
- Build capacity

Washington STEM is among a network of organizations who advance and advocate for STEM education. These networks, which include U.S. Department of Education, National Science Foundation, state organizations, and the Educate to Innovate campaign, are working at the state and national levels to ensure STEM education is effectively implemented throughout our education system.
http://www.washingtonstem.org/

Senator McAuliffe also announced that $50,000 has been provided to train 25 instructors in STEM education as part of Project Lead the Way at Seattle University. This project has several components, including:

- Interactive, project-based high school and middle school technology curriculum;
- A professional development program;
- School counselors' professional development conferences;
- Continuous improvement in curriculum and training;
- Systematic program evaluation;
- Support for PLTW schools on a national and state/regional level; and
- Partnerships among schools, colleges, and the private sector.

Finally, Senator McAuliffe thanked the efforts of the Washington State Academy of Science symposium organizers and speakers, the public/private partnerships, teachers, parents and students across our state for their roles in moving Washington's STEM-education efforts forward to help prepare all our kids for life and career success as a global citizen.

She concluded with the promise to "continue to be STEM's biggest advocate in Olympia."

Video for this talk is available at www.washacad.org.

After Dinner Address – Education for the Next Generation: Meeting the Challenge

Mr. Brad Smith, Microsoft General Counsel and Senior Vice President for Corporate and Legal Affairs.

The Symposium concluded with an inspirational after-dinner talk by Mr. Brad Smith, who served as Chair of Governor Gregoire's Higher Education Funding Task Force. His assessment of the dire situation for STEM education in Washington echoed the message delivered by the symposium speakers earlier in the day. But he also outlined a positive way forward based upon the Task Force experience – by starting "outside government" through alignment of key stakeholder groups and then working within government to implement their recommendations. "It will take all of us coming together and recognizing that this may be the most important issue of our time."

Mr. Smith opened his talk by recounting why he accepted the Governor's invitation to chair the Task Force, saying it was rooted in "Microsoft's passion for the importance of education in Washington." He explained how Microsoft brings a global perspective to this issue, doing business in 190 countries and with employees from almost 150 countries in their Washington operations. Echoing the comments of Dan Mote, he noted how they "see education changing elsewhere, but failing to change here at home."

He told the audience how he brought a business perspective to this task, noting that in setting out to do something, you first need to figure out what your goal is, and then direct all your energy to accomplish it. One goal emerged above all else – "We need to enable more students in this state to get a high quality college education, because the world has changed." In 1973, only 28% of the jobs in the U.S required any kind of college education. By 2008 it had grown to 58%. And by 2018, the number is projected to be 63%. With the Washington economy being even more dependent on employees with some college background, the number required to have some college education in the state is expected to be 67%. Reinforcing the comments of Ed Lazowska, he emphatically said Washington has a "skills gap", and that production of bachelor degrees in STEM-related fields needed to grow by 40% in the next seven years from Washington's public universities. This need drove the Task Force to develop a plan to meet that goal, even given the "tough times" we are in. Mr. Smith said the State did not need another report, but rather, "had to find a way to get something done."

Governor Gregoire formed a Higher Education Funding Task Force of 16 business and higher education leaders in July 2010 to focus on three tasks:

- Develop a realistic and viable long-range funding strategy that provides Washington's students with affordable higher education opportunities.
- Recommend ways to improve accountability and performance in our public four-year higher education institutions to ensure we get the very highest value for the state's and student's investments.
- Consider whether the higher education system's current governance model should be modified to improve system-wide performance and accountability.

Given this charge, the Task Force zeroed in on three recommendations: (1) enable the state public universities to set their own tuition rates, even though it would be a painful step to raise tuition by a significant degree; (2) develop a formula for tuition rates linked to state funding, so if state funding falls tuition must rise; and (3) add a "third leg" to the public university funding stool by doing what no other state has done – a 50-50 private-public partnership to build an $1B state (not school) endowment for student financial aid and require that the state maintain its prior funding for financial aid.

Unlike many task forces, their job was only partially done when the report was produced in January 2011. They then turned to implementation through the legislative process in 2011 to "master the politics" as well as the policy. Smith noted, "in many ways that was even more enlightening" and "he came away with three lessons" that might be useful for the work ahead for WSAS and others in the coming years.

1. Although issues like this need "coming together to meet in the middle", these issues "don't start in government." He said "it is not realistic for people within government to meet in the middle if everyone outside of government stays in their respective corners." It must start with individuals and groups outside government coming together, working together, and standing behind some common proposals – in contrast to 30 groups taking 60 ideas to Olympia.

2. In the end, it still requires people in government coming together, meeting in the middle and making some hard decisions. He complimented the legislators and administration for coming together and rolling up their sleeves, recognizing that this "could not be just another year. We had to take some new steps forward."

3. An idea is not dead until it is dead. Smith recounted how the two bills – one to grant the universities the authority to set tuition and the other to create the $1B financial aid endowment fund – almost died multiple times in the legislative process. But the second bill "crossed the finish line" with 2-1/2 hours left in the session. He noted, "I will always appreciate the people … who refused to give up."

For the last part of his inspirational talk, he said, "now that we have finally gotten something done, where do we go next?" He suggested three things to focus on in the coming years: (1) a reinvestment plan for higher education to support the state's economy when it starts to rebound, to give an "opportunity to the next generation of students;" (2) grow the endowment for student financial aid, following the first big step by Boeing and Microsoft who each pledged $25M over five years to be matched by the state, and (3) with this successful effort as a backdrop, start to take steps for K-12 and STEM education to equip them to be college ready. He complimented groups like Washington STEM who are tackling this.

Mr. Smith concluded his moving talk by saying that we "need to come together" to develop plans for meaningful public school reform so that our students can be taught by "great teachers", including ones who may not be full time teachers. "It is up to us."

Video for this talk is available at www.washacad.org.

PART II: IMPROVING MATHEMATICS AND SCIENCE LEARNING

How the Storm Begins: Cultural Stereotypes, Identity Formation, and Principles of Child Development

Dr. Andrew Meltzoff, Job and Gertrud Tamaki Endowed Chair and Co-Director of the Institute for Learning and Brain Science, University of Washington, Seattle.

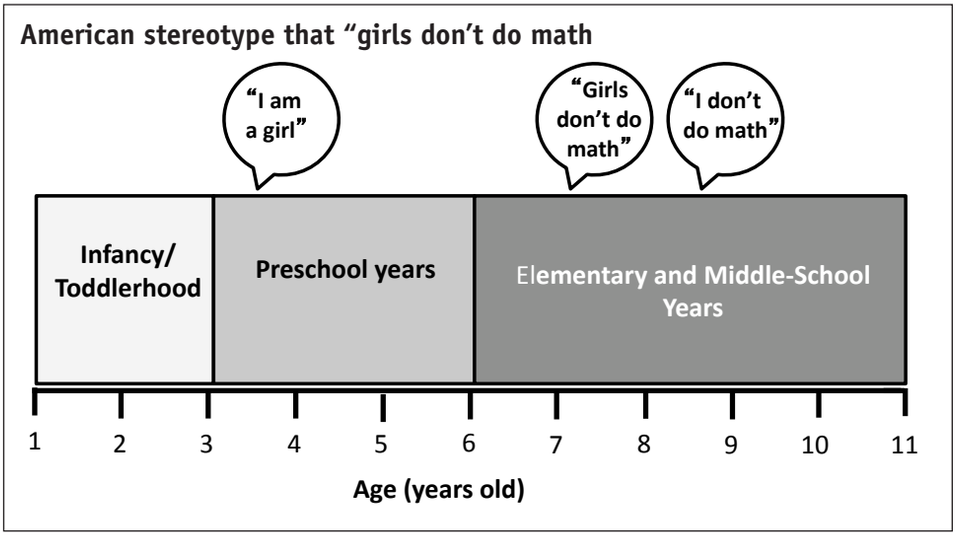
At last year's 2010 symposium on The Science for Early Childhood Development: Learning for Life, Dr. Patricia Kuhl gave a very enlightening presentation on her research showing that the ability of a child to learn the language spoken by the mother begins by 6 months of age and is well established by the time they are 1 year old. This remarkable example of the science of early childhood development and learning for life serves as both a model and a very practical example of what we can learn and understand thanks to the emerging and exciting field of brain science. If babies are developing the basis for learning the language spoken by their mother before they are 1 year old, what else are they learning – or developing the basis for learning – already during their very early years?

Dr. Kuhl is the Bezos Foundation Endowed Chair for Early Childhood Learning and serves with Dr. Andrew Meltzoff as Co-Director of the Institute of Learning and Brains Science (I-LABS) at the UW. The day after the 2011 symposium, Drs. Kuhl and Meltzoff traveled to New York where they helped kick off the NBC News' Education Nation Summit on September 26. This summit was part of a weeklong initiative by NBC News "to engage the country in a solutions-focused conversation about the state of education in America." The talks by Drs. Kuhl and Meltzoff were part of a session entitled: Brain Power: Why Early Learning Matters." Their talks included a visual tour through the brain of a baby, showcasing new data for the MEG brain facility at I-LABS and supporting the thesis that we are born social and during early childhood learn best from other people.[3] Their presentations followed presentations by Warren Buffet and Melinda Gates and preceded a talk by Secretary of Education Arne Duncan. A total of 52.4 million Americans watched the Education Nation coverage.

Dr. Meltzoff began his symposium presentation by stating that "to rise above the gathering storm, we need to understand the mechanisms—the biological, cultural, and psychological processes—that give rise to American children falling behind in STEM disciplines." As an example, he discussed research showing that children readily assimilate the dominant cultural stereotypes about who is good at math and

[3] A posting about how cultural stereotypes steer young girls away from math can be viewed on NBC News' Education Nation website at:
http://www.educationnation.com/index.cfm?objectid=D82D8BA0-F358-11E0-B00E000C296BA163&aka=0

computer science. He discussed new research from his laboratory at the University of Washington showing that by second grade, girls have caught the American stereotype that "girls don't do math" and this begins to influence their self-concepts, interests, and aspirations. Further, this stereotype affects girls at a young age before there is a gender difference in math achievement. It is also reflected in career choices made by women, and the underrepresentation of women in STEM disciplines on university faculties. Meltzoff showed data on the tiny fraction of female faculty in math at the University of Washington (15%) and Stanford University (7%).



Dr. Meltzoff went further and said based on research that most American adults believe that math is a male thing. Even teachers can have stereotypes reflected in whom they ask to answer questions. The psychological process involved in the development of a girl's self-concept for math is: "I'm a girl; girls don't do math; therefore I don't do math." He emphasized that the math-gender stereotype is "amazingly consistent" within our culture. In Singapore, on the other hand, girls excel in math, suggesting that cross-cultural studies investigating cultural stereotypes and math performance would provide a promising avenue for determining how beliefs, values, and expectations influence children's development.

It was mentioned early in the symposium that the loss of interest in science and math seems to begin in the sixth grade. Meltzoff announced at the beginning of this talk that the problem starts before sixth grade and that the emergence of stereotypes in particular starts as early as 2nd grade. This is because children learn by observing statistical regularities in the culture, much as a baby begins to learn its mother's language before age 1.

In Meltzoff's words: "We are born socially connected," and "children absorb what they see from us." He concluded by noting that, "understanding the seeds of the [gathering] storm, will potentially allow us to alter its course."

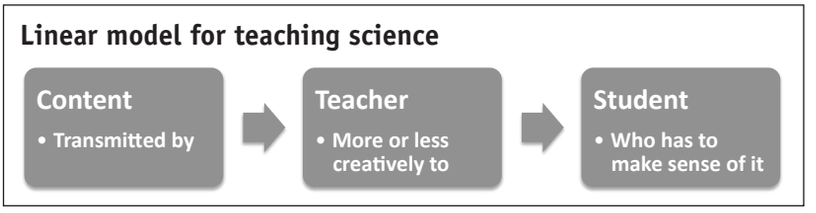
Slides and a video for this talk are available at www.washacad.org.

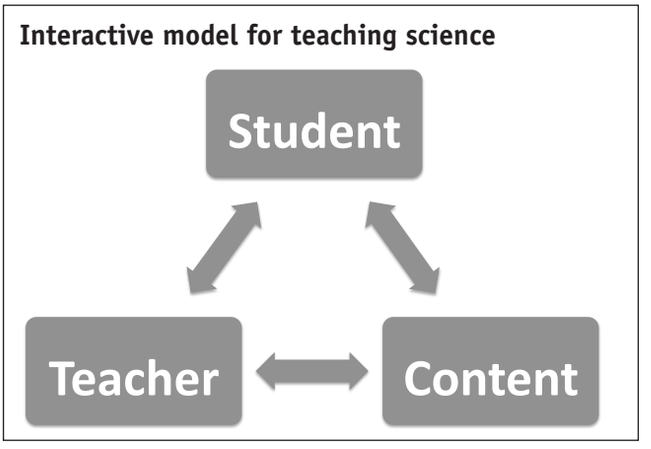
Teaching for Understanding in K-12 Science and Mathematics

Dr. Tamara Homlund Nelson, Associate Professor in Science Education, Washington State University, Vancouver, WA.

Dr. Tamara Nelson called attention to one of the most significant changes in science and mathematics education today, which is an explicit shift in focus from the teacher and teaching practices to student understanding. She explained that, while "teach for understanding" seems obvious, all too often the focus is on teaching to prepare students to pass a test or for the next course. In science education specifically, research shows that students' ideas about natural phenomena tend to be resistant to change, that learning in one class does not transfer well to other content areas or contexts outside the classroom, and that learning too often consists of disconnected bits of information rather than an understanding of how these pieces fit together as a conceptual whole. To accomplish a shift from traditional teaching practices to teaching for understanding, teaching must be viewed as a learning profession that requires ongoing study and feedback.

She also emphasized the need for another shift in focus from teaching science and math to students that are already planning for a career in science or engineering to teaching all students to some level of understanding of science and mathematics, i.e., "science for all citizens." She noted that many students take science only to meet high school requirements, and do not have an interest in or identity with mathematics or science. A significant number of these are black, Hispanic, and Native American students. Girls receive slightly more than 50% of undergraduate science degrees in the U.S., but few go into the physical or computer sciences or engineering. Regardless of the career choices, the population as a whole depends on and uses science and technology on a daily basis, but usually with little or no understanding.





She described two models for teaching science: linear and interactive. The more common linear or transmission model involves teachers transmitting knowledge to students. The teacher does most of the work and learning; students are less active in their interactions with scientific ideas and processes.

In a more powerful "teaching for understanding" model, teachers carefully design and support students' interactions with scientific ways of thinking and doing. This approach gets students working themselves on content by generating their own questions, collecting evidence to answer their questions, and experiencing the excitement of coming up with their own explanations for natural phenomena. She noted a common misconception among students is that everything scientific has already been discovered, that there is nothing new left to be discovered.

Dr. Nelson also emphasized that teaching for understanding requires more than the expertise that comes from just having disciplinary knowledge in math and science – the "what" of teaching. Pedagogical Content Knowledge (PCK) – the knowledge that embodies the "how to teach" – and an Inquiry Stance are also needed. The former implies that teachers are able to translate scientific ideas into models and explanations that students can access. The latter involves teachers' willingness to question the relationship between their instruction and how students are making sense of the content, and to change what they are doing when necessary. These latest findings on teaching for understanding were also embedded in the following talk by Dr. Pinky Nelson.

Copies of slides and a video for this talk are available at www.washacad.org.

Preparing Teachers for Tomorrow's Schools

Dr. George D. "Pinky" Nelson, Director of Science, Mathematics and Technology Education and Professor of Physics and Astronomy, Western Washington University, Bellingham, WA

Dr. Nelson opened with the comment that effective teaching goes well beyond good teachers—that there is too much talk about teachers when it is teaching that is important, that current teachers are fully capable of effective teaching. He went on to state that if our new teachers are prepared to function well in today's schools, then we have every reason to expect that today's outcomes in terms of student interests and achievements will be what Rising Above the Gathering Storm hopes to achieve. His emphasis on "new" teachers was reemphasized at the end of his talk with the statement that, "we are not preparing teachers to replace today's teachers."

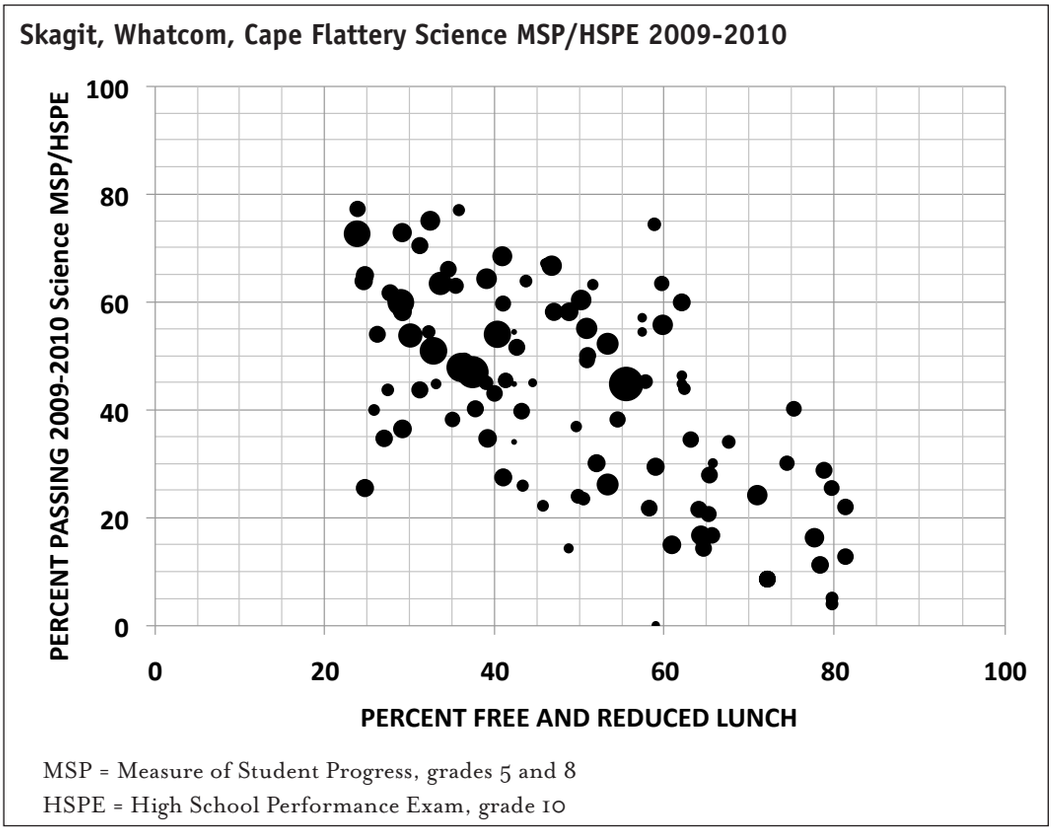
Stealing a phrase from Neil Postman & Charles Weingartner, Nelson sees "teacher preparation as a subversive act," that "learning to teach is much more involved than a 6-week boot camp for privileged, well-intended college graduates." Similar to the points made by Tamara Nelson regarding content, Pinky Nelson made clear that "new teachers need to master the knowledge and skills that come from the new research on teaching and learning, and from the rare examples of successful systems that have incorporated these ideas into classrooms." He added that "since new teachers really learn to teach in K-12 classrooms as much as they do in university classrooms, reforming the K-12 schools where our students intern is critical to the success of teacher educators. You cannot decouple the reform of teacher education from the reform of K-12 education."

He went on to list a series of teacher criteria that he considers fundamental to effective teaching. These are:

A shared belief that all students can learn—no excuses for not learning;

Knowledge of research;
Deep knowledge of content;
Knowledge and skills to teach specific content;
Practical knowledge and skills;
Collaborative knowledge and skills;
Experience and a mentoring plan;
Clear learning goals;
Excellent, balanced curricula and assessments;
Sufficient resources;
High expectations by and support of leaders;
Coherent community support; and
Low noise, meaning initiatives are coordinated.

Dr. Nelson then presented a diagram that illustrated the effect of income-level of the family on the ability of children from that family to succeed academically. Income level was inferred based on whether the child or children from the family qualified for free or reduced-price lunch. There was a direct negative relationship between academic successes based on the collective test scores of students of different schools and the percentage of students within that school receiving free or reduced-price lunch. These results are similar to data presented by James Heckman[4] showing for children ages 6, 8, 10 and 12 that the average percentile rank for math-test scores was directly and positively related to mean income of the family, with the highest score percentile across all four ages going to students from families in the highest income quartile, second highest score percentile going to students from families in the second highest income quartile, third highest score percentile going to students from families in the third highest (second lowest) income quartile, and lowest math score.



MSP = Measure of Student Progress, grades 5 and 8
HSPE = High School Performance Exam, grade 10

Copies of slides and a video for this talk are available at www.washacad.org.

[4] James J. Heckman, "Skill formation and the economics of investing in disadvantaged children", Science Vol 312, pp 1900-1902, June 30, 2006

PART III: SCIENCE AND ENGINEERING FAIRS—A ROLE FOR WSAS

It is well known that understanding science and engineering increases greatly through application of concepts in projects such as those represented by science and engineering fairs and competitions. The challenge and fun of planning, executing and reporting a project is an excellent way to engage students, introduce them to structured research and problem solving, and give them deeper immersion into a topic area of their choice. Furthermore, science and engineering fairs and competitions highly leverage volunteer and donor resources added to the increasingly constrained expenditures for public education. For all these reasons, there could be an implementable role for WSAS in fairs and competitions.

South Sound Science and Engineering Fair Director Steve Colgan

Representatives of seven major state science and engineering fairs were invited to the symposium, and five attended. During the luncheon, each representative informed the audience with an overview of their annual event and their needs for volunteer help. Four of the ten Washington student participants in the 2011 Intel International Science in Engineering Fair (ISEF) attended the symposium with their prize-winning posters for the audience to view. These inputs together with (1) informal interaction with the fair directors, students and advisors; (2) responses to feedback questions during and after the symposium; and (3) additional interaction with Gary Foss of the Washington State Science and Engineering Fair and Boeing's representative to the symposium form the basis for the content of this section.

Science and engineering fairs in Washington go back to the 1956 establishment of the Mid Columbia Regional Science and Engineering Fair followed in 1957 by establishment of the Washington State Science and Engineering Fair (see table on next page). However, most of the fairs have been established recently, with one yet to have its first fair. Collectively, the fairs engage many students from grades K-12, but only a small fraction of the total enrollment.

The prize-winning students participating in the symposium demonstrated the outstanding talent in Washington schools. These students also revealed the excellence that can be realized when dedicated and passionate teachers can be supported by volunteered resources. It was truly exciting to engage with both the students and their advisors and to hear the enthusiasm from the fair organizers.

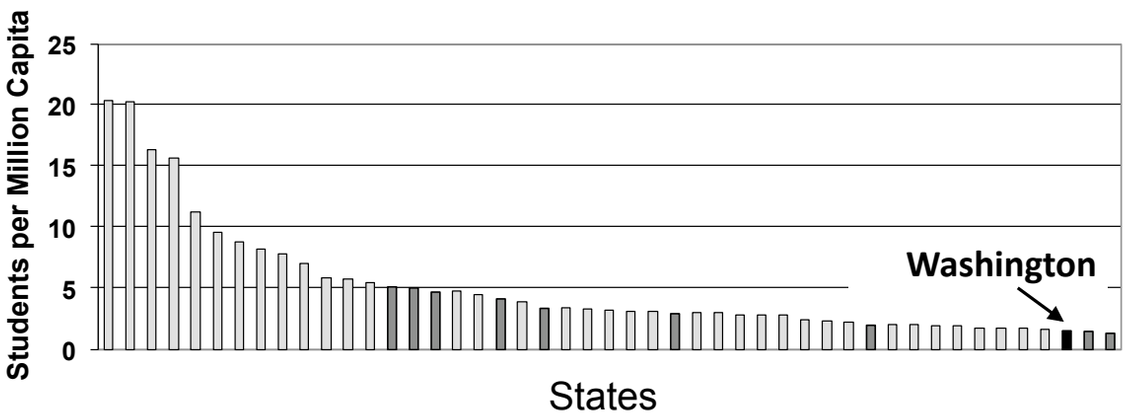
It was more sobering to learn how far behind Washington is compared to other states in the level of participation in science and engineering fairs. Washington ranked 44 out of 47 participating states and eighth out of ten peer technology states introduced in Ed Lazowska's talk.

Major Washington State Science and Engineering Fairs

Fair Name	Year Founded	Grades	2011 Participants
Mid-Columbia Regional Science & Engineering Fair	1956	6 – 12	169
Washington State Science and Engineering Fair	1957	K – 12	463
South Sound Regional Science Fair	1998	K – 12	405
Student BioExpo, NW Assn. for Biomedical Research (NWABR)	2001	9 – 12	330
Central Sound Regional Science & Engineering Fair	2010	9 – 12	28
Southwest Washington Science & Engineering Fair	2012	9 – 12	N/A
Washington Junior Science & Humanities Symposium		9 – 12	~85

Only New Jersey and California ranked lower than Washington. If the student participation data are sorted without being normalized by each state's population, Washington rises to 36 out of 47, but drops to ninth place among the peer technology states. There are other national competitions that could be examined for Washington student participation, such as FIRST, Intel National Talent Search, and the National Junior Science and Humanities Symposium. However, the Intel ISEF is an adequate surrogate to gauge Washington's participation relative to other states.

State participation in 2011 Intel ISEF. WA (black) ranks 44 out of 47 participating states. It ranks 8 out of 10 technology states (grey).

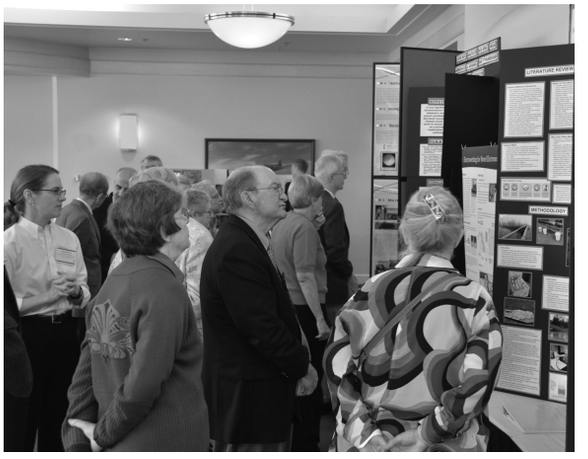


Data provided by Gary Foss, private communication.
Participant list at http://www.societyforscience.org/document.doc?id=295

In addition to science and engineering fairs as a source of student engagement and learning, such projects afford a way to implement the 2009 Washington State K-12 Science Learning Standards, which state that by 8th grade, students should

"Investigate an answerable question through valid experimental techniques. Conclusions are based on evidence and are repeatable."

"Work with other members of a team to apply the full process of technological design and relevant science concepts to solving a problem."



Viewing the prize-winning student science and engineering fair displays.

Washington has fewer such opportunities for its students than many other states. For example, in 2011 neighboring Oregon had eight fairs, sending 29 students to ISEF (3.6 students per fair), and Florida had 32 fairs sending 86 students to ISEF (2.7 students per fair). This compares to the four Washington fairs that sent ten students to the ISEF (2.5 students per fair). Additional fairs, expanded awareness, volunteer help and financial support could increase the level of student participation. The question is "what role should the WSAS play in increasing student participation in science and engineering fairs?"

PARTICIPANT RESPONSES TO TWO QUESTIONS

Symposium participants were asked to respond to two questions before leaving the Symposium: *Consistent with its charter, what can the WSAS do as an organization to help improve STEM education in Washington; and What can WSAS members do as individual volunteers to help improve STEM education in Washington?*

Although these questions were not directed specifically at science and engineering fairs, many of the responses addressed this topic. These suggestions, combined with remarks from the fair representatives and audience commentary, aligned around the following ways WSAS could contribute to science and engineering fairs.

As an organization:

- Be an advocate for these events and add a voice to others promoting and raising awareness;
- Establish or contribute to an online mentor network for linking students with project advisors and mentors; and/or
- Encourage donors to support the science and engineering fairs.

As individual WSAS members:

- Serve as mentors for student projects;
- Serve as judges during the fair;

- Promote the need for mentors and judges among their peers, employees, and students;
- Encourage their employer to contribute financially to the fairs; and/or
- Make financial donations to support the fairs.

Junior Academy of Sciences

Forty-three of the fifty states have Academies of Sciences. Of these, 29 state academies sponsor a Junior Academy of Sciences (JAS) in their state, five of which are in Washington's peer group of technology states. Twenty-nine state academies also sponsor a student competition, of which five are in Washington's peer group (although not the same five that sponsor JASs). Most of these state science academies have a different charter than the WSAS, which was established by the legislature primarily to support state policy makers as a source of objective scientific and technical information. In 2011, the WSAS launched a program enabled by member-donated funds to support the attendance of one or more high-school students each year at the annual meeting of the American Junior Academy of Sciences. At the symposium luncheon, two students were announced as the awardees to attend the 2012 meeting of the AJAS in Vancouver, BC (see pg 8). With limited financial and human resources, the WSAS must carefully consider the added value of sponsoring a JAS for Washington State or an additional event in the state.

Recommended WSAS Actions

As an organization:

- Continue to support the attendance of one or more Washington State students to attend the annual meeting of the American Junior Academy of Sciences;
- Raise public awareness of the importance of science and engineering fairs;
- Establish a mentor network for pairing students with project mentors; or
- Support existing fairs and nurture new ones by promoting member participation as mentors and judges, and encouraging them to donate.

As individual WSAS members:

- Being mentors or judges as science and engineering fairs;
- Promoting mentoring and judging among their peers, employees and students; and
- Being financial sponsors or asking their employers to be financial sponsors of students at state, regional, national and international science and engineering events.

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SPEAKER BIOS

C. D. (Dan) Mote, Jr.

Dr. Mote is Regents Professor at the University of Maryland College Park where he served as its President from 1998 to 2010. He is a Fellow of the American Association for the Advancement of Science, the American Academy of Arts and Sciences, an honorary member of American Society of Mechanical Engineers and is a Member and officer of the U.S. National Academy of Engineering. He served on the 2005 "Rising Above the Gathering Storm . . ." committee chaired by Norm Augustine and on the 2008 American Academy of Arts and Sciences committee "Investing in Early-Career Scientists and High-Risk, High-Reward Research" chaired by Tom Cech. Mote has emphasized global engagement at the University through research and joint programs, education and exchanges, entrepreneurial programs and competitiveness, and services to, and partnerships with governments globally. Dan Mote earned his degrees in mechanical engineering at the University of California, Berkeley and served on its faculty for three decades before moving to Maryland in 1998.

Ed Lazowska

Bill & Melinda Gates Chair, Department of Computer Science and Engineering, University of Washington. Lazowska received his A.B. from Brown University in 1972 and his Ph.D. from the University of Toronto in 1977, when he joined the University of Washington faculty. His research and teaching concern the design, implementation, and analysis of high-performance computing and communication systems.

He is a member of the National Academy of Engineering, a Fellow of the American Academy of Arts & Sciences, and a Fellow of the Association for Computing Machinery, the Institute of Electrical and Electronics Engineers, and the American Association for the Advancement of Science. Twenty two Ph.D. students and twenty three Masters students have completed their degrees working with him.

Senator Rosemary McAuliffe

With an involvement in the education community spanning more than 30 years, Senator Rosemary McAuliffe serves as Chair of the Senate Early Learning & K-12 Education Committee. She works hard to better Washington's public schools and prepare students for life surrounded by new and emerging technology. Rosemary is a staunch advocate for teachers, students and for parent involvement in their child's educational career.

Sen. McAuliffe lives in the Bothell community with her husband, James; they are both active in the community. They have six grown children and twelve grandchildren. Rosemary and James are small business owners. She graduated from Seattle University with a Bachelor of Science in Nursing.

Rosemary is the recipient of numerous awards throughout her legislative career. A Democrat, she began her fourth term in the State Senate in January, 2009. Prior to her service as a state lawmaker, she served on the Northshore School Board of Directors for 14 years, from 1977 to 1991. She was board president for two years.

Andrew Meltzoff

Dr. Meltszoffn international leader in child development research and cognitive science. His interests include imitative learning and how cultural stereotypes are assimilated by children. Meltzoff received a B.A. from Harvard and Ph.D. from Oxford. At UW, Meltzoff holds the Job and Gertrud Tamaki Endowed Chair and is the Co-director of the Institute for Learning and Brain Sciences. Meltzoff received awards from the Society for Developmental and Behavioral Pediatrics for outstanding research, the Kenneth Craik research award in Psychology from Cambridge University, and a MERIT research award from NIH. He is a Fellow of the American Academy of Arts & Sciences, American Association for the Advancement of Science, and a foreign member of the Norwegian Academy of Science and Letters.

Tamara Holmlund Nelson

Associate Professor in Science Education at Washington State University Vancouver. As Principal Investigator on a National Science Foundation grant, she has been researching collaborative inquiry amongst secondary science and mathematics teachers for seven years. Information on this work can be found at www.vancouver.wsu.edu/stride. Holmlund Nelson also does research on science teaching in relation to students from populations underrepresented in science achievement, and on scientist-teacher partnerships. Prior to becoming a professor, she was a secondary science and mathematics teacher for 13 years. Outside of work, she loves to travel with her husband and two grown children, and hike with her chocolate lab.

Dr. George D. Nelson

Director of Science Mathematics, and Technology Education and Professor of Physics and Astronomy at Western Washington University in Bellingham, Washington. From 1996 to 2001, he was Director of Project 2061 and a member of the senior staff of the American Association for the Advancement of Science. From 1989 to 1996 Dr. Nelson was Associate Vice Provost for Research and Associate Professor of Astronomy and Education at the University of Washington. From 1978 to 1989 he served as a NASA Astronaut and flew as a Mission Specialist aboard three Space Shuttle flights.

He earned his B.S. in physics from Harvey Mudd College and M.S. and Ph.D. in astronomy from the University of Washington. He has received many honors and awards including the NASA medal for Exceptional Engineering Achievement, and the Faculty Outstanding Service Award from Western Washington University. He was inducted into the Astronaut Hall of Fame in 2009.

He lives in Bellingham with his wife, Susie.

Brad Smith

Microsoft's general counsel and senior vice president, Legal and Corporate Affairs. He leads the company's Department of Legal and Corporate Affairs (LCA), and is responsible for the company's legal work, its intellectual property portfolio and patent licensing business, and its government affairs and philanthropic work.

Since becoming general counsel in 2002, Smith has overseen numerous negotiations leading to competition law and intellectual property agreements with governments around the world.

During Smith's tenure, the company's citizenship programs have reached almost 300 million people in 120 countries through technology training programs that help individuals develop the skills needed to obtain jobs.

Smith also serves as Microsoft's senior executive responsible for the company's corporate citizenship in Washington State. In 2010 he chaired for Washington State Governor Christine Gregoire her Higher Education Funding Task Force, and in 2011 he helped advocate for the successful adoption by the legislature of the Task Force's recommendations.

Before joining Microsoft in 1993, Smith was a partner at Covington & Burling, having worked in the firm's Washington, D.C., and London offices. He graduated summa cum laude from Princeton University and received his law degree at the Columbia University School of Law. He also studied international law and economics at the Graduate Institute of International Studies in Geneva, Switzerland.

Smith has written numerous articles and commentaries regarding international intellectual property and Internet policy issues, and has served as a lecturer at The Hague Academy of International Law.

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The WSAS also acknowledges the very helpful assistance of Kristin Osborne, Director of Policy and Communications, Washington Technology Alliance, for providing much of the data on STEM education in Washington State used in the presentation of Ed Lazowska and some of the factoids included in this report.

Gary Foss, Associate Technical Fellow at the Boeing Company and Vice President of the Washington State Science and Engineering Fair was a valuable liaison to the science and engineering fair directors and students, enabling their effective participation in the symposium. He also provided data and insight for Part III of these proceedings and several factoids. The WSAS greatly appreciates his help.

Special thanks also go to WSAS staff members Mary McDonough and Laurel Le Noble for their invaluable administrative support and organizational and technical skills so critical to the success of this annual meeting and symposium, and preparation of this report.

ABOUT THE AUTHORS

R. James Cook is dean and professor emeritus, Washington State University. His 40 years at WSU included 33 with USDA-Agricultural Research Service (ARS), five as the R. J. Cook Endowed Chair in Wheat Research, a position endowed with a $1.5 million gift from the Washington Wheat Commission; and two as Interim Dean of the College of Agricultural, Human and Natural Resource Sciences. He was elected to the National Academy of Sciences in 1993, inducted into the ARS Science Hall of Fame in 1997, and was co-recipient of the 2011 Wolf Prize in Agriculture awarded in Israel. He holds BSc and MSc. degrees from North Dakota State University and a PhD in plant pathology from the University of California, Berkeley.

Earll M. Murman spent 26 years as Professor of Aeronautics and Astronautics and of Engineering Systems at MIT. Prior to that, he worked at the Boeing Company (Seattle), Flow Research (Kent) and NASA (CA). Dr. Murman is a member of the National Academy of Engineering, a Foreign Member of the Royal Swedish Academy of Engineering Sciences, and an Honorary Fellow of the American Institute of Aeronautics and Astronautics. He graduated summa cum laude in Aeronautical Engineering from Princeton University in 1963 and received his PhD in Aerospace Engineering from Princeton in 1967.

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Academy of Sciences

Washington State Academy of Sciences
410 11th Avenue SE, Suite 205
Olympia, WA 98501
programs@washacad.org
http://www.washacad.org
(360) 534-2338