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Seventh Physics Education Symposium Highlights Problems and Needs

S. James Gates, Ramon Lopez, and Richard Steinberg were the three featured speakers at the Seventh Annual Symposium on Physics Education held on 8 January 2013 at the Winter Meeting of the American Association of Physics Teachers (AAPT) in New Orleans. Gates, of the University of Maryland, spoke as one of the 20 members of the Presidential Council of Advisors in Science and Technology (PCAST). Lopez, of the University of Texas, spoke to the problem of training enough workers in STEM (Science, Technology, Engineering, and Mathematics) fields and how this problem is to be addressed by the Next Generation Science Standards (NGSS). Steinberg, of the City College of New York, spoke about his experience teaching at a New York City public school.

Gates spoke about two recent PCAST reports, *Prepare and Inspire: K-12 Science, Technology, Engineering, and Math (STEM) Education for America's Future* and *Engage to Excel: Producing One Million Additional College Graduates With Degrees in Science, Technology, Engineering, and Mathematics*. Noting that *Prepare and Inspire* called for training 100,000 STEM teachers in 10 years (and that *retaining* them was another question), he stated that *Prepare and Inspire* is based on seven "pillars," among which are 1) a partnership between the Federal Government and local education systems; 2) provision of professional development to improve the teachers we now have; 3) a STEM Master Teacher Corps to retain the best STEM teachers and to employ them to improve STEM education; and 4) 1000 STEM-themed schools, 200 at the high school level, 800 at the middle school level, to increase enrollment in STEM courses.

Engage to Excel, Gates said, calls for a national effort to engage more students in math and the application of the science of learning to the learning of science, advocating a structure in government like PCAST to monitor

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ROSE = Relevance Of Science Education

When Ramon Lopez asked his audience at the Seventh Physics Education Symposium of the American Association of Physics Teachers (AAPT) to "Google 'rose' and 'science education,'" He was steering them to the ROSE (Relevance Of Science Education) Project. The URL for this Project is <http://roseproject.no>, where you can learn that the project is headed by Professor Svein Sjøberg at the University of Oslo and learn that it "is an international comparative project meant to shed light on affective factors of importance to the learning of science and technology,"

If you download "Sowing the Seeds of ROSE," by Camilla Schreiner and Sjøberg, you will read that "ROSE is based on a conviction that science and technology (S&T) are important aspects of life in all countries, regardless of culture and level of material development" but that "the S&T curriculum should be adapted to the needs of the learners." (p. 5)

To this end the ROSE Project has developed an extensive questionnaire, with ten parts:

A. "What I want to learn about" (students are asked about their interest in learning 48 science topics)
B. "My future job" (students are asked the importance of 26 job characteristics)

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ROSE Project

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C. "What I want to learn about" (students are asked about their interest in learning 18 examples of how things work)
D. "Me and the environmental changes" (students are asked about their agreement with 18 statements about the environment)
E. "What I want to learn about" (students are asked about their interest in learning 42 general topics in S&T)
F. "My science classes" (students are asked about their agreement with 16 statements about science education)
G. "My opinions about science and technology (students are asked about their agreement with statements about the value of S&T)
H. "Out-of-school experiences" (students are asked about their experience with 61 types of science-related events outside their science classes)
I. Free response questions about the student's life goals
J. Question about number of books in the student's home.

As such, Schreiner and Sjøberg point out, "the ROSE instrument is *not* a test for conceptual understanding of science contents. It is meant to gather information of *emotional* and *attitudinal* nature held by the students. We focus on aspects that may be of importance for how students engage with and relate to S&T in schools and in life in general." (p. 5)

As pointed out by Lopez at the AAPT Symposium, this questionnaire has been administered to many students in many countries. Schreiner and Sjøberg write much of what Lopez had to say, "that many, mainly highly industrialized OECD-countries, experience a fall in the recruitment to S&T subjects, studies and occupation," but that "The problem seems to be the interest in school S&T, not in S&T as such," (p. 12) The inverse relationship between student responses to sections A, C, and E of the ROSE questionnaire and the Human Development Index developed by the United Nations and the statistical analysis showing the -0.91 correlation between the HDI and responses to the ROSE questionnaire item, "I would like to get a job in technology," is found in their paper, "How do learners in different cultures relate to science and technology?" at the December 2005 Asia-Pacific Forum on Science Learning and Teaching, where they write, "The more developed a country is, the less positive young people are towards the role of S&T in society."

The TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC., was founded at The New Lincoln School on 11 March 1982 by Irma S. Jarcho, John L. Roeder, and the late Nancy S. Van Vranken. Its purpose is to channel information on science and society education to interested readers. To this end it publishes this *Newsletter* three times a year. Thanks to funds from tax-deductible contributions, the Clearinghouse is happy to be able to offer its services for a one-time nominal charge. In order to continue offering its services for a nominal charge, it also solicits underwriting of its publications by interested corporate sponsors. All correspondence should be addressed to the editor-in-chief at 194 Washington Road, Princeton, NJ 08540-6447 or via e-mail at <JLRoeder@aol.com>. The Clearinghouse is sponsored by the Association of Teachers in Independent Schools, Inc., and is affiliated with the Triangle Coalition for STEM Education.

IN THIS ISSUE

Next Generation Science Standards published in two forms

After feedback following publication of two initial drafts, the final version of the *Next Generation Science Standards* is now a public document. Accessible online at <www.nextgenscience.org>, it is published in two versions, one following the disciplinary core ideas of the *Framework for K-12 Science Education* (covered in our Fall 2011 issue), the other a list of science topics. In both versions each topic or core idea is listed by grade level (numerically through grade 5, middle school and high school after that), highlighted by performance expectations which are followed by a column for each of the three dimensions of the *Framework* (science and engineering practices, disciplinary core idea, and crosscutting concepts). Both versions cover the same set of performance expectations and disciplinary core ideas for each respective grade level, as can be seen in comparing the lists below, although the titles of items on each list are, in most cases, different.

If you are familiar with the *Framework*, you will recall that it contains four core disciplinary ideas for physical science, four core disciplinary ideas for life science, three core disciplinary ideas for earth and space science, and two core disciplinary ideas for engineering and technology, distinguished by number and subdivided by letter. All of these are used and addressed in the *Standards* except the second engineering and technology core disciplinary idea of the *Framework*, "links among engineering, technology, science, and society." There are, however, "Connections to Engineering, Technology, and Applications of Science" and "Connections to Nature of Science" added to the columns for science and engineering practices and crosscutting concepts, which were drawn from the *Framework*, as were the core disciplinary ideas. Also included are connections to other disciplinary core ideas, articulation of disciplinary core ideas across grade levels, and connections to Common Core State Standards in English and mathematics.

The chart to the right lists the performance expectations for grade levels K-2 by disciplinary core idea:

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Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
K	PS2: Motion and Stability: Forces and Interactions	K-PS2-1 K-PS2-2	PS2.A PS2.B PS3.C ETS1.A
K	PS3: Energy	K-PS3-1 K-PS3-2	PS3.B
K	LS1: From Molecules to Organisms: Structures and Processes	K-LS1-1	LS1.C
K	ESS2: Earth's Systems	K-ESS2-1 K-ESS2-2	ESS2.D ESS2.E ESS3.C
K	ESS3: Earth and Human Activity	K-ESS3-1 K-ESS3-2 K-ESS3-3	ESS3.A ESS3.B ESS3.C ETS1.A ETS1.B
1	PS4: Waves and Their Applications in Technologies for Information Transfer	1-PS4-1 1-PS4-2 1-PS4-3 1-PS4-4	PS4.A PS4.B PS4.C
1	LS1: From Molecules to Organisms: Structures and Processes	1-LS1-1 1-LS1-2	LS1.A LS1.B LS1.D
1	LS3: Heredity: Inheritance and Variation of Traits	1-LS3-1	LS3.A LS3.B
1	ESS1: Earth's Place in the Universe	1-ESS1-1 1-ESS1-2	ESS1.A ESS1.B
2	PS1: Matter and Its Interactions	2-PS1-1 2-PS1-2 2-PS1-3 2-PS1-4	PS1.A PS1.B
2	LS2: Ecosystems: Interactions, Energy, and Dynamics	2-LS2-1 2-LS2-2	LS2.A ETS1.B
2	LS4: Biological Evolution: Unity and Diversity	2LS4-1	LS4.D
2	ESS1: Earth's Place in the Universe	2-ESS1-1	ESS1.C
2	ESS2: Earth's Systems	2-ESS2-1 2-ESS2-2 2-ESS2-3	ESS2.A ESS2.B ESS2.C ESS2.D
K-2	ETS1: Engineering Design	K-2-ETS1-1 K-2-ETS1-2 K-2-ETS1-3	ETS1.A ETS1.B ETS1.C

Physics Ed Symposium

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the progress of STEM education. It focuses on the science and technology pipeline, addressing specifically the first two years of post-secondary education, to avoid a shortfall of a million STEM workers. One type of field for which there are not enough qualified American worker, Gates said, is computer numerical controls, to control robots to do manufacturing. He added that our current culture underappreciates teaching.

Picking up on Gates's observations about *Engage to Excel*, Lopez noted that 80% of the decrease in post-secondary STEM enrollments comes in the first two years, and he did not see that current efforts on behalf of STEM education were producing a "bumper crop" of students interested in STEM. In fact, he invited his audience to "Google 'rose' and 'science education'" to see that interest in STEM was found to vary *inversely* with such characteristics as a country's literacy and gender equality, measured by the Human Development Index (HDI) developed by the United Nations, according to student responses to questions on the A, C, and E sections of the ROSE questionnaire (see separate story on the ROSE Project, this issue). Specifically, he reported a -0.91 correlation between the HDI and the ROSE questionnaire item, "I would like to get a job in technology."

Lopez continued by observing that K-12 education is like a large marshmallow – 16,000 independent school districts: "If you push too much, you just get covered in goo." He urged the physics community to partner in developing the NGSS, for which he is a writer, where he has done most of his work writing elementary standards. He said that he expects most states to adopt the standards that Achieve would present in May 2013 in terms of Performance, Expectations, Foundation Boxes, and Connections, based on the K-12 Science Education Framework developed by a committee under Helen Quinn, and he noted that AAPT is already refashioning its Physics Teaching Resource Agent (PTRA) program to address them. These standards are intended to develop science literacy for all, not just STEM students, Lopez emphasized. To meet these standards, he expected that four years of science courses would be needed, as Texas already requires. In calling for all to work together to improve science education in the United States, Lopez characterized us all as "nomads" in the field, because we won't know when we have "arrived."

As one who grew up with *Physics by Inquiry* at the University of Washington, Steinberg lamented finding that students have weak math, science, and reasoning skills and flawed approaches to learning physics. He also reported finding that teacher candidates have varied strengths in subject matter and an authoritarian perspective of science, which leads to a "transmission" approach to teaching science. His experience teaching in a New York City public school, described in *An Inquiry into Science Education: When the Rubber Meets the Road*, found students with short-sighted perspective, mainly wanting to know what would help them "tomorrow." After describing some of his troublesome students, he said that a more serious problem than classroom management was student dependence on the teacher to tell them everything to do. *They* wanted to look up, memorize, and repeat, while *he* wanted them to think.

Referencing the PCAST *Prepare and Inspire* report described by Gates, Steinberg noted that it called for students to show factual knowledge, conceptual understanding, procedural skills, and habits of thought. When he went back to match these categories on the New York State Regents Exam, the ultimate evaluator of a high school physics course in New York, he found the following:

	1982	2011
factual knowledge	73%	80%
conceptual understanding	26%	16%
procedural skills	1%	4%
habits of thought	0%	0%

Steinberg added that "Teachers learn science one way, are taught to teach it a different way, are told by their principals to do it a third way, and are put in a classroom where none of it works." But would he repeat his public school teaching experience? "Yes."

Gates offered the following concluding comment to the Symposium: What is now required educationally is the equivalent of transforming our citizenry from working on the farm to working in the city. If we don't, he warned, there will be dire consequences.

(*Editor's Note*: The PCAST reports, *Prepare and Inspire* and *Engage to Excel*, respectively, were reported on in the Fall 2010 and Winter 2012 issues of this *Newsletter*, respectively; and Richard Steinberg's *An Inquiry into Science Education: When the Rubber Meets the Road* was reviewed in the Spring 2012 issue. For pdfs of these back issues, e-mail the Editor at <JLRoeder@aolcom>. For more information about the ROSE Project cited by Ramon Lopez, see separate article in this issue.)

Monitoring Progress Toward Successful K-12 STEM Education

As a result of a request of Representative Frank Wolf (R-VA), a workshop was held in May 2011 that led to the National Research Council's publication of *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, covered in our Fall 2011 issue. This year the Council has published *Monitoring Progress Toward Successful K-12 STEM Education: A Nation Advancing?*— in response to a Congressional follow-up request to "identify methods for tracking progress toward the earlier report's recommendations."

The committee charged with this task developed 14 indicators linked to the 2011 report's recommendations, with key indicators to monitor for each recommendation, a listing of available and potentially available data, and data and research needs. The recommendations and associated indicators are shown in the table below, with indicators of highest priority in boldface:

Recommendations from *Successful K-12 STEM Education* (2011)	**Indicators**
Districts Should Consider Multiple Models of STEM-Focused Schools	1. Number of, and enrollment in, STEM-focused schools and programs in each district.
Districts Should Devote Adequate Instructional Time and Resources to Science in Grades K-5	2. **Time allocated to teach science in grades K-5.**
	3. Science-related learning opportunities in elementary schools.
Districts Should Ensure that their Science and Mathematics Curricula are Focused on the Most Important Topics in Each Discipline, are Rigorous, and are Articulated as a Sequence of Topics and Performances	4. **Adoption of instructional materials in grades K-12 that embody Common Core State Standards in mathematics and *A Framework for K-12 Science Education*.**
	5. **Classroom coverage of content and practices in Common Core and *A Framework for K-12 Science Education*.**
Districts Need to Enhance the Capacity of K-12 Teachers	6. **Teachers' science and mathematics content knowledge for teaching.**
	7. Teachers' participation in STEM-specific professional development activities.
Districts Should Provide Instructional Leaders with Professional Development that Helps them to Create the School Conditions that Appear to Support Student Achievement	8. Instructional leaders' participation in professional development on creating conditions that support STEM learning.

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Fusion in thirty years?

"Fusion is still 30 years in the future." Plasma physicist Andrew Zwicker from the Princeton Plasma Physics Laboratory (PPPL) acknowledged this as a long-standing joke to his audience at the spring meeting of the New Jersey Section of the American Association of Physics Teachers at Princeton University on 15 March 2013, but there was an air of seriousness when he said it and when he added his feeling that the time has come for plasma physicists to "put up or shut up."

The need to make fusion a commercially viable energy source was underscored in Zwicker's mind by the dire nature of the world's present energy situation: China's 24% of the world's primary energy use in 2009 was greater than the 20% used by the U.S. Feeding a coal-fired 1000 megawatt electric power plant requires 250 100-car trains per year. Fission fuel for a year occupies a car and a half; fusion fuel for the same time can be put into a pickup truck, he added. In terms of fusion fuel, the top inch of Lake Erie, he said, was equivalent to the world's oil reserves.

Zwicker recounted that fusion research started at Princeton with the stellarator proposed by Lyman Spitzer, who also proposed putting a telescope in orbit to avoid the atmospheric interference with astronomical viewing. Since the cross section for fusion of deuterium (hydrogen -2) and tritium (hydrogen-3) is larger than other fusion cross sections and this fusion reaction has a lower energy threshold than do other fusion reactions, present efforts are centered on the fusion of deuterium and tritium to form a nucleus of helium-4 (an alpha particle) and a neutron. Deuterium atoms are one out of every 1000 hydrogen atoms, he went on, and easy to get. Tritum, though radioactive with a relatively short half-life, can be made from neutrons incident on either stable isotope of lithium. The major cost of fusion, he emphasized is the cost of the confining magnet, not the fuel.

	gravitational confinement	inertial confinement	magnetic confinement
temperature (keV)	about 1-2	10	10
density (in m^{-3})	10^{32}	6×10^{30}	3×10^{20}
confinement time (s)	$>10^{13}$	10^{-10}	2

Comparison of fusion parameters

The three critical parameters determining the achievement of fusion are temperature of the plasma of deuterons and tritons, the density of the plasma, and the time it can be confined. Plasma can be confined gravitationally (as in stars), inertially (of greatest interest to the military), and magnetically (as at the Plasma Physics Laboratory). The values of these parameters for the three different types of confinement are given in the table at the bottom of the page.

The values of these three critical parameters have increased considerably since 1953 when Lyman Spitzer first proposed the stellarator, as can be seen by the values achieved in 2000 by the Joint European Torus (JET) Tokamak (so far the most successful design for magnetically confined fusion, originating in Russia). Although density has increased by only a factor of 10, temperatures have increased by a factor of 2000, and confinement times have increased by a factor of 100,000. Zwicker pointed out that this progress toward fusion power has outpaced that of Moore's Law for progress in computer power.

Although the tokamak has been the most effective fusion reactor design, Zwicker noted that machines of various designs throughout the world are focused on determining the "best bottle" for fusion, among them the NSTX (the Next Spherical Tokamak Experiment, a compact tokamak) at PPPL. Had they been built to gather their data earlier, what was learned from them could have been incorporated into the design of ITER (International Thermonuclear Energy Reactor), the first fusion machine to ignite a plasma – slated for 2020, though its 50 megawatts will not be commercially-generated power. But the pilot plants following ITER could lead to the first commercially-generated fusion power by 2040, Zwicker noted, within the thirty-year time frame. Of the $1.2 trillion the U.S. spends for energy per year, he said, only $400 million goes to ITER. He would like to see a more aggressive approach to commercially-generated fusion energy, about $35 billion over 10-15 years.

Meanwhile, Zwicker noted, utility companies are starting to visit PPPL with interest in the development of fusion power. And the development of plasma physics technology has had other positive spinoffs, including computer chip manufacturing, toxic waste cleanup, and fluorescent light bulbs.

Doubling Energy Productivity by 2030

Energy efficiency has fueled 75% of new demand for energy services in the U.S. since 1970, and it contributed more to the U.S. economy in 2011 than any other energy source (55 Q (quadrillion Btus) *vs*. 35 Q from oil, 28 Q from natural gas, 23 Q from coal). If the recommendations of the Commission on National Energy Efficiency Policy from the Alliance to Save Energy are followed, households would save more than $1000 per year, a million jobs would be added, and carbon dioxide emissions and oil imports would be lowered by a third.

These recommendations come from the Alliance's report, *Energy 2030: Doubling U.S. Energy Productivity by 2030*, written by a commission which was co-chaired by Senator Mark Warner (D-VA) and Tom King, President, National Grid US, and included the Director of the National Renewable Energy Laboratory and the President of the Environmental Defense Fund. They are based on seven research reports and are framed in terms of three overarching strategies. The seven research reports address the history of energy efficiency; residential and commercial buildings; transportation, land use, and accessibility; manufacturing; smart grid and power generation; natural gas infrastructure; and systems integration. The overarching strategies are to "unleash investment in energy productivity throughout the economy," "modernize regulations and infrastructure to improve energy productivity," and "educate and engage consumers, workers, business executives, and government leaders on ways to drive energy productivity gains."

The report defines energy productivity as economic output per energy input ("bang for the Btu") and cites economic competitiveness, technological innovation, energy reliability and security, and stewardship of the environment and natural resources among its benefits. Energy productivity in the U.S. has increased from $63 billion per Q in 1970 (in 2005$) to $135 billion per Q in 2011. Business-as-usual projects $207 billion per Q by 2030 rather than the $270 billion per Q doubling goal. Moreover, energy productivity is both greater and increasing at a greater rate in Denmark.

The economic impacts of doubling energy productivity were modeled by the Rhodium Group. They found that while the cost would be great, $166 billion per year, the benefits would be even greater, $494 billion per year, leading to a net benefit of $327 billion per year. This would break down as follows in the various sectors of the economy:

sector	investment cost ($billion per year)	energy savings ($billion per year)	net savings ($ billion per year)
Buildings	72	167	95
Industry	15	109	94
Transportation	79	218	139
Total	166	494	327

When in his 2013 State of the Union Address President Obama urged his fellow Americans "to cut in half the energy wasted by our homes and businesses over the next 20 years," he was advocating the goal of this report. And when he said, "We'll work with the states to do it. Those states with the best ideas to create jobs and lower energy bills by constructing more efficient buildings will receive federal support to help make that happen," he was advocating this report's recommendation to "create a national 'Race to the Top' style energy productivity competition targeted at states and communities" as part of its second overarching strategy. The report can be accessed from the Alliance to Save Energy's website at <http://ase.rg/sites/default/files/full_commission_report.pdf>.

FORTHCOMING SCIENCE & SOCIETY EDUCATION MEETINGS

11-13 September 2013, World Nuclear Association Annual Symposium, Central Hall Westminster, London. Contact <events@world-nuclear.org>.

3-5 October 2013, Association of American Colleges and Universities, "Global Learning in College: Asking big Questions, Engaging Urgent Challenges," Providence, RI. Call (202)-387-3760 or write Siah Annand at <network@aacu.org>.

31 October – 2 November 2013, Association of American Colleges and Universities, "Transforming STEM Education," San Diego, CA. Call (202)-387-3760 or write Siah Annand at <network@aacu.org>.

4-6 March 2014, Building Energy 14: Conference and Trade Show for Renewable Energy and Green Building Professionals, Seaport World Trade Center, Boston, MA. Contact Northeast Sustainable Energy Association, 50 Miles St., Greenfield, MA 01301, (413)-774-6051, <nesea@nesea.org>.

Murkowski shares 2020 Energy Vision

by John L. Roeder

Senator Lisa Murkowski (R-AK) has issued a document titled *Energy 20/20: A Vision for America's Energy Future*. Although she writes that it is "intended as a blueprint for discussion, not an 'energy plan' in and of itself," it would appear that any discussion issuing from this document would deal with what Murkowski firmly believes, which is pretty much what one would expect from a Republican senator from a large energy-producing state.

"Energy is good," she begins, and after iterating the reasons for this she states that it is in our national interest to make it "abundant, affordable, clean, diverse, and secure." The emphasis on this "energy is good theme" shows in the fact that almost half the 121-page document is devoted to "Producing More," and almost half of this section is devoted to fossil fuels, both "conventional" and "unconventional." Murkowski notes that directional drilling and hydraulic fracturing have increased U.S. conventional oil reserves, not to mention the "unconventional" reserves. On page 6 she advocates increasing production of "oil, biofuels, and synthetic fuels to become independent of OPEC imports by 2020," the first of the goals she would like to achieve by 2020 (see box), though on page 10, she lumps Canada's production of 2.9 million barrels per day and Mexico's 2.6 million barrels per day with the U.S. production of 10 million barrels per day to broaden the list of sources to achieve this. The results of independence from OPEC imports, she goes on, include more jobs and federal revenue, a reduced budget and trade deficit, and affordable world energy prices (but nowhere does she note that the principal beneficiary of affordable world energy prices would likely be China). Murkowski laments that increased U.S. oil production thus far has not benefited from exploration on federal lands but argues that it should. Such increase of U.S. oil production would entail expedited federal permitting, the Keystone XL pipeline, exploration of the Outer Continental Shelf and other offshore areas, also exploiting the Arctic National Wildlife Refuge and National Petroleum Reserve-Alaska. To those who would object that fossil fuel producers are subsidized, she responds that they are "eligible for many of the same tax treatments available to other industries." (p. 113)

"The United States will never run out of energy," Murkowski writes on page 24, adding that "Oil scarcity is a myth." To substantiate this, she shows 22 billion barrels of "proved" reserves at the top of a much large pyramid containing 400 billion barrels of "technically recoverable" crude oil, 800 billion barrels of oil shale, and 2303 billion barrels of "undiscovered resources." Her cited references for this are the Energy Information Administration (of the US Department of Energy), the Rand Corporation, and the Institute for Energy Research. "Private sector estimates project unconventional fossil fuel production to far surpass conventional fossil fuel production in the near future," she goes on. "This rapid growth will create jobs and fuel our economy." (p. 25) It will also make the U.S. "the Saudi Arabia of oil shale," and Murkowski says that we should take advantage of that role by accelerating oil shale permitting/leasing – "with a comprehensive plan for addressing water scarcity risks and impacts" and renewing "R&D funding for viscous (heavy) oil technology/production research at the Department of Energy." (p. 28)

When Murkowski switches from fossil fuels to other energy sources – those that don't emit greenhouse gases – the term "clean energy" surfaces. Murkowski would define clean energy as "less intensive in global lifecycle impacts on human health and the environment than its likeliest alternative" – a definition that others might consider to describe "cleaner" energy – and would also "develop more efficient and less invasive ways to promote it – specifically, by avoiding federal mandates. In order for new clean technologies to succeed," she continues, "their costs must fall and they must be allowed to mature in a way that enables sustained private investment." (p. 31) Requiring that new technologies succeed by being accepted rather than mandated, Murkowski insists that government programs and policies governing them be technology neutral, as can be seen in her goals related to clean energy (see box). Moreover, she states in her initial advocacy for clean energy (p. 5), she notes that "our challenge is to reduce the cost of 'cleaner' sources of energy, not raise the cost of existing sources." Here she acknowledges that her definition of "clean" is really of "cleaner": "Too often, 'clean' is treated as an absolute, but it is better regarded as a comparison."

Murkowski's attitude toward what is commonly called "energy conservation" – using less energy to complete a job – parallels her attitude toward "cleaner" energy sources: that they must gain their acceptance through lower costs, not by increasing the price of fossil fuels, say, by figuring in their external environmental costs. "Energy policy should drive conservation without detracting from our standard of living," she writes on page

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Murkowski

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62. Her focus in considering conservation is the ratio of energy per unit of gross domestic product, which she calls "energy intensity." By emphasizing "energy intensity," she focuses on using less energy to do things rather than using less energy by doing without things.

In the penultimate two sections of *Energy 20/20* – "Effective Government" and "Environmental Responsibility" – Murkowski revisits many of the points she has already made regarding fossil fuels: "We need to put the federal government's house in order so that urgently needed new energy projects can proceed. . . . The government needs to do a better job of striking a prudential balance between energy requirements and environmental concerns." (p. 87) One of those environmental concerns is hydraulic fracturing ("fracking"), which she credits along with horizontal drilling for more than quintupling shale oil production and quadrupling shale gas production between 2007 and 2011. She adds that fracking has assisted the extraction of Alaskan oil since the 1970s. Yet, respectful of the control individual states have over the use of fracking, she advocates a uniform federal fracking policy only if the present system is found not to be effective.

The other major environmental concern is climate change. Murkowski claims that since modeling climate change is more complex than modeling commodity prices, natural disasters, and housing market risks, which have all seen computer models fail, climate modeling needs to be viewed with caution. Pursuing "burdensome and costly legal and regulatory responses that are unlikely to be matched by other countries" puts the U.S.

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MURKOWSKI'S GOALS FOR 2020

- Achieve independence from OPEC imports.
- Diversify coal utilization while continuing to improve its environmental performance.
- Define clean energy as "less intensive in global lifecycle impacts on human health and the environment than its likeliest alternative" in all federal programs and policies.
- Supplant federal renewable resource programs and policies with a new system that is more cost-effective and technology neutral.
- Energy storage should be a cost-effective means for leveling demand.
- Federal funding should be directed to technology-neutral basic research supporting energy storage.
- Increase access to federal lands for geothermal power development, especially in the west.
- Shift to a wholesale efficiency approach that encourages integrated systems rather than silos of efficiency.
- Eliminate the dependency on government subsidies and implement a new system of clean energy finance that is cost-effective, technology-neutral, and conducive to private investment.
- Significantly increase funding for basic science research as well as transformational research, development, and demonstration programs.
- Upgrade energy delivery infrastructure to mitigate risk from degradation.

2013 NYC Solar Summit

Further progress for solar energy in New York City was reported at the seventh annual NYC Solar Summit at the City University of New York (CUNY) on 4 June 2013. The NYC solar market was reported to have grown by 85% in 2012 relative to 2011, and PV applications filed thus far in 2013 were reported to continue the same trend of active growth. This also acts in support of New York Governor Andrew Cuomo's NY-Sun Initiative, which "aims to quadruple by 2013 the amount of customer-sited solar power installed annually in New York," according to the governor's Chairman of Energy and Finance, Richard Kauffman.

Technological advances reported at the Summit included NYSolar Smart, "a detailed plan to reduce the soft costs of installing solar across New York State that is supported in part by NYSERDA (New York State Energy Research and Development Agency) and NYPA (New York Power Authority) through Governor Cuomo's NY-Sun Initiative." It was also announced that, rather than having to shut down solar installations tied to the grid when the grid shuts down, "new technology and designs are available that re-route the power captured on our rooftops by solar and other distributed generation, allowing these resources to contribute during emergencies. The development of a policy and programmatic framework to support this capability is part of a substantial new effort by CUNY."

Many Uses of Science at Consumer Reports

Recently retired from Consumer Reports, Robert Karpel shared his insights on "The Usefulness of Science at Consumer Reports" from his thirty years as a senior engineer with the organization in a talk to the Physics Club of New York at New York University on 14 December 2012. Headquartered in Yonkers (NY), Consumer Reports has been fulfilling its mission to test, report, and protect since 1936. When Consumer Reports first began doing this, it was viewed as subversive for questioning the practices of manufacturers at the time from the standpoint of safety. Here Karpel chronologued a series of questions raised by Consumer Reports through the years, each one raising a valid safety issue that has led to greater protection of the American public.

Consumer Reports pays cash for the materials it tests and sells them to its employees afterward, Karpel said; thus, the organization is beholden to no one. And because the claims it makes are supported by scientific research, Consumer Reports has never lost a lawsuit, including two that went all the way to the U.S. Supreme Court.

Karpel gave several examples of this scientific research. All clothes washers are tested with water from the same large sample the size of a swimming pool. Dishwashers are tested with plates onto which cherry compote has been baked at 450°F for four hours, and increased water pressure has been found to be more effective in removing food particles, even without scraping the plates. In fact, Karpel stated that dishwashers, clothes washers, and refrigerators have all made astounding progress in recent years.

The highest energy costs, Karpel reported, come from the transmission of thermal energy. With the bottom line being consumer comfort, sometimes the manner in which thermal energy is transferred is more important than the actual temperatures involved. This has been found to be true, Karpel said, for both toasters and thermostats. (Here he noted that programmable setback thermostats had lost their Energy Star ratings because no one had programmed them.) When testing clothes dryers, Karpel went on, he sought to minimize cost by determining the minimum time the dryer needed to run to dry the clothes and developed an algorithm to determine this using Chebyshev polynomials.

Other examples of product testing which Karpel touched on in his talk were batteries (and how the rate at which they transmit energy relates to the match of their internal resistance with the resistance of the load they are supplying energy to), plastic bags (GLAD bags were found to be advertised more, cost more, and hold less), paper towels, drain cleaners, coffee makers, paints, sound systems (with their own anechoic chamber), and chocolates (a testing panel of experts is used – similar panels are used to test the comfort level produced by thermostats).

Hamlin emphasizes sustainable diet

How can we practice "Sustainability at Home and at School: Saving the Planet 3 Times a Day"? This was the question asked by Amie Hamlin, Executive Director of the New York Coalition for Healthy School Food, in her keynote address at the Annual Conference of the Science Council Of New York City at Stuyvesant High School on 6 April.

Her answer was to eat a plant-based diet. Citing Mark Bittman's *Food Matters* as her reference, she stated that agricultural animals emit more carbon dioxide than cars and that a meat-based meal causes sixteen times the carbon dioxide emission as a plant-based meal.

Hamlin then went on that humans are the only mammals who drink milk – of another species – after weaning, and who smoke and consume sugary beverages. She added that the dangers of our diet are an inconvenient truth that not even Al Gore talks about and that the food industry lobbies against telling us about.

Among the faults Hamlin found with animal-based foods were that they give cholesterol but no fiber, are higher in solid fat and dioxin, and cost more. On the other hand, vegan diets have facilitated weight loss and reversal of medical problems brought by excess weight. Moreover, she added, agricultural animals are raised in deplorable conditions. And omega-3 fatty acids can be obtained from algae and walnuts – fish are not needed.

The New York Coalition for Healthy School Food offers an alternative menu and a curriculum. They can be visited at <www.healthyschoolfood.org>.

The electronic water cooler

by H. Frederick Dylla

The recent decision by the new Yahoo CEO to rein-in telecommuting in favor of "all hands on deck" in corporate headquarters has unleashed a national conversation about the business strategy of telecommuting. Are group creativity and innovation better inspired by face-to-face interactions than by modern electronic connections?

Twenty years after the web moved from interconnecting high-energy physics labs to being an essential tool of commerce, high-bandwidth connectivity has certainly made it easier for employees to carry on many tasks that once required their presence in the workspace. Such remote activity has obvious advantages to child-rearing parents and commuters in congested areas. But do the advantages of this relatively newfound connectivity compensate for the loss of physical interaction in the workplace?

It should be noted that even without telecommuting, electronic communications often suppress in-person communications because of their ease. I have often urged neighboring colleagues to forgo email and walk down the hall to have a face-to-face conversation.

In responding to a thoughtful March 2nd editorial published in *The New York Times* on this controversy, a letter to the editor was published by Norman Axelrod, a former Bell Labs employee, who touted his institution's iconic reputation as a hotbed of innovation — in part because of its working environment at both its Murray Hill and Holmdel, NJ, locations.

The environment fostered frequent encounters of staff in hallways, resource centers such as libraries, and especially in the lunchroom. When you talk to a former Bell Labs employee or read last year's superb Bell Labs history book authored by Jon Gertner aptly called *The Idea Factory,* management considered real estate to be a major part of the grand design in creating a culture for personal interaction. Bell Labs' unmatched creativity also stemmed from the hiring of a broad array of scientists, engineers, and technicians that spanned the whole range of skills needed to develop communication technologies — a practice that became a tradition for most of the 20th century. Moreover, the AT&T-managed monopoly with the US government allowed for stable, long-term funding of Bell Labs until the court-ordered breakup of the Bell system in 1984. The Bell Labs real estate was designed to encourage and enable the interdisciplinary staff to mix both formally for the task at hand, and informally, to take advantage of a serendipitous meeting of the minds.

I have had the pleasure of knowing and working with many Bell Labs colleagues over my 40-year career, and have come to admire and envy what they experienced. I have also seen where similar cross connections of creative people have encouraged innovative behavior. I worked for two modest-sized DOE national labs and each required a highly interdisciplinary staff. The communal lunchrooms at these two labs gave birth to more good ideas than the sum total of motivational courses to which we subjected our staffs. I had the pleasure of working for the founding director of Jefferson Lab, Hermann Grunder, who stacked every lunch table with a pencil and notepad to make sure a good thought didn't lose its fidelity on a napkin.

One of my jobs at Jefferson Lab was fostering collaborations between the laboratory and neighboring research universities. I quickly became aware of the geographical disadvantages of modern universities, where academic departments are often enshrined in separate buildings. As I made my campus visits, I encountered two independent groups at one university doing laser-induced chemistry studies; they were separated by a street and two departmental bureaucracies. Had they talked to each other, both groups *could* have strengthened their efforts. They could have boosted their power collectively — but didn't. At a second campus, I found a trio of scientists all working on nanocrystalline diamond — one an experimentalist, one a device builder, and one a modeler — but none of the three had ever talked to each other about collaborating and combining their obvious strengths.

My personal experience in the sciences and engineering compels a strong bias for staff co-location—not only for the obvious tasks of designing, building, and testing machines from small instruments to gargantuan particle accelerators, but also for the day-to-day chance collaboration that creates a serendipitous solution to a shared problem. I don't see this being replaced by a virtual presence on a handheld device or laptop screen. Now, I might change my mind when my laser buddies usher in a full 3D holographic presence — but how will we share the same cup of caffeinated conversation starter?

(*Editor's Note*: H. Frederick Dylla is Executive Director and CEO of the American Institute of Physics. This article is excerpted with permission from his newsletter, *AIP Matters*, for 18 March 2013. John White reviewed Gertner's *The Idea Factory* in our Spring 2012 issue.)

Maximizing Student Facility with Technology for their Education

Seventy-seven percent of 12-17 year olds own cell phones, 23% of which are Smart Phones, and this statistic is independent of race, ethnicity, or socioeconomic status. Three quarters of American teens have at least one social networking site, with 68% of them on Facebook and 22% on Twitter, and 11% tweeting daily. A third of these teenagers favor texting over other communication modes, with older girls sending an average 100 texts per day (boys only half that much). Thirty percent of 6-8 graders and 46% of 9-12 graders use sites like Facebook and YouTube to collaborate on school projects.

Today's students have never lived without the Internet and cell phones. "Technology" is part of their lives. But being able to game, text, and network socially doesn't insure being able to find information. Moreover, the Internet does not always present information organized as a textbook would.

This is the background for *Born in Another Time: Ensuring Educational Technology Meets the Needs of Students Today and Tomorrow*, a report of the National Association of State Boards of Education (NASBE) Study Group on the Role of Technology in Schools and Communities. The issue they wrestle with is that, given the capability of today's students with digital media and the fact that some of them are using these media in their educational endeavors, how these digital capabilities can be brought to bear systematically on the processes of their education. In fact, the NASBE Study Group found that 32-39% of students would like schools to provide tools to communicate with each other and their teachers. They also desired schoolwide Internet access and safe chat rooms.

Given this information, the Study Group concluded the first chapter of its report, "Addressing the Voice and Needs of Today's Students," with the following recommendations:

1) "Address digital citizenship and digital literacy."
2) "Design instruction to take advantage of how each student learns now."
3) "Create policies that allocate resources based on data, student needs, and student, parent and stakeholder voices."

In their second chapter, "Ensuring Educators Can Use Technology in Meeting the Needs of Today's Students," the Study Group noted that the ability of teachers to integrate digital technology into their teaching is mixed. The goal, they write, should be for all teachers to be "networked" in the sense of being able to integrate digital technology into their teaching. Administrators should be "networked," too; and online teaching and learning is to be encouraged. They charge State Boards with defining a "networked educator" and determining barriers to and incentives for pooling resources and blended learning. State Boards are to ensure that teacher candidates have "robust clinical experiences" with technology and online learning and can personalize instruction and "teach students in a 21st century environment" and that teachers experience online and virtual learning and are provided high-quality professional learning and mentorship through technology. To have maximum flexibility in the use of alternative means of learning, districts should be allowed local control of their calendar.

The final chapter of the report, "Educational Technology Infrastructure: Preparing for the Technology of the Future," points out that using technology for more than teaching in the same old way requires a robust educational technology infrastructure. Among the characteristics of this infrastructure to consider it lists the following: access and equity, "data systems that provide timely, meaningful information," digital instruction materials, blended and online learning, broadband, bandwidth, and privacy. The chapter closes with the following recommendations:

1) "Ensure that every student has adequate access to a computing device and the Internet at school and home, with sufficient human capital in schools to support their effective use."

2) "States should have an up-to-date technology plan and policy that is reviewed on a predetermined timeline."

3) "States and districts should address the interoperability of devices, software and data."

Born in Another Time is most easily accessed online by entering its short title into a search engine.

ACS issues Guidelines and Recommendations for Teaching High School Chemistry

by Frank Lock

At the NSTA regional meeting in Atlanta, 1-3 November 2012, the American Chemical Society (ACS) hosted a session to introduce teachers to their 28-page booklet, *Guidelines and Recommendations for Teaching High School Chemistry*, published in the spring of 2012. It is a revision of the ACS booklet of the same title published in 1984. I attended the session because I was interested in finding out what ACS is doing to enhance the teaching of high school chemistry and support high school chemistry teachers.

As a high school chemistry and physics teacher, I had been frustrated at the lack of support for high school chemistry teachers locally, regionally and nationally. The American Association of Physics Teachers does a wonderful job of supporting and encouraging high school physics teachers at all levels. For a few of the thirty years in which I taught chemistry in Florida, I worked at trying to get ACS and its Division of Chem Ed to develop programs supporting high school chemistry teachers, but I was unsuccessful.

At the ACS session, I spoke up about the need for such support. As a retired teacher I have more time to work on such a project, and I have made plans to work on developing a local high school chemistry teachers organization this spring. I hope to receive some support from ACS.

The ACS “Guidelines” booklet is divided into three sections: “Pathways to Learning,” “Physical Plant,” and “Professional Preparations and Responsibilities.” The first topic addressed in “Pathways to Learning” deals with expected student outcomes. Scientific literacy is stressed. The other topics addressed that are important to me as a chemistry teacher include the “Big Ideas” of high school chemistry, “Effective Teaching Strategies,” “The Laboratory Experience,” and “Assessment.” The big ideas listed include conservation of matter and energy, behavior and properties of matter, particulate nature of matter, and equilibrium and driving forces. “Effective Teaching Strategies” includes information about effective questioning strategies, problem solving, cooperative learning strategies, and vocabulary, including the idea of concept before word. In “Laboratory Work,” the idea of student centered instruction is stressed, as well as Green Chemistry considerations when selecting or designing labs. Addressing assessment, the booklet revisers write, “Proper assessment will be used to continually adjust the classroom environment to improve learning.” Information about the importance of tracking post-secondary student performance is also included.

In the section on “Physical Plant,” recommendations are made about classrooms where chemistry is taught, laboratory settings and lab equipment, and prep room and chemical storage, as well as a list of necessary safety equipment.

“Professional Preparations and Responsibilities” stresses safety considerations, equity, ethics, professional development and extracurricular activities. Glaringly missing from the booklet is a statement about where chemistry should fall in the high school science sequence. The traditional alphabetical sequence, biology-chemistry-physics, has been questioned for many years, and ACS missed the opportunity to perform a great service to the teaching of high school science by not including a sequence recommendation. One of the most enjoyable experiences my students had in a chemistry related extracurricular event was a competition called Chem-a-Thon. This interesting and enjoyable competition was great fun for my students and me, and a terrific reward for good effort, and it was not included in the extracurricular activities listed in the booklet. At the ACS session I also suggested that the organization consider producing a publication similar to Chem13 News. Free copies of that high quality publication can be downloaded at <https://uwaterloo.ca/chem13news/issues>. Those interested can view an online version of the ACS “Guidelines” booklet by visiting <acs.org/education> and clicking on the link “ACS Guidelines and Recommendations for Teaching High School Chemistry.”

(*Editor’s Note*: A frequent contributor to this *Newsletter,* Frank Lock recently retired from teaching at Lemon Bay (FL) High School.)

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Next Gen Science Standards

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The following chart lists the performance expectations for grade levels K-2 by science topic:

Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
K	Forces and Interactions: Pushes and Pulls	K-PS2-1 K-PS2-2	PS2.A PS2.B PS3.C ETS1.A
K	Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment	K-LS1-1 K-ESS2-2 K-ESS3-1 K-ESS3-3	LS1.C ESS2.E ESS3.A ESS3.C ETS1.B
K	Weather and Climate	K-ESS2-1 K-ESS3-2 L-PS3-1 L-PS3-2	PS3.B ESS2.D ESS3.B ETS1.A
1	Waves: Light and Sound	1-PS4-1 1-PS4-2 1-PS4-3 1-PS4-4	PS4.A PS4.B PS4.C
1	Structure, Function and Information Processing	1-LS1-1 1-LS1-2 1-LS3-1	LS1.A LS1.B LS1.D LS3.A LS3.B
1	Space Systems: Patterns and Cycles	1-ESS1-1 1-ESS1-2	ESS1.A ESS1.B
2	Structure and Properties of Matter	2-PS1-1 2-PS1-2 2-PS1-3 2-PS1-4	PS1.A PS1.B
2	Interdependent Relationships in Ecosystems	2-LS2-1 2-LS2-2 2-LS4-1	LS2.A LS4.D ETS1.B
2	Earth's Systems: Processes that Shape the Earth	2-ESS1-1 2-ESS2-1 2-ESS2-2 2-ESS3-3	ESS1.C ESS2.A ESS2.B ESS2.C ETS1.C
K-2	Engineering Design	K-2-ETS1-1 K-2-ETS1-2 K-2-ETS1-3	ETS1.A ETS1.B ETS1.C

The chart to the right lists the performance expectations for grade levels 3-5 by disciplinary core idea:

Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
3	PS2: Motion and Stability: Forces and Interactions	3-PS2-1 3-PS2-2 3-PS2-3 3-PS2-4	PS2.A PS2.B
3	LS1: From Molecules to Organisms: Structures and Processes	3-LS1-1	LS1.B
3	LS2: Ecosystems: Interactions, Energy, and Dynamics	3-LS2-1	LS2.D
3	LS3: Heredity: Inheritance and Variation of Traits	3-LS3-1 3-LS3-2	LS3.A LS3.B
3	LS4: Biological Evolution: Unity and Diversity	3-LS4-1 3-LS4-2 3-LS4-3 3-LS4-4	LS2.C LS4.A LS4.B LS4.C LS4.D
3	ESS2: Earth's Systems	3-ESS2-1 3-ESS2-2	ESS2.D
3	ESS3: Earth and Human Activity	3-ESS3-1	ESS3.B
4	PS3: Energy	4-PS3-1 4-PS3-2 4-PS3-3 4-PS3-4	PS3.A PS3.B PS3.C PS3.D ETS1.A
4	PS4: Waves and Their Application in Technologies for Information Transfer	4-PS4-1 4-PS4-2 4-PS4-3	PS4.A PS4.B PS4.C ETS1.C
4	LS1: From Molecules to Organisms: Structure and Processes	4-LS1-1 4-LS1-2	LS1.A LS1.D
4	ESS1: Earth's Place in the Universe	4-ESS1-1	ESS1.C
4	ESS2: Earth's Systems	4-ESS2-1 4-ESS2-2	ESS2.A ESS2.B ESS2.E
4	ESS3: Earth and Human Activity	4-ESS3-1 4-ESS3-2	ESS3.A ESS3.B ETS1.B
5	PS1: Matter and Its Interactions	5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4	PS1.A PS1.B
5	PS2: Motion and Stability: Forces and Interaction	5-PS2-1	PS2.B
5	PS3: Energy	5-PS3-1	PS3.D LS1.C

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Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
5	LS1: From Molecules to Organisms: Structures and Processes	5-LS1-1	LS1.C
5	LS2: Ecosystems: Interactions, Energy, and Dynamics	5-LS2-1	LS2.A LS2.B
5	ESS1: Earth's Place in the Universe	5-ESS1-1 5-ESS1-2	ESS1.A ESS1.B
5	ESS2: Earth's Systems	5-ESS2-1 5-ESS2-2	ESS2.A ESS2.C
5	ESS3: Earth and Human Activity	5-ESS3-1	ESS3.C
5	ETS1: Engineering Design	3-5-ETS1-1 3-5-ETS1-2 3-5-ETS1-3	ETS1.A ETS1.B ETS1.C

The following chart lists the performance expectations for grade levels 3-5 by science topic:

Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
3	Forces and Interactions	3-PS2-1 3-PS2-2 3-PS2-3 3-PS2-4	PS2.A PS2.B
3	Interdependent Relationships in Ecosystems	3-LS2-1 3-LS4-1 3-LS4-3 3-LS4-4	LS2.C LS2.D LS4.A LS4.C LS4.D
3	Inheritance and Variation of Traits: Life Cycles and Traits	3-LS1-1 3-LS3-1 3-LS3-2 3-LS4-2	LS1.B LS3.A LS3.B LS4.B
3	Weather and Climate	3-ESS2-1 3-ESS2-2 3-ESS3-1	ESS2.D ESS3/B
4	Energy	4-PS3-1 4-PS3-2 4-PS3-3 4-PS3-4 4-ESS3-1	PS3.A PS3.B PS3.C PS3.D
4	Waves: Waves and Their Application in Technologies for Information Transfer	4-PS4-1 4-PS4-3	PS4.A PS4.C ETS1.C
4	Structure, Function, and Information Processing	4-PS4-2 4-LS1-1 4-LS1-2	PS4.B LS1.A LS1.D
4	Earth's Systems: Systems that Shape the Earth	4-ESS1-1 4-ESS2-1 4-ESS2-2 4-ESS2-4	ESS1.C ESS2.A ESS2.B ESS2.E ESS3.B ETS1.B
5	Structure and Properties of Matter	5-PS1-1 5-PS1-2 5-PS1-3 5-PS1-4	PS1.A PS1.B
5	Matter and Energy in Organisms and Ecosystems	5-PS3-1 5-LS1-1 5-LS2-1	PS3.D LS1.C LS2.A LS2.B
5	Earth's Systems	5-ESS2-1 5-ESS2-2 5-ESS2-3	ESS2.A ESS2.C ESS3.C
5	Space Systems: Stars and the Solar System	5-PS2-1 5-ESS1-1 5-ESS1-2	PS2.B ESS1.A ESS1.B
3-5	Engineering Design	3-5-ETS1-1 3-5-ETS1-2 3-5-ETS1-3	ETS1.A ETS1.B ETS1.C

The following chart lists the performance expectations for middle school by disciplinary core idea:

Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
MS	PS1: Matter and Its Interactions	MS-PS1-1 MS-PS1-2 MS-PS1-3 MS-PS1-4 MS-PS1-5 MS-PS1-6	PS1.A PS1.B PS3.A ETS1.B ETS1.C
MS	PS2: Motion and Stability: Forces and Interactions	MS-PS2-1 MS-PS2-2 MS-PS2-3 MS-PS2-4 MS-PS2-5	PS2.A PS2.B
MS	PS3: Energy	MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5	PS3.A PS3.B PS3.C ETS1.A ETS1.B

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Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
MS	PS4: Waves and Their Applications in Technologies for Information Transfer	MS-PS4-1 MS-PS4-2 MS-PS4-3	PS4.A PS4.B PS4.C
MS	LS1: From Molecules to Organisms: Structures and Processes	MS-LS1-1 MS-LS1-2 MS-LS1-3 MS-LS1-4 MS-LS1-5 MS-LS1-6 MS-LS1-7 MS-LS1-8	LS1.A LS1.B LS1.C LS1.D PS3.D
MS	LS2: Ecosystems: Interactions, Energy, and Dynamics	MS-LS2-1 MS-LS2-2 MS-LS2-3 MS-LS2-4 MS-LS2-5	LS2.A LS2.B LS2.C LS4.D ETS1.B
MS	LS3: Heredity: Inheritance and Variation of Traits	MS-LS3-1 MS-LS3-2	LS1.B LS3.A LS3.B
MS	LS4: Biological Evolution: Unity and Diversity	MS-LS4-1 MS-LS4-2 MS-LS4-3 MS-LS4-4 MS-LS4-5 MS-LS4-6	LS4.A LS4.B LS4.C
MS	ESS1: Earth's Place in the Universe	MS-ESS1-1 MS-ESS1-2 MS-ESS1-3 MS-ESS1-4	ESS1.A ESS1.B ESS1.C
MS	ESS2: Earth's Systems	MS-ESS2-1 MS-ESS2-2 MS-ESS2-3 MS-ESS2-4 MS-ESS2-5 MS-ESS2-6	ESS1.C ESS2.A ESS2.B ESS2.C ESS2.D
MS	ESS3: Earth and Human Activity	MS-ESS3-1 MS-ESS3-2 MS-ESS3-3 MS-ESS3-4 MS-ESS3-5	ESS3.A ESS3.B ESS3.C ESS3.D
MS	ETS1: Engineering Design	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4.	ETS1.A ETS1.B ETS1.C

The chart to the right lists the performance expectations for middle school by science topic:

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Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
MS	Structure and Properties of Matter	MS-PS1-1 MS-PS1-3 MS-PS1-4	PS1.A PS1.B PS3.A
MS	Chemical Reactions	MS-PS1-2 MS-PS1-5 MS-PS1-6	PS1.A PS1.B ETS1.B ETS1.C
MS	Forces and Interactions	MS-PS2-1 MS-PS2-2 MS-PS2-3 MS-PS2-4 MS-PS2-5	PS2.A PS2.B
MS	Energy	MS-PS3-1 MS-PS3-2 MS-PS3-3 MS-PS3-4 MS-PS3-5	PS3.A PS3.B PS3.C ETS1.A ETS1.B
MS	Waves and Electromagnetic Radiation	MS-PS4-1 MS-PS4-2 MS-PS4-3	PS4.A PS4.B PS4.C
MS	Structure, Function, and Information Processing	MS-LS1-1 MS-LS1-2 MS-LS1-3 MS-LS1-8	LS1.A LS1.B
MS	Matter and Energy in Organisms and Ecosystems	MS-LS1-6 MS-LS1-7 MS-LS2-1 MS-LS2-3 MS-LS2-4	LS1.C LS2.A LS2.B LS2.C PS3.D
MS	Interdependent Relationships in Ecosystems	MS-LS2-2 MS-LS2-5	LS2.A LS2.C LS4.D ETS1.B
MS	Growth, Development, and Reproduction of Organisms	MS-LS1-4 MS-LS1-5 MS-LS3-1 MS-LS3-2 MS-LS4-5	LS1.B LS3.A LS3.B LS4.B
MS	Natural Selection and Adaptation	MS-LS4-1 MS-LS4-2 MS-LS4-3 MS-LS4-4 MS-LS4-6	LS4.A LS4.B LS4.C
MS	Space Systems	MS-ESS1-1 MS-ESS1-2 MS-ESS1-3	ESS1.A ESS1.B
MS	History of Earth	MS-ESS1-4 MS-ESS2-2 MS-ESS2-3	ESS1.C ESS2.A ESS2.B ESS2.C
MS	Earth's Systems	MS-ESS2-1 MS-ESS2-4 MS-ESS3-1	ESS2.A ESS2.C ESS3.A

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Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
MS	Weather and Climate	MS-ESS2-5 MS-ESS2-6 MS-ESS3-5	ESS2.C ESS2.D ESS3.D
MS	Human Impacts	MS-ESS3-2 MS-ESS3-3 MS-ESS3-4	ESS3.B ESS3.C
MS	Engineering Design	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4	ETS1.A ETS1.B ETS1.C

The following chart lists the performance expectations for high school by disciplinary core idea:

Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
HS	PS1: Matter and Its Interactions	HS-PS1-1 HS-PS1-2 HS-PS1-3 HS-PS1-4 HS-PS1-5 HS-PS1-6 HS-PS1-7 HS-PS1-8	PS1.A PS1.B PS1.C ETS1.C
HS	PS2: Motion and Stability: Forces and Interactions	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS2-5 HS-PS2-6	PS2.A PS2.B PS3.A ETS1.A ETS1.C
HS	PS3: Energy	HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-PS3-4 HS-PS3-5	PS3.A PS3.B PS3.C PS3.D ETS1.A
HS	PS4: Waves and Their Applications in Technologies for Information Transfer	HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5	PS3.D PS4.A PS4.B PS4.C
HS	LS1: From Molecules to Organisms: Structures and Processes	HS-LS1-1 HS-LS1-2 HS-LS1-3 HS-LS1-4 HS-LS1-5 HS-LS1-6 HS-LS1-7	LS1.A LS1.B LS1.C

Grade Level	Number and Title of Disciplinary Core Idea	Performance Expectations	Disciplinary Core Idea Divisions
HS	LS2: Ecosystems: Interactions, Energy, and Dynamics	HS-LS2-1 HS-LS2-2 HS-LS2-3 HS-LS2-4 HS-LS2-5 HS-LS2-6 HS-LS2-7 HS-LS2-8	LS2.A LS2.B LS2.C LS2.D LS4.D PS3.D ETS1.B
HS	LS3: Heredity: Inheritance and Variation of Traits	HS-LS3-1 HS-LS3-2 HS-LS3-3	LS1.A LS3.A LS3.B
HS	LS4: Biological Evolution: Unity and Diversity	HS-LS4-1 HS-LS4-2 HS-LS4-3 HS-LS4-4 HS-LS4-5 HS-LS4-6	LS4.A LS4.B LS4.C LS4.D ETS1.B
HS	ESS1: Earth's Place in the Universe	HS-ESS1-1 HS-ESS1-2 HS-ESS1-3 HS-ESS1-4 HS-ESS1-5 HS-ESS1-6	ESS1.A ESS1.B ESS1.C ESS2.B PS1.C PS3.D PS4.B
HS	ESS2: Earth's Systems	HS-ESS2-1 HS-ESS2-2 HS-ESS2-3 HS-ESS2-4 HS-ESS2-5 HS-ESS2-6 HS-ESS2-7	ESS1.B ESS2.A ESS2.B ESS2.C ESS2.D ESS2.E PS4.A
HS	ESS3: Earth and Human Activity	HS-ESS3-1 HS-ESS3-2 HS-ESS3-3 HS-ESS3-4 HS-ESS3-5 HS-ESS3-6	ESS2.D ESS3.A ESS3.B ESS3.C ESS3.D ETS1.B
HS	ETS1: Engineering Design	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	ETS1.A ETS1.B ETS1.C

The following chart lists the performance expectations for high school by science topic:

Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
HS	Structure and Properties of Matter	HS-PS1-1 HS-PS1-3 HS-PS1-8 HS-PS2-6	PS1.A PS1.C PS2.B

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Next Gen Science Standards

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Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
HS	Chemical Reactions	HS-PS1.2 HS-PS1-4 HS-PS1-5 HS-PS1-6 HS-PS1-7	PS1.A PS1.B ETS1.C
HS	Forces and Interactions	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-PS2-4 HS-PS2-5	PS2.A PS2.B PS3.A ETS1.A ETS1.C
HS	Energy	HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-PS3-4 HS-PS3-5	PS3.A PS3.B PS3.C PS3.D ETS1.A
HS	Waves and Electromagnetic Radiation	HS-PS4-1 HS-PS4-2 HS-PS4-3 HS-PS4-4 HS-PS4-5	PS3.D PS4.A PS4.B PS4.C
HS	Structure and Function	HS-LS1-1 HS-LS1-2 HS-LS1-3	LS1.A
HS	Matter and Energy in Organisms and Ecosystems	HS-LS1-5 HS-LS1-6 HS-LS1-7 HS-LS2-3 HS-LS2-4 HS-LS2-5	LS1.C LS2.B PS3.D
HS	Interdependent Relationships in Ecosystems	HS-LS2-1 HS-LS2-2 HS-LS2-6 HS-LS2-7 HS-LS2-8 HS-LS4-6	LS2.A LS2.C LS2.D LS4.C LS4.D
HS	Inheritance and Variation of Traits	HS-LS1-4 HS-LS3-1 HS-LS3-2 HS-LS3-3	LS1.A LS1.B LS3.A LS3.B
HS	Natural Selection and Evolution	HS-LS4-1 HS-LS3-1 HS-LS3-2 HS-LS3-3	LS1.A LS1.B LS3.A LS3.B
HS	Natural Selection and Evolution	HS-LS4-1 HS-LS4-2 HS-LS4-3 HS-LS4-4 HS-LS4-5	LS4.A LS4.B LS4.C

Grade Level	Topic	Performance Expectations	Disciplinary Core Idea Divisions
HS	Space Systems	HS-ESS1-1 HS-ESS1-2 HS-ESS1-3 HS-ESS1-4	ESS1.A ESS1.B PS3.D PS4.B
HS	History of Earth	HS-ESS1-5 HS-ESS1-6 HS-ESS2-1	ESS1.C ESS2.A ESS2.B PS1.C
HS	Earth's Systems	HS-ESS2-2 HS-ESS2-3 HS-ESS2-5 HS-ESS2-6 HS-ESS2-7	ESS1.B ESS2.A ESS2.B ESS2.C ESS2.D
HS	Weather and Climate	HS-ESS2-4 HS-ESS3-5	ESS1.B ESS2.A ESS2.D ESS3.D
HS	Human Impacts	HS-ESS3-1 HS-ESS3-2 HS-ESS3-3 HS-ESS3-4 HS-ESS3-6	ESS2.D ESS3.A ESS3.B ESS3.C ESS3.D ETS1.B
HS	Engineering Design	HS-ETS1-1 HS-ETS1-2 HS-ETS1-3 HS-ETS1-4	ETS1.A ETS1.B ETS1.C

Murkowski

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"at a competitive disadvantage without making a meaningful impact on global greenhouse gas emissions." (p. 108)

Although Murkowski's views on fossil fuels and their environmental consequences may be considered predictable, Murkowski also should be credited for raising many points that are rarely considered in documents presenting visions of energy futures, among them energy storage, infrastructure for transporting energy and fuels, strategic materials, the interdependence of energy and water, the back end of the nuclear fuel cycle, and cybersecurity protection. Her document can be accessed on line at <http://theholl.com/images/stories/news/2013/02_february/energy-2020.pdf>.

News from Triangle Coalition

StudentsFirst Makes a Splash with State Policy Report Card

StudentsFirst, a bipartisan grassroots movement working to focus the nation's education system on "common sense reforms that help make sure all students have great schools and great teachers," released its first-ever "State Policy Report Card," which grades how well each state's education reform policies are working.

According to StudentsFirst CEO and Founder Michelle Rhee, "The most powerful way to improve student achievement from outside the classroom is to shape policy and implement laws at the state level that govern education." Thus, their "State Policy Report Card" examines and rates states' policies on 1) elevating teachers; 2) empowering parents with data and choice; and 3) spending resources wisely. These are the only topics addressed, not coincidentally because they directly correspond to the StudentsFirst policy agenda.

The narrow focus prompted criticism from a number of education organizations that also questioned whether these were the "right" metrics to determine such grades. At a forum to discuss these questions in more depth, Rick Hess, Director of Education Policy Studies at the American Enterprise Institute (AEI) wondered if the reform policies promoted by StudentsFirst were "good ideas for everyone everywhere" and suggested that more nuance was needed when looking at different state reforms. Alternatively, Tom Luna, Superintendent of Public Instruction in Idaho (which received a grade of D-), stated he believed the report focused on the right policy areas for both urban as well as rural school districts. Erick Smith, Executive Director of Chiefs for Change and former Florida Commissioner of Education (Florida received the second highest score of B-), stressed that reform efforts have to be comprehensively enacted and that over time improvement in student achievement scores will occur. Lastly, Ulrich Boser, Senior Fellow at the Center for American Progress, emphasized the subjective nature of the StudentsFirst A-F grading system, noting that states such as Massachusetts and Maryland whose education systems are often cited as the best in the country each received grades of D+, prompting a concern that the grades in the report are adversely affected if states don't agree with the StudentsFirst policy agenda. In addition, Boser was concerned that the issue of equity of resources was not included as part of the grading rubric. To learn more about the report, go to: <http://reportcard.studentsfirst.org>.

Energy Department Launches Web Tool to Explore Pathways to Clean Energy Economy

The U.S. Department of Energy announced a new interactive online tool to help researchers, educators, and students explore future U.S. energy-use scenarios. The interactive Buildings, Industry, Transportation, and Electricity Scenarios (BITES) tool allows users to adjust inputs, such as electricity generation and transportation fuel use, to compare outcomes and impacts on carbon dioxide emissions and the U.S. energy mix.

The energy-use scenarios and analytical framework behind BITES were originally developed for the Energy Department's Office of Energy Efficiency and Renewable Energy to help identify and implement new research and technical opportunities that will have the greatest impact on achieving our national energy goals. The BITES tool demonstrates that continued technology and policy deployment is needed in every energy sector to meet U.S. climate and energy security goals.

BITES can also be a useful tool for students and educators who focus on how research, policy, or other forms of national action can impact U.S. energy use. Future plans for BITES include hosting online discussion forums on the scenarios created in the tool and delivering BITES as a learning module on the National Training and Education Resource (NTER), <https://www.nterlearning.org>. These efforts are part of the Energy Department's broader Energy Education and Energy Literacy initiative (http://www1eere.energy.gov/education) to help U.S. families and businesses make informed energy decisions.

(*Editor's Note*: The preceding two items were excerpted from the Triangle Coalition STEM Education Bulletin for 17 January 2013, reprinted with permission. Albert Einstein Distinguished Fellow DaNel Hogan also wrote about the Energy Education and Energy Literacy initiative in our Fall 2012 issue.)

Sen. Franken Reintroduces STEM Master Teacher Corps Act

On 14 February, U.S. Senator Al Franken (D-MN) reintroduced legislation that would invest in educators of science, technology, engineering, and math (STEM). The STEM Master Teacher Corps Act (S. 358) offers career advancement and higher pay to the top 5% of K-12 STEM teachers in the United States. Members of the

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teaching corps would, in turn, mentor other STEM teachers, share best practices, and serve as role models in their districts and states. The legislation includes plans for competitive regional grants for program implementation, specialized training and support for corps members, and funding for program evaluation. Seventy-five percent of the Master Teachers Corps Members would teach in high-need schools, with an emphasis on teachers in rural schools as well. Over the course of four years, the Master Teacher Corps would grow to include 10,000 educator members.

Report Supports Need for 21st Century Skills Education in Classrooms

In February, the Partnership for 21st Century Skills (P12) and the National Research Council (NRC) held a briefing on the report, "Education for Life and Work: Developing Transferable Knowledge and Skills for the 21st Century." The report as presented by Margaret Hilton, Study Director at the National Research Council, represents a conceptual shift in education supporting the 21st Century Skills movement. The study committee found that goals for "deeper learning," the process through which a person becomes capable of taking what was learned in one situation and applying it to new situations, and the three 21st century cognitive, intrapersonal, and interpersonal competencies, align with the goals illustrated in the Common Core State Standards and the NRC Framework for K-12 Science Education. Thus, developing students' 21st century competencies will require a change in education practices. The report concludes by stating the need for policy to reform curriculum and assessment methods in schools and suggests this can be achieved in the reauthorization of the Elementary and Secondary Education Act.

(*Editor's Note*: The preceding two items were excerpted from the Triangle Coalition STEM Education Bulletin for 21 February 2013, reprinted with permission. The Partnership for 21st Century Skills is described fully in our Winter/Spring 2009 issue.)

NASBE Supporting State Implementation of NGSS

The National Association of State Boards of Education (NASBE) announced that it is taking on a year-long initiative to provide state board members with information, analysis and resources about the new Next Generation Science Standards (NGSS) so "they are fully prepared to make the best, evidence-based decisions for their states." The project is supported by a $319,000 grant from Carnegie Corporation of New York.

NASBE hosted a webinar on the standards and their implementation. The development of the science standards is being spearheaded by Achieve in conjunction with the National Research Council, the National Science Teachers Association and the American Association for the Advancement of Science.

"State education policymakers, like many others, are working hard to answer the national call for greater emphasis on science, and the Next Generation Science Standards will provide them with a critical tool to do this," said NASBE Deputy Executive Director Brad Hall. "But the existence of the NGSS is just a first step. The state board members who must adopt them need targeted resources and opportunities to discuss the meaning, content and policy implications of the standards in order to effectively do their jobs. NASBE, in partnership with other education stakeholders, including those involved in the NGSS development as well as other state-level policy organizations, is uniquely positioned to provide this assistance to state boards."

During the year, NASBE will host regional symposia at which state board of education members can develop adoption plans and conduct policy audits to identify other policy areas affected by the NGSS, such as assessments, teacher professional learning and educator licensure. In addition, NASBE staff will provide state board members with online and print resources, webinars and toolkits — all with a special emphasis on communications — to help inform policymakers and other local, district, and state-level stakeholders.

(*Editor's Note*: The preceding item was excerpted from the Triangle Coalition STEM Education Bulletin for 5 April 2013, reprinted with permission.)

Next Generation Science Standards Released

On 9 April 2013 the Next Generation Science Standards (NGSS) were released to the public at <www.nextgenscience.org>. The standards are the culmination of a two-year collaborative process involving 26 states, a 41-member writing team, and lead partners – The National Research Council (NRC), National Science Teachers Association (NSTA), American Association for the Advancement of Science (AAAS), and Achieve. Based on the NRC's *Framework for K–12 Science Education,* the NGSS establish learning expectations for students that integrate three dimensions — science and engi-

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neering practices, disciplinary core ideas, and crosscutting concepts.

The NGSS development process has not been without controversy. Most recently, the various views surrounding evolution as well as climate change and its causes have dominated discussions of the standards. The standards make evolution fundamental to understanding the life sciences and call for teaching about climate change and describing human activities as "major factors." These debates could make adoption in certain states more politically difficult. The 26 "lead state partners" involved in developing the standards have pledged to "give serious consideration" to adopting them. Several other states, including Florida, Louisiana and Wisconsin, have been providing feedback on drafts and are expected to take a close look at adoption. It should be noted that adopters commit to adopting all of the standards. They can add to the content if they like, but they will be required to teach all of the content outlined. Certain science advocates, like computer science supporters in Massachusetts, are suggesting that there be some additions to the standards in their particular states.

(*Editor's Note*: The preceding item was excerpted from the Triangle Coalition STEM Education Bulletin for 15 April 2013, reprinted with permission. Also see coverage of the Next Generation Science Standards beginning on page 3 of this issue.)

Education and the Workforce Subcommittee Discusses STEM Education

On 10 April, the House Education and the Workforce Subcommittee on Early Childhood, Elementary and Secondary Education held a hearing titled, "Raising the Bar: Reviewing STEM Education in America." The hearing focused on improving the efficiency of federal investments in STEM (science, technology, engineering and mathematics) education. Subcommittee Chairman Rokita (R-IN) opened the hearing by noting the asymmetry between the rapid growth of STEM jobs in the US and the shortage of skilled workers to fill these positions. He went on to state that while the federal government has taken an active role in improving STEM education, the Government Accountability Office (GAO) had completed "reports [that] have shown that taxpayers' multi-billion dollar investments are failing to produce results." The GAO found in FY 2010 alone, there were 209 programs operated by 13 different agencies that invested over $3 billion in efforts designed to increase knowledge of the STEM fields and degree attainment. In addition, 83 percent of these programs overlapped with at least one other program and many of the programs lacked a strategic plan or accountability standards.

In her opening remarks, Ranking Member Carolyn McCarthy (D-NY) said "STEM education is a worthwhile investment that Congress must consider furthering." "The Democratic approach to reauthorization of the *Elementary and Secondary Education Act* (ESEA) should be looked at as a model for STEM education," said McCarthy, explaining that the Democratic approach ensures students are "assessed in science and it provides dedicated funding for STEM education, while still giving states and districts flexibility to use those funds as they think best."

Representative Phil Roe (R-TN) asked panelists for their thoughts about how to encourage young people to take interest in science and technology and improve the federal government's efficiency in providing these services. George Scott, Director for Education, Workforce and Income Security Issues for the GAO, pointed out the need for the government to develop a government-wide STEM education and strategic plan that ensures programs have meaningful transparent performance goals and measures with periodic evaluations to determine effectiveness.

Ranking Member McCarthy asked Bill Kurtz, the Chief Executive Officer of the Denver School of Science and Technology, to identify practices that are the most successful among minority populations and how these efforts could be replicated. Mr. Kurtz said the school's "non-track" program is the most important aspect, explaining how tracking can limit the "potential and possibility" of certain students. He went on to state, "There is a complete belief that all students can get there and we will help them get there regardless of their background."

Chairman Rokita asked panelists their thoughts on having retired professionals from particular industries enter the teaching profession. Dr. Steve Schneider, the Senior Program Director for WestEd, discussed industries that are allowing employees to participate in STEM education. He spoke about an initiative at Microsoft that allows young computer programmers "who thought about going into teaching, but decided they couldn't afford it" to work with teachers who are interested in teaching advanced placement (AP) computer science courses but may not be fully prepared to do so. The Microsoft employees instruct one class per day for two years while helping to develop the teacher's content skills.

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More information, including full witness statements and a recording of the hearing, is available at <http://edworkforcehouse.granicus.com/MediaPlayer.php?view_id=2&clip_id=143>.

White House Announces STEM AmeriCorps to Inspire Young People's Interest in Science and Technology

The Corporation for National and Community Service (CNCS) will launch a new STEM AmeriCorps initiative to spur student interest in science, technology, engineering, and math education, President Obama announced 22 April at the White House Science Fair. STEM AmeriCorps is a multi-year initiative to place hundreds of AmeriCorps members in nonprofits across the country to mobilize STEM professionals to inspire young people to excel in STEM education.

(*Editor's Note*: The preceding two items were excerpted from the Triangle Coalition STEM Education Bulletin for 23 April 2013, reprinted with permission.)

Monitoring Progress

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Recommendations from *Successful K-12 STEM Education* (2011)	**Indicators**
Policy Makers at the National, State, and Local Levels Should Elevate Science to the Same Level of Importance as Reading and Mathematics	9. **Inclusion of science in federal and state accountability systems.**
	10. Proportion of major federal K-12 education initiatives that include science.
	11. State and district staff dedicated to supporting science instruction.
States and National Organizations Should Develop Effective Systems of Assessment that Are Aligned with A Framework for K-12 Science Education *and that Emphasize Science Practices Rather Than Mere Factual Recall*	12. States' use of assessments that measure the core concepts and practices of science and mathematics disciplines.
National and State Policy Makers Should Invest in a Coherent, Focused, and Sustained Set of Supports for STEM Teachers	13. State and federal expenditures dedicated to improving the K-12 STEM teaching workforce.
Federal Agencies Should Support Research that Disentangles the Effects of School Practice from Student Selection, Recognizes the Importance of Contextual Variables, and Allows for Longitudinal Assessments of Student Outcomes	14. **Federal funding for the three broad kinds of research identified in *Successful K-12 STEM Education*.**

The report ends with discussion of ways to use and develop the indicators. It can be accessed online at <http://www.nap.edu/catalog/php?record_id=13509>.

Three Websites Focused on Climate Change

Three websites with emphasis on education about climate change have been developed and funded by a host of organizations well-known in science education. CLEAN (the Climate Literacy and Energy Awareness Network) was developed in 2010 as a Pathways Project of the NSDL (National Science Digital Library) with science education expertise from TERC; CIRES (Cooperative Institute for Research in Environmental Science), University of Colorado at Boulder; SERC (Science Education Resource Center), Carleton College; and NOAA (National Oceanic and Atmospheric Administration), with funding from NOAA, the NSF (National Science Foundation), and USDOE (US Department Of Energy). BSCS (Biological Science Curriculum Study), in partnership with Oregon Public Broadcasting and with funding from NASA (National Air and Space Administration), has developed *Carbon Connections*, "a three-unit, online curriculum for grades 9-12 . . . developed to improve . . . understanding of the carbon cycle and the science of Earth's climate." And the ACS (American Chemical Society) has developed its Climate Science Toolkit.

With its linkage to the NSDL, CLEAN has the broadest set of offerings of the three sites. Its database of "scientifically and pedagogically reviewed digital resources for teaching about climate science, climate change, and energy awareness" can be searched by type, topic, and grade level (from grade 3 to graduate level). CLEAN also offers links to frameworks to teach about climate literacy and energy literacy. Each is based on seven principles. In the case of teaching energy literacy, CLEAN has adopted the Essential Principles and Fundamental Concepts of the Energy Literacy Initiative, reported in the Spring 2012 issue of this *Newsletter*. In the case of teaching climate literacy, CLEAN's seven climate literacy principles are as follows:

1. The Sun is the primary source of energy for Earth's climate system.
2. Climate is regulated by complex interactions among components of the Earth system.
3. Life on Earth depends on, is shaped by, and affects climate.
4. Climate varies over space and time through both natural and man-made processes.
5. Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
6. Human activities are impacting the climate system.
7. Climate change will have consequences for the Earth system and human lives.

To this CLEAN adds an overall guiding principle: Humans can take actions to reduce climate change and its impacts.

For all the principles providing the frameworks to teach about both climate literacy and energy literacy there are links to 5-7 supporting concepts and to learning more about teaching each principle and activities for teaching each principle (for middle school, high school, lower and upper college) selected from the CLEAN database. One can also download *Climate Literacy: The Essential Principles of Climate Science* from the U.S. Global Change Research Program and *Energy Literacy* from the Energy Literacy Initiative. Each of these publications is based on the climate literacy principles and energy literacy principles, respectively.

CLEAN has an additional framework to teach about energy "awareness," based on the principle that "Being aware of the role of energy in the Earth system and human society allows us to take actions to conserve, prepare, and make energy choices," which is supported by the following six concepts:

1. Energy drives the Earth System.
2. The primary sources of energy used by society are non-renewable sources, such as fossil fuels, and nuclear, and renewable sources, such as solar, wind, hydro, and biomass."
3. Humans' use of energy has consequences on the environment that sustains them.
4. The distribution of stored non-renewable and renewable energy sources varies around the planet, resulting in distribution and transmission costs.
5. There are significant social, political, and equity issues associated with the human use of and access to energy.
6. Developing a sustainable energy supply that minimizes impacts on the environment will require informed decision making, technological and societal innovation, and improved efficiency.

CLEAN is energy education resource #10 in the list provided by DaNel Hogan in our Fall 2012 issue. It is accessed online at <http://cleanet.org/clean/educational_resources/index.html>.

With its focus on teaching about the role of the carbon cycle in Earth's climate for high school students, *Carbon Connections* is much more narrowly-based that CLEAN. But it singularly benefits from the interactive videos of its

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Climate Change

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funder, NASA, one of which shows the the fluctuations in atmospheric carbon dioxide concentration are much greater at Point Barrow (Alaska) than at Mauna Loa (Hawaii) and another which shows atmospheric carbon dioxide concentration never rising above 300 ppm for the past 650,000 years until now. Each of its three units contains five lessons, the last of which is largely review of the first four. The focus of the three units are carbon in our past, carbon in our present, and carbon in our future. The entry of carbon into a system is brought about by adding dry ice, and the leaving of carbon from a system is brought about by letting bubbles escape from seltzer; both are observed by the changing color of bromthymol blue indicator. The lesser tendency of water made with oxygen-18 to evaporate, which enables this isotopic form of water to serve as a proxy for temperature in ice cores, is modeled by shaking a box of marbles of two different masses in a sheet.

As one could expect from BSCS, the role of carbon in the living processes of photosynthesis and respiration is emphasized as an important part of the carbon cycle. To this they add the combustion of fossil fuels which has added to the carbon dioxide content of the atmosphere since pre-industrial times. Among the fine points of climate considerations they devote considerable effort to the concept of "forcing," starting with asking students how they feel when they are "forced" to do something, and the time delays that can occur in their response. Another important fine point is the definition of an average temperature for the Earth, with reference given to three different methods, one used by the British and two by Americans (one by NASA/GISS (Goddard Institute for Space Studies), the other by NOAA, though Gordon Aubrecht did not distinguish between these two in the Editor's Note on page 19 of our Winter 2010 issue).

Carbon Connections also asks students to take action on the basis of what they have learned, one of which is to inventory their use of electrical energy at home and calculate their carbon footprint, then to reduce it by "conserving" in their use of energy and using energy more efficiently. It is accessed online at <http://www.carbonconnections.bscs.org>.

Rather than provide a curriculum or a framework, the ACS Climate Science Toolkit, accessed online at <http://www.acs.org/climatescience>, provides its users answers to questions about climate science. It starts users out with answers to eleven Frequently-Asked Questions, then continues with what amount to be fact sheets about topics grouped as follows under four headings:

Energy Balance and Planetary Temperature
- Energy from the Sun
- Predicted Planetary Temperatures
- Atmospheres and Planetary Temperatures
- Taking the Earth's Temperature (here the same three different methods cited by *Carbon Connections* are cited)

Atmospheric Warming
- A Sngle-Layer Atmosphere Model
- A Multilayer Atmosphere Model
- Application to Earth's Atmosphere
- Forcing and Feedback
- Radiative Forcing
- Climate Sensitivity (included here is a derivation of the forcing in terms of the energy received from the Sun and relevant temperatures)

Greenhouse Gases
- Properties
- Which Gases?
- Changes since the Industrial Revolution
- Sources and Sinks

Oceans, Ice and Rocks
- Thermal Energy in the Ocean
- Ice and Climate
- Ocean Chemistry
- Geology and Climate.

And for people inclined to make a PowerPoint presentation about what they learn from this website, three PowerPoint presentations are provided: for the public, for educators, and for industry professionals.

RECOMMENDED SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

1. Joshua Hammer, "The Hunt for Ebola," *Smithsonian*, 24-34 (Nov 2012).

Outbreaks of infection of humans by the Ebola virus still occur, and this article describes how a recent outbreak in Uganda was dealt with. The U.S. Centers for Disease Control and Prevention are still trying to learn how humans become infected with the virus, and the Army Medical Research Institute of Infectious Diseases at Fort Detrick, MD, is working toward a vaccine to combat a potential bioterrorist weapon.

2. Beryl Lieff Benderly, "Head Games," *Miller-McCune*, **5**(1), 38-43 (Jan-Feb 2012).

After Phase I trials of a new drug verify that it is safe, "double blind" Phase II trials are conducted to determine whether the drug is more effective than a "control," which could be a placebo or the best existing standard treatment. But in the case of Parkinson's disease, placebos have brought about gains that "may even result in part from 'actual physiological changes in the damaged brain dopamine nerve cells,'" in which case drugs effective in treating Parkinson's could emerge from a Phase II trial as *not* more effective than a placebo.

3. Colleen Shaddox, "Where Have You Gone, Marcus Welby?" *Miller-McCune*, **5**(1), 46-51 (Jan-Feb 2012).

Among the projected shortage of workers in STEM fields in the next decade, 90,000 of them are physicians, half of them to provide primary care. The nine new American medical schools opened in the past decade and the nine more currently under development aim to bridge this gap with innovative programs. Commonwealth Medical College in Scranton, PA, plans to intersperse classroom and clinical work rather than cluster the former into the first two years and the latter into the last two years. The new medical school opened by the University of California, Riverside, hopes to improve the quality of medical care in inland Southern California. And the medical school of Quinnipiac University in Hamden (CT) is attempting to replace the hierarchy of medical personnel by training teams of doctors, nurses, physician assistants, and other health professionals who will work together as equals. (Health care is a "team sport," its dean says.)

4. Wendell Holtcamp, "Did Tap Water Kill Lou Gehrig?" *Miller-McCune*, **5**(1), 52-57 (Jan-Feb 2012).

Beta-methylamino-L-alanine (BMAA) is an amino acid, but not one of the 20 forming all proteins in living organisms. It is a neurotoxin made by cyanobacteria which can find its way to the brain by being incorporated into proteins, which are then caused to misfold. The misfolded proteins are "thought to lead to neurofibrillary tangles, a telltale sign of neurodegenerative disease." BMAA has been found in the brains of victims of ALS (amyotrophic lateral sclerosis, known for killing Lou Gehrig), Parkinson's, and Alzheimer's diseases (but not Huntington's a neurodegenerative disease whose course is linked to a specific gene). Although BMAA has not been established as *causing* ALS, Parkinson's, and Alzheimer's, the indigenous chamoaros of Guam succumb to the symptoms of these diseases at rates 50 to 100 times that of ALS worldwide, and BMAA has been found in their diet, produced by cyanobacteria in the roots of the island's cycads.

5. Vince Beiser, "The Deluge," *Pacific Standard*, **6**(2), 36 -45 (Mar-Apr 2013).

The "deluge" in this article refers to newfound supplies of oil and natural gas, some from underground and some from hydraulic fracturing ("fracking") and horizontal drilling, not only in the United States but also in many other locations in the world as well. "Every time known reserves start looking tight, the price goes up, which incentivizes investment in research and development, which yields more sophisticated technologies, which unearth new supplies," Beiser writes. Moreover, these new supplies are showing up in new places, changing the geographical distribution of oil and natural gas among the world's nations, with consequences for the relationships among these nations. In addition, Beiser notes that "wind, solar, and other renewable sources . . . are having a harder time than ever competing now that natural gas is dirt cheap. . . . Which brings us to the biggest unknown of all: what this new era means for our rapidly warming planet." He hopes that the same innovation which led to the increased supplies of oil and natural gas will also enable us to cope with climate change>

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REVIEWS OF SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

Mark Pendergrast, *Mirror, Mirror: A History of the Human Love Affair with Reflection* (Basic Books, 2003) paperback, 369 pp., $17.00. ISBN 0-465-05471-4.

This is a well-written, thoroughly researched book that is jam-packed with interesting information about the history, cultural influence, and science of reflection and optics. The cover of the book is attractive, with the first word of the title written normally, and the second word written so that it can be read by reflecting it in a plane mirror.

Pendergrast indicates that the earliest archeological evidence for human production of mirrors dates to 6200 BCE. He describes in some detail the adventures and investigations of John Dee, born in England in 1537. Dee was the most prominent of a group that believed that people called "scryers" could use mirrors to predict the future.

Pendergrast then presents information about investigations involving how vision works, and describes the work done by Roger Bacon. Also described is the work of Dietrich of Freiberg, in the early fourteenth century, in determining how rainbows form. Dietrich created a "giant artificial rain drop" and found that when his eye was at a 42 degree angle to a sunbeam entering the drop, he could see red light. He discovered that light was both refracted and reflected by the drop. Included are descriptions of the work of Giambittista della Porta, Leonard and Thomas Digges, Thomas Herriott, Johannes Kepler, and Galileo.

Pendergrast writes that Hans Lippershey developed the refracting telescope as a result of "Two children playing with lenses in his shop (noticing) that the weathervane of a nearby church looked a lot bigger if they held two lenses up in a certain position." Galileo's investigations with the telescope he developed using information about Lippershey's work soon followed, as well as the publication of his research in March 1610.

Next Pendergrast writes of the development of the reflecting telescope, including proposals by Niccolo Zucchi in 1616, and Marin Marsenne in 1636. He writes that René Descartes believed that using mirrors in a telescope was a silly idea. A great deal of information is included about Descartes' work. This includes a description of Descartes' dissection of a human eye to determine how it focused light. Concluding the section on the work of Descartes, Pendergrast writes, "Essentially, then, Descartes' split the mind from the body and science from religion."

Pendergrast describes the work done by the Huygens brothers, Christian and Constantijn, who in 1655 used a twelve foot refractor with a two inch aperture to discover Saturn's brightest moon, Titan. Their 123 foot telescope is also described. When they used it in 1656, the rings of Saturn were turned edge-on when viewed from earth, so were not visible. By 1657 the rings had opened up, and the brothers viewed "a ring, thin, plane, nowhere attached" around the planet.

Pendergrast writes of the work done by Johannes Hevelius, Adrien Azout, Dominique Cassini, and Robert Hooke. He identifies Father Francesco Maria Grimaldi as the researcher who coined the term "diffracted," which he used to describe what happens to a stream of light created by a pin hole when he placed a small opaque object in the light stream. Grimaldi expected "a clean shadow line along a mathematically predictable path. Instead the shadow was larger and more diffuse than it should be, and part of it was colored."

Pendergrast writes extensively of the life and optic phenomena research of Isaac Newton. He indicates that Newton's first reflecting telescope was completed in 1668, and an improved one was produced in 1671. The description of the presentation of that reflecting telescope at a meeting of the Royal Society is particularly enjoyable to read. That event resulted in Newton's selection as a member of the Royal Society.

The section on the development of the reflecting telescope is followed by a long section on the use of mirrors in art, as well as improved manufacturing techniques for producing mirrors. This is followed by extensive information about the work of William and Caroline Hershel, and William's son John. Leon Foucault's contributions to reflecting telescopes are described, including information about the thirty-one inch aperture telescope he constructed in 1862, which "continued to do useful astronomy for over a century."

Pendergrast details the contributions of Faraday, Maxwell, Michelson and Morley, as well as Marconi, Roentgen, Planck and Einstein. A long section on the use of

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mirrors in magic shows and theater presents much interesting information.

Pendergrast does a very thorough job of describing the use of reflecting telescopes in expanding knowledge of the universe. Challenges and successes and failures in producing larger and larger telescope mirrors are described. This is followed by a section on the expansion of the use of mirrors in our culture. Radio telescopes are reflectors and Pendergrast describes the development of radio astronomy thoroughly. The description of the mirrors used in X-ray telescopes provides excellent reading, as does Pendergrast's description of infrared astronomy. The section on the Hubble Space Telescope "odyssey" and eventual success is enjoyable to read.

The concluding sentence in the book says a great deal about the book itself. Pengergrast writes "Mirrors should inspire terror, wonder, and comprehension." I enjoyed this book a great deal. It is an excellent resource that provides extensive information about the history of science, optics, and reflection.

\- Frank Lock

Michael D. Gordin, *The Pseudoscience Wars: Immanuel Velikovsky and the Birth of the Modern Fringe* (U. of Chicago Press, Chicago, 2012). x + 291 pp. $29. ISBN 978-0-226-30442-7.

Immanuel Velikovsky was not the first to seek astronomical explanations for cataclysms on Earth when he published *Worlds in Collision* in 1950. Newton's successor (as Lucasian Professor) William Whiston posited a comet as the cause of the flood that sent Noah to his ark. But Princeton history professor Michael Gordin sees the publication of *Worlds in Collision* as the onset of Cold War pseudoscience, which is the topic of this book. Moreover, Velikovsky's own massive documentation of his work – 65 linear feet of material now cataloged by Princeton University and available to researchers – enabled Gordin to be especially thorough in treating his subject (sixty-five of the book's pages are endnotes).

For those wondering how someone with a background in psychoanalysis like Velikovsky could come to develop a set of astronomical explanations for cataclysms in Earth's recorded history – and, along with it, a revision of that recorded history that would make the dates of some events 600 years more recent than their presently-established dates – Gordin informs us that *Worlds in Collision* began as a rebuttal to Freud's *Moses and Monotheism*. Yet, the only historians who challenged Velikovsky's reconstruction of history were historians of science, and they did so on scientific grounds, as did the community of scientists, whose protests were directed more to science publisher Macmillan, lest Macmillian's publication of *Worlds in Collision* be interpreted as making the book to appear to be a legitimate work of science.

Velikovsky is best known to the scientific community for his skirmishes with it and his desire to be accepted by it. Gordin argues that Velikovsky also sought vindication for his historical reconstruction as well – when he suggests that Velikovsky was "motivated by a quest to rewrite the history of the ancient Near East so as to reconcile discordances that had some bearing on the history of the Jews" (p. 73) and when he writes that "Velikovsky thought his major contribution was in *history*, not astrophysics." (p. 126) But in the end Velikovsky never was accepted by either the scientific or historical communities. In the quest for scientific acceptance, Harry Hess, Albert Einstein, Lloyd Motz, Valentine Bargmann, and William Plummer granted Velikovsky the courtesy of a hearing but not the satisfaction of recognizing his ideas as valid. And radiocarbon dating made Velikovsky's reconstruction of ancient history untenable.

Velikovsky nevertheless *did* sell a lot of books, and many of those who read them became enthusiastic supporters, many of them college students. Groups devoted to Velikovsky's ideas were formed, and similarly-devoted periodicals were published, and the last of Gordin's six chapters describes these in detail. That some joined the movement in support of Velikovsky for the purpose of furthering their own ideas while others sought to push beyond what Velikovsky had done put Velikovsky in a position of wanting to be both in control of the movement and disassociated from it. Only the British *Chronology and Catastrophism Review* continues to publish today.

Gordin spends a great deal of his Introduction describing the difficulties of demarcating pseudoscience from science, especially because "Pseudosciences are the products of actions and categorizations made by scientists." (p. 15) Though he finds himself in disagreement with demarcation criteria of Karl Popper, Irving Langmuir, and Philip Kitcher, he does agree with Martin Gardner that "pseudoscience is a fuzzy word that refers to a vague portion of a continuum on which there are no sharp boundaries." (p. 12) In his Conclusion, subtitled "Pseudoscience in Our Time," he notes two points along that continuum in addition to the "pseudoscience" exem-

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plified by Velikovsky: studies of science by humanists and social scientists in the "Science Wars" of the 1990s, and denials of mainstream science, such as those described in the cases of tobacco smoke (both primary and secondhand), acid rain, ozone depletion, and climate change by Naomi Oreskes and Erik Conway in *Merchants of Doubt*. Because of their questioning of the premises of mainstream science, humanistic science "studies" are regarded by the scientific community as a greater threat than Velikovskian pseudoscience. "Denialists" are established scientists, though they may have been co-opted by industry; thus they see themselves as legitimate, if not more so, than the scientists they are denying and hence not posing the threat to mainstream science that they see coming from Velikovskian pseudoscience or humanistic "studies." One issue which Gordin does not place along this continuum is that of creationism and "Intelligent Design." Although the "deniers" described by Oreskes and Conway are vociferously opposed to creationism, Gordin's only reference to creationism is to Velikovsky's interaction with it in his penultimate chapter. Because I feel that denial of climate change and "Intelligent Design" are the two most serious present threats to mainstream science, I would have liked to see a comprehensive consideration of both of these issues in any discussion of "Pseudoscience in Our Time."

- John L. Roeder

(*Editor's Note*: The preceding review was originally written for the American Physical Society's publication, "Physics and Society.")

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6. Lisa Margonelli, "The Energy Debate We Aren't Having," *Pacific Standard*, **6**(2), 30-34 (Mar-Apr 2013).

"The energy boom has the nation mired in chatter about a burgeoning job market, or panicked over certain environmental destruction, Margonelli writes. "Instead, we should be asking: To whom will go the spoils of this bonanza, and on whose shoulders will the risks fall?" In simpler terms the issue could be rephrased in terms of "fracking" *versus* jobs, and Margonelli cites several examples in which large numbers of expected jobs never materialized while pointing out that, in spite of examples of groundwater contamination in Wyoming and Pennsylvania from fracking, "after 60 years of using the technique in hundreds of thousands of wells, there are relatively few cases of groundwater contamination." She adds that "well-regulated, fracked natural gas could be a plus for the environment – particularly if it were coupled with a ban on coal." Regarding the issues of wealth and risk, she notes that the newly energy-rich states should have drilling taxes like the old ones have. And to place the risk on the drillers, they should be made to have insurance.

7. Stephen P. Lownie and David M. Pelz, "Stents to Prevent Stroke," *Am. Sci.*, **101**(4), 292-299 (Jul-Aug 2013).

The stents discussed in this article are those placed in carotid arteries blocked with plaque as an alternative to carotid artery surgery.

Infusion Tips

The late Dick Brinckerhoff suggested the following criteria for ways to infuse societal topics into our science courses: items should be a) challenging, b) relevant, c) brief, and d) require a value judgment. Consider the following:

1. On 10 December 2012 Aljazeera raised the question about the security implications of the plans of the World Wildlife Foundation to use drones in its struggle to curb poaching of animals. Given that security (and the use of security equipment) has traditionally been the function of the state and that these anti-poaching activities would be carried out mostly in African countries, the question raised is how the governments of these countries would respond to the nongovernmental use of security equipment within their borders. If you were the President of, say, Uganda or Kenya, how would you respond to the use of drones by the World Wildlife Foundation?

2. The driverless cars first reported on in our Fall 2008 issue and updated in our Fall 2012 issue have now been addressed in terms of liability by a report on National Public Radio's "Morning Edition" on 8 March 2013. If a driverless car causes an accident, is the manufacturer liable? A parallel is cited with the refusal of vaccine manufacturers to continue manufacturing their vaccines under threat of lawsuits until Congress provided them financial protection. Is it possible the manufacturers of driverless cars will need similar protection? If you were the manufacturer of a driverless car, how would you proceed?

Clearinghouse Update

From time to time we update our readers on situations which have been described in our *Newsletter*.

Update on Nuclear Waste

Our Fall 2005 issue reported the efforts of the Skull Valley Band of Goshutes to license a temporary nuclear waste site on their territory in Utah. The Clearinghouse Update in our Fall 2007 issue reported that, while this site had been approved by the Nuclear Regulatory Commission, it was still awaiting approval by the US Department of Energy. According to the 4 January 2013 issue of *World Nuclear News*, the final blow to developing this temporary nuclear waste site was delivered by the US Department of Interior, which failed "to approve the lease and a right-of-way to cross other Indian lands to Goshute territory." According to *World Nuclear News*, "This leaves America with no disposal route and no long term management strategy for highly radioactive waste, some three decades after responsibility for this was given to government by the Nuclear Waste Policy Act of 1982."

Mindful of this, President Obama directed Energy Secretary Steven Chu to form the Blue Ribbon Commission on America's Nuclear Future, whose recommendations were reported in our Fall 2012 issue. According to the 14 January 2013 issue of *World Nuclear News*, Secretary Chu announced a new nuclear waste disposal strategy on 10 January 2013 that would implement the recommendations of the Blue Ribbon Commission.

Recycling Cigarette Butts

Our Spring 2008 issue reported how TerraCycle had converted many components of household waste into new products. The 13 December 2012 issue of *The Times of Trenton* reported that this waste-to-product strategy was now being applied to cigarette butts. According to *The Times*, the cellulose acetate which comprises 97 percent of cigarette filters can be melted and mixed with other recyclable materials to create plastic pellets which can be used to manufacture industrial products. (Because the pellet material was once exposed to nicotine, it cannot be used to manufacture household products.)

Update on H5N1 Research

Our Spring 2012 issue reported the steps leading to the eventual publication of research on genetic engineering of the H5N1 avian flu virus to make it transmissible between mammals by Ron Fouchier and Yoshihiro Kawaoka and the moratorium on further research they and other researchers announced in January 2012. A year later these researchers ended their moratorium; but, because of their dependence on federal funding of their research, they needed to await guidance from the National Institutes of Health (NIH) what types of research they could resume. Officials with the NIH and the U.S. Department of Health and Human Services provided that guidance in the 22 February 2013 issue of *Science*. The research done by Fouchier and Kawaoka would be allowed under the new guidelines, which aim to balance risk and benefits by laying out a review process and seven criteria for judging a proposed experiment.

Benefits from Chlorine Disinfection

A report in our Spring 1995 issue classified chlorine as a "controversial element" because of the role of chlorofluorocarbons in depleting stratospheric ozone and the unsavory consequences of such chlorine compounds as DDT, dioxins, and PCBs. Calls to eliminate or reduce organochlorine compounds were reported. A detailed article in our Fall 2001 issue, wondering whether there might be a "sunset for chlorine," elaborated on these con-

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3. The 18 February 2011 issue of *Science* describes the emerging field of forensic DNA phenotyping, which allows the eye color, hair color, and age of a person suspected of committing a crime to be predicted from a DNA sample left at the crime scene. Unlike DNA fingerprinting, which has a high degree of certainty, DNA phenotyping is probabilistic in its predictions – more than 90% accuracy in distinguishing between brown and blue eyes, 90% accuracy in distinguishing black and red hair, but only 80% in distinguishing blond or brown. Attempts to predict skin color had not become successful at the time this article was written, because some of the genes overlap those for eye and hair color. Age prediction has a margin of error of at least nine years.

DNA phenotyping is regulated in the Netherlands to allow investigation of only the genes related to physical appearance, so that personal information such as genetic susceptibility to diseases is not intruded upon. Because of the same privacy concerns, DNA phenotyping is banned in the nations of Belgium and Germany and the states of Indiana, Rhode Island, and Wyoming. If you had to vote on whether to regulate or ban DNA phenotyping where you live, how would you vote?

Musings

by REY

A New Vision for Reform of Science Teaching: Beyond Mindless Progressivism

by Robert E. Yager

James Paul Gee (http://www.jamespaulgee.com/node/51, 2012) has written a publication titled "Beyond Mindless Progressivism." He confesses his surprise that so many educators lapse into "mindless progressivism" with the assumption that children learn best by participation and immersion in activities proposed by teachers and/or the directions provided in textbooks and associated laboratory activities. Students are merely expected to follow directions and repeat in classrooms what teachers or instructional materials provide. Parents are often encouraged to help their children to do all that they are told to do and to be ready to report on it as evidence of their "learning." Teachers often report as wanting higher-order and meta-level thinking skills – but too often teachers and the curriculum do not help students to reach such learning goals.

Gee indicates that most classrooms result in a few student "producers" but, most continue to be "consumers" (of real learning!). He has called for more to recognize that all students are different. He has found that students in typical classrooms are divided into a small number of "priests" (insiders with "special" knowledge and skills) and the "laity" (followers who use language, knowledge, and tools they do not understand deeply and cannot transform ideas for use in new contexts). This situation is normal and should be expected by the most effective teachers.

Gee advocates "post-progressive pedagogy" and wants his readers to consider use of the term "situated learning." He has offered 17 examples of such environments which can lead more students to useful learning and understanding. Gee's first feature of the learning classroom is recognition that there are multiple routes to full and personal participation for all members of a group, *i.e.*, a group organized around interests and passions to which the interest might lead.

His last feature of the learning classroom (#17) is that all learners will be well prepared to be active, thoughtful, engaged members of the public sphere which is the ultimate purpose of "public" education! This means an allegiance to arguments and evidence over ideology and force. It also means the ability to take and engage with multiple perspectives based on people's diverse life experiences defined not just in terms of race, class, and gender, but also in terms of the myriad of differences that constitute the uniqueness of each person and the multitude of different social and cultural allegiances all have.

Gee's efforts provide vital thoughts and forward-looking suggestions for current efforts to develop the Next Generation Science Standards (NGSS). This means defining Science as the exploration of the material universe seeking explanations for the objects and events encountered. Science then is portrayed as a search for explanations found in nature, keeping in mind the importance of looking for evidence to establish the validity of the explanations offered both by scientists and others. It often means work in collaboration with others – much unlike the products of art, music, economics, and physical training. Unfortunately, this central ingredient of science is something few students experience as science in schools.

Wondering about the natural world is fun and rewarding, but it is seldom enhanced or encouraged in classes called "science" in K-16 educational settings. For students to succeed in real science they must use their minds concerning something more than the information included in textbooks or the explanations teachers "give" students in their classrooms. The best science students too often are the ones who do what they are told – and who remember the words defined and described in typical science classes. In a sense, real science is missing in most educational settings (schools and colleges) where it is supposedly being provided. Teachers seek to control by assessing what students do not remember rather than being involved in learning with a purpose.

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Technology results when engineers apply their understanding of the natural world to design ways to satisfy human needs and wants. It illustrates its effectiveness (necessity) of being central to educational reforms and how it can illustrate the curriculum and the teaching in all K-16 educational settings. One problem is that most educators define science as the information in textbooks and/ or from state and national standards or from their own experiences with one or more science discipline in classrooms. This ensures that progressivism will continue and result in no real reforms of science teaching/learning.

How to get more educators interested and working to meet the reforms which Gee has so meaningfully defined and illustrated? Instead progressivism and the teaching of a set curriculum will continue to result in failure. Few graduates are prepared to provide science for all students for use in fulfilling citizenship responsibilities.

(*Editor's Note*: Robert E. Yager is Professor of Science Education, University of Iowa. He is a past contributor to this *Newsletter*, past President of the National Science Teachers Association and of the National Association for Science, Technology, and Society.)

Yager Foundation establishes NSTA Award

The Robert E. Yager Foundation has established Excellence in Teaching Awards to be awarded by the National Science Teaching Association (NSTA) to six full-time K-12 science teachers "who successfully use innovation and excellence in their classroom." Each awardee will receive $1000 plus another $1000 toward expenses to attend the next NSTA National Congress on Science Education. One of the six awardees will receive an additional support of up to $1500 to present at a future NSTA National Conference on Science Education. Yager is a past president of NSTA and was a chief proponent of the Science, Technology, and Society approach to science education. In the latter capacity he has made many contributions to this *Newsletter*.

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cerns and added to them the concern about the increased use of polyvinyl chloride. Now, in the 7 January 2011 issue of *Science*, David L. Sedlek and Urs von Gunten pose what they call "The Chlorine Dilemma." They acknowledge that chlorinating drinking water produces toxic disinfection by-products (DBPs) and also reacts with synthetic chemicals in water to produce chloroform and dioxins, but they also note that chlorine can also transform endocrine-disrupting compounds (EDCs) that cause fish feminization. The alternative disinfectant chloramine, produced by treating the water with ammonia before adding chlorine, results in a different set of toxic DBPs, including carcinogenic N-nitrosodimethylamine (NDMA). Moreover, water treated with chloramines has shown higher concentration of lead, because elemental chlorine coats lead pipes with a coating of "sparingly soluble" lead (IV) oxide, whereas chloramines results in a coating of more soluble lead (II) oxide. They observe that chlorine disinfection is also more effective in transforming antibiotics and beta blockers in waste water to less reactive compounds. Thus switching to a non-chlorine disinfectant for drinking water must be mindful of the additional beneficial effects resulting from chlorine. The primary candidates are ozone and ultraviolet light, as noted in our Fall 2001 issue, and ozone brings its own DBPs, including bromated and low-molecular-mass aldehydes.

Sucralose Found to Affect Body's Response to Glucose

When Dominic Vellucci spoke to the Physics Club of New York on sweeteners in February 2006, as reported in our Winter/Spring 2006 issue, he described sucralose (the sweetener in Splenda®) as sucrose with chlorine atoms substituted for two hydrogen atoms – with a sweetness 600 times that of sucrose but with a calorie count of zero. Now M. Yanina Pepino of the Washington University School of Medicine has reported research in which 17 severely obese people without diabetes were given a glucose challenge test (similar to a glucose-tolerance test) twice – once after consuming water and once after consuming a sucralose solution. "When study participants drank sucralose, their blood sugar peaked at a higher level than when they drank only water before consuming glucose," Pepino explained. "Insulin levels also rose about 20 percent higher. So the artificial sweetener was related to an enhanced blood insulin and glucose response."

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Science of Innovation

It has repeatedly been pointed out on the pages of this *Newsletter* that innovation is the key to leadership in STEM (science, technology, engineering, and math) fields. Now, in partnership with the National Science Foundation (NSF) and the U.S. Patent and Trademark Office (USPTO), NBCLearn has developed a series of eleven videos on the *Science of Innovation*. They consist of one overview titled "What is innovation?" and ten additional videos, each on a separate aspect of innovative development involving one or more STEM fields: anti-counterfeiting devices, synthetic diamonds, fuel cell efficiency, biofuels, self-driving cars, biometrics, smart concrete, electronic tattoos, bionic limbs, and 3D printing. And the National Science Teachers Association (NSTA) has developed lesson plans to use the videos in STEM classrooms.

To view the videos you can go to <www.NBCLearn.com> or to <www.uspto.gov/education>. The USPTO site has the added feature of short texts to introduce each video. To get the lesson plans, go to <http://nstacommunities.org/blog/category/videos-and-lessons>. You will find lesson plans for each applicable STEM category, with each one listing the contents of the video (by time), providing cross-references to the K-12 Science Education Framework (on which the Next Generation Science Standards are based), and describing the role of innovation, occasioned by inspiration, the relationship of innovation to STEM, and approaches to Design Investigations following the video. Also included are ways to use the video and copy masters.