Affiliated with the Triangle Coalition for STEM Education

TEACHERS CLEARINGHOUSE
FOR SCIENCE AND SOCIETY EDUCATION
NEWSLETTER

Vol. XXXIII, No. 2
Fall 2014

Prospects for Integrated STEM Education Assessed

by John L. Roeder

STEM has become a frequently-used acronym for the related fields of science, technology, engineering, and mathematics in recent years. The importance of including these related fields is seen in Triangle Coalition's changing their name from "for Science and Technology Education" to "for STEM Education" and PhysicsTeachersNYC becoming STEMTeachersNYC. Some have even sought to integrate the arts as well under the rubric of "STEAM." An examination of recent issues of this *Newsletter* shows that STEM has appeared in every issue which has carried the featured "News from Triangle Coalition," since 2006. Long before that, in our Fall 1997 issue, there appeared an article about the National Institute for Science Education receiving a grant from the National Science Foundation "to improve K-College SMET education. . . ."

As I wrote that article, I couldn't help but think that, because "SMET" sounded like "smut," there surely should be a way to express this collection of related fields by an acronym with a more positive connotation. And since the same letters could spell the actual word "stem," it occurred to me that STEM would be more appropriate an acronym than SMET. Thankfully, I was overjoyed by the emerging use of STEM as a validation of this type of reasoning.

But if STEM is to be useful as an acronym for science, technology, engineering, and mathematics, there must be usefulness in being able to mention all these fields in one word. One possible use could be to consider these fields to be unified in the sense of being taught together. *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research* is the report of a two-year study by the Committee on Integrated STEM Education "to develop a research agenda for determining the approaches

(continued on page 13)

Programs of Integrated STEM Education Described

by John L. Roeder

In their report on *STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research*, the Committee on Integrated STEM Education pointed out that existing research on the effect of integrated STEM education was limited in quality as well as quantity. When I reviewed this report, I had the impression that the Committee was looking for examples in which science, technology, engineering, and mathematics were taught as one integrated subject. It was with this in mind that I viewed an anthology edited by Robert E. Yager and Herbert Brunkhorst, *Exemplary STEM Programs: Designs for Success* (NSTA, Arlington(VA), 2014), whose 24 chapters each describe a different approach to integrated STEM education.

These 24 chapters were chosen from over 100 submitted draft chapters, largely on the basis of demonstrated success with student learning. In some cases the evidence of success is largely anecdotal, but in most cases it consists of comparisons of results from pre-tests and post-tests, and in a few cases the test results from students experiencing the STEM education program are compared with those from students in a group not experiencing the program.

But did any of these STEM education programs teach science, technology, engineering, and mathematics as one integrated subject? A few did, but *in addition to* already existing science and math courses. Rosa International Middle School in Cherry Hill, NJ, decided to add STEM as a fourth "special course" to their existing curriculum. Menifee Valley Middle School (CA) decided that adding a STEM elective would make learning more relevant (and they back this up with results of standardized tests).

(continued on page 11)

Further Appreciations of Irma Jarcho

Dear John and Bernice,

I was glad to see your remembrances of Irma in this issue of the newsletter of the Teachers Clearinghouse for Science and Society Education. Thanks for writing the columns.

In 1967 I joined the New Lincoln faculty as a young, wet-behind-the-ears science teacher. Irma became an important mentor whose bookshelves were full of the alphabet soup of NSF-supported curricula (e.g., ESCP, which I later taught), as well as many other valuable resources. The breadth of her knowledge and interests was remarkable. In later years I obtained a doctorate in science education and have worked on STEM education issues, and related matters, my whole career.

I hardly need to tell you, who knew her so well, that Irma was an impressive and formidable woman who left her mark on many people and institutions.

Regards,

Andy Zucker
Cambridge, MA

Hi John,

I read your wonderful tribute to Irma Jarcho and it reminded me how much I have missed seeing her at NABT for the last several years. She was an absolutely delightful woman! She never tired of sharing her ideas about teaching STS and she was so supportive when I talked about my own Science and Society class. She was never shy about giving advice and I always appreciated it; it was invariably helpful! My favorite memory is a story she told about calling "home" to Puerto Rico and having her brother (I think) take the phone into the yard so she could hear the tiny tree frogs, the cogui, that she missed so much. I had traveled a few times to Puerto Rico and loved the sound as she did. Irma will be missed!

Betty Carvellas
Colchester, VT

A Correction

Although development of the “School Power Naturally” program cited in our Winter/Spring 2014 coverage of Al Gore’s “Turning Point” was reported in the coverage of the NESEA Conference on 14-15 November 2002 in our Winter 2003 issue, Richard Perez’s talk pointing out the peaking of electricity demand with maximum sunlight in New York State was made to a gathering of curriculum developers and workshop presenters on 7 July 2003 and reported in our Fall 2003 issue.

IN THIS ISSUE

The TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC., was founded at The New Lincoln School on 11 March 1982 by the late 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 17 Honeyflower Lane, West Windsor, NJ 08550-2418 or via e-mail at <JLRoeder@aol.com>. The Clearinghouse is affiliated with the Triangle Coalition for STEM Education.

Please read my paper

by H. Frederick Dylla

There is no shortage of reading material in the research community. Scholars are now publishing nearly two million journal articles a year in over 28,000 different scholarly journals in the English language.[1] This is the result of a well-established trend. The number of journal titles has grown roughly 3% a year since the first scholarly journals appeared over three and a half centuries ago. In 1665, The British Royal Society began to publish *Philosophical Transactions,* the same year that the Académie Royale commenced publication of *Journal des sçavans.* As pointed out in analysis by Michael Mabe,[2] this growth in journals simply scales with the number of researchers. There is no way for an individual to deal with the volume of content, even a subset restricted to a field of the literature that matches the researcher's interest.[3] Regardless, access to the scholarly literature has become a high-profile issue in the community. Because much of the literature is supported by subscription access, the more acute problem is discovery of the most important articles — and its associated data — by the inquisitive researcher. How can one identify the absolute essential research articles pertinent to any particular research endeavor?

To solve this problem, we will not rely on an army of research assistants, because even the low-cost, extended workday of graduate students can't make a dent in this problem. Clearly, the dominant reader of the future will be a machine rather than a person. Adapting the scholarly literature to be efficiently and accurately machine-readable and developing machine-reading tools with user-friendly interfaces are frontier development projects in the publishing and information technology communities. This enterprise has a catchy name — text and data mining, or TDM for short — and there is considerable discussion of its prospects and potential benefits in the publishing community and among its customers and policy makers.

In its simplest form, the search and indexing routines used by commercial search engines such as Google, Yahoo, and Bing perform text mining adopted to the full corpus of literature on the web to allow key topics to be discovered and exposed by these search engines. Most scholarly publishers sign agreements with these firms to allow their content to be "crawled" by robotic readers to tag the content for identification against key words and terms. Taken to the next level, more sophisticated TDM uses more sophisticated analytic tools, such as natural language processing and machine learning, to recognize relationships in unstructured text and key identifiers, such as names, chemical structures, and experimental methods. TDM is a ripe arena for research, development, and testing of techniques.

Research funding agencies should be and are facilitating such development. When the US DOE recently announced its public access plan for scholarly publications and data, the plan was criticized in some camps for not spelling out details or requirements for TDM of publicly accessible content. A careful reading of the February 2013 OSTP memorandum (which is the basis for DOE's policy, and other US funding agencies will soon follow suit) shows that specific requirements for TDM were not mandated. Given the relative infancy of this field, the OSTP memorandum encouraged the development of creative "reuse" of scholarly content — thus providing broad incentives rather than specific mandates at this early stage of development of TDM. One could easily imagine the havoc that could be generated if scholarly publishers had to open up their complete content to unregulated crawling by machine readers. All public and private databases of digital content have to be protected from ubiquitous online threats.

The potential value of TDM tools and techniques are greatly enhanced if the widest possible collection of all content from related and seemingly unrelated subjects is made available for the mining exercise. It opens up the possibility of serendipitous discoveries when connections or relationships are examined beyond more narrow searches. Within the realm of physics, we have the recent example of last year's Nobel Prize on the discovery of the Higgs boson. The fundamental theoretical work by Peter Higgs and his collaborators in high energy physics was based on examination of quantum phenomena in superconductors previously done by Philip W. Anderson.[4] However, careful vetting and application of crawling tools on the primary content or special mirror platforms created for these applications are sensible approaches. With the public access statutes introduced by the UK government in April of 2013, researchers with access to subscribed content are permitted to copy such content for noncommercial TDM purposes. Most publishers that I interact with will allow controlled TDM of their content upon request. The field is so new there are presently but a handful of such requests.

But this status will change quickly. The most active work is occurring in the biomedical and pharmaceutical fields, where important topics such as drug discovery and patient reactions can be tracked across the literature. For a recent example of mining electronic health records for patterns, see Scientific Data. For those interested, a succinct analysis of TDM for this field has recently been published by a collaboration called the Pharma Documentation Ring and the publishing organization, Association of Learned & Professional Society Publishers.

(continued on page 6)

The IAGD : Expanding Opportunities in the Geosciences to People with Disabilities

by Michael J. Passow, Earth Sciences Correspondent

Sight. Sound. Motion and touch. You probably take these senses for granted and rarely think about how essential they are in your quest to understand the world — that is, to "Science." But what if you could not see or hear or walk? How could you still engage in activities that scientists and science students do?

In late 2008, the basis for the International Association for Geoscience Diversity (IAGD) was begun by a group concerned about underrepresentation of people with disabilities in the geoscience professions. Joining from a variety of backgrounds in geoscience, science education, disability education, and research organizations, a national advisory group was formed to identify current research opportunities and inclusively-designed instruction for underrepresented students with disabilities. They were also asked to find strategies that raise awareness of improving access and inclusion in geoscience disciplines.

International interest facilitated expansion of the original group into a network of participants from the US and eight countries on four other continents. Through the website, <www.TheIAGD.org>, and conferences across the globe, members share success stories, concerns, and plans. They present workshops for instructors and graduate assistants on how to use inclusively-designed pedagogies in geoscience courses.

Examples of research and training programs available on the website are as follows:

"The Magic of Space in Your Hands: Feel a Meteorite!" Offered by the Natural Sciences Museum of Tenerife, Canary Islands (Spain), the objective of this short course is to give a general overview about the significance of meteorites. This earth and planetary course is devoted to all people but primarily people with sensory disabilities (blind and low vision). <http://www.theiagd.org/the-magics-of-space-in-your-hands-feel-a-meteorite/>

"Ocean InSight" Ocean InSight is a collaboration between Dr. Amy Bower of the Woods Hole Oceanographic Institution and bhe Perkins School for the Blind in Watertown, Massachusetts. The oldest school for the blind in the US, Perkins offers accredited K-12 education to over 200 students on campus as well as support to local educational organizations for the blind in over 50 developing countries. <http://www.theiagd.org/ocean-insight/>

"Expanding Geoscience Diversity through Simulated Field Environments for Students with Physical Disabilities" The proposed effort seeks to address the problem of limited inclusion for the mobility impaired to participate in field experiences required in the geosciences curriculum. This underrepresented community has been previously excluded due to limiting physical conditions that are generally required for field study. The PI on this project is Dr. Christopher Atchison, who began the study at Georgia State University and has continued it in his new position at the University of Cincinnati. <http://www.theiagd.org/expanding-geoscience-diversity-through-simulated-field-environments-for-students-with-physical-disabilities/>

Also available through the website are resources to assist learners who are blind, deaf, physically (mobility) impaired, or have non-apparent disabilities. One major area of the IAGD focus on campuses and elsewhere has been to raise awareness of "Inclusive Design for Living" accommodations. They provide summaries of IDL guidelines and principles, and links to websites providing successful examples and additional resources. <http://www.theiagd.org/idl/.>

The American Geoscience Institute focused its 2014 Leadership Forum around this theme. Entitled "Accommodating Geoscience Workforce Diversity: Including the Talents of All Geoscientsts," the forum included representatives from 15 AGI Member Societies. Christopher Atchison, Heather Houlton of the AGI, and others led sessions exploring barriers to inclusion within institutions, legal issues of accommodation, and effective data collection practices. Dr. Atchison described one program which allowed six college students in wheelchairs to access Mammoth Cave National Park, in conjunction with "virtual explorations," and so gain experiences normally reserved only for those who can walk.

In other sessions of the AGI Leadership Forum, Dr. Shirley Malcolm of the AAAS described efforts to building a geoscience access coalition, and Dr. Nick Tew, Alabama State Geologist, described the remarkable story of his colleague who was paralyzed in an accident more than a decade ago, but has been able to continue his pro-

(continued on page 6)

Mary Virginia Orna tells about false discoveries of elements

Chemistry Professor Mary Virginia Orna of the College of New Rochelle is responsible for many resources for chemistry education, and she has generously shared them with the Physics and Chemistry Teachers Clubs of New York. On 12 December 2014 she shared her latest – *The Lost Elements*, her translation of a book originally published in Italy in 2009 supplemented by additional chapters she wrote. (The two original co-authors are Marco Fontani and Mariagrazia Costa, both of the chemistry department at the University of Florence.)

The "lost" elements are those whose "discoveries" turned out to be spurious or false, and Orna stated that there are more than 400 of them, each one representing a dead end in the evolution of science. She described several of them, according to the several parts of the book.

Part 1: Chemistry before the concept of element. Orna listed among the early discoverers of false elements Josiah Wedgewood, famous for his English porcelain, and Christian Friedrich Samuel Hahnemann, the originator of homeopathy. But she placed most of her emphasis in covering this period on "The Undiscovery of Erythronium," which occurred in the New World by del Rio, who had studied under Lavoisier. Del Rio first called his discovery panchromium and gave a sample of it to Alexander von Humboldt to have it tested in Europe, where it was misidentified as chromium. A quarter century later Nils Gabriel Sefström discovered vanadium, which was subsequently determined to be del Rio's erythronium, which had mistakenly been identified as chromium, thus cheating del Rio of being the discoverer of vanadium. Orna added that in 1947 an effort to rename vanadium and credit del Rio was quashed.

Part 2: From Lavoisier to Mendeleev. During this period one of the mistaken discoveries was originally called glucine (Gl), now known as beryllium. Orna said that the symbol "Gl" is still used in France – a false name if not a false element. She added that American Chemical Society presidents even announced discoveries of false elements. For example, J. Lawrence Smith "discovered" mosandrium, rogerium, and columbium. Orna noted that people were hungry to have their name entered into the annals of chemistry for being the discoverer of a new element, though few of these attempts were fraudulent.

Part 3: From the Periodic Table to Moseley's Law. The empty boxes on the periodic table to be filled by the rare earth elements were unknown in number, and Orna observed that the concepts of atomic number and isotope were unknown at this time. There were believed to be three types of terbium.

Part 4: From Nuclear Classification to the First Accelerators. Orna noted that there was much controversy over naming element 72 during this period — celtium *vs.* hafnium. There was also controversy surrounding element 61, named florentium, among other things, before it was established as promethium. Orna reported that, though many discoveries of false elements were never retracted, Rolla did retract his false discovery of florentium but that he did so in a very obscure place. With no stable isotopes, promethium was not identified until the discovery of nuclear fission.

Part 5: 1939 to the Present. Here Orna focused on Enrico Fermi, who won the 1938 Nobel Prize in Physics, but, she said, for the wrong reasons. In his investigation of bombarding the elements with neutrons, he concluded that bombarding uranium with neutrons resulted in the formation of elements 93 and 94, which he named ausonium and hesperium. On the other hand, Ida Noddack, who thought that the result was uranium fission, was laughed at by Otto Hahn, who later claimed the discovery of nuclear fission for himself. But though the 1938 Nobel Prize in Physics may have been awarded for the wrong reason, Orna noted that it enabled the Fermis to escape the Fascists – they went directly to the U.S. after Enrico received the Prize in Stockholm.

Part 6: Bizarre Elements. Here Orna related bizarre facts about scientists who had made highly respected contributions to science. Mendeleev believed in the ether, she said. Alfred Wegener, known for his geological theory of tectonic plates, posited an element called "geocoronium." And William Ramsay, known for his discovery of many inert gases, posited "asterium" as an alternative form of helium (they were actually two different helium isotopes). In addition, Orna reported that cultists Charles Webster Leadbeater and Annie Besant hypothesized the existence of subatomic particles, and that she got their photographs for the book from the Theosophical Society.

Part 7: Modern Alchemy. Here too the focus was on William Ramsay, for positing the conversion from copper to lithium; the lithium was later found to come from the smoke and ashes of his cigarettes.

One conclusion Orna drew from her researches into the discoveries of false elements is that when scientists venture too from their area of expertise, they are more prone to error. Another observation she shared about the book was from Roald Hoffman, who wrote the preface. Be-

(continued on page 6)

Please read my paper

(continued from page 3)

For more general references on this quickly developing field, particularly with respect to scholarly publishing, I refer you to a recent STM statement and report by the Publishing Research Consortium and new initiatives recently announced for TDM services by the publishing services organizations, the Copyright Clearance Center and CrossRef.

[1] Mark Ware and Michael Mabe, *The STM report: An overview of scientific and scholarly journal publishing,* 2012.
[2] Michael Mabe, *Serials* **16**(2), 191–7 (2003).
[3] A. G. Fraser and F. D. Dunstan, "On the impossibility of being an expert," *BMJ* 2010;341:c6815.
[4] P.W. Anderson, *Phys. Rev.*, **130**, 439 (1963).

(*Editor's Note*: Fred Dylla is the Executive Director and CEO of the American Institute of Physics. This article is excerpted from the 29 September 2014 issue of *AIP Matters* and reprinted with permission.)

IAGD

(continued from page 4)

ductivity in geologic research with suitable accommodation.

I attended as representative of the National Earth Science Teachers Association, and like all others in the audience, we walked away with greater appreciation of our abilities to see, hear, and move, together with aspirations to share what we have learned with others. NESTA members include classroom teachers who often have students with disabilities. This forum plus the IAGD can help identify resources to meet the needs of such students so as to develop their interests and understanding in science, including the earth sciences, which especially demand use of the senses and mobility.

Would you like an electronic subscription to the *Newsletter*?

All you need to do is to e-mail Editor John Roeder at JLRoeder@aol.com with a request and your e-mail address.

You can also request electronic copies of all issues back to 2009.

false discoveries of elements

(continued from page 5)

cause the book consists of little vignettes rather than a continuous narrative, he felt that it would make a "good bathroom book."

A forthcoming book edited by Mary Virginia Orna is *Science History: A Traveler's Guide*, to be published by ACS Books in 2015; in 2013 she published *The Chemical History of Color* (Springer), in which the subtopics of fashion, pharmaceuticals, food, and fun play an important part.

Prior to Orna's talk Chemistry Teachers Club President Chris Ward presented his gas laws lab (discovery of Charles' Law) and a UC-Irvine video of "Chemists Know," a parody of "Let it Go" from *Frozen* on YouTube.

News from Triangle Coalition

NGSS High School Evidence Statements Now Available

The NGSS Evidence Statements for High School are now available (evidence statements for elementary and middle school are under development). These statements were developed by educators and scientists, including many members of the NGSS writing team. The evidence statements are intended to identify clear, measurable components that, if met, fully satisfy each performance expectation (PE) described within the NGSS. Given that each PE is three-dimensional, the statements describe how students can use the practices, crosscutting concepts, and disciplinary core ideas together to demonstrate proficiency on the PEs by the end of instruction. They are not meant to limit or dictate instruction and were written to allow for multiple methods and contexts of assessment, including assessing multiple related PEs together at the same time. The document is available online at <http://www.nextgenscience.org/sites/ngss/files/Front%20Matter%20Evidence%20Statements%20PDF%20Jan%202015.pdf>.

(*Editor's Note*: The preceding was published in the Triangle Coalition *STEM Education News* for 9 January 2015 and is reprinted by permission.)

Earth Science Education in the "Nation's Attic"

by Michael J. Passow, Earth Sciences Correspondent

The Smithsonian Institution is sometimes called "Our Nation's Attic." But unlike many attics, which serve only as a place to dump unwanted items, the Smithsonian provides vibrant exhibits attracting huge numbers of visitors each day, as well as valuable online resources for teachers and students. Here's a brief survey of some of the Earth Science education offerings.

The Smithsonian Institution (http://www.si.edu/) actually comprises 19 museums in the District of Columbia, Cambridge, MA, New York City, and the National Zoo (http://www.si.edu/Museums). The National Museum of Natural History (NMNH) (http://www.mnh.si.edu/) contains some of the most famous gems and minerals in the world — including the Hope Diamond in the Harry Winston Gallery — as well as permanent and temporary exhibits explaining geology, paleontology, oceanography, anthropology, and much more. The National Fossil Hall is currently undergoing extensive renovations that will keep it closed until 2019, but visitors can view "The Last American Dinosaur," a display that will be open until 2018. So there are still many other halls that make a visit to DC incomplete without spending much of a day in these interconnected learning spaces.

Supplementing the physical exhibits are "virtual exhibitions" created by NMNH staff. For example, "Dig It! The Secrets of Soils" (http://forces.si.edu/soils/index.html) is based on an exhibits at the museum more than four years ago. It is one feature in the "Forces of Change" (http://forces.si.edu/index.html) online resources that describe the importance of understanding ecological, climate, cultural and other changes impacting scientific and social issues.

Behind the public displays is the research of the NMNH scientists and curators, currently more than 150, and in excess of 126 million specimens and artifacts in the collections. Some of these are accessible through web searches (http://collections.nmnh.si.edu/search/). The Office of Education & Outreach (http://www.mnh.si.edu/education/index.html) provides hundreds of programs for schools and visitors every year. They also cooperate with scientific organizations for special events: your Earth Sciences correspondent is planning a special K-12 teachers' visit in conjunction with the Geological Society of America meeting in Baltimore next November.

(continued on page 8)

The Federation of Earth Science Information Partners (ESIP)

by Michael J. Passow, Earth Sciences Correspondent

The Federation of Earth Science Information Partners (ESIP) (http://www.esipfed.org/) is an open networked community that connects science, data and information technology, and education practitioners. Since its inception in 1998, the ESIP Federation has grown and attracted a diverse group of including more than 150 member organization partners. The ESIP Federation's membership includes federal data centers, government research laboratories, research universities, education resource providers, technology developers, and various nonprofit and commercial enterprises.

Participation in the ESIP Federation provides an intellectual commons to gather and enhance capabilities that support member organizations' activities. These efforts catalyze connections across organizations, people, systems, and data, allowing for synergy and more effective programs. Membership in the ESIP Federation is free and open to organizations that work with earth science data and wish to cooperate with other programs. By participating in the ESIP Federation, organizations can leverage investments made by NASA and NOAA, the ESIP Federation's principal sponsors.

ESIP connects with other networked organizations, such as the Climate Literacy & Energy Awareness Network (CLEAN, http://cleanet.org/index.html). CLEAN organizes a collection of educational resources around energy and climate topics to supports learning about these topics. Launched in 2010 as a National Science Digital Library (NSDL, http://nsdl.org) Pathways project, CLEAN is led by the science education expertise of TERC, the Cooperative Institute for Research in Environmental Science (CIRES) at the University of Colorado Boulder, the Science Education Resource Center (SERC) at Carleton College, and NOAA.

ESIP has identified four "Pillars" to guide its activities:

- ESIP is the trusted community authority that supports the integration of science and data into mainstream use.

(continued on page 8)

"Nation's Attic"

(continued from page 7)

NMNH Education has created exciting new ways to connect the public with Smithsonian science and collections through the Q?rius Education Center (http://qrius.si.edu/). Pronounced "curious," Q?rius is a first-of-its kind interactive and experimental environment that focuses on teens, tweens, their families, and educators. Here, visitors, students and their teachers can handle specimens, use advanced microscopes and other equipment, have personal learning explorations of a variety of scientific themes, and have the opportunity to meet scientists who work at the museum and from other institutions.

The complimentary Q?rius website resources bring the science to remote audiences and extend the physical displays. Students can create their own digital field book (http://qrius.si.edu/fieldbook/17/recent), allowing them to save objects from the online collection or any images and other media they want found in the Collections Browser (http://qrius.si.edu/science-webcast-schedule#cboverlay=browse). They can make notes on anything they add to their field book and share what they have created through social media.

NMNH scientists have worked with the museum staff to create 'science stories,' and interactives that are accessible through the website. "When Volcanoes Erupt" with geologist Elizabeth Cottrell (http://qrius.si.edu/jump/when-volcanoes-erupt#), "Uncover DNA Secrets in 'Reefs Unleashed'" (http://qrius.si.edu/do/reefs-unleashed_) and "Be a Satellite Sleuth in 'Decoding Mars'" (http://qrius.si.edu/do/decoding-mars) are just a few examples.

Science How webcasts provide opportunities for students to connect with Smithsonian scientists and research through dynamic and interactive programs such as "The Amazing Race to Excavate a Fossil" featuring Nick Pyenson, the fossil marine mammal curator (http://qrius.si.edu/watch/preparing-extinct-toothed-whale#.VHn4aDHF-So). Each program is achieved and can be viewed at any time. The schedule of webcasts for the 2014-2015 school year can be found at http://qrius.si.edu/science-webcast-schedule.

Across the National Mall from the Natural History Museum is the Air and Space Museum (http://airandspace.si.edu/), the nation's largest collection of displays about traveling through Earth's atmosphere and into outer space. Of course, many aircraft and spacecraft are too large to be displayed in the Mall building, so a satellite facility was opened over a decade ago near Dul-

(continued on page 10)

ESIP

(continued from page 7)

- ESIP achieves sustainability through diversification, global partnerships, and partner recognition.
- ESIP provides the Earth science informatics intellectual commons to drive innovation.
- ESIP leads the development of science data information professionals.

Representatives from member organizations meet in Assemblies to share information and make decisions about future action. The next scheduled meeting (as of the writing of this report) will be in early January 2015. The theme for this program is "Earth Science and Data in Support of Food Resilience: Climate, Energy, Water Nexus."

Presentations at the Assemblies often focus on advancing technologies to observe, analyze, and present data. For classroom teachers, ESIP member organizations have created resources that can be used by teachers and students. One example is "My NASA Data" (http://mynasadata.larc.nasa.gov/), an online tool that provide access to data sets which can be used to create charts, plots, and graphs. NASA has worked with teachers to create lesson plans for elementary, middle, and high school science classes. The intent is to improve learning through using real data and creating interactive opportunities for students. One example is "Seasons and Cloud Cover, Are They Related?" (http://mynasadata.larc.nasa.gov/lesson-plans/lesson-plans-middle-school-educators/?page_id=474?&passid=42). The National Earth Science Teachers Association promotes My NASA Data lessons and ESIP through workshops at area and national NSTA conferences, making these known to classroom teachers.

ESIP has developed its extensive collection of resources and stimulated much progress in science, technology, and education since its beginnings in 1998. The Education and Outreach standing committee promotes both K-12 education and professional development for specialists in ESIP member organizations. ESIP offers many telecons to connect members throughout the year. You can learn more about all of ESIP's activities at <http://www.esipfed.org/>.

(*Editor's Note*: CLEAN and SERC are described in greater detail on p. 23 of our Winter/Spring 2013 issue.)

Highlights of the AGU 2014 Fall Meeting

by Michael J. Passow, Earth Sciences Correspondent

The American Geophysical Union (AGU) Fall Meeting each year in San Francisco is one of the largest and most important gatherings of geoscientists. (Note/joke: AGU is also the most misnamed of organizations — it's not just American, it's international; it's not just Geophysics, it's all areas of the Earth Sciences; and we're far from united!) This December, more than 24,000 gathered at the Moscone Center in San Francisco to share cutting-edge research through oral and poster presentations, hear featured talks by world-leading experts, network for job and educational opportunities, confer awards, and celebrate with colleagues past and present. The 2014 Fall Meeting home page is <http://fallmeeting.agu.org/2014/>.

Understanding our planet requires approaches that are much more interdisciplinary than in the past, so the AGU offers "SWIRL" themes to bring specialists from various research areas together. Among the ten SWIRL topics this year were carbon dioxide sequestration, characterizing uncertainty, comparative planetology and habitability, understanding systems across a range of scales, climate change at high latitudes, science literacy and societal impacts, and volatile cycles. You can learn more about these and the other themes at <http://fallmeeting.agu.org/2014/scientific-program/swirls/>.

Each day of the meeting is packed with hundreds of oral and thousands of poster presentations on the wide range of Section and Focus Groups that make up the AGU, as well as field trips, committee meetings, browsing through the extensive Exhibit Hall, workshops, and much more. Here are a few highlights concerning K – 12 Earth Science Education.

Exploration Station. "Exploration Station" is a public program featuring about 30 exhibits offering family-friendly, hands-on activities presented by scientists, engineers, and educators. Parents, children, and others viewed short videos in the Discovery Dome planetarium, created science arts & crafts take-home pieces, played with stomp rockets, and learned more about space exploration, polar expeditions, soils, and many other topics. Boy Scouts, Girl Scouts, Cub Scouts, and Brownies earned points toward merit badges. (I covered for a NASA astronomer unable to attend and became an expert on Earth's magnetosphere, or at least enough to sign Scout badge forms.)

GIFT (Geophysical Information For Teachers) Workshops. Another annual highlight for classroom and informal educators at AGU Fall Meetings are the two-day GIFT Workshops that provide opportunities to learn about "Hot Topics in Science." Organized by NESTA (National Earth Science Teachers Association) with the AGU Education Program, this year's free programs were hosted by scientists and educational specialists from NASA, UNAVCO, the Howard Hughes Medical Institute, Cooperative Institute for Climate and Satellites, Institute for Global Environmental Strategies, and the Earth2Class (E2C) Workshops for Teachers at the Lamont-Doherty Earth Observatory of Columbia University. The program opened with an overview talk about the Next Generation Science Standards from Dr. Michael Wysession of Washington University, St. Louis. He was a leader in developing the NGSS, especially the Earth Science components. Links to past GIFT workshops are available at <http://education.agu.org/education-activities-at-agu-meetings/gift/>.

More than fifty teachers from schools, museums, and other venues participated this year, including teachers from Australia, Canada, Germany, and Portugal. The last two and your correspondent may also take part in the similar program offered in conjunction with the European Geophysical Union meeting in Vienna next April. More about the EGU GIFT programs is available at <http://www.egu.eu/education/gift/workshops/>.

AGU Education Section sessions. Among the hundreds of sessions held during the Monday-to-Friday programs were dozens organized by the AGU Education Section <https://agu.confex.com/agu/fm14/meetingapp.cgi#Program/1007>. Michael Wysession and your correspondent organized poster and oral sessions entitled "The Next Generation Science Standards: A Potential Revolution for Geoscience Education." You can read the abstracts and, in some cases, download e-posters at <https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/5059>. Abstracts and some slideshows from the oral presentations are available at <https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/3134>. These talks included examples of programs designed to support implementation of the NGSS from the National Earth Science Teachers Association, National Association of Geoscience Teachers, American Museum of Natural History, Science Education Resource Center at Carleton College, and E2C. Don Duggan-Haas of the Paleontological Research Insti-

(continued on page 10)

AGU Meeting

(continued from page 9)

tute shared examples of virtual field work as a vehicle for teacher three-dimensional NGSS science.

Another Education Section conference session with a K – 12 focus was the "Bright STARs: Bright Students Training as Research Scientists" poster session <https://agu.confex.com/agu/fm14/meetingapp.cgi#Session/1502>. Many were from students participating in programs conducted through the California Academy of Sciences, Stanford University, UC Santa Cruz, and other local institutions. But perhaps the most eye-catching poster was one about capabilities of quadcopters (small unmanned aircraft with 4 wings and rotors) to study glaciers, presented by sixth-grader Matthias Urs Herzfeld Mayer of Boulder, CO, co-presented by Dr. Ute Herzfeld, a University of Colorado glaciologist. (When she tried to interject something as Urs was explaining his display to me, he told her sternly, "Mommy, I'm the poster presenter!")

<u>*AGU Featured Sessions*</u>. Dr. Sally Jewell, Secretary of the Interior, delivered the Union Agency Lecture (Keynote Address). Like many of the AGU sessions, it was recorded and available online. You can view it at <https://virtualoptions.agu.org/media/Kenote+AddressA+Secretary+of+the+Interior+Sally+Jewell/1_ahz0n5jj>. Sidebars on that page can link you to other important talks on such topics as "The Business of Science," "Policy Perspectives," "Climate Preparedness," and "Under Water: Flood Risks."

AGU is increasingly using "Virtual Options" to provide access to meeting sessions because many people cannot attend them at that time and place. The complete menu of recorded sessions is available at <https://virtualoptions.agu.org/category/Fall+Meeting%3E2014+Fall+Meeting/25417281>.

What Else Can AGU provide for you? AGU recently inaugurated its online newsletter, <EOS.org (https://eos.org/)>. This enhanced version of the long-time weekly print publication that AGU members receive in the mail allows for livelier articles and social interactions, appealing to many newer members. The AGU home page (http://sites.agu.org/) is also filled with timely news articles and information about important trends and events in science. Other opportunities for educators, students, and the general public are described at <http://education.agu.org/teachers/>. AGU also cooperates with NESTA (National Earth Science Teachers Association) to present featured lectures on "hot research topics" at the Earth and Space Science Day during the national NSTA conferences.

Take-away message: If you're doing interesting things in science ed, consider joining and presenting at AGU.

World Bank: an STS data resource

If your students need data for research related to science, technology, and society at the national or international level, they are likely to find it online at <http://data.worldbank.org>. This is the URL for a large data base of STS-related information compiled by the World Bank, which can be browsed by country, year, topic, and individual indicator. The topics, each of which is comprised of a list of individual indicators, are agricultural and rural development, aid effectiveness, climate change, economy and growth, education, energy and mining, environment, external debt, financial sector, gender, health, infrastructure, poverty, private sector, public sector, science and technology, social development, social protection and labor, trade, and urban development.

SCIENCE & SOCIETY EDUCATION MEETINGS

21-23 April 2015, World Nuclear Fuel Cycle 2015 Conference, Prague. For Information contact Isis Leslie at <isis.leslie@world-nuclear.org>.

"Nation's Attic"

(continued from page 8)

les Airport at the Udvar-Hazy Center (http://airandspace.si.edu/visit/udvar-hazy-center/). Huge hangars provide visitors with close-up views of the space shuttle *Discover*, a Concorde supersonic jet, and many military and civilian aircraft going back to the dawn of flying. (I provided a review of the Udvar-Hazy Center shortly after it opened in the Winter 2004 issue of this *Newsletter*.)

All of the Smithsonian Institution museums are free to visitors (although some, like Udvar-Hazy Center, charge for parking.) Support comes from your tax dollars, as well as contributions from foundations and the general public, so you've already paid for it! So get your money's worth by exploring and using the Earth Science and other educational resources to be found in "Our Nation's Attic."

STEM Education Described

(continued from page 1)

In other cases STEM courses were the basis for challenge-based learning, as was the case with "struggling learners" in Lebanon, TN, for whom the STEM challenges made science and math their favorite subjects rather than the most hated. Challenges were also an important part of the Cherry Hill program; a program developed at George Mason University (VA), which is based on Problem-Based Learning; the Research Investigations Practices program, whose end product is a research investigation; and the Engineering is Elementary program, whose 20 units for grades K-8 culminate in completing an engineering challenge. The *STEM Integration in K-12 Education* report, in fact, acknowledges that science inquiry, engineering design, and project-based learning "share features that can provide students with opportunities to apply STEM concepts and engage in STEM practices in interesting and relevant contexts."

Yet in other cases STEM prompted program developers to see STEM as the basis for rethinking the teaching of existing courses. This was certainly true about Mary Hanson in teaching her chemistry course at Humboldt High School in Saint Paul (MN). "Gone are the days," she writes, "of presenting students with notes, answering questions from a chapter in the assigned text, taking a test, and moving on regardless of student performance. Gone also are the days of expecting students to arrive to class mentally, emotionally, socially, intellectually, and academically prepared to absorb a teacher's content delivery. Additionally, gone are the days of the teacher-centered focus of student achievement." (p. 163)

Hanson also writes that "Education today is an enormous challenge." (p. 164) She then goes on to describe how she has met that challenge with a STEM approach, but as I read her chapter, I could not lament the passage of the past approaches to teaching but rather rejoiced that we now recognize the value of new methods to engage students to enhance their learning, some of them enabled by new technologies, and regretted that we did not use them or have them to use in days gone by.

Another example in which STEM provided a fresh approach to teaching existing courses is the *Mission Biotech* project in Florida, a biotechnology curriculum based on investigations in computer-simulated labs. This curriculum saves money, time, and exposure to toxic reagents, yet immerses students in cutting-edge science.

But the most prevalent STEM integrator in the Yager and Brunkhorst book is the use of engineering to make science and mathematics more relevant. This is the basis for a program developed for middle school students in Columbia Heights, Minnesota. In describing the STEM approach used to reformulate her chemistry course, Hanson writes that "Engineering is the crux of STEM!" (p. 167) The Mathematics and Science Teacher Partnership defines "STEM education as 'an effort by educators to have students participate in engineering design as a means to develop technologies that require meaningful learning and an application of mathematics and/or science.'" in providing professional development for teachers in Minneapolis-St. Paul (MN) (p. 219).

STEM Integration in K-12 Education reports, in fact, that that the integration of engineering with other STEM disciplines is most frequently done in terms of design. Two programs which do this and are both among those reviewed by the Committee on Integrated STEM Education and those described in the Yager and Brunkhorst book are Engineering by Design and Engineering is Elementary.

> ***". . . the integration of engineering with other STEM disciplines is most frequently done in terms of design."***

Based on Wiggins and McTighe's *Understanding by Design*, Engineering by Design offers to its Network of member schools a series of courses developed by the Center for Teaching and Learning of the International Technology and Engineering Educators Association (ITEEA) for grades K-12. They integrate technology and engineering in an integrative STEM education context, defined as "the application of technological/engineering design-based pedagogical approaches to *intentionally* teach content and practices of science and mathematics education concurrently with the content and practices of technology/engineering education." (p. 354) The four overarching goals of Engineering by Design are 1) understanding the natural and designed world; 2) using scientific and engineering processes to make decisions; 3) public engagement in matters of technological and scientific concern; and 4) productivity in the global marketplace related to the natural and designed world. At its inception in 2007, Engineering by Design developed its courses on the basis of ITEEA's *Standards for Technological Literacy* (covered in our Fall 2001 issue), the National Research Council's *National Science Education Standards* (Winter 1995 and 1996 issues), the American

(continued on page 12)

STEM Education Described

(continued from page 11)

Association for the Advancement of Science's *Benchmarks for Science Literacy* (Winter 1994 issue), and the National Council of Teachers of Mathematics's *Principles & Standards for School Mathematics*. More recently Engineering by Design has moved to accommodate the *Next Generation Science Standards* (Winter/Spring 2013 issue) and *Common Core State Standards*. Engineering by Design courses, which run from one to six weeks at the primary level to yearlong at the secondary level, use a 6E cycle – Engage, Explore, Explain, eNGINEER, Enrich, and Evaluate – and can be assessed by both design challenge solutions and standard means.

Engineering is Elementary is the creation of a team at the Museum of Science, Boston, headed by Christina Cunningham, which began their work in 2003. By 2011, 20 units for grades K-8 were completed, each intended to occupy 6-12 class periods. Six of the units are on earth science topics, five on life science, and nine on physical science. Each unit opens with a story of a young student facing an engineering challenge at a different place in the world (an opportunity to infuse some geography as well). The student also has an engineer mentor, who leads students in the classroom through experiments to learn the scientific principles to complete the challenge. The Engineering is Elementary units were developed in accordance with the *National Science Education Standards* of 1996 and are also compatible with the *Next Generation Science Standards*, setting forth challenges that are related to real-world problems that allow for multiple acceptable solutions. The challenges point up the career aspects of engineering and are completed by students working in groups.

There is one other program reviewed by Committee on Integrated STEM Education that is not included in the Yager and Brunkhorst book: the *Active Physics* curriculum I have been teaching at The Calhoun School in New York City the past 20 years and have described in the Spring 1994, Fall 1997, and Fall 1998 issues of this *Newsletter*. The last of these articles promotes the format of *Active Physics* as ideal for teaching STS issues. In this format, each chapter begins by presenting students a challenge they will be asked to meet at the end of the chapter – *e.g.*, present a two-to-four minute sound and light show at the end of the chapter on sound and light – then leading students through a series of experiments preceded by asking them what they already think about the topic they are to investigate. The end-of-chapter challenge involves a design typical of engineering, and using it as a basis for assessment eliminates what I call the "right answer syndrome."

I recall that I was invited to submit a chapter for this book, and I contemplated writing a chapter based on my experience teaching *Active Physics*. However, I had no "Evidence of Success" to present, because I had not evaluated my students with a standardized test. The publisher of *Active Physics*, however, *had* conducted a formal assessment of the program's effect in the state of Arkansas, and one of the publisher's vice presidents was set to write a chapter on *Active Physics* which would include the results of this assessment. Unfortunately, chapters by publishers or their employees were not to be included.

Kiva President Speaks

"Mark Twain said that the two most important days of your life are the day you are born and the day you find out why" was the opening statement of Primal Shah in his presentation to the Calhoun Upper School on 22 September 2014. The President and Cofounder of Kiva then went on to describe that second day in his life. Although he had been born and grew up in Minnesota, he returned with his family to India, the country of their ancestry, when he was five years old. Then was struck by the poverty he saw. Children were tapping on taxicab windows to beg for change, and a woman even thanked God while picking up a coin he had dropped in the mud which his mother considered too dirty to pick up.

Shah went on to relate how he later learned about microfinance in college and joined PayPal as a startup. After Ebay bought PayPal, he left in his late 20s to start Kiva, which allows people to lend increments of $25 to small business owners in developing countries. On 15 April 2005 they made their first seven loans in Uganda, and by 2008 the total money they had loaned topped $50 million. The statistics on their website, <www.kiva.org>, showed that as of the day of Shah's presentation a total of $613,262,900 had been lent in 771,048 loans to 1,420,668 borrowers, with more than 98% of the loans repaid. Those who lend money to these entrepreneurs through Kiva are encouraged to relend their money after the repayment of their initial loans.

Shah showed two videos from among the many available from the Kiva website, one of a young worker in a coffee shop who sought to open his own, then opened a second after the first succeeded, the other of a young woman who sought a loan to buy more groceries to sell in her store. He added that Kiva is now directing some of its efforts to fund developments such as solar lighting that would improve sustainability. He closed with his mantra that instead of asking the meaning of life, one should ask how to make one's life meaningful.

STEM Education Assessed

(continued from page 1)

and conditions most likely to lead to positive outcomes of integrated STEM . . . education at the K-12 level in the United States." The Committee, chaired by Margaret Honey, CEO of the New York Hall of Science, "identified and characterized existing approaches to existing STEM education" and reviewed the evidence for their impact. (p. vii)

As has been repeatedly stressed on the pages of this *Newsletter*, education in STEM subjects is held to be "vital not only to sustaining the innovation capacity of the United States but also as a foundation for successful employment." (p. vii) Yet the Committee notes that historically K-12 STEM education in the U.S. has focused on separate subjects, especially science and math, but recognizes that the *Next Generation Science Standards* (*NGSS*) "explicitly connect science concepts and practices to those of engineering." (p. viii) and that both Common Core State Standards for Mathematics (CCSSM) and the *NGSS* call for "more and deeper connections among the STEM subjects." (p. 1)

With little research on the best way to integrate STEM subjects or what would cause integrated STEM education to enhance student achievement, the Committee was charged with

- "identifying and characterizing existing approaches to integrated STEM education. . . ."
- "reviewing the evidence for the impact of integrated approaches on various student outcomes."
- "determining a set of priority research questions to advance understanding of integrated STEM education" (p. 2)

They based their report on the papers they commissioned and on published literature identified from Internet searches based on whether engineering was included and whether research on the impact of integrated curriculum was presented. Of 158 identified programs, 14 formal and 14 informal programs were reviewed in greater detail.

To develop "A Descriptive Framework for Integrated STEM Education" (the title of their second chapter), the Committee focused on four features: goals, outcomes, nature and scope, and implementation. Their goals for students are "STEM literacy and 21st century competencies," "a STEM-capable workforce," and "interest and engagement in STEM." Their goals for teachers are increased STEM content knowledge and increased pedagogical content knowledge.

Their outcomes for students overlapped the aforementioned goals but also specifically included learning and achievement, STEM course taking, educational persistence and graduation rates, STEM-related employment, and the ability to transfer understanding across STEM disciplines. Their outcomes for teachers likewise overlapped the aforementioned goals but also included changes in practice.

They considered that nature and scope of STEM integration to be determined by three elements: "which subjects are connected," "which disciplines are dominant," and the "duration, size, and complexity" of the integration. They noted that connections may be of concepts or practices and that not all STEM areas need be given equal emphasis.

Under implementation they considered instructional design, types of educator supports, and adjustments to the learning environment. Although traditional direct instruction is used in some approaches to integrated STEM education, they note that science inquiry, engineering design, and project-based learning "share features that can provide students with opportunities to apply STEM concepts and engage in STEM practices in interesting and relevant contexts." (p. 43)

The third chapter of the report reviews the limited existing research on the effect of integrated STEM education experiences on achievement, learning, problem-solving ability, and ability to make connections between domains. The Committee found that the research was limited in quality as well as quantity, yet from the "well-designed studies" they could conclude that integrated STEM education can lead to improved conceptual learning, depending on the nature of the integration. They note five types of integration, as distinguished by M. M. Hurley, who "conducted a meta-analysis of 31 studies that compared integrated mathematics and science instruction to a nonintegrated control group and reported mathematics and/or science achievement measures" (p. 53): sequenced, parallel, partial, enhanced (the predominant discipline enhanced by the others), and total. The most positive effect came from sequenced integration, but parallel integration produced a negative effect. The positive effect on science learning was greater than that for math learning. But other examples showed that integrated STEM education programs deliberately enhanced with mathematics increased math learning.

The Committee found that when engineering education is integrated with that in science and mathematics, it is most frequently done in the context of design. But unless

(continued on page 14)

STEM Education Assessed

(continued from page 13)

science concepts are stressed as part of a design activity or "design failure provokes conceptual change" (p. 57), students are found to tend to focus on the aesthetic and ergonomic aspects of their design rather than improve their science learning.

The Committee also observed that most tests of integrated STEM education still consider the disciplines individually and note that development of tests which address the integrated disciplines will take years but that without them we can't be sure that integrated STEM curricula treat all of the STEM "partners" in a balanced way.

The "Implications of the Research for Designing Integrated STEM Experiences" are addressed in the fourth chapter of the report. The Committee wrote that "integration may be effective because basic qualities of cognition favor connected concepts over unconnected concepts so they are better organized for future retrieval and meaning making," but that learning the connectedness among STEM concepts "can also impede learning because it can place excessive demands on resource-limited cognitive processes, such as attention and working memory." (p. 4) Learning transfer – transferring what is learned in one context to another – is a challenging learning goal for a single discipline, but it is expected to be even more challenging from one STEM discipline to another.

Three key "implications for the design of integrated STEM education initiatives" are as follows:

1. *"Integration should be made explicit."* "Students are less likely to make connections on their own without explicit integration." (p. 90) This is all the more true when engineering design is integrated with science and math. Moreover, in many examples of integrated STEM education, technology is limited to its use as a measuring tool rather than being the topic of learning. Teachers should not assume that their students will recognize connections among STEM disciplines but rather be very explicit about them.

2. *"Students' knowledge in individual disciplines must be supported."* Integrated STEM curricula should support student learning in both individual STEM subjects and the connections among them. Connecting ideas among disciplines requires understanding the ideas of those disciplines, then "support to elicit the relevant scientific or mathematical ideas in an engineering or technological design context." (p. 5) Although integrated STEM education can promote expertise through organizing knowledge, research shows that this is most effective for people with knowledge of the fields being integrated.

3. *"More integration is not necessarily better."* This is almost a corollary of (2).

Because integrated STEM education typically asks students to work with each other and engage in collaborative problem solving, social and cultural factors have an effect on its effectiveness. Accepting student ideas fosters a classroom culture that is more like an actual science laboratory than a classroom focused on finding the "right answer." Activities to trigger student interest in this way include "real-world connections and connections to prior experiences," "puzzles and group work," "open learning environments," and "opportunities for sustained inquiry." (p. 95)

In framing the "Context for Implementing Integrated STEM" in their sixth chapter, the Committee writes that the three elements of the education system that can affect implementing integrated STEM education are 1) standards, 2) assessment, and 3) teacher education and professional development.

1. *Standards.* The 2010 *Common Core State Standards for Mathematics*, the 2013 *Next Generation Science Standards*, and the 2000 *Standards for Technological Literacy* "can support efforts to make connections across the disciplines" (p. 107) because of their emphasis on applying their respective STEM discipline to each of the others.

2. *Assessment.* Historically, assessments have "focused on concepts in a single discipline." (p. 110) But with the advent of three dimensions of learning specified in the *Next Generation Science Standards*, STEM assignments will need to address not only core ideas but also cross-cutting concepts and scientific practices. "The designs of integrated STEM assessments should be firmly grounded in research from the learning and measurement sciences, which has led to a shift from emphasis on questions about discrete, factual content to questions about interactions among concepts and to tasks that require integration of reasoning and inquiry in the context of significant applied problems. Thus integrated STEM assessments should feature tasks that provide real-world contexts for using and integrating discipline specific knowledge while engaging in engineering and scientific practices." (p. 112)

"At present, the *Technology and Engineering Literacy Framework for the 2014 National Assessment of Educational Progress* . . . is the primary example of assessment design that integrates technology and engineering . . .

(continued on page 15)

STEM Education Assessed

(continued from page 14)

[and] could be adapted to integrated mathematics and science." (p. 112) Other examples of assessment of integrated STEM learning are the exam of the revised AP Biology course, the 2009 National Assessment of Educational Progress (NAEP) Interactive Computer and Hands-On Tasks Science Assessment, and the high school course *Engineering the Future* from the Boston Museum of Science.

3. <u>*Educator Expertise*</u>. This is considered by some to be *the* key factor in determining the success of implementing integrated STEM education, because it combines subject matter and pedagogical knowledge. Preparing teachers of integrated STEM education is more challenging than preparing teachers of a single academic subject. Teaching integrated STEM education requires acquiring content knowledge in more than one STEM field and pedagogical knowledge for teaching these fields in an integrated way, and "if teachers have not themselves experienced integration of science, mathematics, technology and/or engineering, they are not likely to teach integrated curricula for these subjects in their classrooms." (p. 124)

This type of background is being provided physics, math, chemistry, and engineering majors at the University of Texas-Austin, through the UTeach *Engineering* program. Other institutions offering UTeach programs in the natural sciences offer similar programs that also incorporate engineering. The report also lists several programs that provide in-service teachers background for teaching integrated STEM via summer institutes.

The final chapter of the report begins with a listing of "converging forces" that "have elevated the importance of understanding the potential value – as well as the limitations and challenges – of integrated STEM education" (p. 135):

1) The "small but growing presence of engineering" in classes both in and out of school. Because it draws from science, math, and technology, engineering is seen as a "natural focus" for integrated STEM.

2) The call of the *Next Generation Science Standards* for learning science concepts in the context of engineering design.

3) The desire to prepare students to enter the workplace with emphasis on problem solving.

4) Dissatisfaction with traditional math and science education.

This is followed by findings and recommendations, grouped in four areas:

1) research on integrated STEM education.

2) outcomes of integrated STEM education.

3) nature of integrated STEM education.

4) design and implementation of integrated STEM education.

The first two recommendations relate to research:

1. "In future studies of integrated STEM education, researchers need to document the curriculum, program, or other intervention in greater detail, with particular attention to the nature of the integration and how it was supported. When reporting on outcomes, researchers should be explicit about the nature of the integration, the types of scaffolds and instructional designs used, and the type of evidence collected to demonstrate whether the goals of the intervention were achieved. Specific learning mechanisms should be articulated and supporting evidence provided for them."

2. "Researchers, program designers, and practitioners focused on integrated STEM education, and the professional organizations that represent them, need to develop a common language to describe their work."

The next two relate to outcomes:

3. "Study outcomes should be identified from the outset based on clearly articulated hypotheses about the mechanisms by which integrated STEM education supports learning, thinking, interest, identity, and persistence. Measures should be selected or developed based on these outcomes."

4. "Research on integrated STEM education that is focused on interest and identity should include more longitudinal studies, use multiple methods, including design experiments, and address diversity and equity."

The last six relate to design and implementation:

5. "Designers of integrated STEM education initiatives need to be explicit about the goals they aim to achieve and design the integrated STEM experience purposefully to achieve these goals. They also need to better articulate their hypotheses about why and how a particular integrated STEM experience will lead to particular outcomes and how those outcomes should be measured."

(continued on page 16)

STEM Education Assessed

(continued from page 15)

6. "Designers of integrated STEM education initiatives need to build in opportunities that make STEM connections explicit to students and educators (*e.g.,* through appropriate scaffolding and sufficient opportunities to engage in activities that address connected ideas)."

7. "Designers of integrated STEM experiences need to attend to the learning goals and learning progressions in the individual STEM subjects so as not to inadvertently undermine student learning in those subjects."

8. "Programs that prepare people to deliver integrated STEM instruction need to provide experiences that help these educators identify and make explicit to their students connections among the disciplines. These educators will also need opportunities and training to work collaboratively with their colleagues, and in some cases administrators or curriculum coordinators will need to play a role in creating these opportunities. Finally, some forms of professional development may need to be designed as partnerships among educators, STEM professionals, and researchers."

9. "Organizations with expertise in assessment research and development should create assessments appropriate to measuring the various learning and affective outcomes of integrated STEM education. This work should involve not only the modification of existing tools and techniques but also exploration of novel approaches. Federal agencies with a major role in supporting STEM education in the United States, such as the Department of Education and the National Science Foundation, should consider supporting these efforts."

10. "To allow for continuous and meaningful improvement, designers of integrated STEM education initiatives, those charged with implementing such efforts, and organizations that fund the interventions should explicitly ground their efforts in an iterative model of educational improvement."

Curiously, the eleven-page Summary at the beginning of the report regroups these recommendations and the categories in which they presented. Rather than group them by aspects of integrated STEM education, the Summary groups them according to the categories of people involved with integrated STEM education: Multiple Stakeholders (recommendations #2 and #10), Designers of Integrated STEM Experiences (recommendations #5 through #8), Assessment Developers (recommendation #9), and Researchers (recommendations #1, #3, and #4).

The report is available online at <http://www.nap.edu/catalog.php?record_id=18612>. It is edited by the Chairperson of the Committee, Margaret Honey, and two members of the Committee's Staff, Greg Pearson and Heidi Schweingruber.

Clearinghouse Update

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

Update on US Energy Spreadsheet

Pat Keefe of Clatsop Community College (OR) reported on his spreadsheet by which students could research past US energy use and investigate various possible future US uses of energy at the summer 2002 meeting of the American Association of Physics Teachers in Boise, ID, and our Fall 2002 issue contained both coverage and editorial about using this spreadsheet with students. In the December 2014 issue of *The Physics Teacher* Keefe describes his spreadsheet and its use with students. Those wanting to use it with their students will need the correct URL, which is <https://www.clatsopcc.edu/academics/academic-dapartments/sciences-department/physics>. This page contains a link to the US Energy Spreadsheet at the bottom of the page.

More on Israeli Nuclear Capability

Our Fall 2013 issue featured an article on Michael Karpin's book, *The Bomb in the Basement: How Israel Went Nuclear and What That Means for the World*. The *Bulletin of Atomic Scientists* published online on 28 October 2014 (prior to publication in its November / December 2014 issue) an article by Hans M. Kristensen and Robert S. Norris titled "Israeli nuclear weapons, 2014." Although they do not cite Karpin's book, they do cite "Seymour Hersh's 1991 best-seller, *The Samson Option: Israel's Nuclear Arsenal and American Foreign Policy*" and recount much of the same historical background presented by Karpin, then go on estimate ranges of various types of nuclear capability available to Israel.

New Approaches to Producing Tc-99m

Resource #5 in our Winter/Spring 2014 issue called attention to the need for new sources to produce the technetium-99m used in nuclear imaging procedures. The online *World Nuclear News* for 14 November 2014 reported two grants from the US Department of Energy's National Nuclear Security Administration to produce Tc-

(continued on page 21)

REVIEWS OF SCIENCE AND SOCIETY EDUCATIONAL RESOURCES

William Souder, *On a Farther Shore: The Life and Legacy of Rachel Carson* (Crown, New York, 2012).

If you were to ask your students to link the name of Rachel Carson to one word or phrase, you would doubtless hear such answers as "DDT," "book about pesticides," "birds," and "was really well known."

All correct, of course. However, they also indicate the perception that Carson and her work are relics of history, and that the pesticide issue is "solved," since we no longer use DDT in the United States. Neither perception is accurate. Pesticides — herbicides, insecticides, "Roundup ready" crops – all evoke controversies in our century. In its fundamental thesis, Carson's *Silent Spring* is as relevant today as it was when it was published in 1963.

William Souder has given us a comprehensive study of Rachel Carson's life and work that places her in the vanguard of the environmental movement and illustrates how relevant they are to our concerns today. In Souder's wide-ranging and astute analysis, Carson laid the groundwork for subsequent environmental goals, policies, and research. When seen in the context of mid-Twentieth Century history, *Silent Spring* is an informative case study in how scientific information that revealed the problems industrial agriculture was causing was received by officials in both the public and private sectors. Cold War politics complicated the ways in which both industry and government reacted to "Miss Carson's book," as President Kennedy called it.

Souder also identifies and reveals the basic philosophical divide regarding humans' place in the universe, one that cuts across economic and political viewpoints. It is the central issue for us in the Twenty-first Century as we observe even greater insults to the natural world, with even greater consequences than those Carson described in *Silent Spring*. As we work with young people who are concerned with global environmental issues, we should place their concerns in the larger context of the struggle. Carson herself noted that context when she confronted Robert White-Stevens on a CBS Reports news special hosted by Eric Sevareid. Sevareid commented that the argument was not over pesticides so much as "a duel between competing views of nature and our place in it."

In *On A Farther Shore*, Souder reveals and analyzes Rachel Carson's life and work and identifies bases for the enduring aspects of her legacy to the Environmental Movement and her contributions to the view that humans must learn to work with rather than trying to oppose Nature.

One was her determination to have her facts exactly right in everything she wrote. In the case of *Silent Spring* that accuracy was essential to the ultimate success of the book in calling attention to the real devastation DDT and other pesticides were having on wildlife, especially birds. Her habit was to call on friends to introduce her to experts, for example, Henry van Jones and William Beebe. She did not rely only on what she learned from the experts, however; she used their advice to help her make her own observations, as with learning to helmet dive, despite her modest swimming ability, so she could describe the denizens of the ocean floor from her own observations. (pp. 80,ff)

Souder describes Silent Spring as "a sober, methodical book, put together like a high wall, each phase a brick helping support all the rest," the central message of which was "Because all life on earth shares a common biochemical evolutionary history, the idea that a synthetic poison can target a single class of organisms and do no other harm is folly. The claim that a chemical was a 'pesticide' denied the shared biology of all living things." (p. 350) Souder supports this view with a quotation from the book which ends, "Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called "insecticides" but "biocides." (p. 350)

As noted above, this is the central issue for us in the Twenty-first Century, which we must address if we are to prevent further degradation of the essential services humans derive from the environment. As we work with young people who are concerned with global environmental issues, we should help them envision their actions in the context of humanity's place in the natural world. When Carson confronted Robert White-Stevens on the CBS Reports news special hosted by Eric Sevareid, she described the inter-related nature of the universe. When Sevareid commented that the argument was not over pesticides so much as "a duel between competing views of nature and our place in it," White-Stevens jumped in with the observation that with the development of the modern

(continued on page 18)

REVIEWS

(continued from page 18)

industrial world, humans had "undone the so-called balance of nature, and that [human] survival depended on control of natural processes that worked against his interests."

Souder states that, "Carson, almost but not quite smiling at this, sat up a little straighter and said:

> Now to these people apparently the balance of nature was something that was repealed as soon as man came on the scene. Well, you might as well assume you could repeal the law of gravity. The balance of nature is built on a series of relationships between living things, and between living things and their environments. You can't just step in with some brute force and change one thing without changing many others. This doesn't mean we must never interfere, never tilt the balance of nature in our favor. But when we make the attempt we must know what we're doing. We must know the consequences." (p. 378)

Clearly, those who hold views close to White-Stevens's have continued to determine much of what humans have been doing in the half century since Rachel Carson uttered her rebuttal. Those of us who understand Carson's view must use Souder's book and other writers who attempt to call attention to the great divide in human thinking about the environment to win more adherents to our side.

Carson was far ahead of her time in understanding the havoc humans were wreaking on the natural environment. In the late 1940s when she was writing *The Sea Around Us*, Carson observed and described what happens when humans arrived on an island previously unknown to them, for example when the Portuguese introduced goats onto Saltelena in 1513. She described such influence on indigenous ecosystems on oceanic islands the 'blackest records' of human history. Animals brought by humans "could transform abundance into barrenness, as effectively as they could with saws, axes and guns." Souder adds that she might have added the devastating effects of diseases on indigenous human populations. (p. 151)

Souder points out that just as Carson's awareness of how exotic species damaged ecosystems was prescient, so also was her reporting on the changes she observed in the Earth's climate. There was, she wrote in 1951, a groundswell of evidence that Earth was getting warmer by pointing to rising sea levels, melting glaciers and shrinking areas of sea ice in the Arctic. While noting that these changes were part of ongoing cycles, "rising levels of carbon dioxide in the atmosphere caused by human activity" were amplifying the natural greenhouse effect, something that had been noted for half a century but was still doubted. Carson noted positive effects such as longer growing seasons, but also the effects on U.S. coast line if all sea ice melted and oceans rose to "break against the foot hills of the Appalachians." (p. 152)

She was alarmed by the reality she perceived that humans were — and still are — actually reshaping the natural world rather than being shaped by it. (pp. 272,ff) This realization unsettled her, causing a case of "writer's block." After trying to shut out the disturbing reality of human power over the environment so evident in atomic power, she came to the conclusion that it was time for someone to write about that reality and that it might be the focus of, as she put it in a letter to her friend Dorothy Friedman, "the book I am to write" — the book that became *Silent Spring*. She would do so from the perspective of "humility rather than arrogance." That statement brought to the mind of this reviewer Barbara McClintock's *The Feeling for the Organism*, as well as the scientific philosophy of an early woman of science, Maria Sibylla Merion in 18th Century Amsterdam. Carson told Friedman that she had always believed the environment molded life, not the other way around. Yet, such inventions as atomic power and DDT showed that human arrogance was resulting in human dominance of the environment with many negative effects. (pp. 278-279)

In many situations, especially after the publication of *Silent Spring*, Carson returned to the theme of humans' role in the natural world. For example, in a speech at Scripps College in Claremont, CA, she emphasized humans' changed relationship with nature since the advent of nuclear power, which began to give humans the control over nature they had arrogantly felt for generations. When she showed people the myriad life in a tide pool, she said, she was mystified when they wanted to know how those organisms were useful to humans. She tried to tell people it "was impossible to 'assign a value' to creatures so exquisite that their mere existence should be cause for contentment with the peerless universe." She continued, telling the graduates about the ways nuclear explosions were polluting "our most precious resource" along with other effluent, "domestic, chemical and radioactive, so that our planet is becoming a 'thirsty world.'" (p. 337)

Souder's book is extremely wide ranging and complete. Here are some other topics on which he offers useful historic and contemporary perspectives. Teachers of both social studies and science will find these insights and information useful.

(continued on page 19)

REVIEWS

(continued from page 18)

- Importance of print media in the 1960s, especially *The New Yorker* and books (p.152)
- Role models for girls (p. 244)
- Similarity of US government actions regarding nuclear tests and the dangers of radiation to those regarding DDT and other pesticides (pp. 237,ff)
- Her female perspective on the human impact on the environment (p. 279)
- Shift in focus to the threat to human health from synthetic pesticides which she had always wanted to emphasize (p. 282)
- Knowledge of insect diseases instead of DDT as way to control them (pp. 283, 288, and 353)
- Juvenile hormones as insecticides — E. O. Wilson (p. 290)
- Chemical pesticides as "stone age science" in which humans fought against Nature instead of working with it. (p. 298); see above on Mc Clintock and Merion—and female view.
- Engineering mentality (p. 299)
- Economic factors war — every critique of a product threatens someone's bottom line (p. 315)
- Patriotism and the Cold War situation (p. 306)

Effects of *Silent Spring*:

- Environmentalism as left-wing (p 336)
- Cold War context (pp. 346-347)
- Water as a resource (p. 337)
- Speed of technological change *vs.* the ability of life to adapt (p. 338)
- Political effect on Kennedy Administration (pp. 326, ff and 340, ff)
- Public relations campaign against *Silent Spring* (p. 342)
- Eric Sevareid's program effects; Carson's view of human role in nature (p. 378)
- Long term effects (p. 377)

\- Sara Anderson

Amanda Gefter, *Trespassing on Einstein's Lawn* (Bantam, 2014). 418 pp. $20.31. ISBN # 978-0-345-53143-8.

To begin this review with the end, consider the following quotation from page 394: "Trust me, it gets weirder." Containing "cutting-edge physics packaged in a personal memoir, which spans the last 17 years of (the author's) life," this book is now my favorite on modern physics.

Over dinner at a Chinese restaurant, Gefter's father asked how she would define the concept of nothing. This led to her asking her father if he was "asking me how the universe began?" She was just fifteen years old, and had little interest in physics. The question however, began what she describes as a cosmic adventure with her father. She writes that she had never cared for science, because she had no idea of what science is all about. She describes her science experience in school; "No one ever tells you (what science is about). You sit down in a classroom and a teacher starts hurling facts your way and you're supposed to memorize them and regurgitate them and you have no idea why. They present the whole thing as a done deal, a list of facts that together constitute a kind of construction manual for nature." Since I have worked very hard at making sure that students in my classes understood the nature of science, that observation about science education made me smile, and made me sad. As a result of being intrigued by her father's question, Gefter began a seventeen year exploration of the nature of science, and so the nature of nature. And her exploration continues.

Trespassing on Einstein's Lawn is a description of a father and his daughter's hunt for ultimate reality, which is in large part what quantum theory is all about. The book examines the author's exploration of modern physics, including the role of an observer (if the universe is a quantum system, who is the observer who causes the collapse of its wave function?); the relationship between the motion of an object and its position, as well as its energy and time; the absence of detection of magnetic monopoles; the theory of relativity, invariance, multiple universes *vs.* multiple histories, and much more.

Physicist John Wheeler plays a very important role in Gefter's exploration. This reviewer was extremely interested in information included in the book about John Wheeler's journals. Born in 1911, by 1978, Wheeler had recorded notes in forty journals. The author had spent time with Wheeler, and as a result, in 2008 she was asked to write Wheeler's obituary for *New Scientist* magazine. Wheeler's journals are on file at the American Philosophical Society Library Hall, located in Philadelphia. Gefter's description of researching the journals is enjoyable. Reading that, you want to do the same. The page before the table of contents of the book has a quote from Wheeler about "the world out there, independent of us."

Gefter and her father had conversations with a number of well-known physicists. On page 295 there is a picture of the senior Gefter, leaning on a parking space sign that

(continued on page 20)

REVIEWS

(continued from page 19)

reads “Reserved for Nobel Laureate at All Times.” The book includes a number of pictures, all of them interesting.

Later in the book, Gefter makes an insightful observation; “Fundamental physics proceeds by paradox. It always has.” She goes on to describe paradoxes overcome by a number of renowned physicists, including Einstein, Polchinski, Susskind, and Rovelli. In concluding this part of her exploration, Gefter writes “Observers create reality, but observers aren’t real,” and “Physics is the machinery behind the illusion that there is a world.”

The book includes an extensive glossary, notes on the book chapters, and a list of suggested readings. It is well-written, informative, and enjoyable.

- Frank Lock

Bob Berman, *Zoom: How Everything Moves* (Little, Brown, New York, 2014). ISBN 978-0-316-21740-8. 323 pp. $27.00.

This reviewer feels very fortunate to have come across this book, because it contains highly interesting information about the science of motion of naturally occurring objects, and much more. The first of these involves the motion of galaxies. Berman writes that nearby galaxies are receding from Earth/the Milky Way at high velocity. He writes that “Visible stars can’t move faster than 600 miles per second, which is the escape velocity for the Milky Way galaxy.” Then comes something that any science fiction fan will find disheartening: “No matter what system of propulsion is invented in the future, we will never visit the vast majority of galaxies: they are fleeing faster than we can ever hope to approach them.” Berman goes on to describe the operation of the Magellan Telescopes, located in the Andes, and provides some valuable information about pure research: “The Magellan telescopes cost forty thousand dollars a night to operate.” For me, that is a worthwhile investment, but costly.

Berman describes the mechanism for the large recessional velocities of the galaxies, indicating that the space between us and them is inflating. This leads to a discussion of the composition of empty space. Berman notes that empty space contains lots of energy, and uses a good analogy to describe it: “According to current theory, an empty mayonnaise jar containing only empty space has enough energy to boil away the Pacific Ocean in less than a second.” The attempt to reach the galaxies farthest from Earth, traveling at the speed of light, is also described.

Slowing to terrestrial speeds, Berman describes the motion of our planet. He indicates that people at the equator “whiz” eastward at 1,038 miles per hour. This leads to information about the magnetic field of the earth and the magnetic pole reversals that have occurred. Most importantly, Berman indicates that that there is no evidence of extinction events that correlate with magnetic pole reversals on earth, and that fossil records indicate that pole flips never affect the biosphere.

Returning to the equator, Berman presents interesting information about his visit to Quito, Ecuador. What he writes, about using his GPS to be sure he stands on the equator, is enjoyable to read. Writing about the demonstration of the Coriolis effect he observed leads to information about Gaspard-Gustave de Coriolis’s accomplishments, including his coining the terms “kinetic energy,” and “work.” Berman’s description of major league baseball players being robbed of home runs by the Coriolis force is fun to read. Another interesting fact is presented: hurricanes don’t form within 350 miles of the equator because there is not enough Coriolis deflection in that area.

Information about the development of the evidence for the rotation of Earth by Leon Foucault involves a description of an exciting scientific endeavor. In 1845, while using a telescope equipped with a weighted clock drive to track the sun, Foucault noticed that the Earth was turning under the swinging weight. He realized that he was observing evidence that the ground beneath the pendulum was changing its path. Foucault then constructed a pendulum by suspending a sixty two pound ball from a wire attached twenty stories high, providing the first evidence that the earth spins.

I always enjoyed introducing my students to how air pressure is measured, so I particularly enjoyed reading portions of the book describing the work of Evangelista Torricelli, Gasparo Berti, and Blaise Pascal.

The first error in the book occurs on page 141. It involves, not surprisingly, conversion of the acceleration due to gravity in English units to metric units. Berman wrote that in metric units, the value of g is “9.8 meters squared.” A second error is found on page 169, where Berman writes “Telescopes show water virtually everywhere” and should have included some information about the need for a spectroscope attached to the telescope. On

(continued on page 21)

REVIEWS

(continued from page 20)

page 214, there is also some confusing information about the relationship between heat and temperature.

Additional information in the book includes a little known fact that Einstein pointed out about rivers, the particle/wave nature of light, the description of the orbital velocity of the moon as one diameter per hour, a description of the Tunguska bolide event by eye witness Semen Semenov, and an interesting description of infinite space; “Any percentage of infinity is zero. So all we can ever observe is zero percent of the cosmos.”

Berman discloses these facts by telling stories and making reading about them enjoyable. The book is written at a level that young teenagers as well as retired physics teachers will probably enjoy. I recommend it to anyone with an interest in things that move and an interest in science history.

\- Frank Lock

(*Editor’s Note*: Frank Lock is a part-time retired high school physics teacher, part-time Teacher-In-Residence in the Georgia State University Physics and Astronomy Department. He has written many book reviews for this *Newsletter*.)

Dana L. Zeidler and Sami Kahn, *It’s Debatable! Using Socioscientific Issues to Develop Scientific Literacy K-12* (NSTA, Arlington, 2014). $37.95

This book contains seven units, based on the Socioscientific Issues Framework, which “gives students practice in the research, analysis, and argumentation necessary to grapple with difficult questions and build scientific literacy.” Their titles, academic level, and “big questions” are listed in the following table:

#	level	title	big question
1	Elem	“Food Fight”	Should schools charge a “fat tax” for unhealthy food?
2	Elem	“Animals at Work”	Should animals perform in circuses?
3	MS	“A Need for Speed?”	Should speed limits be lowered to reduce traffic fatalities?
4	MS	“Space Case”	Do humans have the right to colonize and use resources on extraterrestrial planets?
5	HS	“A Fair Shot?”	Should the Gardasil vaccines be mandatory for all 11-17-year-olds?
6	HS	“’Mined’ Over Matter”	Should rare earth elements be mined in the United States?
7	HS	“Pharma’s Market”	Should prescription drugs be advertised directly to consumers?

A breakdown of Unit 3 into its lessons gives more insight into the thrust of the units. In lesson 1, “Slippery When Wet,” students in bathing suits experience lack of friction when the “Slip’nSlide” is wet. In lesson 2, “Data Driven,” students analyze their Slip’nSlide data. In lesson 3, “Speed Kills?” students read and analyze articles about speed limits and deaths. The final lesson is a Town Hall Meeting in which students debate the lowering of speed limits.

The authors claim that their Socioscientific Issues Framework differs from Science, Technology, and Society, but an examination of their lessons in Unit 3 makes it difficult to see how.

\- John L. Roeder

Clearinghouse Update

(continued from page 16)

99m. One is to NorthStar Medical Radioisotopes to develop production of molybdenum-99 from neutron capture by stable Mo-98; Mo-99 decays to Tc-99m with a half life of 66 hours. The other grant is to Shine Medical Technologies, which seeks to produce Mo-99 by fission of low-enriched uranium in accelerators (rather than reactors). Most present production of Mo-99 involves the use of high-enriched uranium, which poses the greater possibility for nuclear proliferation.

(continued on page 23)

Musings

by REY

Features of STEM Education Envisioned for Current Reform Efforts

by Robert E. Yager

In December 2011 the National Governors Association (NGA) released a forty-four page report for use in shaping science education reforms across the U.S. It was designed to advance the current reform efforts in four areas now commonly called STEM (Science, Technology, Engineering, and Mathematics). This new report focuses on six key steps for use in actually accomplishing the STEM reforms in all 50 states. They were offered to help frame the specific reforms. They are: 1) Adopting rigorous math and science standards and improved assessments; 2) Placing and retaining more qualified teachers in classrooms; 3) Providing more rigorous preparation for STEM students; 4) Using informal learning to expand math and science beyond the classroom; 5) Enhancing the quality and supply of STEM teachers; and 6) Establishing goals for postsecondary institutions to meet STEM job needs.

The six features were reported to provide "structure" needed for funding! But, they did not indicate how the act of "teaching" might better help in realizing the reforms. The actual actions were to be left up to the States. The key issues regarding defining the STEM focus by Rodger Bybee offered important cautions. He stated: "STEM education must advance beyond a slogan; educators in the STEM community must clarify what the acronym actually means for defining educational policies, programs, and practices".

A look at each of the six steps from the Framework illustrates the problems! Concerns regarding the issues raised concerning the features include: **1) Adopt rigorous math and science standards and improved assessments**: Who can be against "rigorous"? But, it is scary when synonyms for it are suggested in dictionary definitions! What is meant with this initial statement in terms of practices? What about the ten million dollars and four years of effort that went into the 1996 science standards? And, what about assessments as defined by Wiggins and McTighe in "Backward Design"? Do these efforts focus on agreements on the nature of evidence used to indicate meeting the Standards? **2) Place and retain more qualified teachers in the classroom:** Placing and retaining qualified teachers "is fine" – but by whose definition of "qualifications"? How could their placement be evaluated? In what ways are "qualified" teachers and their practices to be defined? **3) Provide more rigorous preparation for STEM students:** Again, the report moves to the same topic with a lack of meaning of the term "rigorous"! What about its real meaning and for what preparation! Whose definition? **4) Use informal learning to expand math and science beyond the classroom:** This fourth feature for the new reforms calls for use of informal education (free-choice learning including efforts outside a single classroom). The evidence is clear that this is an exciting idea. But, how to do it? How to accomplish it? How is it related to "rigorous"? How is it related to specific curricula? **5) Enhance the quality and supply of STEM teachers:** Who would oppose this? But how could/should it be done? **6) Establish goals for postsecondary institutions to meet STEM job needs:** But, how to accomplish these? How different from the four goals for PreK-12 science? Recent efforts by NSTA with its Exemplary Science Programs (ESP) indicate the non-existence of many program/project features for accomplishing the goal(s)! How to get more specific goals?

The report also claims to include "current examples" of needed programs. Attempts to contact these "groups" to report more specifically on the efforts were not successful! There were few examples and interpretations for the definitions for success. The evidence included in each of the sixteen chapters of NSTA's Exemplary Science Programs contain useful ideas that have been found to be useful for encouraging more students to pursue STEM careers. The current monographs include: 1) Exemplary Science in Grades PreK-4; 2) Exemplary Science in Grades 5-8; 3) Exemplary Science in Grades 9-12; 4) Exemplary Science: Best Practices in Professional Development; 5) Inquiry: The Key to Exemplary Science; 6) Exemplary Science in Informal Education Settings; 7) Exemplary Science for Resolving Personal and Societal Challenges; 8) Exemplary Programs for building Interest in STEM Careers; 9) Exemplary College Science

(continued on page 23)

Marching into 2015

(continued from page 24)

activities related to fossil fuels (http://climate.nasa.gov/scientific-consensus/). In fact, the "Intergovernmental Panel on Climate Change (IPCC), which includes more than 1,300 scientists from the United States and other countries, forecasts a temperature rise of 2.5 to 10 degrees Fahrenheit over the next century." (http://climate.nasa.gov/effects/) For a person who likes warm weather, this can seem like a good thing. However, as temperatures rise, glaciers melt, and sea level rises, species are endangered, vegetation patterns change, and the frequency of droughts, wildfires, floods and storms increase. Additionally, as we chop down more trees to mine for coal and other fossil fuels (and create paper products), we are removing one of nature's ways of eliminating the CO_2 from the atmosphere. These effects are happening today! As for the future, according "to the Centers for Disease Control and Prevention (CDC), health impacts from climate change and ozone pollution will result in significant increases in acute respiratory symptoms, asthma, weather-related hospital admissions for children and the elderly, and premature deaths." Other studies predict that "if we continue on our current path, by 2050 between $66 billion and $106 billion worth of existing coastal property will likely be below sea level nationwide."

The effects of climate change are beyond disturbing. We know that gradually destroying entire species of animals, increasing the number of deaths due to heat and other climate related effects, and adversely affecting the balance that results from the interconnectedness of our planet, are not indicative of our respect and love of this planet, its inhabitants or ourselves. Yet, what can we do? The answer is both simple and complex. At the simplest level, we can reduce our fossil fuel consumption by purchasing green/non-fossil fuel generated electricity. We can turn off electrical devices (lights, A/C, TV, etc.) when they're not in use, buy longer lasting fluorescent bulbs, reduce paper consumption (and recycle), and use energy efficient appliances (with the best Energy Star rating). We can increase our positive contribution by driving cars that are fuel efficient (e.g., smaller or hybrid cars). And even more benefits could be had by heating our homes with geothermal energy and supporting legislation that supports rather than degrades the well-being of the earth and all of its inhabitants. Additionally, as we learn more, we can do more. A Google search will answer many of your questions and there are a number of people and groups that teach individuals, churches, businesses and other organizations how they can take better care of our planet which means taking better care of our neighbor. Check out Greenfaith.org, InterfaithPowerAndLight.org, and ClimateRealityProject.org, to name a few.

We can march physically by walking with others down the streets of New York, Los Angeles, Paris, London, or any of the 162 countries that participated in the People's Climate March, and/or we can march metaphorically by walking the walk of change in our everyday lives. By making big and small, simple and not so simple changes, and asking our government to stand with us, we as individuals and as a nation can be role models for others. Whatever way we choose to walk, let's March into 2015, with a greater resolve to care for our planet and all its inhabitants. Whether it's making a statement about climate change or other injustices in our land, let's make this not only a "Happy New Year" but a "Happy Do Year" as we live out the change we want to see in the world!

(*Editor's Note*: Charlene Marable is a theology student at Drew University, Madison, NJ. Here she recounts her experiences at the People's Climate March in New York City on 21 September 2014, with emphasis on her commitment to the March's goals.)

Musings

(continued from page 22)

Teaching; and 10) Exemplary Programs Arising from New STEM Efforts.

(*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.)

Clearinghouse Update

(continued from page 21)

Nuclear Waste and Yucca Mountain

The Obama Administration abandoned previous efforts to establish a repository for spent nuclear fuel from US reactors at Yucca Mountain in 2009, but according to the online *World Nuclear News* for 19 December 2014, a US Court of Appeals ruled in August 2013 that the Nuclear Regulatory Commission (NRC) could not abandon the Yucca Mountain Project. The NRC has now published volume 4 of its safety evaluation report on the proposed Yucca Mountain nuclear waste repository.

TEACHERS CLEARINGHOUSE FOR SCIENCE AND SOCIETY EDUCATION, INC.
17 Honeyflower Lane
West Windsor, NJ 08550-2418

Marching into 2015

by Charlene Marable

As I stood on the corner of 58th and 9th Avenue in New York City, I observed a little girl and her father crossing the street. "Are we almost at the parade, Daddy?" she asked. Holding her hand as they waited for the walk sign, he answered, "Almost, but we're not going to a parade. We're going to a march. A parade is when people walk or watch others walk to celebrate a special day or event, like the Thanksgiving Day parade. But a march is when people walk together to show others that they don't like what's happening and want it to change." "What do we want to change, Daddy?" the little girl asked. Crossing the street, her father began his explanation. I wanted to follow along to hear more, but I remained at my designated post greeting and directing people as they came to engage in one of the largest marches in United States history – *The People's Climate March*.

On this lovely late summer day, an estimated 400,000 people came from all parts of the country (and the world) to show their solidarity and resolve that the source of our energy must change. Messages like "Creation is Sacred, Stop Destroying our World," "This is What Love looks like," "Love God, Love your Neighbor, Stop Climate Change" and "Baptist Peace" appeared on some signs. Buddhists held signs like "Embody Fierce Compassion." A Quaker sign exclaimed, "Quakers for Peace!" and a Unitarian Universalist's sign noted that "Environmental Justice Equals Social Justice." Other signs bluntly noted that "Greed Kills," "Pollution = Suffering," and "There's No Planet B." Others expressed the sentiments of "Raging Grannies" and "Angry Pacifists." Yet others noted that, "Small Acts When Multiplied by a Million Can Change the World," as we can "Divest from Fossil Fuel," and create "One Million Climate Jobs Now." Then there were those who tried to capture the humor of denial with signs that hearkened back to a day when there were other doubts, stating: "Those Wacky Scientists, Next They'll Say the Earth is Round." This sampling of messages conveyed the marchers' passion for saving the planet and all of its inhabitants. They were marching for change.

Whether we're heating our homes, fueling our cars, or energizing our appliances, as we source our energy with fossil fuels like coal, natural gas, oil, or gasoline, the CO_2 emitted creates a heat-trapping effect which makes the planet increase in average temperature over time — ultimately changing the Earth's overall climate. But wait a minute… Isn't climate change a bit overstated? After all, the climate is always changing, right? Indeed the climate is always in a state of flux. But, over the past century — since the Industrial Revolution – there's been a heightened warming trend that, according to NASA and 97% percent of climate scientists, is very likely due to human

(continued on page 23)