NETWORK OF EDUCATORS IN SCIENCE & TECHNOLOGY

Working to Promote Science Literacy in association with the Massachusetts Institute of Technology

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Contents

Co-Chair Report

Eric Klopfer

For the first time in years, I didn't make it to the NEST board meeting in January because it coincided with the first of many (*many*) snowstorms in the area. Instead I joined by videoconference—I have a knack for appearing on screen lately, not just when I'm snow-bound, but also for the ongoing series of MITx courses our lab has been producing (the next one on April 1st). As I write, we're still buried under snow, and thoughts of summer make SEPT even more alluring—I look forward to seeing many of you face-to-face in the warmth of June!

In the meantime, MIT initiatives to tackle challenges in education and learning are gaining ground on campus—including an emphasis on K-12 education. Emerging from a report on The Future of MIT Education published last summer (https://future.mit.edu), there's a concerted and focused effort taking shape to make exciting changes in how MIT approaches education—on campus and off, across the US and internationally. Detailed proposals and dedicated groups of people are finally coming together—and, by the time SEPT rolls around, I'm sure there will be more news to share.

This broader effort at MIT does raise questions around how SEPT and NEST are positioned in a growing landscape of efforts on campus. Of course, the increasing enthusiasm and conversation around K-12 issues at MIT is a very good thing—but it does present the challenge of figuring out how everything fits together. In the months ahead, I hope to carry on a discussion with everyone about how best to position our organization as we move forward.

With interesting opportunities and issues on the table, this year's NEST program in June should be even more interesting. I hope to see many of you there, as long as the snow has ceased by then….

Spiderman and Spider Silk

Avi Ornstein [NEST '89]

In the comic book, Spiderman gained his fantastic powers by being bitten by a radioactive spider. What may be the most fantastic 'power' that he has, however, is his spider webbing. This is something he invented himself at the age of fifteen. Having that scientific ability, it is surprising that he is only able to scrape by on the money he gets for the photos he submits to the local newspaper!

His spider webbing is ejected from compartments situated on each wrist. It can be shot out as either silk or in the form of a web. It is sticky to others, but not to Spiderman, which is

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Why Science?

[This excerpt is from an editorial by Rush D. Holt in the February 20, 2015, issue of *Science*.]

Among the various ways of thinking and knowing about the universe and ourselves, science is special. Asking questions that can be answered empirically and engaging in open communication so that others can collectively review and verify possible answers lead to the most reliable knowledge—a knowledge that is powerfully applicable in daily life. Science is, as physician and essayist Lewis Thomas wrote, the "shrewdest maneuver" for discovering the world. This grand and clever enterprise, while surely not removing all worldly woes, brings beauty, wonderfully fulfilling intellectual pleasure, and cultural enrichment. It can lead to improved human interaction, more constructive commerce, and a better quality of life. Science helps bring what I think is a human need—a sense of progress.

Calendar of Events

March 21
Submission deadline for NEST Teacher of the Year Award nominations

March 31
Announcement of NEST Reunion registration and McNamara Workshop plans

April 24
Submission deadline for:

- NEST Reunion registration
- NEST Student Award requests

April—May
Student Award books and certificates are sent out to nominating teachers

June 21-June 27
Science and Engineering Program for Teachers at MIT

- Thursday evening, June 25 - McNamara Workshop
- Friday, June 26 – NEST Reunion programming
- Saturday morning, June 27 – NEST member meeting

September 1
Submission deadline for the fall newsletter

October
Deadline for NEST board member nominations by email and annual fee announcement

November
NEST board member election

January
NEST Executive Meeting

January
Annual membership fee collection

Cockroaches

[This excerpt is from an article by Rachel Nuwer in the March 2015 issue of *Scientific American*.]

Cockroaches could inspire superheroes if they weren't so repulsive. Some species can hold their breath for as long as 40 minutes. Others can survive blasts of strong radiation, subsist on paper and dried glue, or live for weeks without a head. Recently researchers discovered another superpower: the nocturnal creatures can see in near-pitch black by pooling light signals over time, like time-lapse photography.

Editorial

[This editorial originally appeared in the September 1997 issue of this journal, but I believe it is worth reprinting.]

In the last issue, I talked about the need for students to know that science is an on-going process. It is critical that this point is included in all science education curricula. It is equally important for all students to learn that science is not a set of facts etched in stone—scientific theory undergoes continuous change and modification.

Vannevar Bush's 1945 report to President Truman ("Science—The Endless Frontier") helped move science research to central stage, creating the environment in which most of us have grown up. This has accelerated the expansion of scientific knowledge, which can be portrayed through the following image:

> At first, humanity lived in darkness—there was no known explanation for what was experienced or observed. A lit match represents early science—there is some light, but much darkness still surrounds us. A candle represents scientific advancement—there is more light, but there is also a larger surface to the area of darkness. A lantern represents more answers, more awareness and more knowledge. At the same time, there is a larger area of darkness—we are more aware of what we don't know. As Buckminster Fuller said, "The more we learn, the more we realize how little we know."

It is easy to show students that new discoveries are ideas cause us to always keep an open mind in science. What is in the news may prove to be erroneous (remember cold fusion), but it needs to be considered and studies. Three recent news items can be used as examples.

One is the idea that the Earth rotated or slipped 90o half a billion years ago. Supporting evidence exists in magnetic records in stone. This could have influenced the Cambrian Explosion—the sudden appearance (in geological terms) of multicellular life. A second is the new findings in humanoid fossils in Spain and England, which may require noticeable readjustments regarding our ancestor's entry into Europe. A third is the discovery of space snowballs entering our atmosphere. If water has continuously been falling to Earth, it may necessitate the rewriting of many concepts.

To quote Carl Sagan: "Scientists often say 'That's a really good argument; my position is mistaken.' Then they actually change their minds, and you never hear the old view from them again. I cannot recall the last time that happened in politics."

Where does this all fit into science education? Students need to understand that there is much that is yet unknown and there is much room for modification in the theories explaining the world around us. At the same time, it does not mean that what we know is purely subjective. It is based on sound observation and experimentation. We have to do a better job of getting this across to our students. Just consider the fact that polls have shown that almost half of the US population still believes that God created humanity within the past 10,000 years!

Worthwhile Websites

The impending disaster due to climate change and the acidification of the oceans:
www.newsweek.com/2014/07/11/disaster-weve-wrought-worlds-oceans-may-be-irrevocable-256962.html

A variety of interesting, educational films good for a diversity of subjects:
www.biointeractive.org/shortfilms

Bringing Why to Generation Y Science Education: Middle School Science—Expanding Their World—Saltwater

Helen J. Flavin [NEST '10]

One important challenge for educators of students in grades 6-8 is encouraging the development of independent thinkers via strengthening in-depth reading, analysis and writing skills. Adolescents question everything. That is part of what drives their quickly changing focus of attention. Educators can seek to utilize this inquisitiveness in their instructional design. Regarding absolute length of attention span, both informal and structured studies suggest that adolescent attention span increases when students are emotionally engaged. Thus, the first priority for the educator is to find a way to present the material in a way that is salient for the adolescent. Salient in this context means first and foremost a problem of interest to be solved. This paper describes a number of enticing web based learning opportunities. To us adults, they are loosely connected around the saltwater theme. To adolescents, each opportunity provides the student an opportunity to be a specific type of scientist for that project as he or she discovers and delves into the relevant scientific concepts.

Let us start with connections to Life Science curriculum. The resource at http://oceanexplorer.noaa.gov/edu/learning/player/lesson05-/l5la1.htm is an interactive chemosynthetic food web that revisits food chain/web vocabulary, introduces students to hydrothermal vent organisms and provides an introduction to a new world where energy is provided by chemosynthesis. In the activity, students click on the name of an organism that then provides a picture and data. From the descriptive data, students must decide where in the food chain to place the organism. They move the organism name to its proper place as producer or consumer. When they have finished the food chain, they click on a button and the web resource diagrams the food web. This activity can be enriched by an individualized reading and writing assignment. One possibility is that students can simply choose (or be assigned) one of the organisms from the food chain for further research. A more open-ended approach to this writing is to provide one or more pages such as http://oceanexplorer.noaa.gov/explorations/04fire/logs/april14/april14.html which provide a wealth of links for individual choice for research. Possibilities on this webpage include: ROVs, seafloor mapping, vent chemistry and underwater volcanoes. Students can be asked to choose a topic and develop their own question that they present to the instructor for approval.

The interactive activity entitled "Sunglasses in the Sea" at http://oceanexplorer.noaa.gov/edu/learning/player/lesson06/l6la1.htm allows students both unpolarized and polarized light views of reefs and animals. Students get to "discover" that some animals use eyes capable of polarized vision in order to select a mate. They also learn that there are some species which appear invisible at these depths. Yet, these "invisible" species can be detected by predators that have polarizing lenses. In this environment, such predators have a decided advantage in hunting for food.

Choices for project ideas for extension for "Sunglasses in the Sea" depend on whether one desires to explore optics and the wave nature of light or have students more deeply explore sensory systems. The physics classroom on polarized light at www.physicsclassroom.com/Class/light/U12L1e.cfm#trans provides a nice written summary of the action of a polarizing lens and what happens to an object viewed through orthogonal polarizing lenses (invisibility). That summary can be used with the MIT open courseware movie at http://ocw.mit.edu/resources/res-6-006-video-demonstrations-in-lasers-and-optics-spring-2008/demonstrations-in-physical-optics/polarization-rotation-using-polarizers which shows the laser beam intensity drop to zero with orthogonal polarizers. Directions for a student-directed, hands-on demonstration of light transmission through water are found at www.exploratorium.edu/snacks/blue_sky. One advantage of this demonstration is the student discovering that scattered and transmitted light has different colors and how this relates to the evening sky. Another possibility for extension is the "Why do we Need a Diving Mask?" at www.deepocean.net/deepocean/index.php?science02.php which provides a comparison of human and fish lenses of the eye and how they handle light rays (Figs 4-9). For an interesting look into fish sensory systems, see www.seagrant.umn.edu/fisheries/senses which provides information on fish senses of smell, taste, vision, hearing and touch. Students can compare and contrast these systems with those of humans.

Shipwrecks are a topic where students can practice forensics (deductive reasoning) and highlight their mathematical skills. The graphing/grid activity at http://oceanexplorer.noaa.gov/explorations/08lophelia/background/edu/media/shipwreck.pdf has students plot and analyze the debris of a sunken ship. This allows students to use the size of the debris field, as well as artifacts found, to determine the type of ship, who was aboard and possible reasons the ship sank. The "Whitefish Point: Wrecks and Rescues" exercise at http://wupcenter.mtu.edu/education/great_lakes_maritime/whitefish_point/lesson_plans2008/12_wrecks_rescues.pdf provides a research activity that allows student statistical analysis of the data. The resource provides a list of names of wrecked ships. Students research the wrecks

at www.boatnerd.com in order to determine type of ship, reason for shipwreck and loss of life. Students then translate absolute numbers to percentages that are used in bar and pie graphs to illustrate the trends seen in the data. One reading/writing project extension is the article at www.bbc.com/news/uk-scotland-highlands-islands-21858385 which describes modern archaeologists at work examining a recently discovered wreck. The site includes a link to a pictorial analysis of the shipwreck along with a link to a brief movie highlighting the underwater photography and 3D cannon reconstruction.

Students have seen both wild and farm raised salmon at the grocery store. The interactive at http://oceanexplorer.noaa.gov/edu/learning/player/lesson12/l12la2.html highlights characteristics of each. The questions ask students to analyze these differences in terms of importance to the consumer and in terms of importance to the ocean ecosystem. Another point of interest is the life cycle of the wild salmon that live in saltwater yet reproduce in freshwater. The resource at http://fish.washington.edu/hatchery/education.html provides a good summary. Teachers can use or adapt the detailed worksheet at http://soundsalmonsolutions.org/education/curriculum-2/reys-salmon-lesson-student-worksheet to guide students through the reading on the salmon lifecycle. One possible project for extension is the virtual lab examining stickleback evolution at http://media.hhmi.org/biointeractive/vlabs/stickleback/index.html. Both stickleback and salmon spawn in freshwater. Students examine the adaptation of a population of stickleback fish descended from ancestors trapped in freshwater.

Respiration and metabolism can be estimated by the rate of water movement past fish gills. The virtual lab at www.glencoe.com/sites/common_assets/science/virtual_labs/CT08/CT08.html allows students to measure and compare metabolic rates of fishes as the temperature is changed. Important areas for extension would be in the theme of animal form and function. With the virtual fish dissection at http://australianmuseum.net.au/Dissection-of-a-Blue-Mackerel-Scomber-australasicus, students can look at the labeled dissection revealing the gills or they can work through the entire image gallery, viewing and learning both the external and internal anatomy of the fish. One easy-to-use student resource for function data for fish is found at www.biology-resources.com/fish-01.html.

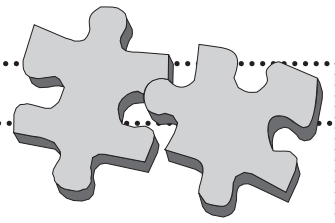
The NOAA resource www.srh.noaa.gov/jetstream/ocean/wave_max.htm allows students to master the basic concepts and vocabulary of water waves. This can be followed by the hands-on activity at www.nanoos.org/education/lesson_plans/pdfs/conditions_at_sea-making_waves.pdf which has students create a mini wave tank so they can determine the effects of wind speed and time on waves. The virtual wave generator at www.pbs.org/wnet/savageseas/multimedia/wavemachine.html allows students to manipulate wind strength, wind duration and fetch to create waves that their vessel must ride out. Research/writing project extensions include: www.srh.noaa.gov/jetstream/ocean/ripcurrents.htm to learn how rip currents form and, should students ever need to know, how to survive one; and www.pbs.org/wnet/savageearth/animations/tsunami/index.html to understand what causes a tsunami and why the waves are so devastating.

The interactive at http://oceanexplorer.noaa.gov/edu/learning/player/lesson06/l6la2.htm allows students a glimpse of some deep sea organisms and their bioluminescence. The questions encourage students both to make detailed observations of the bioluminescence and to make predictions based upon those observations. The site http://biolum.eemb.ucsb.edu/chem/index.html provides students a big picture understanding of the chemistry of bioluminescence. As an assessment or as a project for enhancement, using either the resource at www.sciencedaily.com/releases/2003/04/030421084227.htm or the resource at http://articles.baltimoresun.com/2003-06-16/news/0306160350_1_firefly-cancer-cell-genes, students can examine and then explain how scientists trick cancer cells into bioluminescence that then triggers the cancer cells' death.

The science of oil spill clean-up is timely as well as interdisciplinary. The interactive at http://ocean.si.edu/gulf-oil-spill-interactive allows students to walk through the steps needed to contain and clean up the 2010 spill where nearly 5 million gallons of oil spilled into the Gulf of Mexico. The students can then put their knowledge to work in a hands-on project where they create and then clean up a sample oil spill. The project at www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_enveng/cub_enveng_lesson01_activity1.xml allows students to be the engineers analyzing the cost and effectiveness of their clean-up methods. An interesting demonstration for bioremediation is found at www.amsa.gov.au/community/kids-and-teachers-resources/kids/teachers/experiment_bioremediation/index.html that provides directions for creating a classroom sample of an oil-water mixture where bacteria consume the oil and produce sludge. Numerous projects for extension can be obtained or derived from http://oceanservice.noaa.gov/education/stories/oilymess/welcome.html which is NOAA's "Prince William's Oily Mess: A Tale of Recovery" project. Unlike the simulated lab that had total clean-up at the end of the day, the effects of real oil spills on the ecosystem are felt for years and the process of recovery is gradual. This site is an important tool in helping young students understand just how long that recovery phase is. One interesting reading/writing topic is "How Toxic is Oil?" as the resource discusses the many ways that oil kills marine and wildlife. Starting at http://oceanservice.noaa.gov/education/stories/oilymess/oily07_time.html, students are marine biologists determining recovery by percent abundance of certain test species. Students examine yearly photographs of one rock for its cover of mussels, barnacles and Fucus gardneri (seaweed). Students estimate the percent coverage of the rock for each species. Next, they graph those percentages over the 15 year period. They use these data to gauge recovery.

The ocean food chain with phytoplankton provides an opportunity for students to showcase their expertise. Both the plankton tow resource at www.coexploration.org/bbsr/classroombats/html/virtual_plankton_tow.html and the food web activity at http://education.nationalgeographic.com/education/encyclopedia/food-web/?ar_a=1 provide students images and background information needed for them to create their own version of an ocean food chain. The project extension for this is biological magnification. The interactive resource at http://oceanexplorer.noaa.gov/edu/learning/player/lesson13/l13la1.html allows students to feed a bird a diet mainly from the bottom consumers, mixed trophic level consumers or solely higher level consumers. Based upon mercury levels in the food the bird eats, it will either die or live to eat again. Students thus discover that there are higher mercury levels as one moves up the food chain. Though the toxin is different, the resource at http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/DDTandTrophicLevels.html provides a simple food chain with DDT levels in ppm. Students discover that DDT amounts significantly increase as one moves toward higher levels and that eagles are high level consumers. The only other background students need to know is that baby eagle egg shells created in the presence of DDT are extremely fragile and may result in reproductive failure. As the US banned DDT use in 1972, long-term eagle population data provide students an opportunity to examine biological resiliency. The resource at www.learner.org/jnorth/tm/eagle/Population.html#30 has data and

PUZZLE CORNER



#1) What interesting property do the two-word answers to the following clues have in common?

a) Catholic service held on the week's holy day
b) Drummer for the Beatles
c) Star of "I Love Lucy"
d) It borders on western North Carolina
e) Less expensive accommodation in a ship or plane

#2) What do these words have in common?

FASTEST WAX TRICORDER HELPLESS BUREAU

Solutions to the previous problems:

#1) The size of a shadow depends on the ratio of the distance between the object and its shadow and the distance between the object and the light source. As you more your hand away from the wall toward a light, the shadow increases in size. At first, the shadow is equal to the size of the object. In the case of a plane, as the altitude increases, so does the size of the shadow, but this increase in size is so small that you cannot measure it. The sun is 93 million miles away. At an altitude of ten miles, the size of the shadow would increase by only a bit more than 0.000001%.

#2) Actually, it is not reversed left-right. The problem is with the choice of words and our mental perceptions. When you are looking in a mirror, what you see is what would be viewed from behind you, if you could see through your body. If you are pointing to the right, so is your image, though it seems to be pointing to its left side.

Think of the image as a map, with the top being North, the bottom being South, the right side being East and the left side being West. Your image is always pointing in whichever direction you are pointing. If you lie sideways and look at a mirror, this will likewise be true. East and West are constant. Left and right depend upon the frame of reference, but seeing the image throws this off.

As a way to test this, take a plastic sandwich bag and draw or write on it with a marker. What you see in the mirror is the same as what you see looking through the back of the sandwich bag. The mirror image is not undergoing a right-left reversal. All that happens is that your frame of reference has changed.

To go one step further, consider what happens to the image passing through the lens in your eye. That image is inverted. That it, the image falling on the retina is upside-down and backwards. (That is, left and right orientations are also reversed.) The remarkable thing is that our brain interprets the image to match the actual world, rather than simply accepting the messages coming from the excited cells!

guides students through plotting both the population size data and percent change per year in population for 30 years of data. These graphs and the eagle history timeline the students make allow them to discover and appreciate just how long it can take for toxin concentrations to fall low enough in the ecosystem so that organisms can recover. A final important consideration is for students to understand that in an ecosystem filled with such toxins, we humans must also be conscious of our diet. The resource at http://rjd.miami.edu/conservation/bioaccumulation-biomagnification-when-bigger-isnt-better has a summary figure that, in one picture, allows students to correlate position in food chain both to mercury levels and to what this means for humans regarding fish consumption guidelines.

One project idea for a summative activity to help students examine and put all of this new science together in a working system is a writing assignment on whales. Sample topics include: relationships and quantities in the food chain; adaptations that make an organism suited for seasonal migration, where an organism takes advantage of available marine resources; and human threats to the organism's way of life. The NOAA resources on humpback whales at www.nmfs.noaa.gov/pr/species/mammals/cetaceans/humpbackwhale.htm or on right whales at www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northatlantic.htm provide a wealth of information for students to synthesize. An alternative resource at www.learner.org/jnorth/search/RightWhale_notes1.html provides similar information for right whales organized around key questions.

This inquiry or problem based instruction requires students to take their prior knowledge and apply it to new and exciting situations. In addition, it requires development of research and analysis skills. After the fact-finding and subsequent analysis, each student is then asked to creatively and independently express his or her solution. In essence, students are asked (and encouraged) to live the skills we wish them to maximize. As they do this, students find that the incentive to learn lies within them. A final, yet exceedingly important, component to this method of instruction is that instructors can selectively enhance web based exercises to promote various scientific skills and analyses. Thus, these projects readily provide a framework for differentiated instruction with timely, individualized student feedback.

Kudos

Marty McMahon (Literacy Coach) and **Jan Frank [NEST '11]** (STEM Coach) of CREC's Academy of Aerospace and Engineering Elementary are receiving a $1000 ORL Innovation Grant for a project entitled "Linking Literacy to Legos."

Shawn Kenner [NEST '13] received the 2014 "Theodore William Richards Award for Excellence in Teaching Secondary School Chemistry" from the Northeast Section of the American Chemical Society.

An article on "Nuclear Energy and Radiation" by **Avi Ornstein [NEST '89]** was published in the Fall/Winter 2014-2015 issue of the *Connecticut Journal of Science Education*.

The Daedalean, an aerospace education publication produced by **Steve Rocketto [NEST '90]**, won a certificate of merit in the Maj. Howel Balsem CAP Public Affairs Exceptional Achievement Award program this year.

Marijuana and Young Minds

Avi Ornstein [NEST '89]

The content of this essay is limited to first-hand observation and research, as I have no first-hand experience. Having suffered a brain hemorrhage when I was ten and not knowing what had caused it, I made a clear decision at an early age to avoid drugs. At first that was limited to alcohol, but that expanded as I grew. Nonetheless, I have seen the impact drugs have had on friends and students.

As Nora Volkow, Director of the National Institute on Drug Abuse, said during a telecommunication in December 2013: "We know that the use of marijuana interferes with learning and memory. These kids at school are going to be unable to properly learn if they are using marijuana regularly."

The regular use of marijuana appears to be increasing. The following two paragraphs are from an article by Michael E. Bratsis that appeared in the Summer 2014 issue of The Science Teacher that was titled "Putting the Brakes on Marijuana Use."

The number of high school students who try marijuana appears to be rising slightly, but more concerning is how few see regular marijuana use as harmful. That number is at the lowest level since the late 1970s, according to a national survey….

Sixty percent of high school seniors say they believe regular marijuana use is not a "great risk," according to the survey of 41,700 students in grades 8, 10, and 12. The survey, called Monitoring the Future, also showed that 35% of seniors used marijuana in the last year. About 55% of sophomores said regular use is not harmful, with about 30% of sophomores reporting use in the last year.

As a closing point, here are a set of excerpts from an editorial written by Robert L. DuPont and Jeffrey A. Lieberman that appeared in *Science* on May 9, 2014.

The debates over legalization, decriminalization, and medical uses of marijuana in the United States are missing an essential piece of information: scientific evidence about the effects of marijuana on the adolescent brain. Much is known about the effects of recreational drugs on the mature adult brain, but there has been no serious investigation of the risks of marijuana use in younger uses. In April 2014, a controversial study suggested that "casual" use of marijuana is associated with structural abnormalities in the brains of young people (ages 18 to 25), particularly in regions vital to emotion, motivation, and decision-making. The fact that the findings are preliminary and disputed indicates that rigorous research is needed to inform discussions about the public health benefits and risks of legalized marijuana.

Although marijuana remains illegal for people under the age of 21 in the United States (including in the two states that have legalized it for adults), young people will almost certainly have greater exposure to, and likely more ways to access, the drug (as they already do with alcohol and tobacco), as new initiatives to change marijuana laws in many states come to fruition. Proponents of legalization argue that the medically harmful effects of marijuana are "no worse" than those of alcohol and tobacco. But even if that is true, it does not mean that the risks are the same. Over the decades, the United States has funded research to study the long-term health effects of alcohol and tobacco, but not marijuana. Yet many of the most worrisome brain pathologies from drug use are seen in mental health (as opposed to pulmonary disease and cancer with smoking, and gastric and liver disease with alcohol), where marijuana use is associated with, among other conditions, anxiety and psychotic disorders. Research suggests that early marijuana use is linked to these problems, but their biological underpinnings are a mystery.

The National Survey of Drug Use and Health has repeatedly found that children who began alcohol or marijuana use before age 15 had a fivefold-increased prevalence of substance use disorders later in life. This may be due to effects of early drug use on the trajectory of the brain's subsequent development, but we don't know for sure….

…Without more scientific evidence to inform policies, we are gambling with the health and safety of our youth in making decisions about psychoactive substances such as marijuana when the real risks are unknown.

Computer Games

[This excerpt is from "Computing in the Classroom," an article by Sophia Nguyen in the March-April 2015 issue of *Harvard Magazine*.]

…"We've loosened up about games," says Eric Klopfer, director of MIT's Education Arcade….Klopfer recalls a time when teachers would tell him, "'Just don't use the word *game* in my school, because the principal will kick it right out.' And now, in fact, there are people who are saying just the opposite: 'Ooh, is that a game? I'd love to try that out in my school.'"

Fracking

[This excerpt is from an article by Luisa Abbott Galvao that appeared in the Fall 2014 issue of *Friends of the Earth Newsmagazine*.]

Fracking, short for hydraulic fracturing, is a process that can be used for extracting natural gas—a fossil fuel found deep underground in rock formations and under the ocean floor. Fracking involves injecting thousands of gallons of water, sand and a slurry of toxic chemicals at high pressure deep underground, fracturing shale rock and releasing trapped natural gas.

Fracking has fundamentally changed the U.S. energy mix over the last decade, supplanting staple fuels like coal, and harming American wind and solar energy industries. As the cost of natural gas production decreased, demand for it increased and the natural gas industry began looking to overcome transportation difficulties to reach overseas markets.

In order to be stored and transported overseas, natural gas must be converted to liquid form, and then regasified for use in receiving countries. Natural gas producers—with the support of the Obama administration—are seeking to expand American liquefied natural gas export capacity. This move, however, would lead to more fracking, more greenhouse gas emissions and more pollution. It would also involve building new gas pipelines, compressor stations and export facilities, as well as weakening the current regulatory process to expedite the permitting of LNG export projects.

Billions in investment going towards this dirty energy source would leave us dependent on this fossil fuel for decades, and distract from our commitment to legitimately clean energy sources.

Ocean Plastics

[These excerpts are from an article included in the "Headline Science" column in the February 2015 issue of *The Science Teacher*.]

The report estimates that some 5.25 trillion plastic particles weighing about 269,000 tons are floating in the world's oceans. Previous reports only looked at one size class and thus reported much lower plastic densities in the world's oceans.

The new research also demonstrated some unexpected findings, namely a dramatic loss of microplastic from the sea surface in the garbage patches of the five subtropical gyres, large areas of rotating currents where the fragments tend to accumulate. In addition, the survey found a wide distribution of the smallest microplastics in remote regions of the ocean. Though concentrations in the gyres are lower than previously reported, plastics occur nearly everywhere, often far outside of the garbage patches.

…The data and model show that large plastics are abundant near coastlines and degrade in the five subtropical gyres into microplastics, the smallest of which are, surprisingly, present in more remote regions such as the subpolar gyres.

The garbage patches should thus be characterized not as repositories or final resting places, but as shredders and redistributors of trash, where sunlight (UV), oxidation, embrittlement, breakage by waves and fragmentation by grazing fish all degrade large plastic pieces to tiny fragments. These microplastics are then ejected from the garbage patches through various mechanisms such as foraging and filter-feeding by marine organisms, and subsurface currents.

Arctic Amplification

[These excerpts are from an article by Carolyn Gramling in the February 20, 2015, issue of *Science*.]

Weather experts were on high alert in December 2009. A region of high pressure had settled over Greenland, forming a roadblock in the path of the circumpolar jet stream. Thwarted, the jet stream meandered, bending southward into a large loop and shunting cold Arctic air toward the center of the United States. Meteorologists were familiar with this "Greenland block." It was a climate pattern historically favorable for winter storms—and as if on cue, record snowfalls blanketed the Eastern United States over the next few months.

Against the backdrop of "Snowmageddon" and other powerful winter storms that have blasted the United States, Europe, and Asia in the past few years, a different kind of tempest has been swirling within the Arctic science community. Its core is a flurry of recent research proposing that such extreme weather events in the midaltitudes are linked through the atmosphere with the effects of rapid climate change in the Arctic, such as dwindling sea ice. The idea has galvanized the public and even caught the attention of the White House. But some Arctic researchers say the data don't support it or that the jury is at least still out. Even some of its proponents agree that the media hype is premature.

Now, scientists are starting to tackle the issue in earnest. Atmospheric links between the poles and midaltitudes are becoming a marquee topic at Arctic-related conferences….

The idea that the Arctic could have a regional, even hemisphere-scale impact on the atmosphere represents a paradigm shift for climate scientists….

…there is a new kind of engine forming in the Arctic. The rapid loss of sea ice in the Arctic Ocean due to global warming—the area of summer ice has shrunk more than 11% per decade since 1979—has created an expanse of dark open water newly available to absorb the sun's energy. This extra energy input and the corresponding flux of moisture and heat to the Arctic atmosphere are helping drive a strong local positive feedback to global warming, called Arctic amplification. As a result, surface temperatures are rising twice as fast in the Arctic as at lower latitudes.

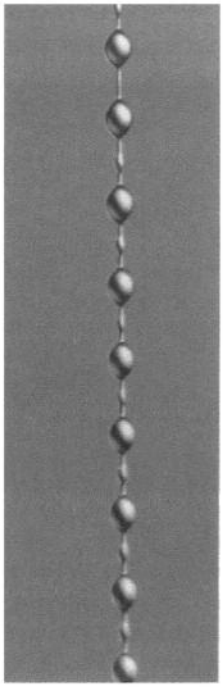
But is the loss of sea ice influencing more than just local warming?...

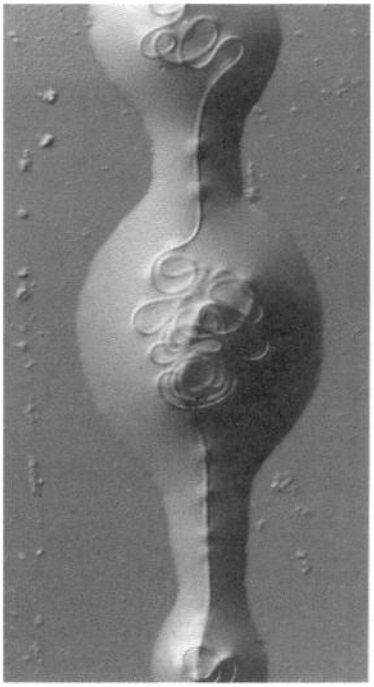
Continued from page 1 "Spiderman and Spider Silk"

interesting in and of itself. In addition, it decomposes after an amount of time, which is why it does not litter the city. However, it conveniently does not decompose before police are able to apprehend the villains Spiderman has left entangled at the scene of the crime. How did Stan Lee come up with this fantastic material?

Actual spider silk spans millions of years of evolutionary development. A very good explanation can be found in Chapter 2 (Silken Fetters) of "Climbing Mount Improbable," which was written by Richard Dawkins, is well worth reading. As Dawkins notes, "…the weight of silk in a spider's web—all twenty metres of it in a big web—is less than a thousandth part of the weight of the spider's body."

To catch its prey, a spider's silk must be resilient so it doesn't tear when the insect strikes the web, but not so elastic that the prey bounces off. This is a delicate balancing act. The way that this is achieved is by having beads in the string of silk. Looking with an electron microscope, it is possible to see that within each bead is a length of the single, continuous thread that can unwind as needed, supplying the necessary resilience and elasticity. [The two pictures below are from page 42 of Dawkins' book.]





The spider is also able to produce more than one type of silk. Some silk is non-sticky so the spider can move on it, making the spokes of the web. Other silk must be sticky. Spiders also have oil they spread on their legs that offers some degree of protection from the sticky silk. This parallels some of the properties of Spiderman's silk, though in a more elegant manner.

Spiderman has sometimes had the problem of running out of his webbing. When this happens, he needs to place new cartridges in his ejection compartments. Spiders have a different way to avoid this problem without having to wait for their body to digest their supper and then produce more silk. Each morning, they consume the silk they have collected to replenish their supply. Since Spiderman's silk decomposes, he is unable to parallel this pattern!

INFORMATION EXCHANGE

2016 is the 50th anniversary of the discovery of dinosaur footprints in Rocky Hill, CT, the site of Dinosaur State Park. The discovery was the largest collection of dinosaur footprints in North America. Many of the footprints are on display in the park's geodesic dome; others were re-buried to protect them from the elements. Plans are being made to celebrate the anniversary with events throughout 2016. If you are either interested in helping plan events, or for more information about the park, contact park director Meg Enkler (Margaret.enkler@ct.gov or 860-529-5816).

The Civil Air Patrol is mandated by its Congressional Charter to support aerospace education as one of its three principal missions. One of the programs they run is for school teachers. You can join as an Aerospace Education Member for a one-time fee of $35. The program is designed for educators who wish to promote the aerospace sciences. Membership benefits include access to a batch of teaching materials matched to STEM standards, opportunities to both take an orientation ride in a CAP aircraft and participate in the national Aerospace Education Excellence Program and competing for $250 classroom grants twice each year.

Steve Rocketto [NEST '90] supports a number of these schools with CAP resources and assists with rocketry programs and aerospace education activities. If you are interested and would like to learn more, contact him at srockett@aquilasys.com or go to www.capmembers.com/aerospace_education/join-as-aem.

Steve Rocketto [NEST '90] still continues to publish his Squadron paper, *The Coastwatcher*. If anyone wants to receive it by email, all they have to do is contact him at srockett@aquilasys.com. It contains a lot of aerospace history and current events.

American Cybersecurity

[These excerpts are from an article by Karl Frederick Rauscher in the March 2015 issue of **Scientific American$.]**

…the event's themes—Internet governance and cybersecurity—are central agenda issues for American political leaders. The former topic is on the front burner for the U.S. Congress, and the latter is a staple of the ongoing dialogue between President Barack Obama and President Xi Jinping of China.

…Trust in American technology is eroding, not only in China but also in economic powerhouses such as Germany….

…The detailed list of recommendations is long, but the keep step American companies would have to take is to state, in clear and certain terms, is that they are *commercial* entities and are not part of any country's national security apparatus….

…American companies not might have much choice. Given the U.S. government's reluctance to engage, tech companies need to be prepared to go it alone.

Serendipity

"Where observation is concerned, chance favors only the prepared mind."
—Louis Pasteur, 1854

[Despite the clearly organized, sequential pattern of the "scientific method," many great advances in science have NOT followed that pattern. They were due to tangential aspects of the research or accidental discoveries that were noticed by researchers with prepared, observant minds. This column shares such fortuitous accidents with you so that they then may be shared with others—especially students—to gain a better, more honest picture of how science has progressed. Perhaps it may alter their attitude in the lab, looking at what actually occurs, rather than just looking for what they expect will happen.]

Sandoz was a Swiss chemical company that was founded in 1886. It first manufactured dyes and, later, saccharin (an artificial sweetener). Its pharmaceutical department began in 1917 with the isolation of ergotamine. This is the active substance in ergot, a deadly poison produced by a fungus that is found in tainted rye. It is attributed with killing hundreds of thousands of people during the Middle Ages. During that time, alchemists and midwives somehow discovered that, in small doses, ergot helped in hastening childbirth and stopping bleeding after delivery.

Albert Hoffman graduated from the University of Zurich in 1929 with a degree in chemistry. He got a job in the pharmaceutical department at Sandoz where he developed a process of synthesizing the compounds in ergot from their chemical components. His starting point was lysergic acid, which is *Lysergsaure* in German.

He attached different organic components to the lysergic acid and then experimented to see if they had any medical uses. By 1938, when Hoffman was 32, he had produced 24 such compounds that had been tested on lab animals. His 25th experiment, using diethylamine (a derivative of ammonia) was referred to as LSD-25. His goal had been to create a medicine that would stimulate the circulatory and respiratory systems, but LSD-25 was written off as a failure when it caused experimental animals to become highly excited without showing any useful effects. Hoffman went on experimenting with other organic molecules built on lysergic acid.

Five years later, during World War II, Hoffman decided to synthesize some more LSD-25. On Friday, April 16, 1943, after crystallizing a few centigrams, he suddenly felt strange and went home early. The following memo to his boss was written when he returned to work the following Monday:

> "I was forced to interrupt my work in the laboratory in the middle of the afternoon and proceed home, being affected by a remarkable restlessness, combined with a slight dizziness. At home I lay down and sank into a not unpleasant intoxicated-like condition, characterized by an extremely stimulated imagination. In a dream-like state, with eyes closed (I found the daylight to be unpleasantly glaring), I perceived an uninterrupted steam of fantastic pictures, extraordinary shapes with intense, kaleidoscopic play of colors."

The Drought You Can't See

[These excerpts are from an editorial of the same title by Marcia McNutt in the September 26, 2014, issue of *Science*.]

The Western Hemisphere is experiencing a drought of crisis proportions. In Central America, crops are failing, millions are in danger of starvation, and if the drought doesn't break soon, even vessels transiting the Panama Canal will need to lighten their loads, which will increase prices for goods transported globally. In the Western United States, the drought-stricken region spans a vast area responsible for much of the nation's fruits, vegetables, and beef. As the drought's grip has tightened, water users have turned to tapping groundwater aquifers to make up the deficit for people, crops, livestock, and industry. But even when the rain does return, regreening the landscape and filling again the streams, lakes, and reservoirs, those aquifers will remain severely depleted. It is that underground drought we can't see that is enduring, worrisome, and in need of attention….

Underground reservoirs are a natural long-term water storage solution. Taking advantage of aquifers avoids the expense and environmental issues of dam construction. Unlike surface reservoirs, aquifers are not subject to evaporative loss, but under natural conditions they are only recharged slowly as excess precipitation percolates into the aquifer. In some cases, the average age of groundwater can be many thousands of years old, dating back to a time when the climate was wetter. But when water is withdrawn through pumping at prodigious rates, hydrologic processes are not sufficient to fully recharge the reservoirs, especially when land development has created impervious surfaces….

Surface- and groundwater are all part of one coupled system, responding on different time scales to changes in precipitation. Five years ago…an Arizona congressman had some concerns about a USGS [U.S. Geological Survey] report on the impact of overpumping of groundwater on surface stream flows. The congressman declared, "You all should be aware that according to Arizona state law, surface water and groundwater flows are decoupled." Jim Leenhouts, the USGS associate director for the Arizona Water Science Center responded, without hesitation, "Thank you, congressman. Here at the USGS we follow the laws of nature, not the laws of man." It is high time we started managing our precious water supplies in harmony with the laws of nature.

Bridging the Opinion Gap

[These excerpts are from an editorial with the same title that was written by Alan I. Leshner appeared in *Science* on January 30, 2015.]

…According to survey results released this week by the Pew Research Center…when asked whether U.S. scientific achievements are either the best or among the world's best, only 54% of the public said "yes," compared to 92% of the scientists. Such disparity is alarming because it ultimately affects both science policy and scientific progress….

What accounts for this large opinion gap? Hot topics such as the safety of eating genetically modified (GM) foods, the importance of using animals in scientific research, the reality of human-caused climate change, the safety of vaccinations, and human evolution are among the issues that cause substantial disquiet among the public. Most scientists (88%) said that eating GM foods is generally safe, for example, whereas a mere 37% of the public agreed. Similarly, the 2014 survey reports that the public's stance on climate change has become "increasingly contentious," as a greater percentage of the public (25% in 2014 versus 11% in 2009) believes that there is no solid evidence that Earth is getting warmer—a result that is inconsistent with the broad scientific consensus.

These findings should come as no real surprise, given increasing public attention to relatively rare events that, even though infrequent, undermine the public's trust of science, such as conflicts of interest, the failure to replicate certain results, or "silly-sounding" grant titles that imply wasteful spending….

Speaking up for the importance of science to society is our only hope, and scientists must not shy away from engaging with the public, even on the most polarizing science-based topics…. there needs to be a conversation, not a lecture.

The public's perceptions of scientists' expertise and trustworthiness are very important, but they are not enough. Acceptance of scientific fact is not based solely on comprehension levels. It can be compromised whenever information confronts people's personal, religious, or political views, and whenever scientific facts provoke fear or make people feel that they have no control over a situation. The only recourse is to have genuine, respectful dialogues with people….

The opinion gap must not be allowed to swell into an unbridgeable chasm….

Transgenics

Avi Ornstein [NEST '89]

Genetic engineering, also known as transgenics, is a hot button in discussions on scientific research. Transgenic deals with organisms that contain genetic material into which DNA from an unrelated organism was introduced artificially. In an article that appeared in the July 9 & 16, 2012, issue of *The New Yorker* ("The Mosquito Solution"), Michael Specter referred to the attitude toward transgenics as "a nightmare question."

Specter was addressing the issue of using transgenics to solve major problems caused by insects when he stated that "environmental activists feared that the release of engineered insects could set off a cascade of events that nobody would be able to control." He later went on to say that "It would be irresponsible to deploy transgenic insects widely without answers to these questions, but most have been answered in environmental-impact statements and by independent research. If the results were put to the vote of biologists, the overwhelming response would be: the potential benefits far outweigh the risks."

"Many people, particularly in the rich Western world, object to modified food," Specter went on to say, "but such complaints are almost never aired against the same scientific process when it used to make insulin or heart medicine." In the first case, he was referring to bacteria (E. coli) that, through genetic engineering, produce human insulin that fights diabetes better than using insulin produced "naturally"—most commonly by cows. The second case may be referring to prourokinase, which is used in treating heart attacks. Other cases of medical transgenics address human growth hormone, tumors and cancer.

In addressing genetically modified foods in the same article, Paul Reiter, Professor of Medical Entomology at the Pasteur Institute in Paris said: "The objections so rarely have anything to do with the science or the safety of the research. It is an opposition driven by fear. I understand that, but this technology has been used in a different form for years….If the phrase 'genetically modified' was not attached, I don't think people would even mind."

As teachers, it is our responsibility to see that students get a rational understanding of this controversial subject. Arming them with facts is far better than letting them go forth influenced solely by fears that have been too often hyped up by the media.

Overhunting in Thailand

[The following news bit appeared in the January 2015 issue of *NSTA Reports*.]

New research from the University of Florida reveals overhunting of large animals in Thailand's tropical forests is not just an issue for species conservation, but also for the survival of trees and forests there.

Elephants, tigers, monkeys, civet cats, and other large animals in Thailand's tropical forests are under attack from hunters and poachers. The researchers found that these animals play a crucial role in maintaining biodiversity by helping to move seeds through the forest. Overhunting is contributing to the extinction of one dominant tree species in Thailand—*Miliusa horsfieldii*, the Miliusa beech—and other species are on the decline. The study shows that loss of animal-seed dispersers increases the probability of tree extinction by more than tenfold over a 100-year period.

"The entire ecosystem is at risk," says Florida researcher Trevor Caughlin. "We hope the study will provide a boost for those trying to curb overhunting and provide incentives to stop the wildlife trade."

Measuring Reflex Time

Avi Ornstein [NEST '89]

A person's reflex time is a measure of how long it takes them to respond to something they have observed. It is normally a fraction of a second, but it can be measured with a simple experiment and some basic math, with the assistance of a calculator. The only material needed to carry out this experiment is a metric ruler.

As an opening demonstration to catch student interest, you can hold a dollar bill vertically by its end with the thumb and finger of one hand. Have the other end between an open thumb and finger of the other hand. You can release the bill with one hand and easily catch it with the other hand. Then ask for a volunteer to see if he or she can catch the bill when you release it. The student should place an elbow on a desk or table and have the finger and thumb open, ready to catch the bill.

Repeat the activity, holding the lower end between the student's open fingers. Carry on a patter conversation so the student will not know when the bill is being released. While talking, without giving any signal, release the bill and it will pass through the student's fingers before they are closed. (It is important that you practice this before doing the demonstration so you know you can do it without giving a signal of when the bill is being released.)

Explain the concept of reflex time and how, while very short, it still allows enough time for the bill to fall too far to be caught. You were able to catch it because your brain knew when the bill was being released, thereby not actually depending on your own reflex time. The patter talk made the student's response depend on his or her actual reflex time.

The speed at which an object falls (ignoring the effect of air resistance) is $d = gt^2/2$, where d is distance in meters, g is the gravitational force (9.8 m/s^2) and t is time in seconds. (When measuring distance with a metric ruler, you have to remember that 1 cm is equal to 0.01 m.) This formula can be rearranged to get $t^2 = 2d/g$, so the time is the square root of 2d/g.

Give the students the following procedure to perform this experiment:

1. Sit so that you and your partner are facing one another. Your partner should have his or her elbow on the edge of the table with his or her hand above the floor. The thumb and forefinger should be about five centimeters apart.
2. Hold a ruler so that the 0 cm end is between your partner's thumb and forefinger.
3. Talk quietly to distract your partner so he or she will not know when you are releasing the ruler. *While talking*, let go of the ruler.
4. When the ruler is released, your partner will pinch his or her fingers together to catch the ruler.
5. Record the distance at which the thumb and index finger are pinching the ruler. If the distance was less than 10 cm, ignore the result and repeat the process, as the partner had gotten a signal of when the ruler was being released or had simply started closing earlier, based upon anticipation.
6. Repeat steps 1 through 5 *at least* four more times.
7. Switch roles and repeat steps 1 through 6.

The students now have a set of data that should be arranged in a table. There should be five columns. The first is labeled **Trial**. The name of the first partner should be recorded above the second and third columns. The name of the second partner should be recorded above the fourth and fifth columns. The second and fourth columns are labeled **Distance the ruler fell (cm)** and the third and fifth columns are labeled **Distance the ruler fell (m)**.

To find their reflex time, the students have two steps left. The first is to find the average distance the ruler fell, in meters. They then needs to double this, divide by the gravitational force (9.8 m/s^2) and then find the square root.

Students are usually surprised at how small the results are, and that they were able to find it without using any fancy, expensive equipment. As a closing note, I have found that it is good to have one meter stick on hand for any students who have slightly slower reflexes. The normal metric ruler may be too short for them to be able to perform the experiment, bit the result is still impressive. For example, an average distance of 20 cm has a reflex time of 0.20 seconds while an average distance of 40 cm is still only 0.29 seconds!

Step Up Your Advocacy for Students

[John Steczak suggested including these steps that can be taken to influence education, as they relate closely with the issues NEST investigated in Washington, DC, in the summer of 2013. This list is edited, not including specific union actions. The complete list appeared in *NEA Today* in January 2015.]

1—Local:
- Keep up with key issues.
- Attend school board meetings and speak up on issues that matter to students.
- Pen a letter to the editor explaining your opinion on key education issues from your perspective as an educator, and perhaps a parent.
- Vote in local elections.

2—State:
- Show up at important rallies!
- Write letters to your governor on relevant issues.
- Make sure your representatives in the state legislature hear from you on education issues. Whether your state superintendent of education is elected or appointed, it's your job to hold them accountable.
- Vote in state elections.

3—Federal:
- Make your voice heard by signing petitions.
- Contact your members of Congress to let them know how they can stand up for students and working families.
- When your lawmakers return home, make an in-person visit and share your experiences.
- Vote in national elections.

4—Level Up!
- Ask others in your school and community to share their stories with elected leaders.
- Invite elected leaders at all levels to visit your classroom! Time spent on your turf will teach them a lot and will help them to understand how to advocate for public education.

The Littlest Christmas Tree

Avi Ornstein [NEST '89]

This seasonal lab can be used in a wide variety of courses. The goal is to have students develop their observational skills in a different, interesting manner. The safety risks are minimal, but they should not be ignored. Students need to be careful in handling and cleaning glassware. The chemical solution is moderately toxic and can stain one's skin and clothing. Therefore, they need to be careful in handling it and should immediately wash off any that gets on them while wearing goggles to protect their eyes and an apron to protect their clothes.

The procedure is as follows:

1 Use scissors to carefully cut off a very small isosceles triangle of copper, about 2 mm high and 0.5 mm on the base.
2 Center the piece of copper on a microscope slide.
3 Bring the piece of copper into focus on the microscope, positioning it so that the base of the triangle is at the bottom and the piece of copper is in the center of the field of vision.
4 Draw how the triangle looks, paying attention to detail.
5 Add a *single* drop of 0.4 M silver nitrate solution on the piece of copper. The solution will react when it comes in contact with the copper, but it will take a little time.
6 Use the microscope to observe the chemical reaction as it occurs.
7 Draw a second picture showing what you observe after the reaction has stopped.
8 Clean up by carefully placing the slide and its contents in the designated beaker. Unplug and put away the microscope. Wash your hands and wash and dry the area where you were working.

Each student should submit a pair of drawings and a paragraph describing what you observed during this lab. In addition, they should write a clear paragraph that *explains* what they learned by performing this lab. The important in this directive is that the student explains what he or she learned. What is learned will vary from student to student and from class to class, depending on what has previously been learned. The important point is that they do not merely claim to have learned something. The explanation supports the claim, giving it value.

Most students have found the reaction fascinating. The single replacement reaction converts the copper triangle to look like a silver-colored evergreen, making it easy to interpret as a Christmas tree. The fact that a microscope is required to see the details adds to the impact, making it a worthwhile lab activity for this time of year.

Things—empires, kingdoms, castles and wealth—these are nothing. Mere forms of more enduring entities, here today and gone or in the hands of another a few years hence. Knowledge, ideas—truths—these are the real materials out of which life is made and measured.

—Gordon R. Dickson
Jamie the Red

Predictive Analytics

[This excerpt is from an article by Jim Soland that appeared in the December 2014/January 2015 issue of *Phi Delta Kappan*.]

…As is so often the case with reform tools taken from industry and applied to schooling, there are differences between predictive analytics in education and in other fields that are often ignored. Perhaps most important, teachers already know a great deal about their students—far more than an investor knows about a stock or a baseball scout about an up-and-coming pitcher. In fact, teachers are a veritable treasure trove of data on student behaviors, attitudes, and aspirations—information not typically included in a statistical model. Teachers also have far more power to shape what happens to students, an influence driven in part by their opinions of each kid. Using predictive analytics in education while ignoring these differences may lead to misidentifying students as at risk of dropping out and negatively influencing how teachers view those students.

Computers and Education

[The following quote appeared in the January/February 2015 issue of *Technology Review*, citing an article by Robert M. Fano that originally appeared in *Technology Review* in March 1970.]

One of my greatest frustrations as a teacher has been my inability to meet simultaneously the needs of all my students. Students differ greatly from one another, not only in their intellectual capabilities: some proceed from the general to the specific; others from the specific to the general; some refuse to pay attention to details before they have acquired an overall view, while others cannot see the forest before having examined each tree. Individual instruction is the ideal answer; however, the necessary number of qualified teachers is just not available. Computers, if properly used, may provide a way out.

Computer-aided instruction is often misleadingly described as 'replacing teachers with computers.' This interpretation implies mechanizing, rather than personalizing, education. Instead, we should strive for an interaction between teacher and student through the medium of a computer system. The goal is to make it possible for a teacher to provide individual guidance to many students instead of a few.

We may envision computer-aided instruction operating as follows: Each student uses the material stored in the computer system, learning and answering questions, under control of a program appropriate to his needs. The teacher monitors progress, and modifies the control program for each student as needed. If a student encounters difficulties, the teacher is called to give personal assistance through his own computer terminal.

This opportunity hinges on bringing the power of computers to the service of the individual, a significant departure from the attitudes and trends that prevail today.

Darkness

[This excerpt is from an op-ed article by Clark Strand that appeared in *The New York Times* on December 20, 2014.]

…There's no getting away from the light. There are fluorescent lights and halogen lights, stadium lights, streetlights, stoplights, headlights and billboard lights. There are night lights to stand sentinel in hallways, and the lit screens of cellphones to feed our addiction to information, even in the middle of the night. No wonder we have trouble sleeping. The lights are always on.

In the modern world, petroleum may drive our engines but our consciousness is driven by light. And what it drives us to is excess, in every imaginable form.

Beginning in the late 19th century, the availability of cheap, effective lighting extended the range of waking human consciousness, effectively adding more hours onto the day—for work, for entertainment, for discovery, for consumption; for every activity except sleep, that nightly act of renunciation. Darkness was the only power that has ever put the human agenda on hold.

In centuries past, the hours of darkness were a time when no productive work could be done. Which is to say, at night the human impulse to remake the world in our own image—so that it served us, so that we could almost believe the world and its resources existed for us alone—was suspended. The night was the natural corrective to that most persistent of all illusions: that human progress is the reason for the world.

Advances in science, industry, medicine and nearly every other area of human enterprise resulted from the influx of the light. The only casualty was darkness, a thing of seemingly little value. But that was only because we had forgotten what darkness was for. In times past people took to their beds at nightfall, but not merely to sleep. They touched one another, told stories and, with so much night to work with, woke in the middle of it to a darkness so luxurious it teased visions from the mind and divine visitations that helped to guide their course through life….

RECOMMENDED READING

[The following articles are highly recommended to be read, by both those reading this newsletter and also appropriate students.]

Biello, David; "Nuclear Letdown"; *Scientific American*; March 2015; p. 16.

Bullis, Kevin; "Forget Hydrogen Cars and Buy a Hybrid"; *Technology Review*; March/April 2015; p. 20.

Nelson, Ben; "Passing the Midterm"; *Scientific American*; October 2014; p. 15.

Richardson, Joan; "Being a Problem"; *Phi Delta Kappan*; October 2014; p. 4.

Shermer, Michael; "A Moral Starting Point"; *Scientific American*; February 2015; p. 84.

Yulsman, Tom; "Climate in Crisis"; *Discover*; January/February 2015; pp. 11-12.

Grading Quizzes

Avi Ornstein [NEST '89]

Over four decades of teaching, I have developed a style of designing and grading quizzes that seems to help students develop meaningful learning skills that go beyond my classroom. This starts with the policy that all quizzes are unannounced, but they are also open-note. This means that students can use their notes while taking quizzes. These, however, refers to only using their own notes, not those of their neighbors.

The unannounced but open-note policy has two beneficial impacts on my students' habits. The fact that the quizzes are unannounced requires students to be organized and to keep up to date, rather than just cramming when a quiz is announced. They need to do assignments and keep current on the subject material and it encourages developing good note-taking skills, along with paying attention in class. In addition, I also have two or more forms of the quiz, so neighboring students have different but equivalent quizzes on the same material. This decreases the problem of having to be a hawk, watching for attempted efforts by students to merely copy answers from classmates.

I divide quizzes into two classes, and each is treated differently. Content knowledge quizzes see if students know straight facts while problem solving quizzes see if students can apply content material. When students take a content knowledge quiz, it cannot be retaken while problem solving quizzes can be retaken, as long as it is within a limited time period (usually two weeks after I have gone over the quiz in class).

While content knowledge quizzes cannot be retaken, I drop the worst quiz of this variety at the end of each marking period (as long as it does not lower a student's grade). If the quiz grades are all similar, it will not mean much. However, it does compensate for a quiz that was 'out of character' due to such things as having forgotten course notes on that day, not feeling well or having stress due to some outside pressure.

On the other hand, there are some limitations to retaking a problem solving quiz. If a student has a grade below 40%, it is mandatory to come for aid outside of class to go over the quiz to be sure they understand why they received such a low grade. They must show a serious concern to earn the privilege of retaking the quiz.

One additional difference is that minimum grades are set for content knowledge quizzes since they cannot be retaken. If the student's grade is below 40, it is raised to 40 and if the grade is from 40 to 49, it is raised to 50. One reason is to prevent students from simply giving up. In addition, it is attempting to modify for the major range of failing grades (0 to 59) while only a ten-point variation exists between other grades. Since problem solving quizzes can be retaken, the responsibility of increasing grades falls upon the students. [This experiment was started this academic year. The results thus far seem to be positive, but the jury is still out as to whether this will continue in the future.]

The deadline for publication in the next issue is: **September 1**

Please send articles to:
Avi Ornstein, **ornstein@alum.mit.edu**

USPTO National Summer Teacher Institute

Tracy Vassiliev [NEST '13]

"No matter what people tell you, words and ideas can change the world."
—Robin Williams

The United States Patent and Trademark Office (USPTO) hosted their inaugural National Summer Teacher Institute on Innovation, STEM and Intellectual Property from August 10-14, 2014, in Santa Clara, California. The USPTO selected teachers from twenty states from all over the country to participate in the inaugural conference. Craig Devine [NEST '09] and Tracy Vassiliev [NEST '13] were both honored to be selected to participate in this professional development opportunity that mirrors the philosophy and spirit of MIT SEPT.

On the first night of the conference, we heard from U.S. Congressman Michael Honda. Congressman Honda has been affiliated with public education for a combined 30 years, he understands the importance of STEAM (we can't forget the arts). He encourages teachers to help students see that STEAM is everywhere, even when boiling an egg. Congressman Honda knows that making mistakes can lead to incredible discoveries, where an **oops** turns to an **oh**, and then to a **wow!** We, as educators, should encourage more academic risk taking by our students. They need to understand that it is all right to fail; after all, failure is where learning grabs hold.

The next presentation was from Jim Cybulski, a PhD student in Mechanical Engineering at Stanford University. He blew all our minds with the Foldscope—a microscope that is made from paper and has the capacity to magnify up to 2000x. This incredible feat of engineering costs about 50 cents to make. Every teacher received a Foldscope perforated sheet of waterproof paper and a 2 mm glass bead (the lens). We all proceeded to build our own fully functioning microscopes. The plans are to get these Foldscopes out to countries that need this diagnostic tool in the field as they are easy to maintain, portable and extremely inexpensive. Such a device can be used to save millions of lives by allowing people to identify, while in the field, malaria, tubercle bacillus, leishmaniasis and more. AMAZING! The Foldscope has the potential to have an enormous global impact, but, as teachers, we are also thinking in terms of our first world problem: school budgets. The Foldscope could be placed in hundreds of students' hands for less than it would cost to purchase and maintain a typical compound microscope. The first few hours of the 2014 USPTO STEM conference were already so inspiring, we all knew we were in for an incredible conference and the USPTO did not disappoint us.

During the conference, we were introduced to impressive panels of speakers, one of which included Stephanie Santos, a researcher of the Technology and Innovation Division of the White House Office of Science and Technology Policy. She asked us to make sure our students develop into MAKERS and not just consumers. Allowing student time to design, construct and create is important in fostering innovation. Steven Davee, the director of education and communications of the Maker Education Initiative, encourages the establishment of inclusive maker hubs that are inviting to ALL students. To demonstrate the maker philosophy, Mr. Davee provided groups of teachers with "Possibility Boxes" and had us create something that either was art or made art. Each box contained a plethora of materials, including batteries, motors and LED lights. The openness of the project was initially intimidating. However, as we collaborated, bouncing ideas off each other, concepts evolved into extraordinary creations.

Dr. Farrow, from the New Jersey Institute of Technology, showed us how he is using nanotechnology (carbon nanotubes) to talk with bacteria through electrical signals. Dr. Farrow said he was intrigued and eagerly engaged with this research because he was told, "it was impossible." This is what makes children natural innovators; since they do not know what's impossible, anything and everything becomes possible. They are not paralyzed with notions of "that's not going to work because of 'X', 'Y' and 'Z'." As educators, we need to make sure our students' innovative spirits are not squashed. Tanaga Boozer, the USPTO STEM Conference program advisor, summarized it perfectly when she said that, by the time students graduate from primary and secondary education, they should not need to be inspired to become innovators but instead they should be innovators that are already inspired.

Dr. Homayoon Kazerooni, professor of Mechanical Engineering at the University of California at Berkeley (who, by the way, earned his doctorate in Mechanical Engineering at MIT), stressed the importance of mathematics and science fundamentals. Students will not be able to "hack" their way into becoming great innovators without putting in the work necessary to understand fundamental concepts. We can definitely hook students with the Maker Movement, but students also need to grow into an open mindset, where they understand the hard work and dedication necessary to be successful. The human exoskeleton work being done at the Berkeley Robotics and Human Engineering Laboratory (affectionately known as "KAZ LAB") is incredible. There are so many applications for these wearable systems that enhance strength and endurance. Dr. Kazarooni stressed the importance of truly understanding the problem before working to develop solutions. The "engineering involved needs to be in contact with reality." This is why the proficiency of mathematical and scientific fundamentals is so important.

Dr. Evangelyn Alocilja, Professor of Biosystems Engineering at Michigan State University, talked about her work with nanotechnology-related biosensors. Her drive to learn and innovate was fueled by her need to make a positive global impact. Her research led to the development of field-operable nanotechnology-based biosensors for global health, food and water safety, homeland security and product integrity in areas with limited resources. Dr. Alocilja also played a big role in a Global Invention Challenge, an activity designed to expose teachers to the innovation process. Teachers were expected to address the Ebola crisis. They were asked to brainstorm a solution, design an invention and perform patent and trademark searches to provide evidence that their ideas were original, create a logo and pitch the invention idea to a panel of experts. Dr. Alocija played a tough venture capitalist evaluative of the science behind the invention ideas.

Mr. Mark Miano, Executive Editor at NBC Learn, introduced us to their Science of Innovation video series. This video series was created in conjunction with the National Science Foundation and the USPTO. It is a free resource educators can use with their students. Each video can easily be connected to the mathematics and/or science concepts associated with the Common Core or the Next Generation of Science Standards. Science Innovation uses these digital cue cards that were developed by the MIT Media Lab. Each video has a transcript and lesson ideas associated with it and when you flip the card you get the general information, a description of the video and

key terms. The research of Dr. Alocilja, Dr. Farrow and Dr. Kazerooni are highlighted in three of the Science of Innovation videos.

Sylvia Martinez, one of the authors of "Invent to Learn: Making, Tinkering, and Engineering in the Classroom" wants us as educators to "figure out ways to help kids play science." Ms. Martinez is a big supporter of authentic learning through designing and hands-on activities because, as Ms. Martinez said, "I was told I was smart for 12 years, but instead I was just good at school" and she has since worked with brilliant people that struggled with the conventional ideas of schools. The do it yourself (DIY) culture is where they were able to excel. Ms. Martinez recognizes that "thinking is just playing brought to the next level." She is passionate about reaching out to all students through the Maker Movement, which emphasizes learning-through-doing, also known in the education community as constructivism.

Alan Zack is the senior director of marketing and communications for the X Prize Foundation, a non-profit organization whose purpose is to benefit humanity by sponsoring competitions mindful in promoting technological innovations. Mr. Zach shared with us several past challenges and their triumphs as well as some new challenges. One student challenge was spawned from a new Disney movie that is set to be released this fall, "Big Hero 6." This student video contest will challenge young people to create a two-minute video about what they can do to "better humanity." There will be two age group categories: ages 8-12 and ages 13-17. More details are expected to be provided in the fall of 2014, closer to the time of the release of the movie.

The STEM portion of the conference was fascinating, but we also learned so much about patent and trademark law from Lana Pham, a USPTO trademark examining attorney, and Mike Razavi from the USPTO Office of Innovation Development. Susan Anthony, an attorney advisor for the Global Intellectual Property Academy at USPTO also spent a long time with us, answering all our questions on fair use copyright guidelines for teachers.

Tracy Vassiliev [NEST '13] would like to personally thank Joyce Ward, Director of the Office of Education and Outreach at the USPTO, and Dr. Jorge Valdes, the USPTO's expert advisor on STEM for the Office of Education and Outreach, as well as the rest of the outstanding USPTO professionals, for developing such an inspiring opportunity for educators. We look forward to implementing several aspects of the STEM conference in our respective high school and middle school classrooms and hope that many MIT Network of Educators in Science and Technology teachers will also find the resources and additional information academically stimulating and useful.

NEST teachers should keep an eye and ear open for information about the 2015 USPTO's Summer Teacher Institute on Innovation, STEM and Intellectual Property, which will be held sometime this coming July.

Resources

- Maker Club Playbook: http://tinyurl.com/lb8dtcc
- NBC Learn Science of Innovation Resources: www.nbclearn.com/innovation
- Environmental Innovation Challenge: www.foster.washington.edu/centers/entrepreneurship/eic/Pages/eic.aspx
- Copyright and Fair Use Guidelines for Teachers: http://schd.ws/hosted_files/usptoteachersteminnovationi2014/c6/Copyright_Chart.pdf
- STEM Innovator Canvas: http://tinyurl.com/l9bl7u7
- Patents for Humanity: www.uspto.gov/patents/init_events/patents_for_humanity.jsp
- X Prize: Making the impossible possible: www.xprize.org
- USPTO, Kids, Teens, Parents & Teachers: www.uspto.gov/kids

Further Information

- Foldscopes, Stanford University: http://web.stanford.edu/~manup
- TED Video: www.ted.com/talks/manu_prakash_a_50_cent_microscope_that_folds_like_origami
- Dr. Reginald Farrow, New Jersey Institute of Technology, Communicating with Bacteria: www.nbclearn.com/science-of-innovation/cuecard/62970
- Dr. Evangelyn Alocilja Michigan State University, Field-operable Nanotechnology-based Biosensors: www.nbclearn.com/science-of-innovation/cuecard/62970
- Dr. Homayoon Kazerooni, University of California, Berkeley (Doctorate in Mechanical Engineering from MIT), Exoskeletons: www.nbclearn.com/science-of-innovation/cuecard/62976

Oceans and Rachel Carson

[These excerpts are from an article by Robert K. Musil that appeared in the December 2014 issue of *Population Connection*.]

Old notions die hard. That the oceans are a handy sink or toilet. Or, that they hold endless bounty for us to chow down on with melted butter and Old Bay seasoning. Conceiving of the deep blue sea as a living, fragile, and exploited ecosystem is challenging. Changes in the oceans and the living things in them are not very noticeable to the average beachgoer.

That we care *at all* about what happens to the oceans is due in large part to Rachel Carson.

Fifty years after her death, Carson is best known for her brilliant exposé about the danger of pesticides in her 1962 bestselling book, *Silent Spring*. Carson is also, to a lesser-known degree, the mother of the movement to protect the oceans….

It was Carson who first described for the American public the World War II ocean research that used sonar, bathyspheres, and submarines….

Overfishing through huge mechanized trawlers and drag nets, rising ocean temperatures and acidification, dying coral reefs, rising sea levels—all would have been seen by Rachel Carson as part of one large, connected problem. And population growth—like molten magma or massive mountains at the sea floor—lies beneath the surface of our turbulent sea of troubles—too little observed, discussed, or understood….

Rachel Carson wrote eloquently about the evolution of all life from the oceans. And she warned that, unless we change our ways, having started in the sea, life could also end there.

NSF and Education

[These excerpts are from a feature article by Jeffrey Mervis that was in the February 6, 2015, issue of *Science*.]

…NSF has poured half a billion dollars into the program, created by Congress in 2002 to draw those with STEM…degrees into teaching at high-needs schools. The lawmakers' key premise: Students would learn more science and math if taught by those who knew—and loved—the subjects….

Noyce….is getting increased attention as a key federal contribution to the Obama administration's pledge to train 100,000 new science and math teachers over a decade. So far, 5008 teachers working in a high-needs district have received funding from one of 494 Noyce programs that NSF has funded at universities in every state.

…Noyce was created specifically to both increase the number of highly qualified science and math teachers in the nation's poorest schools and raise the achievement levels of students in those schools.

…success or failure—including attitudes toward the teaching profession and the myriad factors that affect how students learn—lie outside NSF's power to control. Still, a recently completed evaluation by Abt Associates of Cambridge, Massachusetts, suggests that the initiative is not having nearly the effect its supporters anticipated.

As part of a broader program evaluation, Abt examined the impact of Noyce grants on teacher production and student achievement in six states. It found that students in science and math classes with Noyce-supported teachers did significantly better on standardized tests than their peers in two of the states, no better in three others, and worse in one state. Similarly, Abt found a small rise in teacher production in two states with Noyce programs, but no impact in three other Noyce states and a drop in one….

NSF officials say they aren't surprised at the lackluster results. Noyce has so many moving parts, agency officials say, that it's unrealistic to expect more than small, haltering steps toward its expansive goals. Besides, they note, any program run by NSF also has a research component that is often difficult to connect to real-time outcomes.

…One study found that 55% of high school physical science classes and 28% of middle school math classes were being led by teachers with little or no training in those fields.

So in 1989 Boehlert…proposed anew scholarship program at NSF to train math and science teachers….

There are many reasons for the current dearth of good STEM teachers. Despite the terrible job market for academic scientists, many mentors of undergraduate STEM students still express disapproval if one mentions a desire to teach in the public schools after graduation instead of pursuing a research career. There's also the low prestige, poor salary, and difficult working conditions attached to the profession….

It often takes an external force—a boring job, perhaps, or the relocation of a partner—for a STEM professional to turn to teaching. The principal investigators who run Noyce programs told the Abt evaluators that recruitment remains their biggest challenge….

As important as it is to attract scientifically trained people into teaching, some education experts argue that retaining current science teachers may ultimately be more important to improving STEM education. Researchers have found, for example, that as many as one-fifth of high school science teachers leave the profession after their first year in the classroom. And 5-year attrition rates rise to 50% or higher across the entire profession….

The program continues to receive strong support from Congress. And poor schools continue to need more well-trained STEM teachers. But the extent to which Noyce can close the gap remains an open question….

Toxic Chemicals

[These excerpts are from an editorial by Julie B. Zimmerman and Paul T. Anastas that appeared in *Science* on January 16, 2015.]

One year ago, an industrial coal-processing liquid contaminated the Elk River in West Virginia and affected the tap water of 15% of the state's population. The spill was declared a federal disaster, and ongoing investigations remain. Last month, a report assessing the water and health impacts of the Elk River spill pointed to the lack of a sound scientific approach for responding to and recovering from such incidents. This year also marks 5 years since the Deepwater Horizon oil spill in the Gulf of Mexico, and last month brought the 30-year anniversary of the Bhopal gas tragedy that killed thousands, considered the world's worst industrial disaster. Despite our best efforts and intentions, human-made chemicals continue to be released into the environment, often with unquantified and potentially unquantifiable deleterious consequences. The questions posed to science are how to better understand the nature of synthetic substances in order to predict their potential adverse impacts on humans and the biosphere, and how do we design future substances to eliminate the need for engineered control systems.

Until recently, descriptive toxicology characterized the impact of toxic substances on living organisms and ecosystems. Today, the emerging fields of mechanistic and molecular toxicology are evolving our understanding of how toxic exposure happens. We also now know that many of the physical and chemical properties that we impart to molecules to gain function and performance are linked to adverse consequences. Furthermore, improves knowledge about the human body's absorption, distribution, metabolism, and excretion of chemicals suggests a path toward reducing hazards through molecular design. These four criteria are enabling predictive modeling that uses the physicochemical properties and structural motifs of a chemical to provide insights into the transport and fate of chemicals in the environment, their metabolism and (bio)degradation, and their epidemiology.

However, associating the physical and chemical properties of a chemical with the mechanism of an adverse outcome is only a beginning….

If traditional analyses can be coupled with integrated systems approaches, then the knowledge gained about the nature of complex systems may well lead to the design of chemicals that are compatible with life.

Close the Teaching Gap

[These excerpts are from an article by Linda Darling-Hammond that appeared in the Winter 2014-2015 issue of American Educator.]

Federal policy under No Child Left Behind (NCLB) and the U.S. Department of Education's "flexibility" waivers has sought to address this problem by beefing up testing policies….Unfortunately, this strategy has not worked. In fact, U.S. performance on the Program for International Student Assessment (PISA), conducted by the Organization for Economic Cooperation and Development (OECD), declined in every subject area between 2000 and 2012—the years in which these policies have been in effect.

Now we have international evidence about something that has a greater effect on learning than testing: teaching. The results of the Teaching and Learning International Survey (TALIS), released this last summer by the OECD, offer a stunning picture of the challenges experienced by American teachers, while providing provocative insights into what we might do to foster better teaching—and learning—in the United States.

In short, the survey shows that American teachers today work harder under much more challenging conditions than teachers elsewhere in the industrialized world. They also receive less-useful feedback, receive less-helpful professional development, and have less time to collaborate to improve their work. Not surprisingly, two-thirds feel their profession is not valued by society—an indicator that the OECD finds is ultimately related to student achievement….

Nearly two-thirds of U.S. middle school teachers work in schools where more than 30 percent of students are economically disadvantaged….This is by far the highest rate in the world and more than triple the average TALIS rate. The next countries in line after the United States are Malaysia and Chile. Ignored by our current education policies are the facts that nearly one in four American children lives below the poverty line and a growing number are homeless, without regular access to food or healthcare, and stressed by violence and drug abuse around them. Educators now spend a great deal of their time trying to help children and their families manage these issues, while they also seek to close skill gaps and promote learning….

Partly because of the lack of time to observe and work with one another, U.S. teachers report receiving much less feedback from their peers than do their counterparts in other countries…, which research shows is the most useful tool for improving practice. They also report receiving less-useful professional development than their global counterparts….during the NCLB era, more-sustained learning opportunities reverted back to the one-shot, top-down, "drive-by" workshops that are least useful for improving practice….

We often think that when we have completed our study of one we know all about two, because "two" is "one and one". We forget that we have still to make a study of "and".

—A.S. Eddington

The Measure of Research Merit

[These excerpts are from an editorial by Marcia McNutt that appeared in the December 5, 2014, issue of *Science*.]

Each year, $1.4 trillion are invested in research by governments, foundations, and corporations. Hundreds if not thousands of high-profile prizes and medals are awarded to the best researchers, boosting their careers. Therefore, establishing a reliable predictor of future performance is a trillion-dollar matter. Last month, the Alexander von Humboldt Foundation convened an international assembly of leaders in academia, research management, and policy to discuss "Beyond Bibliometrics: Identifying the Best." Current assessment is largely based on counting publications, counting citations, taking note of the impact factor of the journals where researchers publish, and derivatives of these such as the h-index. These approaches were severely criticized for numerous reasons, with shortcomings particularly apparent when assessing young scientists for prestigious, interdisciplinary awards. It is time to develop more appropriate measures and to use the scientific method itself to help in this endeavor.

…Faced with the challenge of gauging the worth of limited publications, evaluators might turn to journal impact factors. Using this as a proxy for the importance of a paper is just plain wrong….

Citations are a better proxy for how much impact a paper is having, but for young scientists and interdisciplinary awards, this metric also has several limitations….

Self-Domestication

[These excerpts are from an article by Ann Gibbons that appeared in the October 24, 2014, issue of *Science*.]

Call a man "tame" or "domesticated" and he's not likely to take it as a compliment. But all of us, male and female, may have to get used to it: Some scientists believe that "self-domestication" was key to the evolution of our species….

No one set out to domesticate humans, of course. But at the first-ever symposium on self-domestication of humans… researchers outlined a set of linked behavioral and anatomical changes seen in animals that humans have tamed as well as in creatures that have tamed themselves. In the course of evolution, some animals have overcome the fear and stress they feel when encountering humans or unfamiliar members of their own species and become less aggressive….

…brow ridges shrank and faces shortened during the past 80,000 years, as our ancestors began to exhibit symbolic behavior and spread around the world. Cranial volume even diminished, particularly after the invention of agriculture about 10,000 years ago.

All of these changes tend to make male faces more like female ones…and are linked to lower testosterone levels.…selection for higher levels of social tolerance led to lower levels of testosterone and stress hormones, especially in males, and thus facial feminization.

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Opportunities for NEST members are outlined on the NEST website—http://web.mit.edu/scienceprogram/nest. They include options to attend the annual NEST Reunion at MIT and submit nominations for Student Awards and the Teacher of the Year Award, which celebrates educators who do extraordinary work promoting science and technology in their communities. Nominations, reunion registration fees, annual dues payments, and donations can be sent to the address below, to the attention of Emily Martin, SEPT Coordinator. Or, please contact us by email (sept@mit.edu) to receive announcements sent via the Network of Educators in Science and Technology Discussion List (NESTD-L).

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