Co-Chair Report

Joyce Gleason [NEST ’92]

Kudos to John Steczak, who completed his term as NEST Co-chair in June. I had met him earlier, but really got to know him during the week at the George Washington University program on legislative empowerment in 2013. I was touched by his stories of struggling to provide his students with a quality science program in spite of socioeconomic conditions and administrative blinders. He truly cares for his charges and for the SEPT and NEST experiences.

My background is a bit different. After many years teaching high school biology in the Boston suburbs (Norwood), I became an urban district science coordinator (Worcester) and later a professional developer for a national television channel (now online as Annenberg Learner). Along the way, I supervised student teachers (Boston College, Brown, Florida Gulf Coast University) and held many volunteer positions with the National Science Teachers Association (including district director, Program Chair for national conferences in Boston and, most recently, chair of the Retired Members Advisory Board). But one highlight of this very long career was my SEPT summer in 1992. As all of you know, it is invigorating and, for me, fostered a long-term commitment to NEST.

In June, I witnessed the end of this year’s SEPT experience. The individuals were exceptional, of course, and the class as a whole was lively, interested and interesting. So now what?

The crush of the new school year is upon all of us. And Life has a way of happening, too. But, for those of us old NESTlings (I prefer this term to “NESTers”) and the new class whom I hope will join us, there is much work to be done for our classes, our students, ourselves and our administrations.

Continued on page 4
Calendar of Events

November 2015
2016 SEPT application posted online
Elections and planning for 2016 NEST Board Meeting

January 2016
Announcement of 2016 NEST Reunion dates, member dues and benefits
NEST Board Meeting and planning for 2016 NEST Reunion, SEPT Hosting, and McNamara Workshop applications (TBD - online or in person)

February 15
Deadline for candidates to submit 2016 SEPT applications directly to MIT (sept@mit.edu)
Announcement of submission instructions for:
  - NEST Teacher of the Year Award nominations
  - NEST Student Award requests

March 1
Submission deadline for:
  - Spring NEST newsletter
  - MIT Alumni Clubs to select top three 2016 SEPT applications

April 1
Announcement of NEST Reunion registration and McNamara Workshop plans
Submission deadline for NEST Teacher of the Year Award nominations

May 1
Submission deadline for:
  - NEST Reunion registration
  - NEST Student Award requests

June
2015 SEPT conference & NEST Reunion (dates to be determined)

Editorial

A generation ago, I occasionally taught science lessons in my children’s elementary classes. This spring, my daughter asked that I do it again, but this time for my grandson. His school year ran a week beyond mine, so a date and subject were worked out with his first grade teacher. I had a window of 30-45 minutes and carefully planned a lesson that I felt would be meaningful and worthwhile.

The factors that I felt were most important were that it would be a hands-on experience for the students and would include unexpected results to heighten the learning experience. I offered to teach a lesson to introduce them to the concept of center of gravity. The teacher approved this topic and I therefore began designing the class while continuing to teach the final unit to my high school chemistry students. Once the lesson was planned, I got together the materials I would need and felt prepared for the experience.

As I drove to New York City, I went over the lesson in my mind, making some final tweaks as the anticipation gradually increased. I wasn’t only teaching very young students (which I had last done 15 years ago), but I was teaching my own grandson and didn’t want to damage the relation we had. He understood he was not going to be treated differently than his classmates, but at that age, small things can have major impacts.

The lesson went fantastically, resulting in positive impacts in several ways. The students had a great time and their teacher was happy that she had learned a lesson that she can now use each year to teach future students. I urge other middle and high school teachers to see if you can fit in teaching at least one hands-on class at an elementary school. It is beneficial to everyone. The students love having an outside visitor coming in and it reinforces a positive perspective of science. Elementary teachers can learn new lessons that they can then incorporate into their own repertoire. (Be sure that he or she has approved the subject of your lesson plan.) In addition, you get a high seeing the look and appreciation offered by such open minds!

RECOMMENDED READING

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

Abbasi, Jennifer; “The Wrong White Crystal”; Discover; September 2015, p. 18.
Greene, Brian; “Why He Matters”; Scientific American; September 2015; pp. 34-36.
Lorch, Mark; “Chemical Reaction”; Reader’s Digest; July/August 2015; pp. 20-23.
Lugo, Ariel; “Forestry in the Anthropocene”; Science; August 21, 2015; p. 771.
McNutt, Marcia; “Ignorance Is Not an Option”; Science; March 20, 2015; p. 1293.
Mervis, Jeffrey; “Why Many U.S. Biology Teachers Are ‘Wishy-washy’”; Science; March 6, 2015; p. 1054.
Shermer, Michael; “The Meaning of Life in a Formula”; Scientific American; August 2015; p. 83.
Tariach, Gemma; “The Numbers Game”; Discover; April 2015; p. 12.
STEM, Business and Government

[These excerpts are from a commentary by Russell Shilling in the April 2015 issue of Scientific American.]

In a recent study sponsored by the Business Roundtable and the nonprofit group Change the Equation, 97 percent of the CEOs of major American companies identified a lack of science, technology, engineering and math (STEM) skills among the national workforce as a problem for their businesses. Over the next five years these firms will need to hire approximately one million new employees with these skills and more than 600,000 with applied science backgrounds. The nation has been in this situation before. In 1944 President Franklin Delano Roosevelt commissioned Vannevar Bush, director of the wartime U.S. Office of Science Research and Development, to create a plan for sustaining the momentum of science achievement that had occurred during World War II, in part by responding to a looming skills shortage—the result of the large number of potential students who had been drafted into the military.

One of the biggest impacts of Bush’s report was to create the separation of basic and applied research, a model that predominates in federally funded science today. Although this separation has been very effective in many fields, in education and the social sciences, basic research sometimes fails to translate successfully into applied settings. As we study ways to confront this new crisis, we should consider an alternate approach to research—one that the Defense Advanced Research Projects Agency has been demonstrating since 1958.

The DARPA process is reminiscent of the development cycles for radar and the atomic bomb during WWII: diverse teams of the brightest minds iterate continuously on basic research challenges aimed at solving enormously complex problems.

To determine where investment should be made, my colleagues and I are currently convening groups of innovators and educators to evolve a vision of STEM education in 2025. Once that vision is clear, we will deconstruct it and outline a plan for achieving it. Will that vision be the correct one? It is hard to say, but this initial vision does not have to be absolutely correct. As long as the basic target of improving educational outcomes remains in sight, the goal and the vision can be adjusted as we work toward them. Just as DARPA researchers could not have predicted what the Internet would become when they laid its foundation in 1968, today’s innovators will not know how technology can transform education until they roll up their sleeves and try it.

Solving the Origin-of-life Puzzle

[These excerpts are from an article by Robert F. Service in the March 20, 2015, issue of Science.]

The origin of life is a set of paradoxes. To get it started, there must have been a genetic molecule—something like DNA or RNA—capable of passing along blueprints for making proteins, the workhorse molecules of life. But modern cells cannot copy DNA and RNA without the help of proteins themselves. Worse, none of these molecules can do their jobs without fatty lipids, which provide the cell membranes needed to contain them. In yet another chicken-and-egg complication, protein-based enzymes (encoded by genetic molecules) are needed to synthesize lipids.

Now, researchers say they see a way out. A pair of simple compounds, which would have been abundant on early Earth, can give rise to a network of simple reactions able to produce all three classes of biomolecules—nucleic acids, amino acids, and lipids. The new work…does not prove that this is how life started, but it may help explain a key mystery.

The RNA World hypothesis got a big boost in 2009. Chemists…reported that two relatively simple precursor compounds, acetylene and formaldehyde, could undergo a sequence of reactions to produce two of RNA’s four nucleotide building blocks, showing a plausible route by which RNA could have formed on its own in the primordial soup. Critics, though, pointed out that acetylene and formaldehyde are still somewhat complex molecules themselves. That raised the question of where they came from.

So [John] Sutherland and his colleagues set out to see if they could find a route to RNA from even simpler starting materials. They succeeded. Sutherland’s team now reports that if created nucleic acid precursors starting with just hydrogen cyanide (HCN), hydrogen sulfide (H2S), and ultraviolet (UV) light. What is more, Sutherland says, the same conditions also create the starting materials for amino acids and lipids.

Sutherland cautions that the reactions for the three sets of building blocks are different enough from one another—requiring different metal catalysts, for example—that they likely would not have all occurred in the same location. Instead, slight variations in chemistry and energy could have favored the creation of one set of building blocks or another in different places on land.

Could life have kindled in that common pool? That detail is almost certainly lost to history. But the idea and the “plausible chemistry” behind it are worth careful thought.

Fast Food

[This brief article appeared in the May 2015 issue of Web MD.]

Fast food could mean slow progress in school. Researchers asked 11,000 fifth graders how often they’d eaten fast food in the last week. By eighth grade, those who had eaten fast food daily were behind their fast-food-free peers in reading. Those who ate it at least four times were behind fast-food abstainers in science. And kids who’d eaten any fast food during that week in fifth grade were behind in math.

Researchers saw the impact of fast food regardless of other possible academic challenges. Possible reasons? Fast food is low in iron, which kids need for cognitive development. It’s also high in fat and sugar, which can hurt memory.
So, why not let your colleagues in NEST, the Network of Educators of Science and Technology, help you? There are so many collective ideas, experiences and wisdom among us. If you were part of SEPT ’15, you learned which participants had which types of expertise. Now imagine that resource multiplied by the more than 25 years’ worth of other classes! The depth of knowledge is mind-boggling.

For example, our Outstanding Teacher awardee, David Iverson, was from a competitive private school in Taiwan. An administrator from his school was present at the dinner and, not surprisingly, acknowledged and praised his efforts. David then explained a project he assigns to his science and engineering students. He then showed sample videos made by them of their projects. The breadth of the topics and inventiveness and energy of the videos were inspiring. David, thank you for sharing! The award is available to all of us who have attended SEPT. Consider applying next spring.

Another benefit of the program is the NEST listserv. It is a forum for questions, ideas, announcements and other forms of sharing with like-minded professionals. In mid-July, Richard Boucher asked for alternatives to a balloon release to honor the passing of a child. He wondered if there were more environmentally-friendly gestures that would convey the longing and respect for the young girl who lost her fight with Type 1 diabetes? Vicky Jordan replied that same day with the suggestion of butterflies and further offered a source. What a great group we have!

As the school year progresses, there will be other opportunities to utilize the NEST contacts, even from people we have not actually met, and the resources made especially available to us at MIT. While some of these are not exclusive to NESTlings, many are. And who could ask for a better team?

Please join us. When Emily forwards information, makes a request (such as dues in January) and has an offer, do join in. We want you to take advantage of who we are and what we stand for! I am pretty sure that you’re that same kind of committed professional and I am personally proud to call you “my colleague.”

Nobody can be saved from anything, unless they save themselves. It is hopeless doing things for people—it is often very dangerous indeed to do things at all—and the only thing worth doing for the race is to increase its stock of ideas. Then, if you make available a larger stock, the people are at liberty to help themselves out of it....Such is the business of the philosopher, to open new ideas. It is not his business to impose them on people.

— T.H. White
The Book of Merlyn

Stephen McCue, the husband of Sharon McCue [NEST ’92], has published a new book. “That Was Not on the Itinerary” is a memoir of the author’s travel experiences. It is an entertaining book detailing the amusing and true stories of travel. Stephen McCue, a husband, aerospace engineer, traveler, writer and now author, has completed this new book unique work that takes the reader on a journey around the world. It is available at Amazon, Barnes & Noble and other sources. It is a collection of Sharon’s and Stephen’s world travels and the little nuances and sidetracks from the planned itineraries that occur. It is also lavishly illustrated with photographs from around the world.

The Beyond-Two-Degree Inferno

[These excerpts are from an editorial by Marcia McNutt in the July 3, 2015, issue of Science.]

In the history of humankind, there is a dearth of examples of global threats so far-reaching in their impact, so dire in their consequences, and considered so likely to occur that they have engaged all nations in risk management. But now with climate change, we face a slowly escalating but long-enduring global threat to food supplies, health, ecosystem services, and the general viability of the planet to support a population of more than 7 billion people. The projected costs of addressing the problem grow with every year that we delay confronting it. In recognition of the shared risks we face and the collective action that will be necessary, an international meeting of stakeholders will convene in Paris next week..., ahead of the United Nations Climate Change Conference (COP21) in December, to discuss solutions for both climate mitigation and adaptation.

The time for debate has ended. Action is urgently needed.... current commitments to cut CO₂ emissions [known as International Nationally Determined Contributions (INDCs)] from the world’s nations are insufficient to avoid warming the entire planet by an average of more than 2°C above the preindustrial level. This is a target viewed as the boundary between climate warming to which we can perhaps adapt and more extreme warming that will be very disruptive to society and the ecosystems on which we depend....

The European Union (EU) is leading the way with the most aggressive INDC target for reduction: a cut of 40% below 1990 levels of CO₂ emissions by 2030. The United States has pledged reductions of 26 to 28% below 2005 levels by 2025, with California independently choosing to match the EU’s more ambitious goal. All eyes are on China and India, two of the largest total emitters of CO₂, both of which have yet to submit their proposed INDCs in advance of COP21....

In Dante’s Inferno, he describes the nine circles of Hell, each dedicated to different sorts of sinners, with the outermost being occupied by those who didn’t know any better, and the innermost reserved for the most treacherous offenders. I wonder where in the nine circles Dante would place all of us who are borrowing against this Earth in the name of economic growth, accumulating an environmental debt of burning fossil fuels, the consequences of which will be left for our children and grandchildren to bear? Let’s act now, to save the next generations from the consequences of the beyond-two-degrees inferno.
As a math teacher, I have heard the following phrase over and over: “I’m just bad at math.” My response is always that of course they can, but it is a cultural problem that is solvable with a little help from the other adults in the students’ lives. When I was at Bates thinking about philosophy, one of the things that interested me was John Locke’s tabula rasa (blank slate) philosophy. To paraphrase, he is saying that we are all born blank slates and we can all learn to do anything. This is powerful stuff, especially as it applies to my students above. If they are truly blank slates, I can help them write numeracy on their mind’s chalkboard in sharpie. To this end, I run a seminar every year on the first day of class to discuss whether or not the blank slate is a real thing. Then, my Socratic questions become mathematical. For instance: “Do you think everyone can do math? Why or why not? How would Locke feel about your answer? What keeps you from excellently at math? What can you do to change that? What can I do to help you this year in my class?”

The shame of all of this is that numeracy should be as important as literacy. No one looks at a book or a road sign and proudly proclaims, “I can’t read!” However, how many times have you heard someone say they can’t do math—without even a hint of embarrassment? Sometimes there’s even an “I’m so cool, I don’t need math” timbre to their voice. We need to change that culture. Adults need to stop saying that math is hard and telling their kids and their students and their relatives that it’s ok not to learn it because it was a struggle for them, too. Do we tell dyslexics that because reading is hard for them they should stop trying? No. Let’s be Tywin Lannister and make Jamie read.

Another related point: every year since I became a math teacher, there has been a “reading/writing across the disciplines” initiative. I have participated glad;y, asking students to write post seminar reflections that justify their mathematical decisions and teaching vocab every day. Hence, the verbal scores on standardized testing usually increase. Everyone in every subject is expected to teach reading and writing. What happened to “rithmetic”? There is a need for this in our country and, until it’s addressed, our students will continue to be sub par mathematicians and unsuccessful financially. They’ll take out credit cards that offer 0% and not realize it changes to a variable 22% after 3 months. Then they’ll wonder why their mortgage is upside down and they have to declare bankruptcy and live with their parents. No man is an island, and neither is any math teacher. We need parents as well as teachers of other disciplines to jump in, show the connections their subject has to math and help make it relevant.

I’ll end this with a plea: If you ever find yourself about to tell a child that it’s ok, math is hard and you never got it either, please stop. Instead, tell them it’s a beautiful language that they can learn to read and that, if they do, their lives will be immeasurably enriched. They will open career doors, understand personal finances, be monetarily successful someday and be an educated, critical citizen who is capable of looking at a statistic and evaluating whether or not they are being lied to. When we can all make smarter financial decisions, we will stop letting credit card companies take advantage of us. We’ll stop bailing out banks that gave us ridiculous, untenable mortgages. As a society, we will learn to prosper. But first, we have to live by the tenet “we all use math every day.” You can certainly live your life without thinking much about mathematics. Many people do, and proudly admit it. However, compared to someone who is aware of math and facile with it, those folks will have a tougher time. So, in conclusion, even if you really feel like you’re bad at math, please resist the urge to tell anyone. You wouldn’t tell them if you couldn’t read.

For more about the bank bailouts, go to: http://abcnews.go.com/Business/story?id=7868310. Of note—they’ve repaid 66 billion dollars, which seems like a lot. However, they were loaned 700 billion, so they’ve only paid back 66/700 to the government, which is only 9.43%. The way the numbers are reported make it sound like the banks are doing a great job, but they still owe 90.57% and they wouldn’t give us a home loan with only 9.43% down.

Science Communication

[These excerpts are from an editorial by Marcia McNutt in the March 6, 2015, issue of Science.]

Scientists frequently lament the scarcity of effective scientific communicators—those who can explain complex concepts to the public, present scientifically sound alternatives to policy-makers, and make cogent arguments for the value of science to society. A few stellar programs are designed to select and train elite articulators, but some simple steps can improve the communication skills of all scientists. Most researchers learn how to talk about science at meetings. If scientists cannot explain their work clearly and succinctly to their peers, it is highly unlikely that they can explain it effectively to nonscientists….

Training the next generation of scientists to communicate well should be a priority. Departments could arrange for students to hold mock presentations for other faculty, researchers, and students in advance of their presentations at conferences—a dress rehearsal before the main event. And researchers attending meetings should take some time to judge a few student papers, visit student posters, or attend student talks. This feedback to young scientists is invaluable, and the great communicators that will emerge may well trace their sharpened skills back to a moment at their poster or at the podium.

[Mark Prelli is a math teacher at Classical Magnet School in Hartford, CT. The Paideia Socratic Seminar is part of the theme of Classical Magnet School. Students participate in seminars in every class every few weeks, in preparation for a rigorous liberal arts college experience.]

The Rising Cost of Innumeracy

Mark Prelli

[These excerpts are from an editorial by Marcia McNutt in the March 6, 2015, issue of Science.]
Characterized by a focus on interactions, from genes to global scales, and between living and nonliving components of ecosystems, basic ecological research has spawned important paradigm changes over the past 100 years. For example, we have learned that a simple graphical model of biogeography can explain species distribution patterns at many spatial scales. Another major change has been the development of our understanding of succession after disturbances, from major forest fires to the effects of antibiotics on intestinal microbial communities. As ecological science becomes more interdisciplinary, shifts in thinking and unexpected impacts will continue. Early ecologists who thought about principles governing plant and animal communities never imagined that their ideas would provide the foundation for understanding the human microbiome, affecting our nutrition, immune system, and even psychological state. The new field of synthetic ecology in which ecologists and medical professionals design beneficial microbial communities, has its origins in century-old ecological field studies. These examples foretell how the roles of ecologists and the applications of ecological principles are likely to change in the next century, and why medical students and practitioners need to understand ecology.

…From the microbes inhabiting the earth beneath our feet to environments of the universe unknown to us know, the next 100 years of ecological discoveries will influence our lives. We enter a time when society is armed with the scientific knowledge and ability to make responsible decisions.
Climate Change

[These two news briefs appeared in Science on June 19, 2015.]

Nations’ pledges to cut greenhouse gases would buy the world only a little time before global temperatures shoot past the 2°C warming goal agreed on during climate talks in 2010, the Paris-based International Energy Agency said 15 June. Promised emissions reductions would keep temperature increases below the 2°C threshold until about 2040—just an extra 8 months compared with projected increases in the absence of those reductions. After that, global temperatures are projected to increase by about 2.6°C by 2010. The agency called for stronger action—including a global peak in energy emissions by 2020—through a series of steps including banning construction of inefficient coal power plants, eliminating fossil fuel subsidies, and a 50% hike in annual renewable energy investment.

Pope Francis squarely blames the burning of fossil fuels for climate change, a leaked version of his long-awaited environmental encyclical revealed on 15 June. There is “a very consistent scientific consensus indicating that we are in the presence of a disturbing heating of the climate system,” says the leaked draft, which is in Italian. Vatican watchers have speculated whether the pope—who was trained as a chemist—would delve into scientific and policy details or would focus on climate change’s impacts. The draft does both, discussing soil and water acidification, methane release feedback loops, and policy ideas for curbing emissions—while decrying a “culture of waste” and noting the damaging health effects of fossil fuel pollution on the poor. As Science went to press, the Vatican was expected to release the final document as planned on 18 June.

Agricultural Research

[These excerpts are from an editorial article by Donald Kennedy in the October 3, 2014, issue of Science.]

Nine billion people are expected to inhabit Planet Earth by 2050. Without agricultural research, there is little hope of sustaining this population surge, given that arable land and water supplies are fixed commodities. Yet for decades the agricultural sector has suffered from neglect. If we want to combat new strains of pests that destroy crops, find new crop varieties enriched in nutritional value, improve yields, develop resistance to disease and drought, and provide environmentally sensitive cultivation practices, then agricultural research must be a priority….

…Over the past 35 years, new ventures in U.S. public investment in agricultural research and development confronted a steady decline. At the same time, great advances in biochemistry, cell and molecular biology, and genetics were being made through increased funding to other agencies for competitive merit-based research grants….

The much-needed revolutions in agriculture can only come about through the investments that we make now. Nine billion people will, we hope, reap the benefits of today’s wise decisions.

The Value of Soil

[These excerpts are from an editorial by Diana H. Wall and Johan Six that appeared in Science on February 13, 2015.]

We are not paying enough attention to the world’s soils, a “nearly forgotten resource” and our “silent ally,” 33% of which are in a state of degradation. We can’t breathe, eat, drink, or be healthy without sustainably managing soils….

A major concern is whether soils will support the growing demand for food. Human activities have transformed soils, lands, and regions, with long-lasting effects that include desertification, decreased organic matter in soil, altered biodiversity, and changed biogeochemical and hydrological cycles. As a result, the land available for food production is shrinking, irreversibly in some cases. Converting cropland to biofuel systems and urban systems is having the same effect. Agricultural practices have increased soil erosion to rates much greater than those of soil formation (it can take up to 1000 years to form 1 cm of soil). The mismanagement of soil resources is exacerbating these assaults on the food supply.

…As U.S. President Franklin D. Roosevelt said, “A nation that destroys its soils destroys itself.”

Sahara Dust Fertilizes the Amazon

[These excerpts are from a “Headline Science” article of the same title in the April/May 2015 issue of The Science Teacher.]

…they are connected. Every year, millions of tons of nutrient-rich Saharan dust cross the Atlantic Ocean, bringing vital phosphorus and other fertilizers to the depleted Amazon soils.

For the first time, scientists have accurately estimated how much phosphorus makes this trans-Atlantic journey…about 22,000 tons per year, which roughly matches the amount that the Amazon loses from rain and flooding.

The phosphorus accounts for just 0.08% of the 27.7 million tons of Saharan dust that settles in the Amazon every year….
The origin of terms used in math may make these words more interesting and meaningful to students. Some are very simple while others are more complex in their etymology. For example, the Latin word for square was *esquare*. The term *triangle* comes from the Greek term for ‘three angles’ and *quadrilateral* comes from the Latin term for ‘four sides.’ *Rectangle* came from the Latin term for ‘straight angle; and *parallelogram* came from the Greek term for ‘alongside another line.’ *Trapezoid* was taken from the Greek word *trapezoids*, which was based on the Greek word *trapeza*, which meant ‘table.’

Arithmetic has a more convoluted origin. In Middle English, the term that was used was *arsmetike* or *arsmetrik*, coming from the Medieval Latin term *ars metrica*. This meant ‘the art of measuring.’ In the 16th century, the spelling was ‘corrected’ to reflect the Greek words *arithmos* and *arithmetike*, which mean ‘number’ and ‘counting.’

The word mathematics goes back to ancient Greece and the Pythagoreans (the followers of Pythagoras). They had coined the term *philosophia*, meaning the love of wisdom, which is now philosophy. Their school was divided into two groups. One was the *lakousmatiko* or listeners. They focused on the religious or ritual aspects of learning. The other was the *mathematiko* or learners. They developed the more mathematical and scientific work of Pythagoras. This term was derived from the Greek word *mathema*, referring to science and knowledge, literally meaning “that which is learned.”

Geometry comes directly from ancient Greece, meaning measuring the Earth. Trigonometry also comes directly from Greek, meaning measuring triangles. Algebra has a more circuitous source, coming from the title of a book by the 9th century Persian mathematician, Abu Jafer Muhammad ibn Musa, who was more commonly referred to as al-Kwarizmi (the man of Kwarizmi, which is now Khiva). A book that he wrote around 820 AD was *ilm al-jabr wal-muqabla*, which translates to “The Science of Restoring what is Missing and Equating Like with Like.” The part of the title that became algebra is *al-jabr*, which means “reunion of broken parts.” Around 825 AD, al-Kwarizmi wrote another book that introduced the Indian system of numeration to Europe. The Latin name for the book was “*Algoritmi de numero Indorum*” and was the source of the word algorithm. Fibonacci used this source to getting Indian numbers to replace Roman numerals.

Zero was a new term that had not existed in Roman numerals. It came from the Latin word *zephirum*, which in turn came from the Arabic word *sifr*. The Arabic word meant empty space or desert or naught. This was also the source of another word in our current language—cipher. Cipher means to write in code.

In the 1640s, a computer was one who computes or calculates. In 1897, it was used to specifically refer to a calculating machine. Forty years later, in 1937, it was redefined to mean a theoretical electronic machine—a Turing device. Nine years after that, in 1946, the word computer gained its current meaning with the creation of ENIAC, the first actual “programmable digital electronic computer.”

As a closing point, consider calculus, which meant pebble in Latin. In ancient times, pebbles were used for counting. Prior to Newton and Leibniz, calculus was a general term referring to any body of mathematics. In 1687, calculus gained its current meaning when Isaac Newton wrote “Principia.” Guillaume de L’Hôpital referred to Gottfried Leibniz’s calculus in a book he wrote in 1696. However, both had used the term in earlier writings, leading to an active dispute as to who first developed the concept. References were included in a paper Newton had published in 1666. Similarly, Leibniz included references in a paper he published in 1674. Each stated that they had developed the idea before publishing it, which makes sense, but leaves open who actually was first.

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**Cultured Meat**

[These excerpts are from an article by Corby Kummer in the May/June 2015 issue of Technology Review.]

Another alternative—test-tube meat, also known as cultured meat, in vitro meat, and lab meat—is probably decades off, despite the introduction of a $332,000 burger at a London press conference in August 2013. The pinkish ground meat had been produced in a Maastricht University lab directed by Mark Post, a vascular biologist and surgeon: it consisted of billions of cells cultured from skeletal muscle cells taken from one beef neck, nourished in a warm broth of synthetic nutrients and cow-fetus serum. To get the cells to grow into myotubes, the building blocks of muscle fiber, the researchers reduce the serum in the broth, which causes the cells to stop dividing and fuse. Then they suspend the cells in a gel surrounding a central column that allows them to align and form muscle fibers. For the scaffold, Post and others first used Velcro and then searched out biodegradable options. At the live-streamed tasting, the testers reported that the burger tasted almost like a real one, but not as juicy and “surprisingly crunchy….”

In theory, cultured meat can be scaled and may offer something closer to real meat than any other inventions in the works. By its nature, it would offer the complex flavors of meat. But it is still in the basic-research phase. The problems are many: scientists must figure out how to build intermuscular fat, sinew, cartilage, and even bone, and a structure to mimic veins and blood vessels that don’t become gangrenous. The work is so expensive that the steps forward are likely to come from trying to produce organs for transplant—which are “worth millions of dollars a pound instead of $10 a pound….”
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.]

John Pemberton had been a colonel in the Confederate Army during the Civil war. He ran the Eagle Drug and Chemical House in Columbus, Georgia. Having been wounded in the Civil War, he had become addicted to morphine and was seeking a substitute for this. In 1885, he began selling “Pemberton’s French Wine Coca,” modeled after a successful European coca wine, which was registered as a nerve tonic.

His ingredients included coca leaves (cocaine is an extract of those leaves), wine, damiana (a flowering shrub that has antianxiety and aphrodisiac qualities) and kola nuts. When Atlanta and Fulton County enacted prohibition laws the following year, he removed the alcohol and added carbonated water to take advantage of the growing popularity of soda fountains. Carbonated water was believed to be good for your health, and he sold it as a patent medicine, claiming it could cure many diseases, including morphine addiction, headache, dyspepsia, anxiety, indigestion, depression and sexual impotence. In the ads, it was referred to as a “Brain Tonic” and a “temperance drink.” (Temperance means anti-alcohol.) While cocaine was not made illegal until 1914, it was removed from this drink in 1903.

This carbonated beverage was first introduced on May 8, 1886, and the name was suggested by Frank M. Robinson, Pemberton’s partner and bookkeeper. He used two of the ingredients—coca and kola—but thought that “two Cs would look well in advertising.” The chosen name was therefore Coca-Cola and the cursive trademark was actually Robinson’s unique penmanship.

Update on Online Education

[These excerpts are from an article by Stephanie Garlock in the July-August 2015 issue of Harvard Magazine.]

In May 2012, edX president Anant Agarwal introduced Harvard and MIT’s joint venture in massive open online courses (MOOCs) with a bold promise: “Online education will change the world.”

…but there were reasons for concern as well. Less than 1 percent of those original CS50x registrants—1,439 students—completed enough of the course to earn a certificate. Observers wondered whether a massive-scale, broadcast model could effectively reach students of different backgrounds and communicate the complex skills taught in college classrooms…. Since the program’s launch, a number of courses at HarvardX have tested a simple solution to many of MOOC detractors’ biggest complaint: scaling down, not up. These experiments—which come with their own acronym, SPOC (small private online course)—enable professors to more fully engage a targeted group of learners, who benefit in turn from an intensive, personal course setting.

…A set of lectures and a reading list could provide a spine, but real learning required deep engagement through intense Socratic discussions and difficult writing assignments, thoroughly graded by a real teacher….

…”The more connections you have between students, the more powerful” a course will be…” both in the classroom and also out there in the wider world.”…But the responsiveness of online platforms offers something totally new: the chance to create meaningful connections between scattered groups of learners—and even to learn from them.

Setting Goals

[This excerpt is from an article by Nicola Spaldin in the July 3, 2015, issue of Science.]

Frighteningly, I have reached the stage in my career when young people often ask me for advice. My safe and sensible side tells me to pass along the same advice I received: Make a solid contribution to an established field and publish a lot to become known and respected by your community. Save the high-risk stuff until after tenure. But, deep down, I hope young scientists—you—will choose not to follow that advice. I hope instead that you will find the question that for you is the most interesting in the world, go after its answer with all your youthful passion, and pioneer your own science revolution.

These discoveries were never independent when the state of scientific knowledge as a whole is considered. Science does not proceed by a series of lucky accidents. It is an organic growth which inevitably will produce the discoveries required by each developmental stage.

—K. Mendelssohn
The Quest for Absolute Zero
Incorporating ‘Shop’ into High School Science

Steve Nystrom [NEST ’14]

Let me start by saying that I had the best high school shop in Maine. It had over 4,000 square feet of play space. It was filled with tools to work in wood or metal, shape steel or composites, design with the leading CAD software and print on 3D printers, plus space to dream! But let’s be realistic—that’s just “stuff”. It’s what you do with it that makes them tools for education.

I’d be happy with cinder block walls, floors stained with years of splattered paint, a good set of work benches and a few cordless hand tools…if I could get the students intrigued about why cinder blocks are shaped the way they are, how paint chemically sticks so tenaciously to cement floors and what the advantages are of straight bits over Philip bits, plus why Torx bits surpass both! So that’s what I do; at every turn, I look for the science and math that surrounds our students and I bring that into the discussion.

There’s chemistry to explain how oxygen and acetylene make a flame hot enough to cut an inch of steel like a hot knife through butter. It requires stoichiometry and a periodic table, but they have already learned that in chemistry (hopefully they were awake), though it usually doesn’t stick too well. But put those chemicals on the tip of a flaming torch and now we can discuss the differences between a neutral, carburizing and oxidizing flame, what chemically changed in the balanced stoichiometry equation and how that impacts the chemistry of a good weld.

After my first semester teaching computer aided drafting/design (CAD), I was convinced it was the perfect venue to teach geometry. It’s been my opinion (as a math teacher for 10 years) that there are two global topics to teach in geometry. One is the logic we try to impart by having students work through proofs, learning why one thing has to happen before the other—that order is important and logical. The other topic is all the properties, theorems and postulates that go into building the proof. I think both of these global topics are critically important. That being said, the way we teach it bores them to tears and ties them into knots. However, wrapping geometry into a CAD class makes it much more tactile and visual. For example, either the part is constrained and doesn’t move because the student knows the properties of geometry (concentricity, tangency, parallelism, midpoints, etc.)…or the bolt hole moves out of position, the gear teeth are no longer equally spaced, the countersink moves off its bolt hole or the square becomes a diamond.

So let’s talk about how to incorporate ‘shop’ into your science class, instead of the other way around.

The recent history of shop, industrial arts or industrial technology (call it what you will—to me it will always be ‘shop’) has, in short, been of a slow decline into oblivion. There are all kinds of reasons that someone else can characterize in full. But my answer of the question of “how do you incorporate shop into science” is simple: “Just ask.” Those of us carrying these titles are anxious to be incorporated back into the mainstream of academia.

Here is what I tell science teachers who are looking to make a lab or experiment. “Absolutely! And here’s how you can make your…fill in the blank…even better.” Shop teachers can:

- Take your lab and make it more extravagant! Sometimes, bigger really is better, and sometimes homebuilt is more intriguing than Carolina or Pasco. Lots of time, the work of making labs pop is all my doing—I think of alternatives based on the capabilities of the shop and then I make it. But, whenever possible, I’ll get a student (who is not in your class) to take on this task, which spreads the impact of your lab beyond your classroom, because, in order for them to partake, they need to know why they are doing it, which requires some explanation of the science.

- Allow your students to work in a larger space. One that’s primed for sawdust to fly, PVC cement to spill, rivets to get pounded or epoxy to be molded. Consider the shop to be a library of tools and materials at your disposal. It’s my opinion that this is your shop teacher’s greatest asset. He has the tools, the knowledge to use them and the ability to safely incorporate students into the process.

- Let students work with their hands. Engineers and architects are known for coming up with designs that the tradesmen can’t build. This happens because these professionals haven’t spent enough time in their respective shops working to make their ideas come to life. Experience is what gives each of us the skills to make better designs or to judge the functionality of a project.

- Provide an opportunity for students to come up with their own experiments. This is the ultimate goal of most STEM educators: to have a student come up with their own inquisitive question that they are invested in and follow it through with an experiment or lab that helps answer it. We know this has to happen outside of the classroom, and the shop is one option. My favorite story is of a student who wanted to use science to specifically rank the heat of different chili peppers! Imagine the depth of knowledge this student had to acquire to accomplish that!

Finally, let’s talk about communication. I think the schools I’ve been a part of are fairly representative of the nation in so far as how we teach subjects in silos—math doesn’t interact with biology, English doesn’t interact with physics and so on. Your shop teacher can represent a great neutral ground—for example, he or she isn’t an AP Environmental Science teacher, but the students need the shop teacher to make their composter. That will necessitate the students communicating to the shop teacher “Here’s what we’re doing….This is what we want to make….We need something that will do this….” These conversations take science out of the science lab; they require vocabulary, drawing and other communications skills that are so often ignored. We’ve all read a student homework assignment and said, “Well, it’s not really clear, but I know what they meant.” That’s not satisfactory in the working world where the job posting requires “Excellent communication, presentation and documentation skills” (literally taken from the first job posting that I came to). Working with a shop teacher can highlight and support communications deficiencies because, when I don’t understand what’s going on, it’s not happening; so explain it again, draw me a picture, model it for me, show me, make it crystal clear (after all, I’m just a shop teacher)!

This summer, I moved and have taken a new shop teacher job. The space and tools are nowhere near what I left behind. The tools are John Deere green and older than I am. But the walls are made of cinder blocks, we’ve got plenty of good work benches, the cordless tools will be charged up and there’s an oxy-acetylene torch at the ready! So, bring on the science!
...Whether it’s prehistoric North Americans hunting the mastodon to extinction, Maori wiping out the megafauna of New Zealand, or modern civilization deforesting the planet and emptying the oceans, human beings are universal killers of the natural world. And now climate change has given us an eschatology for reckoning with our guilt. 

...climate change is seductive to organizations that want to be taken seriously. Besides being a ready-made meme, it’s usefully imponderable....To take an aggressive stand against the overharvesting of horseshoe crabs (the real reason that the red knot, a shorebird, had to be put on the list of threatened U.S. species this winter) might embarrass the Obama Administration, whose director of the Fish and Wildlife Service, in announcing the listing, laid the blame for the red knot’s decline primarily on “climate change,” a politically more palatable culprit. Climate change is everyone’s fault—in other words, no one’s. We can all feel good about depleting it. 

...To prevent extinctions in the future, it’s not enough to curb our carbon emissions. We also have to keep a whole lot of birds alive right now. We need to combat the extinctions that are threatened in the present....

A little tragicomedy of climate activism is its shift of goalposts. Ten years ago, we were told that we had ten years to take the kind of drastic actions needed to prevent global temperatures from rising more than two degrees Celsius in this century. Today we hear, from some of the very same activists, that we still have ten years....At the rate we’re going, we’ll use up our entire emissions allowance for the century before we’re even halfway through it. Meanwhile, the actions that many governments now propose are less drastic than what they proposed ten years ago. 

...In the twenty-three years since the Rio Earth Summit, at which hopes for a global agreement ran high, not only have carbon emissions not decreased; they’ve increased steeply....

The reason the American political system can’t deliver action isn’t simply that fossil-fuel corporations sponsor denials and buy elections....America’s inaction on climate change is the result of democracy. A good democracy, after all, acts in the interests of its citizens, and it’s precisely the citizens of the major carbon-emitting democracies who benefit from cheap gasoline and global trade, while the main costs of our polluting are borne by those who have no vote: poorer countries, future generation, other species. 

...The problem here is that it makes no difference to the climate whether any individual, myself included, drives to work or rides a bike. The scale of greenhouse-gas emissions is so vast, the mechanisms by which these emissions effect the climate so nonlinear, and the effects so widely dispersed in time and space that no specific instance of harm could ever be traced back to my 0.000001-percent contribution to emissions....maintaining a typical American single-family home exceeds it in two weeks. Absent any indication of direct harm, what makes intuitive moral sense is to live the life I was given, be a good citizen, be kind to the people near me, and conserve as well as I reasonably can. 

...climate change is different in category from any other problem the world has ever faced. For one thing, it deeply confuses the human brain, which evolved to focus on the present, not the far future, and on readily perceivable movements, not slow and probabilistic developments....The great hope of the Enlightenment—that human rationality would enable us to transcend our evolutionary limitations—has taken a beating from wars and genocides, but only now, on the problem of climate change, has it foundered altogether. 

...it’s important to acknowledge that drastic planetary overheating is a done deal. Even in the nation most threatened by flooding or drought, even in the countries most virtuously committed to alternative energy sources, no head of state has ever made a commitment to leaving any carbon in the ground. Without such a commitment, “alternative” merely means “additional”—postponement of human catastrophe, not prevention. The Earth as we now know it resembles a patient whose terminal cancer we can choose to treat either with disfiguring aggression or with palliation and sympathy. We can dam every river and blight every landscape with biofuel agriculture, solar farms, and wind turbines, to buy some extra years of moderated warming. Or we can settle for a shorter life of higher quality, protecting the areas where wild animals and plants are hanging on, at the cost of slightly hastening the human catastrophe. One advantage of the latter approach is that, if a miracle cure like fusion energy should come along, there might still be some intact ecosystems for us to save. 

...We’ve always been not only universal despoilers but brilliant adapters; climate change is just the same old story writ larger....

The story that is genuinely new is that we’re causing mass extinctions....It’s the same argument that Rachel Carson made in Silent Spring, the book that ignited the modern environmental movement....The dangers of carbon pollution today are far greater than those of DDT....

Climate change shares many attributes of the economic system that’s accelerating it. Like capitalism, it is transnational, unpredictably disruptive, self-compounding, and inescapable....

Of the three new criteria for successful conservation projects, integration with surrounding communities is the most difficult to meet....

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Social Gaps

[This excerpt is from an article by Dana Goldstein in the Spring 2015 issue of American Educator.]

For 200 years, the American public has asked teachers to close troubling social gaps—between Catholics and Protestants; new immigrants and the American mainstream; blacks and whites; poor and rich. Yet every new era of education reform has been characterized by a political and media on the existing teachers upon whom we rely to do this difficult work, often in the absence of the social supports for families that make teaching and learning most effective for kids, like stable jobs and affordable housing, childcare and healthcare.
Permian Extinctions

[These excerpts are from an article by Eric Hand in the April 10, 2015, issue of Science.]

Things went really sour for life on Earth 250 million years ago. A team of European geoscientists has found the most direct evidence yet that the world’s oceans became sharply acidic at the boundary between the Permian and Triassic periods—when scientists estimate 90% of Earth’s species died in the worst mass extinction ever.

The “PT” die-off affected all types of living things, but it hit marine species the hardest—killing off, for instance, the once ubiquitous trilobites. The new study...concludes that the ocean acidification played a major role in the cataclysm. Acidifications can kill sea creatures by weakening their ability to produce their calcium-bearing shells, and it is driven by excess carbon dioxide (CO₂) dissolving in the ocean. As such, the extinction holds a cautionary lesson for today: Because of CO₂ released by burning fossil fuels, oceans could now be acidifying even faster than they did 250 million years ago, although the process hasn’t yet persisted nearly as long.

Unlike the asteroid-induced extinction that killed the dinosaurs 66 million years ago, most scientists think the even bigger catastrophe at the end of the Permian was homegrown: triggered by a massive bout of volcanism in Siberia that released trillions of tons of carbon into the atmosphere and oceans. Researchers previously found signs that living things endured multiple stresses as a result of the eruptions: global warming, ocean acidification, a drop in dissolved oxygen in the oceans, and even a buildup of toxic sulfur. But sorting out the relative importance and interdependence of these effects has been difficult.

Now, scientists have better evidence that ocean acidification hit living things hard. It comes from carbonate-bearing limestone in the United Arab Emirates. They formed some 250 million years ago in the shallow waters off the subcontinent at the time, locking in the geochemical signals of the ancient Tethys Ocean. Traditionally, geochemists have used variations in certain carbon isotopes as a sign that a pulse of atmospheric carbon dioxide was entering the ocean and triggering acidification.

The Permian-Triassic catastrophe holds mixed messages for Earth today. On the one hand, the pace of acidification was slower than it is now. The study team estimates that, in the acidification event, 24,000 gigatons of carbon were injected into the atmosphere over 10,000 years—a rate of 2.4 gigatons per year—and most of it wound up in the oceans. Currently, scientists estimate carbon from all sources is entering the atmosphere at a rate of about 10 gigatons per year.

On the other hand, today’s economically viable fossil fuel reserves contain only about 3000 gigatons of carbon—far shy of the Permian total, even if human beings burn it all.

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Long-acting Contraceptives

[These excerpts are from an editorial that appeared in the Pittsburgh Post-Gazette on November 9, 2014.]

The American Academy of Pediatrics recently recommended that sexually active teenage girls use long-acting forms of contraception, such as intrauterine devices. The advice is rational and scientifically sound for the health of women and girls; doctors and parents should heed it.

Long-acting contraceptives are the most effective and easiest forms of contraception available to women. IUDs have a failure rate of less than 1 percent—much lower than the rate for condoms or birth control pills, in part because women on the pill must remember to take it at the same time every day. Long-acting methods, in contrast, last between five and 12 years without regular maintenance and are entirely reversible. Thanks to the Affordable Care Act, many women will have access to costly IUDs without a copayment.

Widespread adoption of long-acting contraceptives is likely to encounter resistance from conservatives. Parents, health care providers, and public officials, in making decisions about girls’ access to medical services, should base their choices on the best science in contraception.

For teenage girls, medical professionals believe that the best choice is long-term contraceptives.

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Parental Control

[These excerpts are from a brief article by Daisy Yuhas in the January 2015 issue of Scientific American.]

As countless unmade beds and unfinished homework assignments attest, kids need rules. Yet how parents make demands can powerfully influence a child’s social skills, psychologists at the University of Virginia recently found after the conclusion of a study investigating the notorious transition from adolescence to adulthood.

Initially 184 13-year-olds filed out multiple surveys, including one to assess how often their parents employed psychological controlling tactics, such as inducing guilt or threatening to withdraw affection.

The researchers followed up with the subjects at ages 18 and 21.

…the 13-year-olds who had highly controlling parents floundered in friendly disagreements at age 18. They had difficulty asserting their opinions in a confident, reasoned manner in comparison to the kids without controlling parents. And when they did speak up, they often failed to express themselves in warm and productive ways.

The researchers suspect that manipulative parents undermine their child’s ability to learn how to argue his or her own viewpoint in other relationships.

The consequences of tense or domineering relationships appear to compound with time.
Emotion vs. Control

[This is an inset from an article by Jay. N. Giedd entitled “The Amazing Teen Brain” in the June 2015 issue of Scientific American.]

Teenagers are more likely than children or adults to engage in risky behavior, in part because of mismatch between two major brain regions. Development of the hormone-fueled limbic system (purple), which drives emotions, intensifies as puberty begins (typically between ages 10 to 12), and the system matures over the next several years. But the prefrontal cortex (green), which keeps a lid on impulsive actions, does not approach full development until a decade later, leaving an imbalance during the interim years. Puberty is starting earlier, too, boosting hormones when the prefrontal cortex is even less mature.

World Oceans Day

[This editorial by Marcia McNutt is in the May 22, 2015, issue of Science.]

On 8 June, the United Nations Educational, Scientific and Cultural Organization (UNESCO) celebrates World Ocean Day, a fitting occasion to remind ourselves of the essential role of the oceans in making Earth a habitable planet. We have had an official day of celebration for the oceans only since December 2008. In contrast, Earth Day has been a celebration ever since 1970. Conceived by U.S. Senator Gaylord Nelson in the aftermath of the 1969 Santa Barbara oil spill, Earth Day became a focus for the growing environmental movement (it became an international event in 1990) and the catalyst that led to the Clean Air, Clean Water, and Endangered Species Acts in the United States. Imagine what might be accomplished if World Oceans Day could similarly inspire actions for improving the state of the oceans worldwide.

Many environmental crises play out in the ocean in slow motion and are not currently addressed by the protections that are in place. For example, oceans absorb about 90% of the heat building up from the release of excess greenhouse gases. The system of Argo profiling floats indicates that the heat content of the upper 2000 meters of the ocean has increased by about $8 \times 10^{22}$ joules over the past 10 years. The yearly increase in heat to the ocean is roughly equivalent to 100 times the average annual energy consumption of the United States ($100 \text{ quadrillion BTU} = 10^{20}$ joules). We have so much to learn about the microbiota in the upper ocean…and the effect that this added heat will have on them is entirely unknown. It is likely to have deleterious impacts on fisheries already stressed from overharvesting. And yet, if it were not for the large amount of heat that the oceans absorb, the amount of global warming we would otherwise experience would be truly intolerable.

It is not just excess heat that the oceans absorb. As CO$_2$ is released to the atmosphere from the burning of fossil fuels, about a quarter is absorbed by the ocean, lowering its pH. Since the start of the Industrial Revolution, ocean acidity has increased by 30%, with negative repercussions for many organisms, including those that build their shells from calcium carbonate minerals. Such organisms are essential links in marine food webs and the foundation for very profitable fisheries. As the oceans become more saturated with CO$_2$, their ability to mitigate the buildup of CO$_2$ in the atmosphere by absorbing it will decrease, and greenhouse warming will accelerate.

The oceans help to moderate climate, keeping tropical latitudes cool and temperate latitudes warm through major circulation systems that transport large amounts of equatorial heat poleward. The ongoing warming could change ocean circulation in complex ways….World Oceans Day’s focus on the ocean’s role in the climate system will expand global awareness…. supplying half of your oxygen and for all the other ways in which it makes Earth a habitable planet. It is time to start valuing the ocean and stop using it as a dump for waste heat, CO$_2$, sewage, pollutants, and other trash.

Susan Groff [NEST ’01] flight visited the Philippines from June 21st - July 8th this summer through the Teachers for Global Classrooms program and also had a second NASA SOFIA.

This is Mark Hungate’s [NEST ’90] 36th year of teaching, 33 of which have been in the same school. His current principal was formerly one of his students!

David Iverson [NEST ’14] was the NEST 2015 Teacher of the year.

Rachel Manzer [NEST ’13] is the Connecticut Science Education Fellow for Outstanding service to science organizations. She also received the Technology Education-Award for innovative curriculum and service to the Connecticut Technology Engineering Education Association and was declared the 2014 Crossfield National Educator of the Year by the National Aviation Hall of Fame.

An article on rats by Avi Ornstein [NEST ’89] entitled “You Dirty…” was published in the Spring/Summer 2015 issue of the Connecticut Journal of Science Education.

An article by Tracy Vassiliev [NEST ’13] and David Neivandt entitled “Let Them Eat Cake…OE-Cake!” was published in the April 2015 issue of the Science Scope Journal.

Open records laws worldwide are critical to holding public institutions, including universities, accountable. Such laws protect against inappropriate influence on the scientific enterprise and promote public trust in the integrity of science and scientists. But the growing use of electronic communications by researchers makes these laws vulnerable to misuse. Conversations that used to occur in person and by other less-reportable means are now electronically written. Increasingly, activists across the political spectrum in several countries are requesting not only records of discussions about the strengths and weaknesses of work, but also preliminary paper drafts and private constructive criticisms from colleagues. These requests can attack and intimidate academics, threatening their reputations, chilling their speech, disrupting their research, discouraging them from tackling contentious topics, and ultimately confusing the public. So what level of discourse is appropriate? How can public accountability be balanced with the privacy essential for scientific inquiry?

...Universities should articulate how to respond to requests in accordance with the law and ensure that faculty know their rights and responsibilities. They should better understand requesters’ motivations—not to determine the appropriate requests, but to help employees understand how access to correspondence could be misused. Legislatures should ensure that laws protect faculty correspondence when disclosure would compromise the conduct of science. The scientific community should develop common disclosure standards for all researchers and creative mechanisms for enforcement. Implementation could become a requirement for university accreditation. The standards could also be adopted by government grant-making bodies, increasing the likelihood that state laws will be modernized, or by legislatures and executive agencies for academics who choose to provide testimony.

Ultimately, more uniform disclosure standards will create more public trust in science.

People in government, business and even education have been cherry picking research results for years. One study found that “a highly effective teacher” was the single most influential thing on student success within the school environment. The classroom teacher was being compared to lower rated teachers, administration, etc. A much larger study by population and longitudinal reach found that the school experience accounted for only about 30% of the total effect upon a student’s success, the other 70% being home environment, socioeconomics, friends, etc. However, when a politician is asked about improving education, which study do you think they reference?

There is money to be made in teacher improvement. It would cost a lot of money to try to fix the real problem. I realize it is a clichéd response, however, scientists have known for years why most struggling students are struggling. They did animal studies in the ’60’s by traumatizing dogs and comparing them to their non-traumatized peers. [Refer to http://jessicarosetop10experiments.weebly.com/learned-helplessness-seligman-and-maier.html]. There is copious evidence to suggest that the neural trauma suffered by many children is the major cause of their dysfunction in school. Worst yet, they usually still live in the environment that damaged them in the first place.

Educated people realize that schools can’t fix the woes of society. Sadly, a desperate population, unable or unwilling to face the enormity of the real problem at hand, chooses to subscribe to the myth of the soul-saving school. It is American romanticism at its best and worst. They praise and celebrate schools and teachers as transformative agents...until we inevitably fail to live up to their mythologized ideal. Then come the pitchforks. It is a comfortable lie we all live with. When there is a crack in the keel, they blame the helmsman for the foundering ship. In this case, the helmsman is pointing at the crew on the benches rowing for all they are worth and everyone is content to blame them.
The Brain, Learning and Teaching Objectives

Avi Ornstein [NEST ’89]

80% of the human brain has been completed by the age of two.1 It is a flaw, however, to equate the size of the brain with mental development. The development of the brain depends on the number of synapses that interconnect the neurons rather than simply looking at the number of neurons. In addition, “the long-term effects of early stress, poverty, neglect and maltreatment were well documented and virtually uncontested years before we could “see” them with brain scanning tools.”2 Similarly, “many children younger than 5 years in developing countries are exposed to multiple risks, including poverty, malnutrition, poor health, and unstimulating home environments, which detrimentally affect their cognitive, motor, and social-emotional development.”3

“The synaptic architecture of the cerebral cortex defines the limits of intellectual capacity, and the formation of appropriate synapses is the ultimate step in establishing these functional limits.”4 However, the popular media portrays mental development as depending solely on simple stimuli, such as singing, reading and active interaction with infants and young children, which is a myth. “We are left with the idea that infant brains are exuberantly growing and connecting in direct response to the actions of watchful singing, reading, and talking parents and caregivers.”5 Synapses will continue to connect neurons throughout a person’s life, but the existing neural development of a child is a complicated issue that, nonetheless, has a direct impact on how he or she performs in school.

The responsibilities a teacher needs to meet go far beyond merely educating children. A simple search in the Internet produces long lists of expectations for this profession. In addition, a growing trend across the nation is for teachers to set quantitative Student Learning Objectives (SLOs) that are then used to evaluate their effectiveness and expertise. This entails setting goals for an entire class, even though each student is an individual, with his or her own abilities, weaknesses, strengths and level of motivation. Each also has a personal home environment and influencing factors outside of school, but this is somehow compressed into a single factor that measures whether the SLO was or was not achieved.

When I entered this profession over four decades ago, I had a naive goal to succeed as completely as Sidney Poitier did as Mr. Thackeray in To Sir, with Love (1967). It did not take me long to recognize that the movie is an idealistic setting that differs greatly from the real world. We cannot take credit for students who enter our classroom with alert, motivated attitudes, just as we cannot take the blame for students who will be in their classes in the future. Take the time to think back to the teachers you had. Some were good, some were poor and a few made a real difference in your life. Then seriously consider those few exceptional teachers and contact them, directly or indirectly, and let them know. That feedback will be invaluable and will be the greatest motivating force a good teacher can have to continue to put their full effort into their profession and the students who will be in their classes in the future.

1 https://faculty.washington.edu/chudler/dev.html
3 www.ncbi.nlm.nih.gov/pmc/articles/PMC2270351/
5 www.jsmf.org/about/j/neural_connections.htm

Artificial Sweeteners

[This excerpt is from an article by Ellen Ruppel Shell in the April 2015 issue of Scientific American.]

…We guzzle enormous quantities of these chemicals, mostly in the form of aspartame, sucralose and saccharin, which are used to enliven the flavor of everything from Diet Coke to toothpaste. Yet there are worries. Many suspect that all these sweeteners come at some hidden cost to our health, although science has only pointed at vague links to problems.

Last year, though, a team of Israeli scientists put together a stronger case. The researchers concluded from studies of mice that ingesting sweeteners might lead us—of all things—obesity and related ailments such as diabetes. This study was not the first to note this link to animals, but it was the first to find evidence of a plausible cause: the sweeteners appear to change the population of intestinal bacteria that direct metabolism, the conversion of food to energy or stored fuel. And this result suggests the connection might also exist in humans.

In humans, as well as mice, the ability to digest and extract energy from our food is determined not only by our genes but also by the activity of the trillions of microbes that dwell within our digestive tract; collectively, these bacteria are known as the gut microbiome. The Israeli study suggests that artificial sweeteners enhance the population of gut bacteria that are more efficient at pulling energy from our food and turning that energy into fat. In other words, artificial sweeteners may favor the growth of bacteria that make more calories available to us, calories that can then find their way to our hips, thighs and midriffs….
scientists studying coral reefs, all night observing with astronomers at Kitt Peak National Observatory? These were inspiring, informa-
tive and all-expense-paid opportunities that revived me and my lesson plans each summer. And, come fall, students shared in my
excitement as they explored with me the latest discoveries in science and related subjects.

With truncated federal K-12 STEM budget and the push for “broader impacts”, these once plentiful programs have withered.
We have to work with what we’ve got, so I decided to organize a similar experience on my own, with the support of like-minded
adventurers. This year, the teachers involved were: Haia Spiegel [NEST ‘97], Gao Qing [NEST ‘10] and Vin Urbanowski (a future
SEPT applicant)!

Non-federal funding was gathered to pilot a two-week astronomy research experience for six students (representing US and China)
and two STEM teachers from three NEST members’ schools. During this experience, students and facilitators immersed themselves in
an authentic science research project at a university setting, facilitated by a professional astronomer and experienced research teacher
(me). Research work was complemented by inspiring talks from professional astronomers and university students, as well as pilgrim-
ages to world-famous research facilities. By the end of the two weeks, the diverse group of students coalesced into an international
team of young scientists. This nascent team will continue to remotely collaborate on the research and plan on publishing their work at
the 2016 American Astronomical Society meeting.

Haia Spiegel (astronomy and capstone teacher) and Vin Urbanowski (math and engineering teacher) facilitated the program. Their
experience varied, and complemented my own. In the end we each brought something different to the program, and as such, support-
ed our own professional development. Together as leaders and as learners, we grew professionally and experienced an invigorating and
unanticipated reward that came to light as the program unfolded.

Fire hose lectures – Haia Spiegel [NEST ‘97]

All of the six participants were interested in pursuing a STEM career—two of which plan on studying astronomy. Background
reading was provided for the students. However, there was limited time for reading, as the schedule included outings and lectures from
faculty members in the astronomy department at University of Arizona!

The University of Arizona has one of the top-ranked astronomy
departments in the country. The lectures by internationally respected
senior faculty were fascinating—and rich with information, perspec-
tive and personal anecdote. Students learned about astronomy, but also
learned something of what it is to actually be a scientist. These lectures included:

• Research in the infra-red on areas of star formation by Dr.
  Chris Walker and Dr. Yancy Shirley. Dr. Walker built his
  instruments for research and placed them in an air balloon that
  left from the South Pole area in order to minimize heating on
  the sensitive infrared instruments.

• Dr. Dan Marrone presented information on galaxies in the early
  universe, and information on the cosmic background radiation
  research by the BICEP group. [Listening to the lecture and read-
  ing about it later, students realized that research information is
  frequently questioned by other scientists and provides area for
  disagreements. The BICRP group claimed to find evidence of
  gravitational waves distorting space-time during the Big Bang’s
  first trillionth of a trillionth of a second. However, the assump-
  tion that the patch of sky they examined was free of dust was
  wrong and the first interpretation needs to be reexamined. It is
  not yet accepted by the entire scientific community, and addi-
  tional data needs to be collected.]

• Rebecca Levy, a student who works with Dr. Dan Marrone, gave a presentation on the physics of the supermassive black hole in
  our galaxy, Sagittarius A, and explained how interferometry from different telescopes locations will collect more light in the IR
  and thus provide information on the area in the black hole in our galaxy.

• Maria Schuchardt, program coordinator, Lunar Planetary Laboratory, organized a presentation on lunar imagery that exposed the
  complexity of understanding the lunar geology via analysis of images. She also shared information on early missions and large
  plate/photos on lunar images.

• Dolores Hill, senior research specialist, Lunar Planetary Laboratory, presented information about the preparation for the mission
to OSIRIS-REX Target Asteroid due for lift-off in 2016 and return in 2022.

Students in the program were lucky to have the opportunity to listen to these lectures, which reminded me of the lectures given
during the SEPT/NEST week at MIT.
Doing the science by doing the math – Vin Urbanowski (future SEPT applicant)

While it’s important for students to grasp science on a conceptual level, many colleges and universities report that students drop out of science and engineering tracks because of the math. Not so much that the math is “hard” per se, but because, after four high school years of training in algorithms for executing calculations and getting questions right on AP exams, students are often ill equipped to actually use math as a tool for communication and exploration.

One of the things that made this research experience authentic for the students was that the concept we were exploring absolutely required “thinking in math.” Not hard math (nothing really beyond Algebra 2 and some statistics), but un-prompted math.

The basic idea of our exploration came from a conversation last summer between our mentor, Dr. Varoojan, and Susan Meabh Kelly. A new mathematical model finds Active Galactic Nuclei (AGN) to be uniform in absolute luminosity and therefore suitable for use as a standard candle for measuring cosmic distances. If the model is robust, the amplitude ratios between wavelengths in the model will match those of real world AGNs. Thus, they suggested an investigation into how the estimated and predicted values compared. Simple, right?

Well, yes, it is conceptually simple. But try doing it with high school math!

First of all, there was the problem of observed wavelength amplitude data (provided as a spreadsheet) being given in apparent magnitude, a logarithmic scale, while the model (also a spreadsheet) gave amplitudes in linear units of power. Dr. Varojian was very generous with his time in multiple video conferences and gave us a good head start, but once the conference ended, the kids were on their own. Which way to convert? What do the answers look like? Nobody actually told the students what to do. They figured out on their own how to linearize the units and develop the spreadsheet to include the new numbers.

Then we had to find a way to quantify the amplitude ratios of various wavelengths in the model to define an AGN signature. But which wavelengths? The model (provided as a spreadsheet giving amplitudes as a function of frequency rather than wavelength) gave power levels across a spectrum at many, many wavelengths. We were given transmittance plots (from web pages for the instruments used) for the filters through which the known AGN were observed. But how to use them? Nobody told the students what to do. As of this writing, some students have successfully used the model’s magnitudes at the peak transmittance wavelength of each filter, while others have successfully taken the mean of values across each passband to generate that signature. Still others are struggling to build a “filtered view” of the model, using the curve’s attenuation of each wavelength within the passband. Once again, nobody told the students which of these approaches is “correct.” They’re figuring out for themselves what’s best by reproducing each other’s work in cycles of collaboration.

Then there’s the problem of comparing the model with the observed data. Again, nobody told the students what to do. They eventually figured out how to make distribution plots and compare prediction with observation.

The point of authenticity is, then, actually two points. First, they’re working to develop a new theory, under an established astronomer, with actual data gathered by professionals under real world constraints. Second, they’re finding their own mathematics to do the job.

It will still be a shock when these students get to college and find the pretty pictures in their high school science books replaced by derivations of formulas and equations used as illustrations. But it’s a shock they will be ready for.

As for myself, I’ve developed this project into a series of authentic mathematical experiences for my algebra, geometry and engineering students in the coming year. I can’t wait!

Beyond the research…participant outcomes – Haia Spiegel [NEST ’97]

Functioning as a Team

Team work, especially of teen age high school students, does not happen upon request. We brought six students who did not know one another prior to the STEM project. Three were from different high schools in Connecticut and three were from different high schools in China, from a province that is close to Hong-Kong. Team mentality was fostered within the short amount of time through planned and unplanned social and cultural interactions by cooking dinners of their cultural heritage, interactions during swimming pool time, playing board games, sharing photos and through phone platforms such as “WeChat”.

Expanding World View

One of the aims was expanding students’ horizons through afternoon-evenings outings and activities. These included:

- Kitt Peak National Observatory (www.noao.edu/kpno)
- Mirror Lab at University of Arizona (http://mirrorlab.as.arizona.edu)
- Mount Lemmon Sky Center (http://skycenter.arizona.edu)
- New Horizons/Live-Streamed Pluto event at Steward Observatory
- Pima Air and Space Museum (www.pimaair.org)
- Saguaro National Park (www.nps.gov/sagu/index.htm)
• Space Imagery Center at University of Arizona
• Summer Evening Astronomy Event at Arizona-Sonora Desert Museum (www.desertmuseum.org)
• Titan Missile Museum (www.titanmissilemuseum.org)

The drives to these locations in themselves helped students understand not only astronomy and aerospace, but also the geology, as well as the flora and fauna of the locations. It was hard not to take photos constantly. The views were incredibly beautiful. One could see miles away when traveling to heights of close to 10,000 feet. One beautiful memory, which will stay with the students for a lifetime, was viewing the green flash of a sunset from that height on the mountain rim and observing objects in the night from a telescope atop Mount Lemmon.

Going Beyond the Comfort Zone

Most high school students, and these were no exception, are not well prepared for reading peer-reviewed papers. One of the goals was to overcome some of these fears by providing proper tools such as a journal article template, clarifying vocabulary and teaching students how to ask/write and discuss questions that come to mind while reading the articles. It is a challenge to the students to read the research papers and not get lost in the sea of material. We hope that students will continue to develop that skill in the coming months while we keep close contact with them.

Beyond the research…teacher outcomes

Teachers started anticipating a research experience, but an opportunity to extend the experience became apparent as the program unfolded. As a result, each teacher will lead different avenues to accomplish this vision. This was a welcomed unanticipated outcome for all.

Haia Spiegel [NEST ’97] envisions this kind of experience can serve as a 12th grade capstone project—something that is required in many schools in Connecticut. As an experienced capstone teacher, she is well-positioned to support teachers in this effort.

Vin Urbanowski (BSEE, MS Ed. and future SEPT applicant) plans on incorporating the research into his practice as a high school math and engineering teacher. He is excited about the rich and practical application of mathematics and technology that astronomy research demands. Vin is currently working on a certificate of advanced study in educational leadership, and hopes to bring authentic experiences like this into to the core of every student’s personal and intellectual growth.

Gao Qing [NEST ’10] and Susan Meabh Kelly [NEST ’10] enjoyed three weeks together this summer. They will continue to brainstorm ways to provide international STEM opportunities. (Qing already plans on incorporating the GLOBE program into her school curriculum so students can collect and share climate data.)

In an effort to support plans for expansion, Gao Qing and Susan Meabh Kelly have co-enrolled in a PhD program in Curriculum and Instruction, with a focus on fostering international K-12 STEM collaborations.

An additional astronomy research project and climate modeling will be pursued for summer 2016, leveraging the experience of 2015. Potential sites include Pasadena, Tucson and New York.

NEST…is indeed a network

Needless to say, NEST has been the keystone for this experience. If you would like to be informed about future opportunities for you and your students or have suggestions, please contact Susan Meabh Kelly (susankelly.ct@gmail.com).
A Love of Science

[These are the first two questions asked of Nobel Laureate Richard J. Roberts that appeared in Science on June 19, 2015. You might want to share this with your students.]

Q: What do you enjoy about science?
A: Science is my hobby as well as my profession. It is enormous fun. Just like every child, when I was young, I was very curious about everything around me. Fortunately, I managed to avoid having that knocked out of me while I was in school, and to this day, I take advantage of my curiosity to explore the life around me. As a result, I think about new things or make discoveries every day.

Q: What traits make a successful scientist?
A: A dogged persistence to solve any problem that comes along. An appreciation that many experiments fail, especially when working in a new field or in areas where we know rather little. I like it when experiments fail repeatedly because it usually means our basic hypothesis—and hence the axioms on which it is based—is wrong and nature is trying to tell us something. A discovery is waiting to be made.

Good scientists are always open to new hypotheses and experimental opportunities. Often, a new technique applied to an old problem will reveal new features that were not predicted—again an opportunity to make a discovery.

Successful scientists will also constantly be on the lookout for good problems to solve. They tend to be skeptical of explanations that seem too simplistic or not well supported by evidence.

Early Birds

[These excerpts are from an article by Michael Balter in the May 8, 2015, issue of Science.]

Birds were born about 150 million years ago, when a group of small meat-eating dinosaurs spread their feathered wings and took to the skies. They soon split into two distinct groups: the lineage that led to modern birds, called the ornithuromorphs, and the so-called opposite birds, or enantiornithines, whose shoulder ball-and-socket joints connected in an inverse way from those of living birds. Relatively poor fliers, the opposite birds also typically had teeth and clawed wings. They thrived for millions of years, but vanished along with their dinosaur relatives in the mass extinction at the end of the Cretaceous.

Meanwhile, the lineage of modern birds evolved “huge chest muscles and wings comprised of many different types of feathers layered over each other”—features essential to high-powered flight.

...Archaeornithura had long legs and feet apparently adapted to wading in water, similar to those of today’s plovers, suggesting that modern birds arose in aquatic habitats. Finding such a modern bird, already specialized for wading, suggests that millions of years of aquatic environment took place even before A. meemanna came on the scene....

The fossils reveal the origins of the features that, tens of millions of years later, may have allowed modern birds to survive the Cretaceous extinction when other birds did not....
have a strong need to know more about their topic of choice and get deeply involved. The project became more than just a video recording—a kind of video yearbook of their time in a high school physics class. The project became a way to help students apply physics to the real world and, more importantly, enhance their learning of physics. The project has also enhanced their literacy in the important area of digital expression.

I must start with a confession and a little personal history before delving into the nuts and bolts of the project. Firstly, I know I am not the only person doing these projects, as there used to be a physics video project run by the AAPT. For some reason, the contest has not been offered the last several years. My experience with this type of video project runs all the way back to 1988 when I taught in Minnesota. One spring, when student motivation was low, I had my students create their own projects on a topic of choice and also had them help me to make a physics promotional video to get more students to take physics. Through their help, I was able to get more students to take physics and I will never forget some of their video submissions, such as the “Doug and Bob McKenzie Show” (“here to pump you up!”) as was popular on Saturday Night Live at that time. Back then, the main difficulty was that editing was done with a couple of connected VCRs. The technology has obviously improved significantly and, ten years later, video editing became much easier thanks to the people at Apple and their iMovie software. I use the word “easy” very loosely! It is my belief that teachers should not have students do a project they could not do themselves. So I told my students I would make my own promotional video about the project before they were to start on their project. Open mouth and insert foot! The recording of my video was not too bad, although my Michael Buffer imitations were terrible. But what really hit me was the amount of time it took to do the video editing! From basically zero editing skills to a complete first project, it took me about 20 hours of work. I have made several videos since and my skills have improved significantly. The main concern with giving a video project as an assignment is to take into account the significant amount of time the editing will require. As this video project has evolved and been polished over the years, the biggest improvements have been made to the process itself.

My background in supervising science projects and science fairs proved very helpful in creating this project. To get good science, an experimental project must be extended over a large period of time to get enough data to derive significant conclusions. Video projects are the same. Students need time to process what to do and, like noted previously, need a lot of time to edit these projects. So I have created a series of deadlines which serve as a guideline for when certain tasks should be done, as most students may not have experience with organizing long-term projects. About every month or so, tasks must be completed as follows with approximate dates:

- Students form groups (December 1)
- Topic selection (January 9)
- Individual research of the topic (Prior to Brainstorm)
- Group Brainstorming Activity (January 20)
- Flow Chart (or storyboarding) (February 1)
- Script (drafts and revisions) (February 20)
- Start editing of the final product (March 10)
- Finished video (April 20)

It is important for the teacher to be very involved, especially at the beginning of the project to make sure student groups are functional and also to help with ideas they may have at the beginning. Since this project is really about applying physics to everything or ‘everywhere’, it is not really the teacher’s responsibility to convince students to do certain topics. At times, it is helpful to steer students into a particular topic they know the students will enjoy. The most important item is for all students to keep up with their work and even stay ahead of the deadlines. Most students have responded on surveys that the most difficult part of this project was to maintain group collaboration over a long period of time. So that is why the creation phase is where teacher input may be needed more than at other times. If students choose a topic they are truly interested in, the work will be much more fun!

Next in the process, the brainstorming activity is one in which the participants throw several ideas out to the group without fear of evaluation. It is supposed to be an idea gathering session that will perhaps generate lots of other ideas in a crucible of communication. At the onset of the video project, it is emphasized that everything is fair game and examples of brainstorm sessions are given to the students so their minds are not limited by what they think they can or cannot do in a project such as this. Doing an experiment, making something, interviewing an expert in their topic, using video from a Hollywood movie, making their own computer simulation, creating their own music or even making a music video could be part of the brainstorming activity. How they will teach the physics of the topic, what specific concepts should be included and any possible ideas are collated.

The next step, after all of the ideas have been presented and students have had time to let the ideas ferment, is to start to make decisions. Making a flowchart or series of storyboards is a way for all of the ideas to be funneled into an introduction, body and conclusion for a script. Students should never start making a video without an organized plan, so that is why some method for organizing the ideas into a script, after several revisions, is vital to success. This also helps the students to split up the work of the project into different parts. I have created a template on Google Apps which allows the students to collaborate on every step from topic through the script with each other and their teacher. Also, I limit the time of their video to approximately 7 minutes! Students must focus their thoughts on how to entertain and teach and not include 4 minutes of bloopers!

In recent years, I have also created my own videos to promote better Physics is Everywhere Videos. Episode one is a 10-minute collage of sample videos that have been done for me at Taipei American School. It is quite a trip down memory lane for the teacher, but it serves to show all of the types of videos that have been done on several different topics. Episode two of my series of promotional videos includes information on the process of the project from topic selection through making an organized plan (script). And episode three is all about how to make their video shine! I include information about how to take good shots, record proper sound and also about how their video will be graded, using a rubric. All of the information referenced in the video is available in electronic format, including the examples of a brainstorm activity and lists of suggestions on how to make a great video. The last 20 minutes of episode three shows how students can meet the requirements of the 7 video rubric with excellent samples of student projects.
There are plenty of supplementary materials for the students in support of this project! All students can get a very good grade if they plan their time wisely!

One of the fascinating items about this project is how my students are much more technologically advanced than their predecessors. Obviously, each student having their own laptop has helped, as I used to teach students how to do video editing and even how to use a camera. These skills can be assumed now and I have been able to include more advanced skills like the use of Vernier Video Analysis. As part of our study of kinematics, using video analysis has become a necessary part of the curriculum and it is awesome to see a significant number of students include this in their Physics is Everywhere Project without prodding. Only the students who are new to our school will need a little help with video editing and, to make sure they are identified, I created a couple of other projects to check needed skills for the summative project. One is the completion of a lab report using video. All of the normal parts of a proper lab report are included and this is usually done during first semester. Each group of students is given a different factor of friction to study in their completion of the video lab report. It becomes known quite quickly who can edit video or not and, at times, it is still necessary to help students to not become too distracted by all of the “bells and whistles” in video editing software. To maximize efficiency, they must first put in all of their video, followed by the editing of the length of the scenes. Too often, students will waste time adding titles or special effects before they edit the lengths of the scenes. I experienced that myself when making my first video, so I encourage students to not make the same mistake!

As one can see, there is a lot included in a project such as this. Although presented early in the process, students will focus on the grading rubric when their editing has started. Here are the factors of grading, besides meeting deadlines, in the grading rubric:

- **Video Quality:** Can the audience understand the narration? Are the transitions smooth or choppy?
- **Creativity:** Is there a high level of inventiveness or original thought in the video?
- **Physics Content:** Is there sufficient information to explain the physics of the topic.
- **Teaching Strategy:** Does the video teach the physics of the topic effectively?

Creativity can permeate several parts of the video and does not necessarily describe some artistic quality in the video. The creative emphasis is on originality! The advantage of physics in a video project is the ability to really see the effects of the physics concept in a macroscopic sense. For example, a project done on basketball can use video more fully to explain how the circle of the hoop becomes more elliptical when the basketball is shot at sharper angles. When the basketball is dropped straight down, the ball will “see” the full circle. During an explanation, one student group faked having a camera on top of a basketball so the observer could see for themselves how the shape of the hoop appeared to change when the basketball is shot at different angles (or approaches the hoop at different angles). This is the type of creativity that maintains the attention of the audience and teaches the physics of the situation. Using the power of digital media to TEACH is important, and creativity in camera angles or in the use of animations or special effects is a great strategy to really teach! During my SEPT experience in 2014, I had one of Dr. Moriarty’s graduate students (Edgerton Center) break a balloon on my face with a camera that could record 300 frames per second. He thought I was crazy, but it was a hot day and my “sacrifice” served more than just letting my students laugh at seeing a balloon breaking on their teacher’s face. I made a short video to illustrate how one can see the physics in action and thusly encouraged students use reverse and slow motion to “see” the physics.

In these video projects, physics content does not necessarily mean a video chock-full of equations. The students should show math equations to support what is seen in the physics. A demonstration involving impulse might show a larger force or a larger time period depend on the action involved, and even doing some recording of the equation on a whiteboard with the “F” or “I” getting bigger or smaller helps to illustrate and teach at the same time. **Students should avoid filling their video with lots of equations in an attempt to satisfy the requirements for sufficient physics content. The audience for the students is their peers, not their teacher!** Their video should change view every 5 or 6 seconds, depending on their style of video, and their narration should not sound like a monotone robot reading a poorly written textbook. In this way, they can truly entertain and inform and teach at the same time!

At my school, this project is done mostly out of class—except when the promotional videos (Episodes 1-3) are shown. To make efficient use of time during second semester, student lab groups mirror the project groups. If there is a bit of time during the class period, they may need to talk about their script or plan when to meet to work. If finding a time to meet is difficult, students are encouraged to create their own individual parts of their video, with the intent of bringing the parts together. In 2006, I had a group of girls do a video on dancing and they split the project up into dancing and inertia, projectile motion and rotational motion. Each did their own part and then collaborated together on their overall story and collated their individual digital videos on one machine. They were the model of collaboration! It is very important for decisions to be made very early and for students to stay way ahead of the schedule. Deciding who will do what work and the style of their video will set them on the correct path. A music video, documentary style, a news program and even a full story (complete with acting) are the more popular types. I require all students to show their face on the video for at least 3 seconds, even if it is just in the credits. The popularity of educational television such as programs on the Discovery channel gives recent students several great examples to emulate. Whatever style they choose, students are encouraged to get out of their comfort zones. You may be surprised by how animated your quiet students can be when they are showing their talent in a video project.

After watching the videos with the students in May, I have even created several awards for great acting, special effects, narration and an award for best overall project. **I created some certificates that are printed out on thick paper and the students who win are happy to put these in their yearbooks as an added bonus from their year in physics. To make the awards more fun, I use famous people.** For example, the best narration award is called the...
“Morgan Freeman Award.” I did not write to Morgan Freeman to see if I could use his name in a class project, but I imagine he would be honored to have his name on a physics project award!

This idea and subsequent projects has grown from the original 30 students in the late 1980s to the over 240 students who now do this project each year in the Physics First program at Taipei American School. Of course, as a teacher, my intent is for students to learn physics better. The project requires students to apply their learning in a video form of summative assessment. And we all know how deeply one must know their topic before teaching it effectively to others. But what warms my heart perhaps more than just the learning acquired by students, is how students perceive physics after the project. The students are learning important skills of collaboration and digital expression, and they will also exit my class with a positive sentiment about physics. As somebody who cares deeply about scientific literacy for all students, I am honored to help unearth the wonders of the universe for my 9th grade physics students. And, at the end of the school year, the Physics is Everywhere Project serves as the perfect vehicle for us to recognize all of the hard work done by the students, and to celebrate our journey of discovery together!

Original documents in support of the project are available for NEST members from iversond@tas.edu.tw

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**Faith in Science**

[This excerpt is from an article by Crosbie Smith in the March 20, 2015, issue of *Science* that reviews a book by Matthew Stanley.]

With a long line of mainstream scientific practitioners, including Isaac Newton and Robert Boyle, theistic science, in recent decades, has been much investigated by historians. Natural philosophers regarded the laws of nature as divinely established for the orderly governance of the world, sustained as uniform and unchangeable, except for God’s will. Rightly undertaken in a spirit of humility, scientific investigation was believed to reveal these laws to humankind, along with the manifold benefits that such knowledge of the natural order could provide. Thus, the uniformity of nature, resting upon faith in a divine being who never acted arbitrarily, made possible the advance of human science. Stanley argues that traditional theistic science is radically different from the present-day theory of “Intelligent Design,” which, he emphasizes, lies outside mainstream science and refuses to acknowledge methodological principles such as the uniformity of nature and the provisional character of scientific knowledge.

Challenging the values of theistic science, Thomas Huxley represented a new and ambitious generation of scientists who interpreted uniformity as naturalistic rather than theistic. According to Stanley, Huxley believed that “one could only assume uniformity if there was no active deity able to disrupt natural processes.” Huxley had rich cultural resources on which to draw to challenge the established views….

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**Rain-Forest Threats**

[These excerpts are from a brief article by Richard Schiffman in the June 2015 issue of *Scientific American.*]

Tree loss in the Amazon reverberates beyond Brazil’s boundaries. It reshuffles the climate deck for the entire Western Hemisphere: the rain forest pumps 20 billion tons of water vapor daily into the atmosphere through leaf transpiration, an influx that has ripple effects in western systems a continent away. The Amazon is currently nearly 20 percent deforested, which may be close to a tipping point in terms of its ability to maintain the climate system and rains that it helps to support….A perfect storm of deforestation, fire and climate change…could potentially transform vast swaths of the southern and eastern Amazon into savanna.

One 2103 study, for example, predicts that a fully deforested Amazon would mean 50 percent less snowfall in California’s Sierra Nevada, quashing spring runoff vital to the region’s agriculture. (Whether the present level of deforestation factors in the current West Coast drought is unknown.) To avoid further damage, many players will need to come together, but Brazil now appears to be moving in the opposite direction.

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**Relationships in Education**

[These excerpts are from an article by Cheryl R. Ellerbrock et al. in the May 2015 issue of *Phi Delta Kappan.*]

…Students in caring classroom communities enjoy school, are motivated to learn, possess strong conflict resolution skills, and develop an ethics of care, which can help them become more empathetic and contribute to the classroom community. Ultimately, addressing the need for care fosters healthy adolescent development and supports student success in school. Fostering a caring classroom community begins on the first day of school and continues throughout the school year.

A caring educator:

- Establishes a safe and academic-focused classroom culture;
- Creates shared norms and values;
- Promotes open and honest communication;
- Makes time for everyone to get to know one another;
- Facilitates mutual respect;
- Encourages reciprocal care and mutual responsibility;
- Demands academic excellence from each student; and
- Uses student-centered cooperative group structures.Each class possesses varying needs requiring different manifestations of care. But regardless of specifics, all adolescents need to feel their teachers care for them. For educators, it is imperative students recognize and receive our care….Through meaningful relationships grounded in genuine care, educators nurture a responsive classroom environment that can help set the foundation for student success.

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### Phi Delta Kappan

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As a NEST member, you are invited to showcase your students’ talents in the Third Annual Innovation and Invention Poster Contest! This contest efficiently guides students to draw upon their life experiences and learned subjects with improved “process of thinking” and presentation skills. The multidisciplinary tool kit of Science, Technology, Engineering, Art, and Math (STEAM) provides many options for the “innovators” to employ appropriate units of measure and magnitudes for their particular ideas. Text, labels, sketches and the collage of design elements are asked to captivate interest and illustrate the power of artistic appeal.

Posters are judged in elementary, middle and high school categories. Judging will be at the Hawaii State Foundation on Culture and the Arts in Honolulu. Submission deadline date for the fall event is 10 October, and for the winter event 20 February. Physical 12”x18” posters may be mailed, or their .jpg image sent by email. The theme this year is: Think about “it”: Imagine! The life and accomplishments of Thomas Edison and Leonard Da Vinci were researched and quoted by students in previous contests. Frank Lloyd Wright was added this year. This American architect designed over 1000 structures he felt achieved harmony with humanity and the environment.

Over $10,000 is earmarked for prizes and opportunities. You may invite an engaging speaker via Skype from our global list. Enjoy facilitated lively student participation dialogs and facilities tours.

Email an expression of interest now along with a brief description of subject, class size and grade level you are working with, and your school name/location to Mentor@alum.MIT.edu. We will reply with details and a sincere willingness to make it a great event for you.

Aloha from sunny Hawaii!

Perception of Chemistry

[These excerpts are from an editorial by Henning Hopf in the March 13, 2015, issue of Science.]

Chemistry is the great enabler. For two centuries, it has played a key role in conquering diseases, solving energy problems, addressing environmental challenges, and providing discoveries that have spawned new industries. To meet the demands of the future, this mature science must expand into new frontiers, a move that will be facilitated if the public and policy-makers understand its pivotal role in every facet of life. Such support will not be forthcoming from those who associate chemistry with harm—intentional or not—to people and the biosphere. Addressing the disparity between those perceptions and the reality of chemistry’s contributions to society will garner broader support for spurring innovations in the 21st century. How can chemistry ensure that it has this support?

Chemistry is connected to the physical and biological worlds, underpinning progress across sectors. Too often, the benefits of chemistry have been overshadowed by harmful effects, such as the toxicity of drugs and food additives, environmental contaminants, and chemical warfare. Consequently, chemistry and its practitioners are held in relatively low esteem by society. …

Obviously, communication and education are key to more-positive public engagement. Chemists must continue to improve their conversations with the public, using language that is accessible to explain the relevance of their work to everyday life. Cultivating a better reputation means not only promoting the good, but also acknowledging the bad—an honest dialogue. Redesigns and reforms within the community are needed as well. Chemistry educators should assess how teaching and learning at all levels can be improved to inspire the next generation of chemists. …

Industry must become less removed from their consumers and have frank conversations with a society that demands transparency and has deep concerns about risks. Here, academia could work with industry to clearly explain the science, applications, and impacts. Society faces many emerging global challenges. Broadening support for chemistry will enable the next generation of solutions to tackle them.
School MIT Science (Schule MIT Wissenschaft (SMW)) – The German Approach of a Science and Engineering Program for Teachers

An important aim of the MIT Club of Germany is to transfer up-to-date science and technology into the classrooms of German schools in order to inspire students in these topics and to influence them in their choice of academic study. In this process, the motivation of teachers in science and technology plays a key role in whether the students start to get interested in subjects like physics, biology or chemistry or not.

So the motto of School MIT Science is “To enthuse the ones that shall enthuse—enthusiasm is the most important driving force for learning, research and innovation.

The concept of School MIT Science pursues three goals:
- **Lectures:** The teachers will hear several lectures of outstanding scientists—among them Nobel Prize laureates and professors from MIT—to get a glimpse on current topics of science and technology.
- **Workshops:** Each teacher can choose two workshops with hands-on experience out of an offer of six. The participants get insight in regional structures and best-practice models so that they get new suggestions of how science can be brought into their schools.
- **Networking:** On several occasions, the teachers have the chance to get into contact with each other in order to exchange experiences. Over the years, we intend to build up a network of teachers in science and technology all over Germany pursuing the goal to connect science and school whenever possible.

This year, School MIT Science will take place during a weekend in the end of October at Braunschweig, Lower Saxony. As last year, our goal is to interest about 100 teachers from all over Germany to take part in the conference. This conference is the second in a row that will take place annually in different cities and regions of Germany. Last year’s conference at Erfurt was a big success. For further information, visit the website www.schule-mit-wissenschaft.de for information about the conference per se, the speakers, the topics and the abstracts of their lectures or workshops. Even videos of last year’s lectures are available.

By means of this website, we also refer to a lot of links that lead to more offerings of further education for teachers, such as MIT Blossoms, edX and Experts into School (Experten in die Schule).

### October 30, 2015

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<td>Ion channels – Their discovery and their role in physiology, pharmacology and pathophysiology (Erwin Neher, Nobel Prize in Medicine or Physiology, 1991, Göttingen)</td>
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<td>Cooperation models of broadband and broadcasting networks (Ulrich Reimers, University of Braunschweig)</td>
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<td>Questions &amp; Discussion</td>
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### Lecture 6
The chemical inner life of solid-state materials (Joachim Maier, Max-Planck-Institute for Solid State Research, Stuttgart)

**Questions & Discussion**

**Networking**

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### November 9, 2014

#### Lecture 7
To learn learning, to learn teaching – from the point of view of a brain researcher (Martin Korte, University of Braunschweig)

**Questions & Discussion**

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#### Lecture 8
Innovations in aerospace propulsion technology (Zoltan Spakovszky, MIT, Cambridge, MA, USA)

**Questions & Discussion**

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<tr>
<td>Neuroscience for everyone (XLab, Göttingen)</td>
<td>Architecture and structure of macromolecules (Agnes-Pockels-SchoolLab, University of Braunschweig)</td>
<td>Bacteria as protein factory (BioS-SchoolLab, Helmholtz-Institute, Braunschweig)</td>
<td>From piezo-electrical effect to the Rosetta Mission (DLR-SchoolLab, Braunschweig)</td>
<td>Arduino for beginners (Siemens AG, Braunschweig)</td>
<td>Change of paradigms regarding SI-units (PTB, Braunschweig)</td>
</tr>
</tbody>
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#### Lecture 9
The Rosetta mission – a journey to the origin of the solar system (Joachim Block, German Aerospace Center, Göttingen-Braunschweig)

**Questions & Discussion**

**Farewell**

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### Team (in alphabetical order)

- Andreas Boelter (SEPT ’10, project manager)
- Christian Burisch (SEPT ’12)
- Rainer Linden (SEPT ’08)
- Helmut Lotze (President, MIT Club of Germany)
- Stefan Weissflog (Treasurer, MIT Club of Germany)

[Note: If you were not aware, the word *mit* in German means *with*.]

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### Science in a Larger Context

[These excerpts are from an article by Kevin Boehnke in the March 6, 2015, issue of *Science*.]

Throughout my science education, I have dutifully memorized facts: the stages of photosynthesis, the enzymes involved in the Krebs cycle, how to balance equations in chemical reactions. In contrast, the focus of my ancient history classes was on answering big, open-ended questions: Why did historical figures act in certain ways? How did the assassination of Julius Caesar affect the Roman Empire? Would our world be different had he not been murdered? There were other questions, too, related not just to historical events but to the nature of knowledge, to what we know and how we know it. What’s the evidence? How reliable is it? Does the conventional explanation account for all the available information (including competing ideas) and the broader context?

Eventually, I tried applying a similar thought process to my science interests. I found that approach to science much more appealing—and also useful. I took it with me as I became a scientist….

I have benefited from studying history in other ways. I learned to think critically and to write rigorous, compelling qualitative arguments….

…Private-sector and governmental careers usually require thinking that encompasses regulatory and cultural concerns—and pragmatic concerns like profits. The ability to consider and weigh diverse arguments and to communicate clearly with various stakeholders is essential.

Science’s inherently reductive approach and its acute attention to the finest details have yielded great benefits. But the scope of science is changing….today’s scientists need to be prepared to tackle complex challenges in a globalized (and multidisciplinary) world, to think critically about how we solve problems, and to communicate persuasively with diverse audiences. More than my science classes did, studying history taught me these skills. Scientists can be too eager to write off other disciplines as “soft,” subjective, and therefore inferior to science and its rigorous approach. Those other fields, though, can enhance the practice and understanding of science, among scientists and the public. I encourage my peers to think about science in this larger context, as a liberal art intrinsically tied to its cousins and aimed at illuminating, improving, and adding meaning to the human experience.
Why Should Teachers Have All the Fun (and Do All the Work)?

Pam Rikard [NEST ’13]


Then I saw the NGSS content standards and I thought, “Yikes, how will I fit in engineering standards!”

Bright idea: create an elective class based on engineering design.

So began my journey into STEAMy Adventures of a Student-Centered Classroom. First, I had to figure out what engineering is. I Googled and found the engineering design cycle (www.teachengineering.org/engrdesignprocess.php). I learned that, basically, engineering is taking a design and trying to improve it.

The great thing about an elective class is that you can design it (a little engineering here) pretty much the way you would like. I decided I would like to incorporate Making (www.makezine.com) and Coding (https://hourofcode.com/us) as well.

You can start small. Teach Engineering (www.teachengineering.org/browse_subjectareas.php) and other sites have lots of low tech, low cost activities.

Now you might be thinking, that’s a lot of extra work. I won’t lie, it is initially. Searching the internet, educating yourself and finding interesting activities takes time. I used Twitter and follow Rockstar educators (https://twitter.com/jcorippo) to get ideas. Once you choose the tasks you would like your class to investigate, it’s time to put your students to work.

This is the student-centered part of the class. You’ve heard that teachers do more work than the students. I decided to turn this around.

The first time I ran a student-centered STEAM classroom, it was the end of the year and, frankly, I was a little burnt out. I chose four, free apps/strands: SketchUp (www.sketchup.com), Bridge Designer (https://bridgecontest.org), Blender (www.blender.org) and a bunch of coding apps like Khan Academy (www.khanacademy.org/computing/computer-programming/programming-games-visualizations). I put Blender in the mix because I had always wanted to try it but never had time. I decide I would let the students to figure it out. I provide a few links to tutorial pages and YouTube tutorial videos to start them, but I didn’t want to do all of the work for them.

I told students they could do one big project using one of the apps or four smaller projects using all four of the apps. It was their choice.

It was a little scary at first. I wasn’t sure if it would be successful, but it was the end of the year and we had accomplished our traditional, step-by-step, teacher-led projects. I already had something to show my principal for the semester.

Students started by exploring the apps and then they completed a learning plan (https://docs.google.com/document/d/1ZSwDNwa0IavT5n9Rmld0PbrtTjbw00gFr7AXS23oOMA/copy?pli=1). I conferenced with each student and went over his or her plan.

Students sat in groups with other students working on the same apps. I told them they could help each other with problems and challenges. They got to work and I found myself wondering what to do with all this extra time I suddenly had.

At the end of each class period, students would write about their daily progress in a blog post. They were to include a screenshot showing their work. That way, I could read and see what they had done.

After a few class sessions, students presented their progress to the class. I gave them a list of questions as talking points: what app are you using, what project do you want to create with the app, what are some problems you have encountered, how did you solve those problems, what problems are you still facing?

The purpose of these questions was two-fold: I could see what challenges students were facing and, more importantly, they could see the problems others were having and work together to solve them.

At the end of the project, students did not stand up and present. Instead, they used Screencastify to create a narrated Fly-Through tour of their project. This way, they could practice and re-record their presentations. Some students included Google Slides. Again, student choice plays a part. Then, on the last day of the project, we watched all of the screencasts.

The one thing I learned from this project was that I needed to give the students benchmarks outlining what I wanted to see in their projects. Because I did not do this, I got various levels of projects—some very basic and some advanced.

One way I remedied this was to give students skill-building assignments for the skills I wanted them to develop. For example, with SketchUp, I gave students YouTube tutorials on the various tools such as the Follow Me Tool (www.youtube.com/watch?v=oX6bn0Q0pIM) that I would like them to use when designing their project. I asked students to screencast themselves showing they know how to use the various tools. I used a rubric specifying the final project must incorporate the use of these tools.

My students-centered classroom is definitely not perfect. It is a work in progress and it gets better every year. The important thing is to start somewhere.
# Personal Learning Plan Template

<table>
<thead>
<tr>
<th>What are my driving questions? What is the question that will drive my inquiry? (Pick something that is personally compelling, something that matters to you.)</th>
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<tbody>
<tr>
<td>How will I pursue answers to this question? (readings, field trips, experiments, interviews, new experiences, research, review of research, building a personal learning network related to your question, online communications, etc.)</td>
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<tr>
<td>How will I document and reflect on my learning journey? (It should be in a form that the teacher/coach can review at any point in the journey. Plan to update it at least twice a week. Possibilities include but are not limited to a wiki, blog, shared Google Doc, video diary on YouTube, etc.)</td>
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<tr>
<td>What culminating project(s) or projects(s) or performance(s) will be the result of my work? (Possibilities include—but are not limited to—papers, presentations to different audiences, models, photo journals, events that you plan and host, things that you design or create, etc.)</td>
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<tr>
<td>How will I monitor my progress and keep feedback on my progress throughout the project? (One possibility is having peers, teachers or experts frequently review and give feedback based on what you are sharing in the place where you document your learning journal. You may also want to schedule “check-up” meetings with people who can help give feedback. Work with your teacher or peers to explore other options, as well.)</td>
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<tr>
<td>What is the tentative timeline for this project? (Note that you will likely adjust this once you get into your project, but it is helpful to have a guide. Use this to start creating a list of things to learn, do and accomplish.)</td>
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<tr>
<td>What are some key resources to be started? (Share 3-5 key people, readings or other resources that helped you create questions and a project idea.)</td>
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<tr>
<td>How will this project connect with one or more key standards or learning outcomes? (Work with your teacher/facilitator to determine this.)</td>
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The Anthropocene Epoch

[This excerpt is from a “Headline Science” article in the September 2015 issue of The Science Teacher and refers to an article by Jan Zalasiewicz, a professor of geology at the University of Leicester.]

…“These changes are advancing so rapidly that the concept that we are living in a new geological period in time, the Anthropocene Epoch, is now in wide currency, with new and distinctive rock strata being formed that will persist far into the future. But episodes of global warming, ocean acidification, and mass extinction have all happened before, well before humans arrived on the planet. We wanted to see if there was something different about what is happening now.”

The team identified four key changes:
• The homogenization of species globally through mass, human-instigated species invasions: Nothing on this global scale has happened before.
• One species, Homo sapiens, is now in effect the top predator on land and in the sea and has commandeered for its use over a quarter of global biological productivity. There has never before been a single species of such reach and power.
• There is growing direction of evolution of other species by Homo sapiens.
• There is growing interaction of the biosphere with the technosphere, the sum total of all human-made manufactured machines and objects and the systems that control them.

Wealth and Health

[These excerpts are from a brief article by Jessica Wapner in the May 2015 issue of Scientific American.]

Wealth typically begets health, as researchers have known for decades. Lower-income families have more medical issues during early childhood and adulthood than wealthier families do. Infants are more likely to be born premature and underweight. Children have higher rates of asthma. Adults have a higher risk of diabetes and cardiovascular disease.

Such disparities among teenagers, however, whose health problems tend to be subtler, had been harder to pin down. According to a new study by researchers at McGill University’s Institute for Health and Social Policy, the socioeconomic fault line divides adolescents, too. Increasingly, low-income youths suffer from more physical and psychological issues than their more affluent peers, which could reverberate well into adulthood.

…the analysis uncovered a growing health gap between teenagers in wealthier and poorer households. Disadvantaged adolescents reported less physical activity and more bodily aches and pains, sleeplessness, and emotional difficulties, such as nervousness and irritability, compared with more advantaged teenagers. The gulf grew wider in countries with more economic inequality. “The U.S. was consistently one of the most unequal countries in terms of health,” says psychologist Frank Elgar, lead author of the study.

Self-Control

[These excerpts are from an article by Roy F. Baumeister in the April 2015 issue of Scientific American.]

The ability to regulate our impulses and desires is indispensable to success in living and working with others. People with good control over their thought processes, emotions and behavior not only flourish in school and in their jobs but are also healthier, wealthier and more popular. And they have better intimate relationships (as their partners confirm) and are more trusted by others. What is more, they are less likely to go astray by getting arrested, becoming addicted to drugs or experiencing unplanned pregnancies. They even live longer….

Self-control is another name for changing ourselves—and it is by far the most critical way we have of adapting to our environment. Indeed, the desire to control ourselves and our environment is deeply rooted in the psyche and underlies human engagement in science, politics, business and the arts. Given that most of us lack the kingly power to command others to do our bidding and that we need to enlist the cooperation of others to survive, the ability to restrain aggression, greed and sexual impulses becomes a necessity.

…It is less a cause than an effect. When researchers tracked students over long periods, they found that getting good grades results in better self-esteem later. But having higher self-esteem does not produce stellar report cards. Self-control, however, is the real deal.

I want to reiterate the importance of doing problems. Through working problems on your own, you will find that there is an enormous difference between learning and being taught.

— Pepper White
The Idea Factory
Identifying good science instruction during classroom observations isn’t the same as identifying good practices for English or social studies….

One way to create a need to learn is by using discrepant or puzzling events. Used at the beginning of a lesson, these demonstrations often spark curiosity, create a sense of wonder, and encourage students to generate potential explanations about underlying causes. When students want to understand the potential cause for what they see inside the classroom, they tend to be more motivated and intellectually engaged….

Teachers must do more than give an occasional quiz or have students use hand signals to indicate understanding. Teachers need to give students opportunities to provide answers and explanations for their answers through words, mathematical representations, and pictures. Teachers then need to identify common alternative conceptions, about the content. Teachers can use this information to design lessons that confront these alternative conceptions, help students abandon them, and eventually adopt conceptions or ways of thinking that are consistent with a scientific worldview….

A third indicator of good science instruction is giving students the opportunity to explore a natural phenomenon before being formally presented with scientific facts, formulas, theories, or other formalized content to be learned….

The Rocket Scientist Syndrome
[These excerpts are from a commentary by Alfred Hall in the April-May 2015 issue of The Science Teacher.]

Emphasis on science, technology, engineering, and mathematics (STEM) has permeated discussions of American education at nearly every level. Our nation’s ability to compete in the global marketplace depends on our ability to properly engage, encourage, and equip our students in STEM. As we strive to address this issue in schools across the country, however, we must include all students.

A common misconception is that STEM programs should be reserved for the best and brightest students…Those students often succeed in handling rigorous STEM coursework, but STEM refers to more than just content knowledge and understanding. STEM education also involves a process of teaching and learning in which students develop skills in critical thinking, problem-solving, working cooperatively in groups, using technology effectively, and communicating orally and in writing. These STEM competencies are critical for success in any postsecondary setting or work-related field, and all students must work toward mastery in each of them to compete in the ever-changing workplace.…

To achieve this outcome, we must work to ensure that all students have the opportunity to complete STEM coursework and participate in STEM experiences that help them develop related skills and competencies.…

Lastly, we must work to help inform parents (in all communities) about the importance of these skills and competencies. STEM is about jobs for the future and preparing all students to be productive citizens, not just rocket scientists. Parents must be continuously encouraged to express the importance of postsecondary experiences and degree competition for their children.…

— T.H. White
The Book of Merlyn

Teaching and Observing a Science Classroom
[These excerpts are from an article by Todd L. Hunter and Victor Sampson in the May 2015 issue of Phi Delta Kappan.]

Identifying good science instruction during classroom observations isn’t the same as identifying good practices for English or social studies.…

One way to create a need to learn is by using discrepant or puzzling events. Used at the beginning of a lesson, these demonstrations often spark curiosity, create a sense of wonder, and encourage students to generate potential explanations about underlying causes. When students want to understand the potential cause for what they see inside the classroom, they tend to be more motivated and intellectually engaged.…

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A third indicator of good science instruction is giving students the opportunity to explore a natural phenomenon before being formally presented with scientific facts, formulas, theories, or other formalized content to be learned.…

— Dr. Donald Hoyt (1965)

Worthwhile Websites

XQ: The Super School Project
(http://xqsuperschool.org/challenge)

The Super School Project is an open call to reimagine and design the next American high school. In towns and cities far and wide, teams will unite and take on this important work of our time: Rethinking and building schools that deeply prepare our students for the rigorous challenges of college, jobs, and life.

This is a challenge to empower all of America to change high school. Together, we can transform communities and build schools that inspire new possibilities.

Over the next few months, we will accept your proposals. Then we’ll partner with the winning teams and provide them expert support and a fund of $50 million to support at least five schools over the next five years to turn their ideas into real Super Schools.

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).

Emily Martin, SEPT Coordinator
Massachusetts Institute of Technology
Network of Educators in Science and Technology
20 Ames Street, Bldg E15-301
Cambridge, MA 02142 USA

The Network of Educators in Science and Technology (NEST) is a member driven organization dedicated to the promotion of literacy in science, technology, engineering, and math.
http://web.mit.edu/scienceprogram/nest

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ornstein@alum.mit.edu
or
Avi Ornstein
207 Garry Drive
New Britain, CT 06052