NETWORK OF EDUCATORS IN SCIENCE & TECHNOLOGY

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

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Contents

Co-Chair Report

Eric Klopfer

Ramping up for SEPT 2012, I've been looking back on last summer's iteration of our now decades-old program. SEPT 2011 was again in the new style, combining hands-on activities with lectures. Reflecting on feedback from the first iteration of this format in 2010, we adjusted this mixture and also added in more evening activities. This year we will again make adjustments based on feedback as we move the program forward. I expect to see more engineering in the mix this year, for example.

As I thought about it, it is probably these continual adjustments to both the format and the content that define the "new" SEPT more than the format or content of any one year. Scientific knowledge and educational practice are both rapidly growing and changing, and the workshop that we put together every summer should reflect the advances in both of these realms. The smaller workshop allows us to make such adjustments and enables a variety of formats of interaction. This opens up possibilities for each new year that have me truly excited. It also means that, along with our partners in the alumni clubs, we can recruit and select the very best teachers to participate.

The details of SEPT 2012 are still being worked out, but the one thing that is certain is that it will be different than last year.

In the rest of my time, I've been working on some exciting new projects. One in particular, code-named "Cosmos" or STEMMO (for Science, Technology, Engineering and

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Urban Teaching in Context: FIRST Robotics, Building our Youths' Future

Elly-May O'Toole [NEST '10]

There have been numerous uplifting and encouraging studies that have praised extracurricular programs designed for adolescents and teens and their impact on reducing youth crime, improving academic performance and generally improving the quality of life for our urban youth. As a teacher, I've seen this demonstrated in the field many times in my career. Perhaps never has there been such a strong example of this positive influence as that provided by FIRST Robotics and their yearly competition.

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Civic Education

Avi Ornstein [NEST '89]

In the March-April 2012 issue of Harvard Magazine, Ellen Condliffe Lagemann and Harry Lewis explain the need for "educated citizens who will sustain the nation." Benjamin Franklin had said that our form of government was "a Republic, if you can keep it." They note how this Republic "will not persist through momentum alone."

In creating the Massachusetts Constitution in 1780, John Adams wrote "Wisdom, and knowledge, as well as virtue, diffused generally

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CORRECTION

There was an error in the last issue of this newsletter. **Susan Matthews [NEST '95]** rather than **Susan Kelly [NEST '10]** presented at the annual "Return to the NEST" at MIT last June.

Calendar of Events

June 24-July 30
Science and Engineering Program for Teachers at MIT

June 28
McNamara Workshops (Thursday)

June 29
Teacher Awards are presented at the Annual Dinner (Friday)

June 28-June 30
NEST June Retreat at MIT (Friday & Saturday)

September 1
Submission deadline for the fall newsletter

November
Renew membership

January 15
Deadline for membership renewal

January 19
NEST Executive Meeting

January 29
Deadline to send letter of interest to Lauren McNamara for Research Experience for Teachers (RET) at MIT

Efficient Vehicles

[These excerpts are from an editorial by Larry J. Schweiger in the October/November 2011 issue of *National Wildlife*.]

In a truly significant national commitment to curb greenhouse gases, the Obama administration, a labor union and key auto manufacturers including Chrysler, Ford, General Motors, Toyota, Honda and Hyundai have joined with the state of California to reach a critical deal requiring passenger vehicles to average 54.5 miles per gallon by 2025. Also announced—and broadly agreed upon—were the first ever standards for heavy-duty trucks that will reduce their fuel use by 10 to 20 percent by 2018. Currently, more than 30 percent of fossil-fuel carbon dioxide emissions in this country come from petroleum that is used mainly by the transportation sector….

According to the Union of Concern Scientists, the latest passenger vehicle agreement will cut carbon pollution by more than 308 million tons in 2030—the equivalent to shutting down 72 coal-fired power plants. The group also predicts "lower fuel expenditures at the pump by over $80 billion in 2030—even after paying for the cost of the necessary technology, consumers will still clear $50 billion in savings that year alone." These savings mean billions more being spent at home, boosting our economy locally and improving our serious trade deficit. They also will reduce our dependence on Middle East oil by saving as much as 23 billion gallons of gasoline annually by 2030, which is equal to the total current annual imports from both Saudi Arabia and Iraq.

Editorial

In an Op-Ed article that appeared in the Hartford Courant on February 5, 2012, Philip A Streifer (Superintendent of schools in Bristol, CT, and chair of the Connecticut Association of Urban Superintendents) discussed how schools do not do an adequate job of preparing students for college. "Employers no longer trust a high school diploma," he said, "and now, nearly all jobs require at least some education beyond high school." He went on to note how "there are many differences between what elementary and secondary schools now teach and what they need to teach." His closing paragraph began with stating how he is "not a fan of mandates," but he went on to say that "mandating public and state higher education systems to work together just makes sense."

While there is merit to some of his points, only teaching curriculum that prepares students for college has a flaw. Education should set goals and standards that make it possible for any student to be able to succeed on that track. However, there are jobs and futures that are built on skills that do not require a college degree. Ignoring that is unrealistic and we need to have open paths for those who follow a different tune.

At the same time, we need to strive to offer all students the best possible education that we can, taking into account their individual traits and needs and working to meet them. In an editorial in the January 13, 2012, issue of Science, John E. Burris (President of the Burroughs Wellcome Fund) focuses on our teachers. His opening paragraph ended with saying that "there are no quick fixes in the world of education. Instead, the United States must commit to the laborious task of improving the teachers we train and the environment in which they teach, while providing teachers with a respect and trust commensurate with their critical social roles." This is a healthier, more complete focus that we usually hear.

Burris later notes that we must "recruit the best and the brightest to be teachers" and that we should then "give them the freedom to develop teaching skills, independent from centralized authority, and ample time to prepare lessons and to interact with peers and students outside the classroom." He finds fault in how, in our nation, "the best and the brightest are often not recruited into teacher education" and how "U.S. teachers are on the treadmill of teaching to endless standardized tests, and there is little recognition of the importance of time spent with peers or participating in professional development."

I strongly agree with the points he raises, including how "much of the high turnover rate of U.S. math and science teachers is due to inadequate professional development and little classroom autonomy." In addition, he recommends that states should "close down underperforming teacher training and certification programs, reduce standardized testing, and recognize excellence in teaching" to achieve the desired goal of better educating our students. These are ideas that deserve to be backed and encouraged!

Worthwhile Website

"Confessions of a Bad Teacher"
www.nytimes.com/2012/03/04/opinion/sunday/confessions-of-a-bad-teacher.html?pagewanted=1

Greetings from Discovery Academy! I am **Jan Frank [NEST '11]**, the STEM (science, technology, engineering and mathematics) coach for CREC's newest magnet school. This year, Discovery Academy has pre-kindergarten and kindergarten students. Eventually, our elementary school will include PK to grade 5. Our magnet theme offers many exciting opportunities for our children and our school reduces racial isolation.

Our Pre-Kindergarten students have been studying the different properties of natural and man-made materials. According to the GEMS (Great Explorations in Math and Science) teacher guide, "Build It! Festival," free exploration is fundamental for the development of math concepts including: measurement, shape and size, balance to make a structure, equivalent shapes, patterns and designs. National Engineers Week is in February, so it was a perfect time to put our early childhood engineers to testing and comparing different building manipulatives to make structures that move, structures that are stable and tall, structures like bridges that can support weight and structures with many geometric shapes. We invited the University of Connecticut Ambassadors, an outreach program where undergraduate engineering students work with K-12 students, to join us. Nine UCONN Ambassadors played with our Pre-Kindergarten students for our *Engineering Extravaganza* event. The teamwork from this partnership created a high level scientific learning experience!

At AAE/GHAMAS, the astronomy class of **Haia Spiegel [NEST '07]** is exploring the transit of planets on far away stars in collaboration with the Harvard Smithsonian Institute for Astrophysics. Students use a telescope that they control online. They take their own images of distant solar systems, interpret the data they gather and detect a planet orbiting a star far beyond our Sun.

Once they find the target star and the companion of two other stars on their image, they calculate the brightness of the star with and without the transition of the planet in front of that star. The calculations have to be precise because the planet is very tiny when compared to the star, blocking only 1-2% of the light. They are also learning how astronomers detect signs of ice, land or water by measuring the albedo (the fraction of reflected light) from any mystery planet.

In this unit, students are learning how to use the MEAD Cassegrain telescopes. In addition, students are going to the Central Connecticut State University Copernicus Observatory Planetarium in New Britain, CT. [Organizations and school groups can book planetarium shows, observing sessions, lectures and hands-on activities absolutely free! Information is available at: http://web.ccsu.edu/astronomy/]

Traci Maxted [NEST '09] has forwarded the information that the Iowa Academy of Science (Iowa Science Teaching Section) will have their annual fall conference October 15th and 16th at the Scheman Center in Ames on the Iowa State University campus. The theme is "Our Students, Our Future: The Social Responsibility to Effectively Teach Science." The keynote speaker is Dr. William McComas, Parks Family Professor of Science and Technology Education Curriculum and Instruction at the University of Arkansas. If you're interested in more information, you can contact Traci at tmaxted@mchsi.com.

Philip Blackman, the club facilitator of SEPT at the MIT club of Hawaii (MITCH) wants to share the following information with NEST members. If you were not aware, MIT announces the list of accepted students each year on Pi Day, March 14 (3.14 at 15:00 hr). MITCH invited those students chosen from the islands to a reception with their parents on the 25th of March. This year they also invited the SEPT graduates to this gathering! MITCH has facilitated the SEPT graduates' presentation to the club and to a Hawaii state teachers' conference. They now hope that this direct link with the Hawaii contingent of the 2015 class has recharged their interest and appreciation of the MIT experience.

This year's Connecticut Science Teachers' Association (CSTA) Conference will be October 13th at Hamden Middle School in Hamden, CT. Those seeking more information can contact **Betty Catelli [NEST '95]** at bcatelli@sbcglobal.net.

Great Learners

[This list is extracted from an article by Kristin Olson that appeared in September 2011 in *Phi Delta Kappan*.]

7 Critical Orientations Toward Learning

1) Great learners see learning as pleasurable and value and cherish this pleasure.
2) Great learners are effort theorists who have learned the hard way that effort is more important than "inborn" ability.
3) Great learners tend to have a strengths-based view of themselves and others, focusing on what they're good at instead of what they don't do so well.
4) Great learners practice letting go of negative emotions, of flipping the script on what might be regarded as a failure.
5) Great learners are unusual problem solvers who know how to ask for help. They excel at reframing their difficulties.
6) Great learners don't let the institution of school define them. Instead, they practice "adaptive distancing," a capacity to accept the institution's gifts without being wholly defined by its feedback.
7) Finally, great learners have passion.

Student Reading

Julianne Opperman [NEST '97]

The following list outlines the reading skills students should have by the time they leave tenth grade. It includes a list of techniques they can use to achieve these skills.

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon or concept; provide an accurate summary of the text.

3. Follow precisely a complex multi-step procedure when carrying out experiments, taking measurements or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

6. Analyze the author's purpose in providing an explanation, describing a procedure or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Reading Techniques – Science Textbooks and Journal Articles

Scientific texts are loaded with concepts, explanations, details and examples. It is sometimes hard to discern which is which. *It takes thought and practice*. Taking notes from the chapter and organizing/classifying them is the best way for students to assure themselves that they have discovered the knowledge hidden in the words.

If the teacher assigns a text to read without explanation, the following steps will ensure finding the important information in the text and understanding it.

They should have learned to read titles, headings and the bold words. This is a good place to start finding the main concepts. Give them the following directions:

- ✓ Use a separate (8.5" x 11") page for each subtitle
- ✓ Write the subtitle at the top of the page.
- ✓ Write the definitions of the words in the title immediately below the subtitle.
- ✓ Read the section of the text once to get a sense of the information. Do not write anything until you are completely through the section.
- ✓ Read the section of the text again.
  - At the end of each paragraph think about what was said.
- ✓ Write the general idea of the paragraph. (It doesn't have to be in a complete sentence.)
  - Read what you wrote and see if it makes sense.
- ✓ Evaluate the vocabulary words you defined at the top of the page. How do they fit into what you wrote?
  - Write a (short) comment about the words and your notes.
  - Is there a detail you might add?
- ✓ If there is a picture or diagram mentioned in the paragraph, find it.
- ✓ Evaluate it. How does it fit your general idea of the paragraph?
  - Is the picture a good example of the general idea?
  - Write about it and/or sketch it.
- ✓ Reread the paragraph and reread everything you wrote. Do they fit together and made sense?

Reading Laboratory Procedures

- ✓ A lab notebook is the place to record your notes when you read a procedure.
- ✓ If there is introductory material in the activity, read it first.
  - Think about what kinds of measurements you might be required to make.
- ✓ Write the title and purpose of the lab in your lab notebook before you read the procedure. This will help you under stand the reasons behind the actions.
- ✓ Read the procedure slowly, maybe out loud. There is detail in a procedure.
- ✓ After you read the procedure once, reread it again and make a data chart for the procedure based on the reading.
  - Do this even if the handout provides a data chart.
  - The data chart shows you know what you are doing.
- ✓ You may compare your data chart to another one provided or to another student's.
- ✓ The data chart should list the identity of each measurement (mass, volume, length, time), the unit that will be used for the measurement (g, ml, cm, s).
- ✓ If you find your data chart doesn't make sense to you, read the procedure again.
- ✓ Before you start the lab, you should know what you are going to be doing with the measurements (or observations).
  - Are you going to calculate value, graph the data, determine a mathematical relationship or draw an observation?
  - If you know what you will do at the end, you will know what to do to get there. That is why the purpose (and perhaps the hypothesis) is so important.

Kudos

Bette Bridges [NEST '90], **Betty Catelli [NEST '95]**, **Harvey Gendreau [NEST '96]**, **Avi Ornstein [NEST '89]**, **Donna Rand [NEST '00]** and **Kristen Record [NEST '11]** all presented at the regional NSTA conference in Hartford, CT, in October 2011.

Susan Groff [NEST '01] has been selected as a NASA SOFIA Ambassador. A press release is available at www.sofia.usra.edu/News/news_2012/01_25_12/index.html.

Under the direction of **Donna Rand [NEST '00]** and two other teachers, students at Glastonbury-East Hartford Elementary Magnet School (GEMS) will participate in the NASA Microgravity Project. Students in kindergarten through Grade 5 will design experiments in their school science lab involving Newton's Laws of motion, mass and fluid dynamics. These experiments will later be tested aboard the NASA Zero-G Aircraft. The GEMS teachers traveled to Houston to visit NASA's Johnson Space Center and observed and recorded the results of the student experiments.

The Human Brain

[This excerpt is from a joint editorial by Sydney Brenner and Terrence J. Sejnowski that appeared in the November 4, 2011, issue of *Science*.]

Linnaeus's catalog of species and the classifications he imposed on them turned data into knowledge, but it did not lead to an understanding of why they were all there. That had to wait for Darwin's theory of evolution and the development of genetics. All the lists that we will accumulate about the brain, although necessary, will be far from sufficient for understanding. The human brain contains an estimated 86 billion neurons and an equal number of glial cells. The complete structure of the enormously simpler 302-neuron network of the nematode worm *Caenorhabditis elegans* was published in 1986. But without the activities of neurons and their synapses, it was far from a complete "wiring diagram." Today, with genetically encoded calcium sensors, with better knowledge of the molecules present at synapses, and by integrating the omic catalogs with developmental and dynamical data, we may finally be in sight of completing the worm wiring diagram, as required for a full understanding of this one relatively simple nervous system.

The challenges to understanding the human brain are immense, and neuroscientists will require powerful technologies to meet them. Fortunately, a revolution in optical microscopy, driven by striking advances in molecular labeling and digital processing, has given us a new window into the inner lives of cells. The ability to see with unprecedented resolution the locations and trafficking of molecules and the dynamical organization of synapses has revealed extraordinarily complex control systems. The biochemical environment inside synapses is seldom in equilibrium and compartments are not well mixed, so stopped-flow biochemistry and new computational tools from physics such as Monte Carlo models will be needed.

Electrical recordings from one neuron at a time deep in the brain can give us clues to what information has passed through a brain area. But neurons are not independent, interacting with each other and the world on a wide range of time scales. New techniques have been developed to simultaneously record from and manipulate many neurons in several brain areas that can give us a picture of how interacting neural populations give rise to behavior.

America's Infrastructure

[These excerpts are from an editorial by Kathy Caldwell, president of the American Society of Civil Engineers (ASCE), which appeared in the October 21, 2011, issue of *Science*.]

When the ASCE issued its 2009 *Report Card for America's Infrastructure*, it gave the cumulative grade of "D" to the condition and performance of 15 of the country's infrastructure systems. Among the worst were roads and drinking water. The United States not only loses about seven billion gallons of clean drinking water every day due to leaking water systems, but pipe failures and resulting floods have collapsed roads, destroyed homes, and endangered people. It would require an estimated $2.2 trillion over 5 years to raise the grade of all 15 infrastructure systems to an acceptable level. Sadly, the situation has not changed since the report was published….the deficient surface transportation infrastructure alone will cost U.S. businesses an added $430 billion (cumulative to 2020) in transportation costs. By 2020, it is projected that exports will be $28 billion lower, 70,000 jobs will be lost, households will lose more than $7000 in personal income, and the country's gross domestic product will take a hit of $897 billion. Businesses will need to divert increasing portions of income to pay for transportation delays, wasting money that could instead be invested in innovation. Nearly all sectors will suffer, but those associated with technology and innovation would probably be the hardest hit….

Promoting a more sustainable and resilient infrastructure must also be part of this conversation. Improved design and construction standards to withstand extreme conditions will require further R&D. Climate change and environmental preservation also require innovative infrastructure designs. Research is needed to determine the best ways to expand power generation and transmission. And the growing demands for information technology mean that underground utilities must be carefully planned.

Infrastructure investments provide an opportunity to improve the economy in the short term by creating jobs, while also driving the long-term growth needed to compete in the global marketplace. Although repairing and modernizing the country's infrastructure may seem daunting in lean times, the cost of doing nothing will be exponentially greater.

Modeled Meiosis

Avi Ornstein [NEST '89]

In teaching a unit on meiosis and reproduction, I was unable to find a lab activity that fit the goals I had envisioned. Students were having difficulty in conceptualizing the topics and I wanted a hands-on approach that would aid them in getting a clearer image. I therefore created the following activity, drawing some ideas from various sources and adding them to ones that I concocted myself.

You are welcome to use this lab and feel free to make modifications to make the best possible fit for the curriculum you are teaching.

Materials:

To create the kits used by the students, you will need snack bags (I prefer ones that can be sealed), colored Popsicle sticks, scissors and sticky-back Velcro. A kit consists of eight pairs of Popsicle sticks—two blue, two green, two red and two yellow. Cut short pieces of Velcro and attach them to the middle of the sticks so that the pairs that are the same color stick to one another. These are placed in one snack bag to make a single kit. You will need one kit for every two or three students. It takes a little time to create them, but they are reusable, meaning a single investment of time will produce something that can be used for many classes and for year after year.

Pre-lab:

The idea is to apply this lab activity after having introduced the class to the general concepts. I had them read the related portion of the textbook and went over a homework assignment on that reading. They were then told to have their notebook out and to not open the kit they were receiving until they were told to do so. I passed out the kits and then went through the following interactive lab activity.

Lab activity:

Throughout this lab activity, you need to be taking notes, as you will have a writing assignment based on this lab. During the lab, I will be coming around to check answers you have written in your notebook or models you have made. You will be graded on effort and participation during this lab activity.

1) Look at the items in the kit without taking them out and think back to the last unit on mitosis. Write down what the wooden sticks might represent?
   [chromatids]
2) Now look at the Velcro. Write down what it might represent?
   [centromeres]
3) Take out one pair of chromatids and place that in front of you. You are dealing with a simple cell that only has a single pair of chromatids. Use what you need from the kit to create how it will look at the start of meiosis.
   [two pairs of chromatids]
4) Rearrange what you have so it will represent the end of meiosis I.
   [the two pairs are moved apart, being in separate cells]
5) Again rearrange what you have so it will represent the end of meiosis II.
   [the four chromatids will be in individual haploid cells]
6) Do you have any questions at this point?
   [After answering any questions, have them return the materials to the kit.]
7) Let's see what happens in producing sex cells. The yel low sticks will be used to represent X alleles and the blue sticks will be used to represent Y alleles. What are the alleles of a female?
   [XX]
8) Make a model to represent this.
   [a pair of yellow sticks]
9) Go through meiosis. What will result?
   [four X alleles – four yellow sticks]
10) Actually, only one egg cell results from this meiosis. The other meiotic cells, called polar bodies, will disintegrate.
   [Have them remove three yellow sticks, leaving only one out and to the side.]
11) Now let's look at the production of sperm. What are the alleles of a male?
   [XY]
12) Make a model to represent this.
   [one yellow stick and one blue stick]
13) Go through meiosis. What will develop?
   [two X alleles and two Y alleles – two yellow sticks and two blue sticks
14) An egg combines with only one sperm in fertilization. Look at the models you have before you. Write down what you think is the probability that the offspring is male or female?
   [50% male and 50% female]
15) Let's look at another aspect relating to meiosis—the passing on of genetic traits.
   [Have them return the materials to the kit.]
16) A dominant trait is seen if you have one or two dominant alleles. A recessive trait is only seen if you have two recessive alleles.
17) Clasp your hands together, alternating the fingers. Look at which thumb is on top. Compare with your teammates.
   [Demonstrate how they should hold their hands.]
18) This is a genetic characteristic. Having the right thumb over the left thumb is the dominant trait. Having the left thumb over the right thumb is the recessive trait.
19) Let the blue stick represent the dominant allele for this trait and let the green stick represent the recessive allele. Now create all possible pairs of these alleles and then separate them into dominant and recessive traits.
   [Blue-blue and blue-green are dominant and green-green is recessive.]
20) Hold up a flat hand. Can you separate the fingers so that the index and middle fingers are together and apart from the ring and pinkie fingers, which are together? This is the Vulcan greeting of Mr. Spock of Star Trek. It is a dominant trait. Being unable to do this is a recessive trait.
21) Let the red stick represent the dominant allele for this trait and let the yellow stick represent the recessive allele. Create all possible pairs of alleles and then separate them into dominant and recessive traits.
   [Red-red and red-yellow are dominant and yellow-yellow is recessive.]

22) Select a set of models of alleles that are recessive for both traits. If you carried out meiosis and looked at the resulting haploid cells, what could you tell about the possible offspring?

[Since only recessive alleles are available, the off spring must have the recessive traits.]

23) Now select a set of models of alleles that each has both a dominant and recessive allele for each trait. What can you say about the traits?

[Since a dominant allele of each trait is present, they will both show dominant traits.]

24) If you carried out meiosis and looked at the resulting haploid cells, what would you see?

[All four alleles are present.]

25) Consider pairing alleles of both traits. How many possible combinations can you get?

[There are 9 combinations – RRVV, RRVv, RRvv, RrVV, RrVv, Rrvv, rrVV, rrVv and rrvv. R stands for right thumb and V for Vulcan.]

26) Betty and Ted fall in love. They introduce Betty's identical twin, Netty, to Ted's identical twin, Fred. Soon there is a double wedding where Betty marries Ted and Netty marries Fred. Both Betty and Netty get pregnant and they wonder if their babies will look exactly alike. What is your answer, including your reason for reaching that decision?

[This is **very** unlikely, as the alleles have too many possibilities of having varied combinations.]

Assignment:

Select three things you learned by doing this activity. For each, write a paragraph. The first sentence will state what you learned and the remainder of the paragraph will be an explanation.

This will be graded for both content knowledge and writing skills.

Global Warming

[This excerpt is from an editorial by Corey S. Powell in the June 2011 issue of *Discover*.]

…Our planet has survived many climate swings in the past, and it will survive this one, too. And while it is true enough that many species may struggle in a warmer world, the one whose fate we should really worry about is *Homo sapiens*.

When temperature and precipitation patterns shift, the organisms hit hardest are the ones with the deepest roots. Unfortunately for us, we humans have a lot of permanent infrastructure. Coastal cities cannot move inland to get away from rising sea levels. Farmers cannot simply relocate their fields in the new optimal locations for agriculture. Adaptation is possible—in fact, it is inevitable—but it will not be easy, cheap, or painless.

Unlike other species, though, we can anticipate the environmental challenges that lie ahead and blunt their impact….

Recommended Reading

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

Alberts, Bruce; "Trivializing Science Education"; *Science*; January 20, 2012; p. 263.

Borrell, Brendan; "Speaking Out on the 'Quiet Crisis'"; *Scientific American*; December 2011; pp. 94-99.

Eveleth, Rose; "Peeling Away Microbes"; *Scientific American*; February 2012; p. 18.

Fox, Douglas; "The Clouds Are Alive"; *Discover*; April 2012; pp. 38-45.

Gleick, Peter H., & Heberger, Matthew, "The Coming Mega Drought"; *Scientific American*; January 2012; p. 14.

Lambert, Craig; "Twilight of the Lecture"; *Harvard Magazine*; March-April 2012; pp. 23-27.

Lehrer, Jonah; "Kin and Kind"; *New Yorker*; March 5, 2012; pp. 36-42.

Mendelson, Joseph R., III; "Lessons of the Lost"; *American Scientist*; November-December 2011; pp. 438-441.

Pringle, Heather; "The 1st Americans"; *Scientific American*; November 2011; pp. 36-45.

Rekart, Jerome L., "Taking on Multitasking"; *Kappan*; December 2011/January 2012; pp. 60-63.

Senechal, Diana; "The Practice of Solitude"; *American Education*; Winter 2011-2012; pp. 8-11.

Chinese Water

[This excerpt is from a news article in the November 11, 2011 issue of *Science*.]

Fully 90% of China's shallow groundwater is polluted, according to the Ministry of Land and Resources, and an alarming 37% is so foul that it cannot be treated for use as drinking water. Common pollutants include heavy metals, organic solvents, petrochemicals, pesticides, and nitrates. The toll is significant. Every year, an estimated 190 million Chinese fall ill and 60,000 die because of water pollution. According to the World Bank, such illnesses cost the government $23 billion a year, or 1% of China's gross domestic product. And that doesn't factor in the impact on China's ecosystems and food supply.

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among the body of people, being necessary for the preservation of their rights and liberties, and as these depend on spreading the opportunities and advantages of education in the various parts of the country, and among the different orders of the people, it shall be the duty of legislatures and magistrates, in all future periods of this commonwealth, to cherish the interests of literature and the sciences, and all seminaries of them."

This aspect seems to be ignored in debating what should be occurring in our educational institutions. We instead focus on what can be directly tested, which is, at best, a secondary value of education. We need to focus on teaching students how to learn and why to learn. They can then proceed to learning what they need to know, which continues to vary in our ever-changing world.

In the Harvard Magazine article, the authors also quote a valuable view of Noah Webster, stated in 1788: "It is an object of vast magnitude that systems of education should be adopted and pursued which may not only diffuse a knowledge of the sciences but may implant in the minds of the American youth the principles of virtue and of liberty and inspire them with just and liberal ideas of government and with an inviolable attachment to their own country."

In their closing paragraph, the authors note that "failing to reinvigorate the civic mission of our colleges and universities carries a high price: it will put at risk the well-being of our nation and the world, perhaps not tomorrow but in decades to come...current dismay over political polarization and skepticism about human progress can give way to the civic idealism that has always characterized the American experiment at its best." These views should not be limited to higher education. These values and virtues should be a part of all levels of education!

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

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

Teaching to the Test

[This excerpt is from an op-ed article by Daniel Long, an assistant professor of sociology at Wesleyan University, which appeared in the *Hartford Courant* on February 12, 2012.]

…using standardized tests to evaluate teachers is ineffective, unfair and counterproductive. In my own study of the performance of more than 200,000 students in school systems in 64 countries, I found that using student test scores to evaluate teachers tends to lower overall student learning outcomes. This occurs because teachers are given an incentive to teach to the narrow test questions instead of promoting an in-depth knowledge of academic subjects and critical thinking skills. The use of student tests to evaluate teachers also blames teachers for factors outside of their control.

Continued from page 1 "Co-Chair Report"

Mathematics Massively Multiplayer Online role-playing game), is a big initiative aimed at creating an on-line game to directly support learning of science and mathematics at the high school level. We will initially be targeting biology and geometry classes and will also be looking for some pioneering teachers who would like to try this out come next year. Stay tuned, and I hope to see many NEST members this summer.

Teacher Evaluation

[This is the opening portion of an article by Linda Darling-Hammond, Audrey Amrein-Beardsley, Edward Haertel and Jesse Rothstein that appeared in *Phi Delta Kappan* on March 2012 (p. 8). The article is well worth reading.]

Practitioners, researchers, and policy makers agree that most current teacher evaluation systems do little to help teachers improve or to support personnel decision making. There's also a growing consensus that evidence of teacher contributions to student learning should be part of teacher evaluation systems, along with evidence about the quality of teacher practices. "Value-added models" (VAMs), designed to evaluate student test score gains from one year to the next, are often promoted as tools to accomplish this goal.

Value-added models enable researchers to use statistical methods to measure changes in student scores over time while considering student characteristics and other factors often found to influence achievement. In large-scale studies, these methods have proved valuable for looking at factors affecting achievement and measuring the effects of programs or interventions.

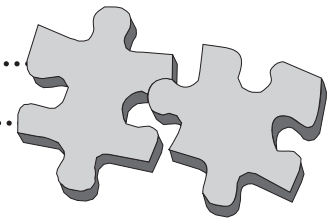
Using VAMs for individual teacher evaluation is based on the belief that measured achievement gains for a specific teacher's students reflect that teacher's "effectiveness." This attribution, however, assumes that student learning is measured well be a given test, is influenced by the teacher alone, and is independent from the growth of classmates and other aspects of the classroom context. None of these assumptions is well supported by current evidence.

Most importantly, research reveals that gains in student achievement are influenced by much more than any individual teacher. Other factors include:

- School factors such as class size, curriculum materials, instructional time, availability of specialists and tutors, and resources for learning (books, computers, science labs, and more);
- Home and community supports or challenges;
- Individual student needs and abilities, health, and attendance;
- Peer culture and achievement;
- Prior teachers and schooling, as well as other current teachers;
- Differential summer learning loss, which especially affects low-income children; and
- The specific tests used, which emphasize some kinds of learning and not others and which rarely measure achievement that is well above or below grade level.

However, value-added models don't actually measure most of these factors….

PUZZLE CORNER



#1) Can you translate these words?

a) 26 – 35 – 92 – 18 – 39
b) 74 – 1 –53 – 52 67 – 92 – 34
c) 49 – 23 68 – 52 – 5 – 88 – 52
d) 16 – 92 – 15 – 68 – 16 – 22 – 22 – 8 – 92 – 16

#2) How was the word *chromosome* selected for this cellular particle?

Solutions to the previous problems:

#1) If you remove the first and last letter, you obtain a new word.

#2) They are the only two-digit prime numbers that produce a larger prime number by reversing the digits.

Assault on Science

[These excerpts are from a book review by Alyssa Pelish of Shawn Otto's book (*Fool Me Twice*) that appeared in the October 28, 2011, issue of *Science*.]

…This illiteracy is troubling for many reasons—not the least of which are the consequences of policy based on highly subjective beliefs and assumptions rather than the relevant science….A public and its elected policy-makers who don't understand the science behind these issues will inevitably respond with their guts.

Otto finds this gut-based, ideologically driven displacement of science from policy decisions to be problematic on a more fundamental level: the way in which laws based on faith and assumptions instead of evidence pull the United States from its democratic foundations toward an increasingly authoritarian government….science influenced Jefferson's ideas of democracy and its aims. A key tenet of Jeffersonian democracy is that an educated, well-informed citizenry can be trusted to govern itself. Something has gone wrong, Otto argues, when those who are supposed to represent the public are not adequately informed about the science behind important issues yet continue to insist on their beliefs. Such a top-down, empirically empty method of governance, he notes, is closer to the blind ideology of authoritarianism than to democracy.

…After discussing several major policy issues to demonstrate problems that arise from the gap between the two, he examines why Americans have become so effectively distanced from science. He contemplates how the fears raised by the atomic age and, later, environmental disasters have left a lingering distrust among the public. Intriguingly, he considers how both the undeniably authoritarian Christian right and the ostensibly anti-authoritarian postmodernist denial of objective truth have undermined appreciation for science….

…Otto's most intriguing idea, however, is "science debates," in which candidates discuss their stances on science-based policy issues. He and scientists who support the idea would like to make these a part of all presidential and congressional election seasons….

Scientific Certainty

[This excerpt is from an editorial by Corey S. Powell in the December 2011 issue of *Discover*.]

…Many letters take issue with individual points of climate science, but I am particularly intrigued by the ones that aim wider, targeting the very concept of scientific certainty.

This critique is often expressed as some variant of "right, and scientists also used to think the world was flat." If they could all be wrong about such a fundamental fact, the thinking goes, how can we trust they aren't being fooled again? The argument has a couple huge problems, though. For one, scientists never thought the world was flat. Even in ancient Greece, educated people understood that our planet is round. Earth's shadow on the moon during a lunar eclipse is clear evidence of that.

More broadly, the flat-earth critique illustrates the opposite of what it claims. Scientists are typically in the vanguard in rejecting old ideas and embracing novel, counterintuitive ones when the evidence becomes compelling. The greatest resistance has generally come from the outside, when those new ideas ran counter to religious doctrine (Galileo versus the Catholic Church) or business practices (Ignaz Semmelweis's battle with the 19th-century medical establishment to institute hygienic rules in hospitals, for instance). And evidence, once collected, does not go away. Galileo didn't discredit prior astronomical observations; he added to them. Likewise, more research can deepen our understanding of climate, but it cannot overrule the evidence that the Earth is growing warmer.

Yet a number of climate-skeptic writers suggest otherwise. They state that researchers in the 1970s predominantly believed in global cooling, implying that climate data have been discredited once and (presumably) might be again. Fortunately, this claim is easy to fact check. A tour around the Internet traces most of the cooling references back to a single, hyperbolic story from Newsweek in April 1975. More telling, a detailed literature analysis by climatologist Thomas Peterson of NOAA and colleagues show that, even in the 1970s, the bulk of the climate papers tentatively foresaw a warming trend.

Classroom Science Activities

Avi Ornstein [NEST '89]

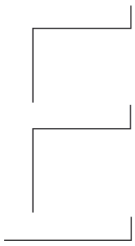
During a "Science Day" at our school, the students went through a variety of activities and presentations. However, the scheduling left a 20-minute period for each class where they were in a class with a non-science teacher. So that the entire day would be focused on science, a set of activities was created that could be used in each class. It consists of a set of directions for the teacher and was accompanied by a printed sheet for each student, along with blank sheets and markers or colored pencils.

Here are those activities for your use at an appropriate time in your school. The three images that go on the printed sheet are placed here after the appropriate activity. To use the activities, just print them on a sheet for the students, each placed in a separate third of the sheet.

Give each student a printed worksheet and a blank sheet. For step three, they will need to borrow a colored marker or pencil. Read the directions to one activity and let the students carry it out. Then read the explanation. Repeat this for each activity.

……

1) Hold the printed worksheet in front of your face and slowly move it away until you can identify what you see in the upper central region of the sheet.



Explanation This is an optical illusion. Your brain wants to make sense of these three lines. Once it is far enough away (the distance varies from person to person), you will see something you recognize and you will then see it even when the sheet is closer to you.

……

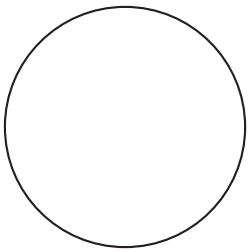
2) Close or cover your right eye and hold the worksheet at a full arm's length with the "R" in front of your left eye. Slowly move it forward until something happens to the "L". Move it a little closer and then move it away again. Something interesting will happen.

L **R**

Explanation There is a blind spot in each eye where the nerves are exiting and going to the brain. The brain 'paints' over the blind spot based on what is viewed around it. In this case, when the letter is in the blind spot, the brain 'paints' the area white and the letter vanishes.

……

3) Solidly color the circle with a marker or colored pencil. Place it over the blank sheet of paper. Focus on the circle and stare at it for at least 30 seconds. (Count **slowly** to 30.) While continuing to stare at the same spot, keep the blank sheet in place and remove the sheet with the colored circle. What do you see?



Explanation Light comes in three basic colors: blue, red and green. The eye has three different types of cones, each responding to a particular color. By staring at the colored circle, some cones are being used more than others and they get tired. When you view the white paper, they do not respond as well and your brain sees an image that is opposite in color.

……

4) Roll one sheet of paper lengthwise into a tube that is about one inch in diameter. Holding it in your left hand, place it in front of your left eye. Keeping both eyes open, hold your right hand upright and flat in front of your right eye with your palm facing you. Position the palm so the edge is touching the middle of the tube. Your palm should be about six inches in front of your face. What do you see?

Explanation Your brain gets information from each eye and combines them into a single image. This gives you depth perception, letting you judge how far away something is. In this case, your brain receives two very different sets of information and they are put together to produce the hole in the middle of your hand.

……

5) Hold your hands with one forefinger pointing horizontally at the other, about half an inch apart from one another. Your hands should be a few inches in front of your face. While holding them still, focus on something across the room. What happens to your fingers?

Explanation By focusing across the room, your brain receives two different sets of data regarding your fingers. The result is that you 'see' a floating finger in front of your face.

……

6) Select a partner. Have your partner close his or her eyes and hold a palm over them for at least 30 seconds. When the time is over, tell your partner "now" and he or she must remove his or her hand and open his or her eyes. Observe what happens to his or her eyes. (This occurs very quickly, so you have to be watching carefully.) Then reverse roles and repeat this.

Explanation The irises of the eye expand and contract according to the amount of available light. When your eyes are closed, less light is getting in. The irises move back, making the pupils larger. When you remove the hand and open your eyes, light floods in and the irises contract and the pupils get.

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.]

Wilhelm Roentgen had heard that another scientists had previously discovered that cathode rays were able to light up a nearby fluorescent screen. Another scientist had found that cathode rays could pass through thin sheets of metal. In 1895, he carried out a set of experiments to see if cathode rays could be seen if the glass tube that produced them was completely covered with black cardboard.

When he darkened his room, he noticed a glow appearing several feet away in his lab. Thinking there was a tear in the dark cardboard, he inspected it carefully. Such was not the case. He instead found that something passing through the thick cardboard was causing a fluorescent screen over a yard away to glow. The invisible rays were not cathode rays. They could pass through solids and even produce images of skeletons on the covered negative behind one's body.

In 1901, the first year of the Nobel Prize, he received the award in physics for his discovery of this radiation which he referred to as x-rays.

The Issue of Tenure

[These excerpts are from an article by Jason Courtmanche that appeared in the Opinion section of the *Hartford Courant* on February 26, 2012.]

Diane Ravitch, an education expert, points out that today's school reformers know nothing about what works in education, and so they try to make schools look more like businesses.

They propose to test students, evaluate teachers according to those tests and then reward or punish teachers consequently. Their proposals make little or no mention of curriculum or instruction. These reforms, as with those proposed by Gov. Dannel P. Malloy and State Commissioner of Education Stefan Pryor, rest upon the premise that teachers know exactly what needs to be done to improve education, but they simply aren't doing it. They assume that if we remove tenure and threaten teachers with reprisal, then teachers will do their jobs. In truth, the challenges in education are much more complex, and tenure is not to blame.

The biggest problem in Connecticut is the achievement gap between wealthy and poor students, which largely correlates with the gap between wealthy and poor students, which largely correlates with the gap between white and minority students. The fact of the matter is, however, that the gap has everything to do with poverty and not a whole lot of anything to do with tenure….

I do not blame the students or their families for this predicament. Most of our ancestors were poor immigrants who faced similar challenges. And I do not fault the choice program in and of itself. If anything, it helped desegregate the schools. But I do fault the federal government and the state government for issuing unfounded mandates and for failing schools whose teachers have been set up for failure. And now I worry that the teachers are being scapegoated even further….

The problem here is not tenure. Tenure didn't fail these kids, impoverish their families, or under fund their schools. What teachers and their students need is not blame, reprisal, failure and sanction. They need funding and professional development.

Positive Feedback

[This excerpt is from a commentary by Michelle M. Shearer, 2011 National Teacher of the Year, which appeared in September 2011 in *Phi Delta Kappan*.]

Despite their positive feelings, poll respondents indicate that they are much more likely to hear "bad stories" than "good stories" about teachers in the news media. It's time for a change: Positive reports about teachers and our schools ultimately benefit our students. Imagine if the national news began with a segment entitled "Highlights in American Education," a broadcast designed to energize nation with inspirational stories about innovative teachers and successful students. Think of the stories we could share! As we strive to provide high-quality education nationwide, we need to showcase the talents of effective classroom educators to get a broad and multi-faceted view of what "good teaching" looks like. Let's focus our attention, in our communities and in the media, on celebrating and emulating extraordinary teaching in an effort to support students and advance public education.

Advice to Parents

[The follow excerpt is from an article by Kathleen M. Comerford that was originally in the *Atlanta Journal-Constitution* and appeared in *Reader's Digest* in November 2011.]

Teachers have been listening to parents complain for decades. It's time for parents to listen to teachers and to treat them like professionals. Pretend that your child's teacher is as qualified in his or her field as your lawyer is in the law. When you treat teaching as a profession and educators as experienced professionals, you might learn something.

Robert Langer Interview

[This interview was submitted by **Teresa Caracciolo [NEST '02]** and had been written by Rebekah Morris, one of her students.]

Anatomy and advanced placement biology teacher Teresa Caracciolo, along with a handful of people, including Principal William Massolio, Assistant Principal Paul Paquette, Assistant Principal Intern Matthew Mitchell, as well as many of Caracciolo's students, had the privilege of meeting and interviewing Dr. Robert S. Langer via Safari Live on Jan. 23 in Caracciolo's classroom. Darryl Saffer of the Education Channel was also there to film the event.

Langer is one of the 14 David H. Koch Institute Professors at MIT. Being an Institute professor is one of the highest honors that can be awarded to any staff member.
Among his many accomplishments, Dr. Langer has also written more than 1,150 articles, has approximately 800 issued and pending patents worldwide, and is the most cited engineer in history.

The first student questioner, junior Michelle Desjardins, asked Dr. Langer about his latest breakthroughs in InVivo Therapeutics, a research program, Langer explained, intended to help "promote functional recovery following traumatic spinal cord injury." After Langer responded, Desjardins looked star-struck.

"I didn't really know what had just happened. I was totally in awe that I was able to talk to someone that important to the world. It was so cool to be face to face with a man who is accomplishing so much for society and that I had the privilege to stand before him and ask him a question. It was incredible; definitely one of the best moments in my life," said Desjardins.

Another student, senior Chris Sawyer, asked Dr. Langer, "If you had to pick two people who motivated you, one being on a personal level and one being a public figure, who would they be?"

Dr. Langer responded, "As my personal motivator, I would have to choose my longtime friend and mentor who was also my post-doctoral advisor, Judith Folkman, because she believed that anything was possible. As for a public figure, I would have to say Abraham Lincoln, because he did so much for this country, and his speeches, writings, and visions are an incredible part of our nation's history."

The next student, junior Niambi Campbell, asked, "What advice would you offer someone who is trying to become a biomedical engineer?"

Dr. Langer responded with a smile and said, "This may sound like a simple answer, and one you may not want, but the best thing to do is study. Find the classes that will prepare you for that career and work hard at achieving the goals you set for yourself."

When the topic of medical and physical research for athletes came up, Caracciolo asked Dr. Langer, "On the topic of sports, who are you rooting for in this Super Bowl?"

Dr. Langer laughed and said, "That's a very easy question, the Patriots," to which there was a mixture of cheers, laughs, and boos from the whole class.

When Caracciolo ended the twenty-minute discussion with Dr. Langer, she said, "Thank you so much for taking the time out of your busy schedule to meet with us, everyone in this room loved hearing from you and talking with you, and I thank you from the bottom of my heart."

Dr. Langer responded by saying, "Thank you all, as well, and hopefully we can do this again sometime. The questions you all asked were very well thought out, and I was happy to answer them."

Everyone clapped and, after Dr. Langer signed off, Mr. Paquette addressed the whole class. "Dr. Langer seemed very down-to-earth," he said, "I could picture him waking up in the morning, putting on a pair of simple pants, and going out just like a normal person; even though his position and accomplishments are so prestigious. How do you think he came off as a person? What was your impression of him?"

There were a lot of answers murmured around the classroom, one being from junior Josh Furr who said, "Dr. Langer is a beast." Amidst other reactions were, "he wasn't stuck on himself," as well as, "he made me feel less nervous," and "he just seemed like the rest of us."

Caracciolo was ecstatic about the meeting, and this was made evident by her literal jumps for joy. "I hopped around a little bit in the beginning, didn't I?" The whole class laughed as Caracciolo said, "Well, I guess Dr. Langer knows how exciting this was for me." She went as far as to say the experience marked "one of the best and most exciting in [her] career."

Massolio finished the discussion with his hopes for the outcome of the meeting. "What I want to come out of this is for every student in this room to be instilled with inspiration to one day do things this great because he used to sit in a classroom like all of you, and look where he is now."

Overall, the experience was one nobody in the audience will ever forget.

Strong Teacher

[This extract is from an op-ed article by Nicholas D. Kristof that appeared in *The New York Times* on January 11, 2112.]

…a landmark new research paper underscores that the difference between a strong teacher and a weak teacher lasts a lifetime. Having a good fourth-grade teacher makes a student 1.25 percent more likely to go to college, the research suggests, and 1.25 percent less likely to get pregnant as a teenager. Each of the students will go on as an adult to earn, on average, $25,000 more over a lifetime—or about $700,000 in gains for an average size class—all attributable to that ace teacher back in the fourth grade. That's right: A great teacher is worth hundreds of thousands of dollars to each year's students, just in the extra income they will earn.

An Interview with Teresa Caracciolo

[This interview was submitted by **Teresa Caracciolo [NEST '02]** and had been written by Rebekah Morris, one of her students.]

I recently interviewed Anatomy and Advanced Placement Biology teacher Teresa Caracciolo about herself, her school, and her teaching methods.

Q: What is one surprising thing many people wouldn't know about you?

A: I drive a motorcycle, a Kawasaki ZZR 600.

Q: What are some tips you would give students coming into your class?

A: Be ready to work, have an open mind, be flexible, and be prepared to gain a lot of information.

Q: How do you improve your method each year?

A: I switch it up for sure. I keep the things that work and throw out the things that don't. I add new stories and ways to make it more fun and interesting for the students who are learning.

Q: You are known by many students and staff as having a "hardcore" method of teaching. Do you agree?

A: I definitely agree with that. Anatomy is nothing to take lightly. We have had previous students graduate and go into Pre-Med. We set students up for success and I take a lot of pride in that.

Q: What is one thing that you think is great about teaching?

A: I can give you two. First and foremost, the feeling that I get when I've realized that I've impacted the life of a student. That feeling overwhelms me with a great sense of accomplishment and is better than a paycheck!

I usually hear from these alumni when they come back to the school for a visit. They have also emailed me. Many times, I share the classroom strategy that worked best for them, maybe one that created a turning point in their academic career that empowered them to master the content.

Students in my classes have always enjoyed the visits in the past from the alumni as they were given the opportunity to ask each alumnus questions about their college experiences.

So, the tradition gives back two-fold: in one way, I learn which strategies they found to be applicable to the next level, and in another way, my students have access to explanations for their unanswered questions.

The second is, teaching allows me to keep evolving within my profession. I learn new things with the students that I teach. It is great to be a lifelong learner.

Q: If you weren't teaching what would you be doing?

A: I would be playing Women's Professional Soccer and Kite Surfing on the weekends.

Q: What do you like most about North Port High School?

A: The staff, the support, the students, the proximity between work and home, and the courses that I get to teach. It's great being able to broaden the range of classes that I can teach to my students, in offering upper level classes. Students can prepare for college, and that is a very beautiful way to set them up for success!

Energy Research

[These excerpts are from a guest editorial by Bill Gates in the November 18, 2011, issue of *Science*.]

As someone now working full time in global health and development, I see firsthand how the U.S. government's support for scientific research has improved people's lives. That support is vital in another area—affordable, clean energy. I believe it is imperative that the government commit to clean energy innovation at a level similar to its research investments in health and defense.

In a time of economic crisis, asking policy-makers in Washington, DC, to spend more money might not be the most popular position. But it's essential to protect America's national interests and ensure that the United States plays a leading role in the fast-growing global clean energy industry. There is really no other choice. Carbon-based fuels are prone to wild price gyrations and are causing the planet to overheat. The United States spends close to $1 billion a day on foreign oil, while countries such as China, Germany, Japan, and Korea are making huge investments in clean energy technologies. The creation of new energy products, services, and jobs is a good thing wherever it occurs, but it would be a serious miscalculation if America missed out on this singular opportunity.

The United States is uniquely positioned to lead in energy innovation, with great universities and national laboratories and an abundance of entrepreneurial talent. But the government must lend a hand. Market incentives, alone, will not create enough affordable, clean energy to get the nation to near-zero CO_2 emissions, the level of emissions that developed countries must achieve if we are going to keep Earth from getting even hotter. Moreover, developing major new technologies, where the time frames necessary for true innovation stretch past the normal horizons of patent protection, requires up-front investments that are too large for venture capital and traditional energy companies.

History has repeatedly proven that federal investments in research return huge payoffs, with incredible associated benefits for U.S. industries and the economy. Yet over the past three decades, U.S. government investment in energy innovation has dropped by more than 75%. In 2008, the United States spent less on energy R&D as a percentage of gross domestic product than China, France, Japan, or Canada….

Energy transformations take generations. But if the United States begins in earnest today, the nation's energy challenges can be solved in ways that truly set America on a path of energy independence and that provide affordable energy for everyone, especially the poor. The return on this kind of investment could change—perhaps even save—the world and provide generations to come with a brighter future.

Continued from page 1 "Urban Teaching in Context"

Founded on the core principles of "gracious professionalism" and cooperation, FIRST Robotics outlines yearly high tech challenges that is designed to completely engage students. The program enthusiastically promotes innovation in problem solving and teamwork, two skills that are growing ever more important in today's global economy. Student participants are introduced to the wondrous world of engineering and science and gain hands-on insight and experience in mechanical design and construction, electrical design and construction, computer programming, robotics and the equally important administrative aspects of fund raising, grant writing and budgeting. Perhaps most exciting for many students is that all these skills are gained through strong partnerships and mentoring, giving them a chance to feel connected to something bigger than themselves.

Participation in a program such as this can change the lives of inner-city youth. It provides a positive and productive focus and allows them to become tangibly engaged in their own education. You can never underestimate the power of providing disadvantaged students with a vision of what is possible. The program is designed to not only deliver an opportunity to show students what they are capable of creating, but also to show them the possibilities that exist for careers in science and engineering. Meeting and working with adult professionals in a variety of fields gives them a window into their own potential futures. Their new interest in engineering sparks a new reason to work hard at school to find a way into a good college or a program to improve their chances for their future. While they work hard academically, it is also an excellent venue for helping to develop and strengthen students' positive social skills and introduce them to professional cooperative behavior that will help them to succeed in their new career goals.

With a core value of cooperation, effort should be made to also broach some of the natural segregations that can arise in the high school environment. Building a team of students from mixed cultural backgrounds, of both boys and girls, and different levels of academic performance increases the value of the exercise in teamwork. Damaging stereotypes can lose their hold as everyone demonstrates what they can bring to the team. Barriers can be broken and the value of having multiple perspectives when problem-solving can be stressed. The bonds that form between these students as they pour their energy into their challenge can last far beyond the classroom.

The dynamic nature of these challenges also provides a unique environment where students can draw upon a wide range of strengths while building confidence in other areas. Student athletes have a chance to appreciate their academic ability while maintaining a high level of physical activity. Students who may otherwise stay lost in the theoretical world of books have a chance to see their ideas in action and construct knowledge in a more kinesthetic manner. Students who are well equipped for the social challenges of life are able to contribute to the healthy team atmosphere while also strengthening their academic engagement.

The student who has never been chosen for a team can now be one of the strongest members of a team, regardless of their physical abilities. Building a robot that will end up approximately the same mass as many of the students somehow works as an inclusive opportunity for any willing to take the plunge—sometimes with surprising social results. For some students, when they tell their friends that they are building a robot to play basketball they are treated with new respect. They manage to gain equal footing with the basketball and football stars. It's impressive and it shows in the pride each team member takes in their work and participation.

Engaging our next generation in academics is always a challenge—inspiring them to careers in science and engineering, perhaps even more so. Finding programs such as FIRST is an important key. While many struggle to keep students awake and alert, the robotics room bustles with activity every day after school, often until 9 pm or later if they were allowed. We owe it to our students to provide as many of these types of opportunities as we can. The robot might be the tangible result, but it isn't the most important thing being built. These students are constructing their own futures, one skill, one interaction, one friendship at a time.

QDA – Quince Docentes Argentinos

Roberto Cerrudo [NEST '01]

We are a group called QDA or Quince Docentes Argentinos (Fifteen Argentine Teachers) and we attended the Science and Engineering Program for Teachers at MIT during the summer of 2001.

From that outstanding experience and on behalf of the spirit of NEST, we decided to organize our own program "Science and Teachers Get Closer" that was held at ITBA (Buenos Aires Institute of Technology) in July 2002 and again at SIDERAR (San Nicolás), in November of the same year. With a very low budget and a lot of personal effort and commitment, eleven outstanding Argentine researchers lectured about the state of the arts in their various fields of investigation. The different topics included genetics, toxicology, nuclear energy, eolic energy (wind power) and plague control. Ten different workshops were held on the third day, most of them developed by us.

Time has passed. During these years, we achieved the legal capacity and registered the mark QDA. In 2011 we had accomplished ten consecutive years of organizing this program. We have had over 2000 teachers attending these lectures and workshops. As a result, they have enriched their professional practice with new ideas and insights. As we are a non-profit organization and there is therefore no fee for the attending teachers, we depend mostly on sponsors of good will that believe in education to support our program. These last three years, thanks to the OSDE Organization (Argentina's premier healthcare network), we have had the possibility to reach teachers in 23 different locations along the country through teleconference.

Every year, all new NESTers are invited to join the group and contribute with there own experience at MIT. This could not have been possible without the constant encouragement and support of the MIT Club of Argentina, to whom we will never be thankful enough, as well as all the Enterprises and Universities that trusted us.

You are all welcome to visit our web page www.grupqda.org.ar.

High School Senior Uses MIT's StarLogo

Nel Venzon [NEST '11]

Chad Uyehara, one of the high school students I have mentored this year with their scientific investigations, conducted an ecological study using the computer program StarLogo, a computer program developed at MIT. Upon returning from participation in the Science and Engineering Program for Teachers (SEPT) at the Massachusetts Institute of Technology (MIT) last summer, I offered Chad, a Mililani High School graduating senior, an opportunity to work on an independent project involving StarLogo.

After weeks of computer simulations, data collection and analysis, Chad presented his project, Computer Modeling and Simulation of Capturing Roi (*Cephalopholis argus*), an Invasive Species of Fish, and Its Impact on the Native Hawaiian Fish Population, at the Pacific Symposium for Science and Sustainability (PS3) last December. PS3 includes presentations of papers by students from Hawaii and other Pacific Islands. It also serves as a regional competition to advance to the Junior Science and Humanities Symposium, a national-level event. Chad was a semifinalist at PS3. Chad's abstract for his project follows.

"In this ecological study, StarLogo, a computer program developed at the Massachusetts Institute of Technology, was used to model and simulate a complex system in which an invasive species of fish is over-running the native fish population. The invasive species, commonly known as roi in Hawaii, is a grouper fish that preys on juvenile fish in Hawaii's reefs. A simulation was created to show the highly asymptotic growth of the roi and the steady decline of the native fish such as the parrotfish. It was then compared to another simulation in which a "roi round up" is conducted annually. A roi round up is when many skin divers gather to dedicate a day of spear fishing strictly to the killing of invasive species such as the roi. This simulation concluded the roi round up to be effective, thus saving the Hawaiian reefs' native fish population. Further testing could be performed in the field based on observations, but further empirically based results need to be conducted to provide evidence. Collectively, the use of new technology such as StarLogo, a user friendly programming interface, could help researchers create an efficient study of complex systems such as ecological interactions."

In the fall 2010 semester, Chad was invited to present his research paper, An Empirical Approach to Maximize the Structural Efficiency of an Elevated Bridge, at PS3. Chad also presented this engineering project at the Hawaii State Science and Engineering Fair in spring 2011, where he earned the Best of Engineering and Materials Science category award.

The high quality of Chad's projects can be attributed to his advanced knowledge, creativity, scientific ability and, above all, his natural passion in science and mathematics. Chad was accepted by early action decision to attend MIT in the coming year.

It is a safe rule to apply that, when a mathematical or philosophical author writes with a misty profundity, he is talking nonsense.

—A.N. Whitehead

Hawaii Local Science Fair Gains International Affiliation

Nel Venzon [NEST '11]

The Central Oahu District Science and Engineering Fair (CODSEF) was able to secure Affiliate status with the Intel International Science and Engineering Fair (ISEF). This is the first time in the history of Central Oahu science education that Central District will have a direct entry into the Intel ISEF and provide those remarkable science projects an audience on a world stage.

CODSEF was held on Saturday, February 18, 2012, at Leeward Community College. The following top projects at CODSEF will represent Central Oahu and join Hawaii student delegates at the Intel ISEF, the world's largest international pre-college science competition, in Pennsylvania in May:

First Place: Viola Mocz (10th grade, Mililani HS)—New ideas in physics: the mass ratio of elementary particles from torus geometry
Second Place: Marc Siler (11th grade, Mililani HS) and Danielle Terukina (11th grade, Mililani HS)—Analyzing the effect of antibiotic microbes from soil-borne bacteria on other bacteria
Third Place: Abraham Kwan (11th grade, Moanalua HS)—Denitrification prevention in an aquaponics system

CODSEF is supported in part by Central Oahu high schools (teachers and staff), Hawaii Academy of Science, Science Learning Center, Leeward Community College, corporate sponsors, judges, volunteers, parents/guardians and the talented students from Central Oahu.

For more information, please contact Nel Venzon (CODSEF Founder and Director) at codsef@gmail.com.

Lecturing Science

[These excerpts are from an article by David H. Freedman that appeared in the December 2011 issue of *Discover*.]

…learned what cognitive have proven repeatedly in recent years: Humans don't learn concepts very well by having someone blab on about them. In other words, the college lecture is to a large extent a waste of time.

…In a landmark paper, "Twenty Terrible Reasons for Lecturing," [Graham Gibbs] points to "overwhelming" evidence that lectures are an ineffective way for universities to achieve the educational objectives they set. Academia continues to rely heavily on lectures…because professors are "overworked," "ignorant," and "don't know how to design courses."

…one section of a University of British Columbia physics course about electromagnetic waves was taught by the cognitive approach, while another section was taught by the standard course lecture. The first group scored an average of 74 percent when tested on the material, while the second group scored only 41 percent….

But scientists who teach have proven reluctant to toss out the lecture, never mind the evidence that it doesn't work.

Young Children and Science

[This excerpt is from a column article by Kathleen E. Metz in the May 2011 issue of *Kappan*.]

Since the first international comparison of student achievement in mathematics and science, we've been worried about the disappointing showing by U.S. students. However, while the United States has tried to improve mathematics achievement in every grade from kindergarten to 12th, its effort to improve science education has emphasized only middle school and high school. Elementary school science has been relatively neglected.

One cause is an outdated idea that elementary school children aren't developmentally ready to handle complex science. But my research and that of others shows that young children can be surprisingly capable scientists. Their abilities far exceed the notions of age-appropriate science in current curriculum policy documents. This means that today's science curricula are unnecessarily watered down.

What children know determines what they can learn next. If we update our thinking about what young people can do with science and give them more optimal learning opportunities, we may be able to significantly strengthen young children's scientific reasoning and position them to take on more rigorous curriculum in later grades.

Biodiversity

[These excerpts are from an article by James Crampton that appeared in the November 25, 2011, issue of *Science*.]

To understand today's biodiversity, biologists must understand fossil diversity. What has controlled patterns of biodiversity through the past ~550 million years? How reliably does the fossil record preserve these patterns? To answer the first of these questions, paleontologists must first answer the second. It now seems that the fossil record may do more than simply impose a set of biases on the preserved history of life. Instead, common-cause factors have simultaneously affected both the nature of the fossil record and true biodiversity. If this is correct, then the challenge is to tease apart bias from common signal from cause-and-effect.

…at large spiral scales and over millions of years, biological diversity reflects complex interplays between abrupt and gradual environmental changes, varying thresholds in dynamic equilibria, and interactions between species. To understand how these classes of factor have shaped diversity patterns through space and time, and ultimately to understand modern diversity, it is necessary to separate cause and effect from bias in the fossil and rock records. The information transfer approach…offers a potentially game-changing way of assessing relationships between the wonderful, but flawed, archives of environmental and biotic change that are captured in the geological record.

Solar Panel Benefits

[These excerpts are from a brief article in the September 2011 issue of *The Science Teacher*.]

In a study in the journal *Solar Energy*, Kleissl and his team published what they believe are the first peer-reviewed measurements of the cooling benefits provided by solar photovoltaic panels. Using thermal imaging, researchers determined that during the day, a building's ceiling was 5˚F cooler under solar panels than under an exposed roof. At night, the panels help hold heat in, reducing heating costs in the winter.

...His team determined that the amount saved on cooling the building amounted to getting a 5% discount on the solar panels' price over its lifetime.

...Rather than the Sun beating down onto the roof, which causes heat to be pushed through the roof and inside the ceiling of the building, photovoltaic panels take the solar beating. Then much of the heat is removed by wind blowing between the panels and the roof.

The benefits are greater if there is an open gap where air can circulate between the building and the solar panel, so tilted panels provide more cooling. Also, the more efficient the solar panels, the bigger the cooling effect....

Global Knowledge

[These excerpts are from an editorial by Nina V. Fedoroff, President of AAAS, that appeared in the February 3, 2012, issue of *Science*.]

Science and technology have long figured in the efforts of societies to gain military advantage. Archimedes invented the defensive engines and burning glasses used to ward off the Roman attack on Syracuse in 214 B.C. Leonardo da Vinci and Michelangelo were military engineers; Napoleon Bonaparte viewed himself as a scientist. Abraham Lincoln established the U.S. National Academy of Sciences during the Civil War in part to provide advice on military matters.

The emergence of scientists as peacemakers and diplomats is recent. Ongoing meetings between top Soviet and U.S. scientists are often credited with keeping the Cold War cold….

…Today, countries all over the world aspire to have high-skill, high-value economies, to become "knowledge societies" and "knowledge economies." The extraordinary value of knowledge is, of course, that there are no limits to its growth or the value it can generate….

Today's communications technologies make it possible to teach and collaborate with anyone anywhere. Online educational resources and organizations devoted to creating partnerships and networks among scientists, engineers, and educators continue to proliferate. But in the end, the task of creating a true global knowledge society, of knitting together the scientific and technical communities of nations to solve humanity's common problems, falls to each and all of us.

Prepare and Inspire

[These excerpts are from an opinion and analysis of a report of this name by the federal administration. The article appeared in the August 2011 issue of *Scientific American*.]

…The report noted that 25,000 STEM teachers leave the workforce every year, mostly because of disgruntlement with their jobs and lack of professional support. To attract and retain enough science and math teachers will require an elevation in their status and a thorough revamping of attitudes toward the entire profession.

…The onus to improve schools should be on federal, state and local educational strategists. The first step should be to tap the strengths of the existing teaching pool. We must identify today's Escalantes—the top 5 percent of the nation's STEM teachers—and, as recommended in the administration report, induct them into a STEM master teachers corps that would receive salary supplements and federal funding to support their activities.

Second, we need to give all teachers the tools they need….Teachers shouldn't have to rely on homemade props. E should form the equivalent of the Advanced Research Projects Agency to help develop educational technologies, including "deeply digital" instructional materials that encourage active participation. At the same time, we should recognize that new technology isn't a solution in itself and shouldn't come at the expense of other needs. Many schools get grants and donations for the latest computers and software yet can't buy books for their libraries or beakers for their science labs.

Finally, we should shift our emphasis from standards to implementation. Developing new standards does have a role, but the problem for most schools is not a lack of good curriculum options. It is the difficulty of putting them into practice, given the day-to-day pressures that teachers are under. If anything, new standards and tests often get in the way by forcing educators to teach to the test, rather than encouraging critical thinking.

To meet all the goals set by the White House report would require an extra $1 billion each year. Against the nearly $600 billion spent annually for public education, it is not a huge sum. Still, with local districts faced with declining tax revenues and unfounded mandates, some of the money will have to come from the federal government.

This goes against the grain during a time when teachers' salaries and benefits are being cut. Yet the costs of doing nothing are a matter of simple calculus. If we do not improve STEM education, the U.S. will continue a decades-long slide from the middle of the pack in student achievement toward the very bottom.

If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves....We have, in effect, been committing an act of unthinking, unilateral educational disarmament.

—National Commission for Excellence in Education (1983)

Urban Water Shortages

[These excerpts are from a brief article by Oakley Brooks in the 2011 *Nature Conservancy*, issue 3.]

With its growing number of companies and more than 7 million residents, Bangalore exemplifies India's high-tech boom. And like many cities in the developing world, it has a drinking problem.

Lakes in Bangalore have been filled in to make way for new apartments, and underground aquifers are being depleted. City officials resorted to cloud seeding to get through the 2011 dry season. As they look to the future, they have set their thirsty sights on the rivers of the Western Ghats, a mountain range along India's coast.

These same mountain rivers, however, provide refuge for a remarkable 300 species of fish, a third of them unique to the area.

Already, 150 million urbanites in the developing world can't get the water they need inside city limits. By 2050, Mature Conservancy scientists predict, ballooning cities could push that number to nearly 1 billion….

Fixes, however, could be surprisingly simple. Some 30 to 50 percent of urban water is lost in delivery and could be saved by repairing leaky pipes. Agriculture could free up more water if farmers would adopt drip irrigation systems.

Trivializing Science Education

[These excerpts are from an editorial by Bruce Alberts that appeared in *Science* on January 20, 2012.]

Few people are aware of what has been learned from research about the teaching of complex science concepts to young people, and there is a string tendency to assume that the best science curricula are the most "rigorous." Although rigor might appear to be a worthy goal, the unfortunate result of this persistent view is that difficult concepts are taught too early in the science curriculum, and they are taught with an overly strict attention to rules, procedure, and rote memorization….

When we teach children about aspects of science that the vast majority of them cannot yet grasp, then we have wasted valuable educational resources and produced nothing of lasting value. Perhaps less obvious, but to me at least as important, is the fact that we take all of the enjoyment out of science when we do so….

The preference for "rigor" in science education can also interfere with the teaching of science at the college level. For example, in an introductory biology class, students are often required to learn the names of 10 enzymes that oxidize sugars in a process called glycolysis. But an obsession with such details can obscure any real understanding of the central issue, leaving students with the impression that science is impossibly dull, causing many to shift to a different major.

Tragically, we have managed to simultaneously trivialize and complicate science education. As a result, for far too many, science seems a game of recalling boring, incomprehensible facts….

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