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

John Matthews [NEST '95]

As the first technology teacher to be a co-chair of NEST, I had every intention of using this opportunity to write, in some way, about STEM—that is, until the return to campus in June. You may or may not be aware that 2010 heralded some changes to the SEPT/NEST program. The SEPT program changed as a result of organizational, philosophical and budgetary reasons. The 2010 SEPT class was downsized from the typical 50-60 participants to about 25 and the program changed from the traditional lecture format to a media lab based experience. The new changes were thoroughly evaluated at

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Moving Forward

[These excerpts are from an editorial by Brooks Hanson that appeared in *Science* on May 7, 2010.]

The main societal challenges—global energy supply, growing the food supply, and improving public health, among others—depend intimately on science, and for this reason society requires a vigorous scientific enterprise. Our expanding global economy is taxing resources and the environment in ways that cannot be sustained. Science provides a deep understanding of these impacts and, as a result, the ability to predict consequences and assess risks.

Addressing anthropogenic climate change exemplifies the challenges inherent in providing critical scientific advice to society….Climate is as global as today's economy; we know from archeological and historical records that an unstable climate has disrupted societies….

We thus must move beyond polarizing arguments in ways that strengthen this joint commitment. The scientific community must

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Science Teaching Mentor

Debra Davis [NEST '06]

During the 2010 Spring semester, I received an email from Texas Region 4 Educational Service Center (www.theansweris4.net) containing an application to participate in the 2010-2011 Regional Science Collaborative in Biology for Excellence in Science Teaching Program. The program provides 105 hours of professional development throughout the 2010-2011 year. Most of the training is held during the summer and on weekends. Participants are issued a one-year usage of a Sony HD GPS-enabled camera through www.visualrealization.com and www.diimsa.com. We are also given a Boreal 2HM Series Digital Microscope from sk@sciencekit.com and, upon completion of the guidelines of this program, we are provided a stipend of $500. I sent my application to Mary Ingle and, on May 18, 2010, I was accepted into the program as a Science Teacher Mentor (STM). The mission of the program is to provide teachers a support system of scientifically researched, sustained and high intensity professional development and mentoring to assist with state guidelines. The activities are designed to improve students' scientific literacy and inspire them to pursue science and engineering related careers.

The professional development provides an opportunity to explore many aspects of teaching methods and developing curriculum. It gave us the chance to explore areas such as the use of the interactive notebook, developing/using 5E lesson plans, reviewing state and national standards and building useful curriculum. Everyone has been highly anticipating receiving the copy of "Gateways to Biology," which is another benefit of the program. We will be using modules focused in areas of the following: life on Earth, homeostasis, energy transformations, growth and development, heredity and biodiversity.

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Calendar of Events

February 12
NEST Executive Board Meeting

March 1
Submission deadline for the Spring NEST newsletter

April 1
Deadline for NEST Student Award selections

April 8
Deadline for 2011 SEPT applications

April 22
NEST Reunion Registration

McNamara workshop proposal info
and form to be sent out via email

April 29
Student Award books/certificates
are sent out to teachers

May 7
Submission deadline for McNamara Workshop proposals

June 19-25 (tentative)
Science and Engineering Program for Teachers

June 23-25 (tentative)
NEST June Retreat at MIT
(Thursday evening through Saturday noon)

Overpowered Nature

[This excerpt is from an article by Lawrence M. Krauss entitled "End-of-Days Danger" that appeared in March 2010 in *Scientific American*.]

One should be free to question the detailed nature of model predictions about the future, but the evidence that humans can, do and will continue to "overpower" nature is so incontrovertible that to deny this fact is to live in a fantasy world. That reality is what we most need to grapple with to address environmental challenges and stimulates the economies of both the developing and the developed worlds….

Achievement Gap

[This excerpt is from an article by Deidra Grode in the April 2010 of *Education Update*.]

According to his research*, some children are so far behind their peers before the first day of kindergarten that 50 percent of the achievement gap can be traced to these critical developmental years before school begins. Murphy attributes another 25 percent of the gap to learning lost during summer break.

[*Lessons to Close the Achievement Gap by Prof. Joseph Murphy of Vanderbilt University]

Editorial

All too often, students are taught mathematical concepts or equations by repetition. The idea is presented and they then repeat it again and again. They do worksheets that are all almost identical, just changing the variables. They have homework that repeats the concept and it is given in the same form on quizzes and tests. The assessments imply that they have learned the idea, but all they have done is record it in short-term memory. It will be forgotten over too short a time period. In addition, if the idea is presented in a different manner, such as in a word problem, many of the students will approach it randomly with far too many getting incorrect answers.

It is far better to actually teach the material in a way that lets the students really learn the concept. It may be more difficult and more time consuming, but the problems should mix up the concept as many ways as possible. Include word problems. Mix the concepts with other concepts. Integrate it with other material over an extended period.

Some students may have difficulty adjusting to this method, but it will pay off in the long run. They will be learning and understanding the concepts, rather than temporarily memorizing them. The concepts will be a part of their knowledge for a far longer time span and will be able to be used in related topics.

Possibly even more important, the students will be learning how to learn material. This skill will be beneficial in all of their courses and will continue to be a benefit even after they finish attending school. Keeping that in mind can serve as a motivating force in facing this more difficult but more worthwhile method of educating students.

Ecology

[This excerpt is from an editorial by William H. Schlesinger that appeared in *Science* on August 6, 2010.]

Global warming, the Gulf of Mexico oil disaster, invasive species—these are but a few of the issues concerning environmental scientists and, increasingly, the public. What is needed is a new partnership between scientists and advocacy groups that conveys ecological information accurately and in ways that stakeholders (including policymakers, resource managers, public health officials, and the general public) can understand. Just as physicians use "translational medicine" to connect the patient to new basic research, "transitional ecology" should connect end-users of environmental science to the field research carried out by scientists who study the basis of environmental problems. Translational ecology requires constant two-way communication between stakeholders and scientists. It should continuously alert scientists to aspects of the environment in need of study to produce new data, while clearly synthesizing what is already known from field studies and its relevance to policy. The partnership's purpose should be to ensure that all stakeholders know the implications of scientific discoveries and understand their impact on alternative ecological diagnoses.

The InvenTeam project was launched on July 10th at Shenzhen Middle School (SMS) which is located in South China. 26 students at SMS have signed up for this project. The lead InvenTeam teacher is **Gao Qing [NEST '10]**. Two MIT alumni who are working in Guangdong province have already stepped forward to mentor the students.

QQ Company, the largest net service supplier in China, will be a corporate sponsor and a great resource in terms of "adopting" these students, providing employee mentors as well as resources/expertise from within the company to help with the invention process. This project offers a wonderful opportunity for students to cultivate their creativity and experience invention while participating in MIT's InvenTeam.

If you'd like further information, please contact Gao Qing at gaoqingdd@hotmail.com or qgao@shenzhong.net.

In the course of orchestrating authentic research opportunities for her students, **Susan Kelly [NEST '10]** found astronomy research circumvents many obstacles rural and inner city students face—access to research-grade equipment and mentors. Through the following resources, an eager student can collect and analyze data on a variety of astronomical phenomena.

Students can collect data on a variety of targets in the Southern and Northern hemispheres at all hours through telescopes via a classroom or home computer.

Faulkes Telescope: http://faulkes-telescope.com
New Mexico Skies: www.nmskies.com
Tzec Maun: http://blog.tzecmaun.org

Depending on your target, there are several relatively easy software programs students can use to analyze and visualize data.

APT: Photometry:
http://spider.ipac.caltech.edu/staff/laher/apt
Astrometrica: Asteroid search and related manuals:
http://iasc.hsutx.edu/index_files/Page389.htm
ImageJ: False color images and light curves:
http://rsbweb.nih.gov/ij
Manual: www.astro.physik.unigoettingen.de/~hessman/ImageJ/Book/index.html
Vernier Graphical Analysis: Spectroscopy (free demo):
www.vernier.com/downloads/ga3demo.html
Project Manuals:
http://uranus.uaa.alaska.edu/rbseu/projects/spectroscopy
http://uranus.uaa.alaska.edu/rbseu/projects/variables
http://uranus.uaa.alaska.edu/rbseu/projects/agn

Your students can participate in timely research opportunities that welcome citizen scientists. Susan has found this to be a great starting point because online tutorials and mentoring are already built into the project.

Citizen Sky: www.citizensky.org
International Astronomical Search Collaboration:
http://iasc.hsutx.edu
Supernovae: www.eu-hou.net/supernovae/index.php
Variable Stars: www.aavso.org

Food Safety

[These excerpts are from an editorial by Gerry Broski that appeared in the March 2010 issue of *American Laboratory*.]

…food safety is a regulated environment, comprising new legislation, regulations, technologies, analytic methods, and business opportunities supporting and validating the safety and quality of food, beverage, and agricultural products. The reach of food safety today includes the following market drivers:

- Food standards and regulatory limits
- Human health
- International trade and commerce
- Chemical, environmental, microbiological, and natural contaminants
- Product authenticity and traceability
- Animal metabolism
- Food additives and dietary supplements
- Brand production….

The world is experiencing a significant rate of change in providing a significant rate of change in providing higher-quality foods, driven by consumer expectations, new regulations, and analytical methods coming primarily from the U.S., EU, China, and Japan. The analytical challenges of food are not always fully appreciated or understood in terms of the complexities of isolating contaminants or residues with high recoveries, quantitatively, from the highly diversified sample matrices…. ❁

Butterfly Tests

[This excerpt is from Howard E. Evans' 1966 book, *Life on a Little-known Planet*.]

Does this mean that color plays no role in the courtship and mating of these butterflies? This is the question that Tinbergen and his co-workers set out to solve with the grayling. They noticed that male graylings flew up after any butterfly that passed, regardless of the species, sometimes even after grasshoppers, dragonflies, or small birds. However, unless the object proved to be a female grayling they soon returned to their perch. Evidently, they first responded to a very general image, but soon were able to identify a female of their own species. Was it by means of the details of her color pattern, which is slightly different from that of the male, and of course quite different from that of other butterflies in the area? Tinbergen tested this by using a series of paper models suspended from a string, and "flown" past a male from the end of a fish pole. He and his co-workers did some 50,000 tests of this nature, extending over several summers….

Stick in the Mud Astronomy

Steven E. Bailey [NEST '10]

The title of this article, as well as my class celestial journal, was inspired by Dr. Neil deGrasse Tyson from his book "Death by Black Hole" and, in particular, his chapter entitled "Stick in the Mud Science." Please note that all observations described in this article correspond to the Northern Hemisphere.

Unlike in the distant past, people in most modern cultures today spend little time gazing at the night sky. However, when there was no electricity, along with its unfortunate visual pollution, people watched the sky with great interest. It was vibrantly alive as ancient animals (constellations) rose and circled about Polaris (in the northern hemisphere), and then dipped below the horizon; all according to plan. During the day, the sun basically rose in the east and set in the west following a predicted path in the sky, that, when projected down onto the earth, is called the elliptic.

Ancient civilizations watched the sky with great interest, and then built phenomenal observatories to note the passing of the seasons or the rising of certain stars. These grand observatories, such as Stonehenge [England], the Big Horn Medicine Wheel [Wyoming], the Caracol Temple [Mexico] and the rock carvings in Chaco Canyon, to name only a few, were used to determine seasonal changes (equinoxes and solstices) so that ancient people would know when it was time to reap or sow. Today there are numerous television productions that reflect a modern astonishment with how those "primitive" people could make such accurate predictions of the seasons. While I am duly impressed with the tremendous effort and architectural aspects of these ancient observatories, I enjoy being able to recreate an equivalent observational tool (sans the huge stones) to determine the changing seasons, along with several other astronomical items (i.e., latitude, apparent noon, etc.), using nothing more than a "stick in the mud."

To perform some basic astronomical calculations, you need to find a stick that is perpendicular to the ground and will produce a shadow throughout the entire day. I use a stanchion in the ground in a nearby parking lot; however, a common toilet plunger will work just as well. This becomes your "stick in the mud" and is akin to a gnomon on a sundial. First, you go out at night and sight a bright star (your choice of star) right at the tip of your stick and, next, start a stopwatch. On the next night return, less than 24 hours later and, with your ticking stopwatch, observe when the star is in the same position at the tip of your stick and, then, stop the stopwatch. You should find that your stopwatch shows an elapsed time of 23 hours and 56 minutes (give or take a few seconds), and not 24 hours. You have now determined the length of a "sidereal" day, the true Earth's rotational period.

You can also use your stick for some daylight observations to find "noon". You will need to go out about 40 minutes before noon (clock time) and place a meter stick or measuring tape along the shadow of the sun from the base of your "stick in the mud." At five-minute intervals, you should record the length of the sun's shadow as it becomes smaller until it finally turns about and the shadow grows larger again. The time when the shadow is smallest (record the length of this shadow for later use) is your solar noon. At solar noon, the shadow of the sun will be pointing directly at celestial North. If you have a compass handy at that solar noon, you can determine the "magnetic declination" (the difference between true North [your stick's shadow] and magnetic North). Here in Connecticut it is about 13˚ west, meaning the compass will point 13˚ to the left of the true North shadow at solar noon.

You should come back the next day and perform the same observation and find that point when the shadow of the sun is again smallest (solar noon). At this moment, it has been 24 hours since the previous day, and this is called a "solar day", which amazingly is about 4 minutes longer than the "sidereal day." In this 4-minute difference of time, the Earth has rotated an additional degree (361 degrees total) while correspondingly moving along its own solar orbit about the sun.

If you have nothing better to do around noon every day, you can perform this observation using your stick in the mud for an entire year. Each day you will note that, at solar noon, the shadow of the sun will either be growing longer or shorter every day. If you are a good observer and diligently record your data, then you can calculate the angle the sun makes with your stick in the mud. If you know the length of the shadow and the height of your stick, then tangent (angle) equals the height of the stick divided by the length of the shadow. The date when the sun is at its highest angle in the sky, at solar noon, is the summer solstice (around June 21st) and the point when the sun is at the lowest angle in the sky, at solar noon, corresponds to the winter solstice (around Dec 21st).

If over the course of a year you have also been recording the times of the sunrise and sunset, along with solar noon, you will note that in summer the days are longer and in winter they are shorter. On the date when you have equal daylight and darkness, it is either the autumnal or vernal equinox (Latin for "equal night"). These are the two dates when the sun is passing directly over the celestial equator and, therefore, the sun's declination (height above or below the equator) is zero degrees. Therefore, on that date you can directly calculate your latitude by taking 90˚ minus the angle of the sun on that date. Also on the equinoxes, you would note that the sun will rise at exactly due east and set at exactly due west. Additionally, if you watch the sunrise daily, you would note that, on the date of the summer solstice, the sun rises at the northernmost position (above due east) and that, on the winter solstice, the sun rises at the southernmost position (below due east).

Our ancestors built wonderful monuments to determine many of these special events based on the sun's position. These special dates told many when to plant or harvest crops and established many prominent religious events and festivals. But I like to believe that, somewhere in the distant past, it all began with a persevering and observant person possessing nothing more than a "stick in the mud."

Worthwhile Websites

Weekly puzzles and shared educational ideas are available on a monthly basis at www.aviornstein.com.

You can read the Summer 2010 issue of "Science@MIT" at http://issuu.com/scienceatmit/docs/science_mit?mode=embed&layout=http%3A//skin.issuu.com/v/light/layout.xml&showFlipBtn=true.

Here is a MIT program you may consider pursuing to support your students: http://web.mit.edu/wi/schools (Thanks to **Susan Kelly [NEST '10]**.)

Kudos

Betty Catelli [NEST '95] and **Bette Bridges [NEST '90]** were the keynote speakers at the New England Association of Chemistry Teachers Summer Conference. The theme was "Tools for Teaching Chemistry."

Erin Escher [NEST '09] was selected as a 2010 Amgen Award for Science Teaching Excellence (AASTE) winner in Rhode Island.

Joyce Gleason [NEST '92] was appointed to the Nominations Committee and the New Science Teachers Academy Judging Panel by National Science Teachers Association President Alan McCormack.

Erich Landstrom [NEST '07] has been honored by SECME, Inc. (formerly the Southeastern Consortium for Minorities in Engineering) as a SECME National Teacher of the Year for 2010 for increasing the number of historically under-represented students who are interested in, and academically prepared for, studies in science, technology, engineering and mathematics.

Traci Maxted [NEST '09] won this year's Excellence in Science Teaching Award for high school physical science from the Iowa Academy of Science. In addition, she will be a presenter at the IAS Iowa Science Teaching Section's Fall Conference in October at the Iowa State University campus.

Elly-May O'Toole [NEST '10] was a recipient of the MIT Inspirational Teacher Award. In addition, she participated in the National Math and Science Initiative Advanced Placement Training program.

Stacey Plummer [NEST '04] was named a winner of the Presidential Award for Excellence in Mathematics and Science Teaching.

Donna Rand [NEST '00] was the recipient of the Connecticut Science Teachers Association's 2010 award for "Excellence in Elementary Science Teaching."

Bhavna Rawal [NEST '09] has been accepted in the NASA Reduced Gravity Education Flight program. She and her students received an award in DC from the National Energy Education Development (NEED) project for the series of energy projects they have carried out.

Dallas Russell [NEST '05] received an award as Master Teacher of the Year for the California State University Los Angeles Charter College of Education, serving as the mentor teacher for selected teacher candidates in the final semester of the process of earning their credentials.

Improving Teaching

[This excerpt is from an editorial by Joan Richardson in the May 2010 issue of *Phi Delta Kappan*.]

Improving the quality of teaching is a systemic challenge that requires buy-in from colleges of teacher education as well as schools, districts, and states. It starts with clear standards of what we want students to know and be able to do. When we're clear on that, we can design programs that prepare teachers to teach to those standards, not to a test. We can ask ourselves whether we're providing teachers with everything they need to meet the standards: good curriculum, administrative support, professional learning, clean and safe buildings, time to work with colleagues, and more. When we've assured ourselves we're doing all of that, we can evaluate teachers on whether they are providing the instruction that will get kids to those standards. We can evaluate principals, superintendents, school boards, and districts on whether they're living up to the promise of the standards.

Nothing about what I've just described is easy or quick. But school change is not accomplished in the twinkling of an eye or by the stroke of a pen. I fear that performance pay is just another distraction from the hard work of school improvement.

International Science

[This excerpt is from an editorial by Timothy J. DeVoogd that appeared in February 26, 2010 issue of *Science*.]

…It is broadly recognized across the western hemisphere that science can provide answers to health and environmental problems and stimulate national development. But in a given region, scientists often face overwhelming barriers to conducting research, and there is far too little interaction among academia, industry, and government on an international level to effect change. Scientists in developing regions have repeatedly raised ways in which help from the United States could be transformational. It is now time to do more.

Efficient Cockroaches

[This excerpt is from Howard E. Evans' 1966 book, *Life on a Little-known Planet*.]

…The Surinam roach has even dispensed with the nuisance of having a male sex; one strain of this species consists entirely of females that produce live female young, which grow up to produce live female young, and so on ad infinitum. If there is a more efficient reproductive mechanism, the roaches will undoubtedly find it.

Density

Avi Ornstein [NEST '89]

Density is a derived measurement, found by measuring mass and volume and then dividing one by the other. It is often the first derived measurement that students work with and it integrates arithmetic with science. The unit used depends on the phase, as volume is normally measured in different ways, depending on the phase. For solids, it is normally measured in g/cm^3. For liquids, it is measured in g/mL. In gases it is measured in g/L. In addition, being a derived measurement, the issue of significant digits comes into play, as students need to understand where it is appropriate to round off the answer to the division problem.

The well-known but probably apocryphal tale of Archimedes credits his discovery of density to a bathtub experience. It is more likely that it was worked out in his careful study of buoyancy. The oldest written record of the story occurred two centuries after the fact. Nonetheless, Archimedes is credited with discovering density over two millennia ago, showing that it is an intensive property that can be used to identify a substance.

A simple way to introduce students to density is to have different individuals or teams measure the mass and volume of a variety of different liquids, such as water, isopropanol (rubbing alcohol) and salt water. The mass of an empty graduate is measured. A quantity of liquid is added, the volume is measured and the mass is measured once more. The results are then graphed, placing the volume (which was the independent variable) on the x-axis. A single, straight line is drawn (including the origin—point (0, 0)—which was the mass of no liquid) and the slope is the density, which is a better result than any single measurement. Each liquid has a different density that is a physical property of the substance.

Solids can then be used, in conjunction with water displacement, to match the tale of how Archimedes tested the metal used to make a crown. The mass of a piece of metal can be measured easily. Carefully lowering it into a container filled with water, an equal volume of water will be displaced, overflowing from the container. If this is collected and measured, one has the volume of the metal. The density can be computed and compared to a table of metal densities and the metal can thereby be identified.

It is more difficult to get students to envision the density of gases. Gases take up space, but the fact that gas has mass is less obvious. However, buoyancy can help here. Explain how less dense materials float in denser substances, showing how some solids float in liquids and certain liquids float on other liquids, such as oil on water. Then show how a helium balloon floats in the atmosphere of soap bubbles, filled with air, float in a tank filled with carbon dioxide (produced by reacting sodium bicarbonate with vinegar). Just as was true with liquids and solids, density is a property that can be used to compare gases.

An important point to bring up at this time is that gases are compressible. That is, the volume of a gas can be changed, meaning that the density would therefore change. For gases, pressure is a variable that must be noted when computing the density. A Cartesian diver can be used to help students understand this. Fill a large plastic bottle to near the top with water. Take a glass eyedropper and fill it partially with water so that it just floats in a large beaker of water. Transfer the eyedropper to the bottle and firmly screw on the cap. As you slowly exert pressure on the bottle, students can observe that the volumes of the gas in the bottle and in the eyedropper both decrease. If the volume of the gas in the eyedropper is decreasing, the density must increase. Once it has decreased sufficiently, the combined density of the eyedropper (glass, water, rubber bulb and air) will be greater than the density of the water. The eyedropper will sink. When the pressure on the bottle decreases, the eyedropper will rise. The role of pressure in the density of gases becomes very visible!

This can be expanded to explain weather patterns. When the atmospheric pressure is rising, the air is becoming denser and you have fair weather. When the atmospheric pressure is falling, the air is becoming less dense, allowing clouds and bad weather to move into the area.

A less obvious but equally important factor is that temperature affects density. As substances get warmer, they expand. (This is ignoring the fact that liquid water expands as the temperature decreases below 4˚C.) This means they become less dense. The change in density is normally minor enough that it can be ignored, but an interesting demonstration can help students understand this.

Add red food coloring to some hot water, being careful that the water is not too hot so as to be a hazard. Then add blue food coloring to some cold water. Fill two clear plastic cups with red, hot water and two with blue, cold water. Place an index card over one cup of hot water, invert it and carefully place it atop a cup of cold water. Repeat this with the other two cups, reversing it so that the cold water is atop the hot water. When the card is removed from the first pair, the colors stay distinct, since the less dense, warmer water floats on the colder water. When the card is removed from the second pair, the color mix, as the cold water descends and the hot water rises.

This concept relates to our everyday lives. When we go to a lake or pond, we often find that the deeper water is colder than the surface water. Less dense warmer water is floating on the cooler water. When a pot of water is being heated, convection currents are formed as the heated water rises. The same fact applies to the ocean currents, which affects the entire world. Students can see that this aspect of density is actually very important.

The fact regarding the anomaly of water can then be discussed. As the temperature falls below 4˚C, the space between water molecules increases as bonding comes into play. The result is that ice has a greater volume than an equal mass of water. Therefore, ice is less dense than water, which is why it floats. This is a critically important issue when considering biology and evolution. If ice did not float, bodies of water would freeze from the bottom up. This would have a disastrous impact. For example, lakes in temperate and frigid regions would mostly consist of ice year round, rather than having ice insulate the lower regions during winter. Life in lakes, rivers and streams would be destroyed during the winter! [To consider the impact, you can read Kurt Vonnegut's 1963 novel—Cat's Cradle. In it, ice-9 is discovered, a form that exists as ice at normal temperature and pressure. In the end, the world's water freezes over!]

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

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

Colorado Summer Ecology Program

Blake Byall [NEST '10]

Woodlin H.S. held its inaugural Summer Ecology course this past summer (7/25-8/4). The intense, off-site class was a two-week long adventure designed to get students into the field, providing them with experience-based, hands-on science exposure covering many fields of study, including, but not limited to: ecology, biology, botany, forestry, astronomy, geology, meteorology, paleontology, history, sociology and zoology. This course was created to stimulate interest in natural science study/appreciation and engender a better understanding of natural resource usage while fostering a love for outdoor recreation and study. The curriculum for Summer Ecology is keyed to State Science Standards I, II, IV and V, while addressing national science standards as well.

Successful completion of this class carried with it one half credit of science at Woodlin H.S. Competition for inclusion was fairly light, owing to the fact that the class was being held for its initial offering; however, judging from the response of those who attended, it may prove more difficult to obtain a spot in future years. Class sections and portions of lessons were taught by professionals representing Woodlin H.S., U.S Forest Service, Colorado Division of Wildlife, National Park Service, Bureau of Land Management, community experts, museum and facilities curators and staff, State Park officials and other private citizens. This group of students, accompanied by me as their science teacher, traversed the state of Colorado, learning about the various ecosystems found within. From the Eastern Plains to the Western Slope, from 4,200 feet above sea level to timberline, Summer Ecology students probed, measured, explored, calculated and literally immersed themselves with the study of nature and all it entails.

Students measured stream variables and collected biotic samples from creeks on the plains and in the mountains. Division of Wildlife biologists worked with the class on Black Bear population studies and fish shocking activities. The entire class went white-water rafting on the Arkansas River, explored a wild cave system near Eagle, visited the National Center for Atmospheric Research, toured the National Seismology Center in Golden and were treated to multiple museums that specialized in geology and mining concerns. They even got to go behind the scenes at the Cheyenne Mountain Zoo to see sights few visitors do, camped out for nine nights and amassed over 1200 miles of road coverage during their trip.

I have taken four different schools through the Summer Ecology experience while teaching in the public school system in Colorado over the past 12 years. Woodlin students were quick studies as they proved resilient in the field under adverse weather conditions and pulled together as team members when faced with the daily challenges presented. Summer Ecology is a lot of fun, but at its core it remains a serious science class that demands much from those enrolled. Everyone involved in the program this year gave it great reviews and if current interest is any indication, this class may become part of the Woodlin science tradition.

Recommended Reading

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

Alberts, Bruce; Prioritizing Science Education; *Science*; April 23, 2010; p. 405.

Baker, Linda; Numbers War; *Scientific American*; March 2010; pp. 20-21.

Callender, Craig; Is Time an Illusion?; *Scientific American*; June 2010; pp. 58-65.

Dorit, Robert L.; Winter 1859; *American Scientist*; July-August 2010; pp. 286-288.

Editorial; Start Science Sooner; *Scientific American*; March 2010; p. 28.

Editorial; Chemical Controls; *Scientific American*; April 2010; p. 28.

Freeman, David H.; The Streetlight Effect; *Discover*; July/August 2010; pp. 54-57.

Hoffmann, Roald, & McGuire, Saundra Y.; Learning and Teaching Strategies; *American Scientist*; September-October 2010; pp. 378-382.

Hulleman, Chris S., & Barron, Kenneth E.; Separating Myth from Reality; *Phi Delta Kappan*; May 2010; pp. 27-31.

Kraft, Matthew A.; From Ringmaster to Conductor: 10 Simple Techniques Can Turn an Unruly Class into a Productive One; *Phi Delta Kappan*; April 2010; pp. 44-47.

Krauss, Lawrence M.; Faith and Foolishness; *Scientific American*; August 2010; p. 36.

Krauss, Lawrence M.; Human Uniqueness and the Future; *Scientific American*; May 2010; p. 36.

Leshner, Alan I., Malcolm, Shirley, & Roseman, Jo Ellen; Seeking Science Standards; *Science*; May 28, 2010; p. 1075.

McAuliffe, Kathleen; The Incredible Shrinking Brain; *Discover*; September 2010; pp. 54-59.

McKibben, Bill; Breaking the Growth Habit; *Scientific American*; April 2010, pp. 61-65.

Sachs, Jeffrey D.; Flying Blind in Policy Reforms; *Scientific American*; May 2010; p. 32.

> Only a few people play the piano, but a lot of people go to concerts. We need to generate that same general interest in science.
>
> —Anthony Nicholson (participant in SEPT '89)

Sickle Cell Biology

Helen Flavin [NEST '10]

Just what can the tenet "DNA provides genes important for health or disease of an organism" mean to a 14-year-old, first year biology student? The protein hemoglobin and one affiliated disease (sickle cell disease) can provide a context for assessment of student understanding of the details of and interplay between transcription; translation; protein shape and function; mutation; heredity; genetics; evolution; DNA analysis; and genetic engineering. I wanted to share one approach to bringing science as inquiry to these curriculum topics and some available internet and lab resources.

The site www.umass.edu/molvis/tutorials/hemoglobin provides an interactive tutorial on hemoglobin structure and function. Even for freshmen who have no chemistry experience, "Activity 7: Sickle Hemoglobin" can stand alone. The point mutation in sickle cell DNA produces a sticky (non-polar) patch in de-oxygenated hemoglobin. In addition, the Jmol images of the tutorial provide an excellent opportunity for extension into molecular modeling. Student microscopic examination of human blood smear slides of normal and sickle cells illustrate the cellular (red blood cell or RBC) consequences of the mutation and "sticky" hemoglobin.

Students are required to transcribe and translate short sections of both normal and sickle cell globin at http://chroma.gs.washington.edu/outreach/genetics/sickle/worksheet.html. Both this sheet and the one on population genetics were created by Jeanne Ting Chowning for The Genetics Project .The transcription sheet reviews the connections between altered RBCs and hemoglobin. Another section of the worksheet requires students to relate organism level changes (sickle cell disease symptoms) to the malfunctioning RBCs. Another section requires students to be a genetics counselor who reviews the incomplete dominance pattern of inheritance and explains the probability of a child inheriting the disease. Rather than the suggested movie, one can introduce students to the National Center for Biotechnology Information (NCBI), where site www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=gnd&part=anemiasicklecell not only provides an excellent summary for the project, but also provides a starting place for extension on treatment options. In addition, the Human Genome Project Information site www.ornl.gov/sci/techresources/Human_Genome/posters/chromosome/hbb.shtml provides both a chromosome illustration showing position of the mutated gene and also further, detailed information about the gene.

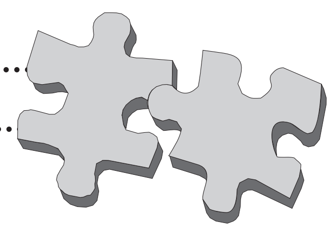
Population Genetics; Hardy Weinberg Equilibrium, evolution and pleiotropic gene effects can be addressed with the exercise at http://genetics-education-partnership.mbt.washington.edu/class/activities/HS/sickle-bean.htm. This is more for an honors level biology course. The mathematical model includes the death of the homozygous recessive from sickle cell anemia; the possible death of the normal from malaria and the fact that the heterozygote is granted some protection against malaria. Although students must be detail oriented and follow the directions to get meaningful results, they can generate data for two generations in one class period. Data analysis and debriefing can follow in the next class period. I split the class into groups with sickle cell allele frequency at 0, 10, 20 and 30%. I have adapted this procedure to have students return beads to the bin (assures random mating based on allele frequency) and to have students draw for 10-20 generations. In addition, one group acts in an environment with a 10-20% sickle cell allele frequency and where there is no malaria. Each group analyzes its data. Afterwards, groups share data and analyses and then the class discusses all the data. This exercise allows students to calculate, graph and watch the change in allele frequency over time/generations (evolution). Further, this model allows students to appreciate the importance of genetic diversity—with severe population decrease or even extinction following in areas with high malaria and a zero sickle cell allele frequency. This combats the common student misperception that organisms adapt by making necessary changes in a gene. Finally, students see that one gene may have multiple effects so that even a disease gene does not disappear from a population, but is carried at a low allele frequency.

Now that students have learned about the gene, altered protein and genetics of sickle cell disease, it is time for them to use their knowledge to analyze another genetic disorder. One popular approach for this is a genetic disorder brochure. Essentially, students research a disorder and present the disorder in terms of gene, altered protein, genetics and treatments. See the Dolan DNA Learning Center's www.dnai.org/teacherguide/pdf/ss_tour.pdf for a student handout for such a project. This site has 20 disorders listed to choose from so each student can research his/her own topic. An excellent start for student research is the NCBI Genes and Disease site at www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=gnd&part=cysticfibrosis. The OMIM (Online Mendelian Inheritance in Man) and other related links on the right hand side put a wealth of information at a student's fingertips. When I run this project, I allow students to choose their own presentation format: poster; PowerPoint presentation; report or brochure. The final assessment is that students are required to explain to me their disease. There is no credit given to items in a student's presentation format that he or she does not understand or cannot explain. This dramatically reduces plagiarism issues with this type of assignment. Finally, 20% of the assignment points are for a research idea of the student's choice. A student researches and learns about something new and exciting that relates to his/her gene or disorder. This encourages students to seek out and actively learn from the many internet tutorials and animations.

Moving to molecular genetics, the sickle cell mutation alters a restriction enzyme site. Thus, the three genotypes are readily distinguishable on a DNA gel. A detailed animation and brief quiz on the allele specific cleavage of globin DNA is found at http://bcs.whfreeman.com/thelifewire/content/chp17/1702001.html. Gel electrophoresis and sickle cell DNA analysis readily lends itself to a case study of paternity or to a forensic case. The wet lab brings a biotechnology lab to freshman biology. Edvotek has a sickle cell DNA kit that can be stained with methylene blue. See www.edvotek.com/pdf/116.pdf for detailed background and kit information. If a gel box is not available for your students, they can do a virtual DNA gel utilizing the globin sequence, the MstII recognition site and either paper or bead DNA sequences.

A possible extension after DNA gels is southern blotting and DNA probes. In the paper "Detection of sickle cell BS-globin allele by hybridization with synthetic oligonucleotides" by Conner et al., *Proc. Nat. Acad. Sci.*, 80, pp 278-282 (1983), the authors demonstrated they could recognize each DNA type with the probes they created, so there are a number of DNA gels illustrating a probe binding to one DNA segment but not another. The emphasis is on the fact that the probe is the base pair complement to the

PUZZLE CORNER



#1) What interesting properties do the following numbers share?

416 39 981 13,169 636 421,764

#2) Which types of organisms require oxygen to survive: animals, fungi or plants?

Solutions to the previous problems:

#1) The numbers are 22, 123, 132, 213, 231, 312 and 321.

#2) These letters look the same when viewed in a mirror **and** when flipped upside-down.

DNA piece and also that each probe has an end that can be detected (P32 can be thought of as a "colored Tag"). Students are amazed and proud when they can look at one or more of the figures of this paper and understand a "real" science paper.

Another possible project extension is why certain treatment options work to ameliorate disease symptoms. This can be extended to genetic engineering to "cure" the disease and can be an opportunity for individual student research and presentation. Upperclassmen in AP Biology or Anatomy & Physiology could assist freshmen with the research or even complete such a research project themselves and their presentation grade is their Guest Lecturer seminar to the freshman biology students. If you have the students research and explain how to use recombinant DNA to cure sickle cell disease, then Figure 6 of Levasseur et. al., 2204 which can be found at www.jbc.org/content/early/2004/04/14/jbc.M402578200.full.pdf is a good debriefing tool. This figure is from an animal model for sickle cell disease where recombinant DNA therapy is being studied. The figure presents spleen, liver and kidney sections that provide a vivid picture of recombinant DNA rescuing the sickle cell phenotype. Detailed anatomy knowledge is not needed to comprehend the figure as the cells from the rescued heterozygotes resemble the normal sections and exhibit none of the pathological changes seen in the animals with sickle cell disease. Students will see scientists working on something the students themselves thought could be a disease cure.

Exercises like this bring the biology from something in a textbook to something that is cutting edge. Student interest, effort and critical thinking necessarily follow. Your students are learning the same curriculum topics. However, they are being the scientist instead of reading about the scientist. How to go from content based to scientific inquiry based learning? Here's my suggestion: make it a game or challenge for students to find and use internet tutorials and animations for all this DNA and genetics stuff. Catalog and use the best of these to your advantage for future years' assignments. Each year you teach, at the end of one or two content based sections, add a sickle cell or other genetic disorder case challenge. The next year you teach, try to start that content section by first giving the kids the challenge question and then teach the content section by having them search out, assemble and present to you the facts that allow them to answer the challenge. After a few years, you will have a complete set of challenge questions/sequences you are comfortable with and, even better; will already be running them as inquiry exercises.

[The SEPT visit to the MIT Museum DNA Exhibit on the synthesis of the protein hemoglobin sparked this article by Helen Flavin, Ph.D. of Bishop Connolly High School in Fall River, MA. Her participation in SEPT was sponsored by the MIT Club of SE Mass.] ❅

Where Are They Now?

Marty Weiss [NEST '95] has reported the following information on previous NEST Student Award winners from **Delaware Valley Torah Institute** [Cherry Hill, NJ]:

Saul Weiner [2003] did graduate level work with lasers while he was still an underclassman at **Yeshiva University** and he intends to continue this work in the future.

Chaim Stobezki [2003 (co-award) and 2004] recently graduated from **Yeshiva University** with a BS in biology and will be pursuing a PhD in biology.

Matthew Sandler [2005] does "stand-up" comedy at various comedy clubs in Philadelphia and New York while attending **Carnegie-Mellon University**. (His standup routine can be seen on You-Tube.)

Etan Levavi [2008] recently completed his training for and received his pilot's certification and he is currently studying for instrumentation certification.

Josh Gold [2009] is a professional videographer and his side job is doing videos for Bar Miztvahs and weddings, as well as producing "Indie" dramatic short films.

Avi Ornstein [NEST '89] reported the following information on one recipient from **Bulkeley H.S.** [Hartford, CT]:

Fludiona Naka [2005] did a fine job of presenting work she had done at **Wesleyan U.** related to epilepsy.

Urban Teaching in Context: Demonstrating that Your Subject Is Not More Important than Your Student

Elly-May O'Toole [NEST '10]

Teaching high school students in the city of Boston is an invigorating pastime. It requires flexibility and a sense of humor. The challenges these students face can be daunting, but assisting them in prevailing over adversity is as stimulating a process as anyone can hope to find in their career. Yet, "daunting" can feel like something of an understatement when you walk into these public high school classrooms and actually have to *teach* these kids, many of whom don't even have a safe place to sleep at night. Where do you begin?

How do you reach a classroom of students who are more concerned with their own day-to-day struggle to survive inner city life than the assignment on the blackboard? Where can you find common ground with students who seem to live a world away from you and your notions of education, college and planning for the future? How can you go about uncovering the hidden engineers, teachers, doctors and scientists that sit before you—and then get their attention long enough to try to convince them that could be their reality?

The first days of school, my classroom fills every 90 minutes with 31 new faces. Each of them has a piece of paper that tells them they are in my room to learn physics. Their first assignment: an essay. I ask each one to write one full page to answer the question, *"Who are you?"* I know when those papers are turned in at the end of that week, I'll find my students are in situations as overwhelming as being the sole caregiver to ailing, elderly grandparents, bearing the responsibility of several younger siblings while parents are in jail or spending many evenings hiding in the closet or under the bed from an older brother's less than savory associates.

Connecting with students and forging the relationship necessary in order to build new knowledge together can be challenging no matter what the context. I have taught a wide variety of youth from a staggering range of backgrounds over the course of my career. One thing that is clear is that many of our inner city youths require an even greater effort be made to forge that solid basis. Perhaps the most important quality to have when teaching these students is open mindedness. No matter what these students face in their personal lives, I have to find a way to convince them that I will not only be non-judgmental, but I will help them find ways of removing obstacles to their ability to succeed in the classroom. Trust is essential in interacting with a population that feels marginalized.

Learning can be nearly impossible for students who are faced with stressful realities, both in their school life and in their personal lives. As their teacher, I need to know where their education falls in their list of priorities. It does no good to berate a student for falling asleep in class or missing assignments, if my subject is a distant runner up to the basic needs of making money to support the family and finding time to sleep. While in an ideal world a teenager's major job should be getting a good education, we cannot assume that these kids have that luxury.

The students need adult support and encouragement to find ways for them to make and take steps of their own choice that will help improve the quality their lives. Often, they need the basic reassurance that they are worth the time and effort of finding solutions to personal issues. Teachers are in the unique position as authority figures removed from the situation to lend moral support and often schools have resources that these students can be encouraged to utilize. A little encouragement and caring go a long way.

Once positive changes, even small ones, are occurring and the students begin to gain control over their lives, it becomes possible for them to focus on learning. When the teacher shows interest in and respect for the student's priorities, the student in return shows respect for what the teacher is trying to teach. Success is measured in less conventional ways in schools where the students do not have their basic needs met at home: security, stability and basic resources. Shorter concrete goals combined with long-term life objectives are very effective. Standing with a student as they set and achieve small goals forges an indelible bond. Often these students begin to spend more and more time in my classroom, staying after hours because they know it is a safe place to do homework, study and work on college and job applications.

As our global society becomes more interconnected and complicated, the life situations of our urban youth in America also become more complex and difficult to unravel. Teachers in urban settings work with higher stakes. Students may have limited options and teachers have a small window within which to make a big impact. Understanding their personal situation and priorities provides the necessary context within which a teacher needs to work. Showing my willingness and ability to both understand and assist my students in their daily struggle has rewarded me with students who then are willing to take a closer look at physics as a subject—and even for the potential career choices it has to offer down the line. In my classroom, the students come first and the subject matter invariably becomes a fun escape from all the other concerns in their lives. ❁

Teaching to the Test

[This excerpt is from a commentary by Daniel Koretz that accompanied a related article by Linda Perlstein in the Summer 2010 issue of American Educator.]

I strongly support the goal of improved accountability in public education. I saw the need for it when I was an elementary school and junior high school teacher many years ago. I certainly saw it as the parent of two children in school. Nothing in more than a quarter century of education research has led me to change my mind on this point. And it seems clear that student achievement must be one of the most important things for which educators and school systems should be accountable. However, we need an effective system of accountability, one that maximizes real gains, and minimizes bogus gains and other negative side effects.

In all, educational testing is much like a powerful medication. If used carefully, it can be immensely informative, and it can be a very powerful tool for changing education for the better. Used indiscriminately, it poses a risk of various and severe side effects.

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.]

When you are using a plastic shopping bag, you are actually taking advantage of two separate serendipitous discoveries. The first occurred in Germany in 1898 while the second occurred thirty-five years later in England.

Hans von Pechmann was heating diazomethane when it accidentally produced a white, waxy substance. Others noted that it was a long, continuous molecule—a polymer. It was given the name polymethylene.

In 1933, Eric Fawcett and Reginald Gibson were applying extremely high pressure to a mixture of ethylene and benzaldeyde. Again, the same white, waxy material was produced. However, it was not reproduced for two years until it was discovered that the reaction had been contaminated by a trace amount of oxygen. This contamination was required for the polymerization to occur.

In 1939, this became the method of producing this chemical at industrial levels. Now known as polyethylene, or, more specifically, as LDPE (low-density polyethylene), 80 million metric tons of this polymer are currently being produced every year, making it the most widely used plastic.

Addressing Science Teacher Needs

[These excerpts are from an article of the same title by Nancy P. Moreno and Deanne B. Erdmann that appeared in *Science* on March 26, 2010.]

Given the pace at which the scientific landscape changes, even practicing scientists can find it difficult to keep up with advances outside their fields of specialization. Imagine the daily challenge faced by classroom science teachers, who are trying to remain current with a broad range of scientific content and to incorporate the new information into existing curricula. This integration requires a depth and breadth of science knowledge not provided by the professional development available to most elementary, and even some secondary, school teachers.

…most have insufficient access to quality continuing education and teaching resources. Secondary-school science teachers need up-to-date content and training in laboratory techniques, such as how to use a micropipettor. Elementary teachers need help with basic understandings and teaching approaches across a wide range of topics….These challenges are heightened in schools with significant populations of economically disadvantaged and at-risk students, where teachers tend to be less prepared to teach science.

The challenges facing the U.S. science education community are of national importance. How do we bolster the science knowledge and teaching skills of thousands of teachers, each with unique professional development and classroom teaching needs? How do we accommodate multifarious local requirements for curriculum, content, and resources? And how do we address these issues in cost- and time-efficient ways? Online approaches are not the only answer to our nation's science education challenges, but they represent an important strategy for our collective response as a scientific community. ❆

Dropout Crisis

[These excerpts are from a report released by Northeastern University in Boston and the Alternative Schools Network in Chicago.]

The dropout crisis impacts all of America, but affects men, Blacks, and Hispanics particularly hard. In 2007, an astounding 16.0% of persons between 16 and 24 years of age (nearly 6.2 million people) were high school dropouts. Among these dropouts, 60.1% were men, 18.8% were Black, and 30.1% were Hispanic. In addition:

- Nearly one in five U.S. men between the ages of 16-24 (18.9%) were dropouts in 2007.
- Nearly three out of 10 Hispanics were dropouts (27.5%), including recent immigrants.
- More than one of five Blacks had dropped out of school (21%)—versus a dropout rate for Whites of 12.2%.

Americans without a high school diploma have considerably lower earning power and job opportunities in today's workforce. Over a working lifetime from ages 18-64, high school dropouts are estimated to earn $400,000 less than those graduated from high school….

America is currently in the throes of a persistent high school dropout crisis that has been a long time in the making. In the current global economy, having a high school diploma is a critical first step for achieving employability at decent wages and avoiding poverty and a college degree is a prerequisite for a well-paying job. The cost of dropping out of high school today are very substantial to both dropouts and to the rest of society, especially for young men and single parents, who find it almost impossible to earn an adequate income to take care of themselves and their families. ❆

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recognize that the recent attacks stem in part from its culture and scientists’ behavior. In turn, it is time to focus on the main problem: The [Intergovernmental Panel on Climate Change] reports have underestimated the pace of climate change while overestimating societies’ abilities to curb greenhouse gas emissions….

If the scientific community does not aggressively address these issues, including communicating its process of discovery and recognizing its modern data responsibilities, and if society does not constructively engage science, then the scientific enterprise and the whole of society are in danger of losing their crucial rational relationship. Carl Sagan’s warnings are especially apt today: “We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology.” “This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces.” ❁

Microbes

[This is Jeremy Jacquot’s “Numbers” from *Discover* in September 2009.]

30 million Estimated number of microbial species. Of these, only 70 are known to cause disease. About 1,000 species normally live on the surface of human skin, according to a recent study by the National Human Genome Research Institute.

5 x 1030 Estimated number of bacterial cells on earth. More than half of them live buried in marine sediment; about 70 trillion reside in and on your body.

235 Maximum temperature, in degrees Fahrenheit, at which the most heat-resistant microbe known, *Pyrolobus fumarii*, can multiply. It makes its home in the walls of deep-sea hydrothermal vents. At the other extreme, microbial activity has been detected in permafrost soils in Antarctica at temperatures as low as -4^{o}F.

580,076 Number of base pairs (the “twinned” letters in the DNA code) in the genome of the bacterium *Mycoplasma gonitlium*, making it the smallest known genome of an independently replicating cell. Researchers who hope to create synthetic life are now trying to build this simple bacterium from scratch.

0.000004 Diameter, in inches, of the smallest known bacterial cells, the ultramicrobacteria. An average-size bacterium, such as the *E. coli* in our digestive tract, is about five times as large. The biggest known bacterial cells, belonging to the coastal sediment bacterium *Thiomargarita namibiensis*, are 7,500 times the size of ultramicrobacteria. At three-hundredths of an inch, they can be seen with the naked eye.

Continued from page 1 “Co-Chair Report”

the conclusion of the program by a survey and an open discussion on Saturday. The NEST Program, however, was not.

The most recent NEST Programs have been thematic, such as Mars Explorer, Emerging Energies, Green Technologies and Education/Media Center. Lectures by MIT faculty and staff have always been the highlight. This year we participated in “Time Lab”, a GPS activity. In the afternoon we watched demonstrations by fellow NEST members that might have been better suited as McNamara presentations. This year’s program, while good, was not what I’ve come to expect. This has made me revisit why I have maintained my affiliation with NEST since 1995. High on the list of reasons for returning every year are collegiality, lab and facility tours and the McNamara Workshops. Foremost on my list, however, are the MIT faculty lectures, which for me have ranged from timely and applicable to just plain interesting. The lectures have traditionally been the focus and focal point of the return to campus. I will advocate for a return to that format.

There is one final issue, which could render all others mute…finances. I am sure those in attendance noticed that things were downgraded or no longer supplied, other charges were applied for things that once were free and we had a buffet rather than a banquet. In my opinion, the NEST workshops are still worth attending, despite the increased fees, provided they follow the traditional format. The truth is that as the co-chair, I do not have any substantive impact on the financial health of NEST. We are all hopeful that the situation improves. If it does not, I am not sure of the consequences for the future of our program. However, as your co-chair, I can and do represent you. Please contact me with your thoughts, ideas and recommendations regarding the future of NEST. Bear in mind that the executive board meeting is in January. ❁

Alchemy

[These excerpts are from an article by Jane Bosveld that appeared in the July/August 2010 issue of *Discover*.]

If two of the greatest scientists who ever lived [Bacon and Newton] were dedicated alchemists, then alchemy needs a makeover, a big one….Back in the day…alchemy was not the misguided pseudoscience that most people think it was. Rather, it was a valuable and necessary phase in the development of modern chemistry. Among alchemy’s signature accomplishments: creating new alloys; manufacturing acids and pigments; inventing apparatus for distillation; the process used in making perfumes and whiskeys; conceiving of atoms centuries before modern atomic theory; and proving a template for the scientific method by running controlled experiments again and again.

….In pursuing what today seems like little more than witchcraft, the alchemists were in fact laying the foundation for modern experimental science.

The Changing Oceans

[This excerpt is from an editorial by John A. Church of the same title that appeared in *Science* on June 18, 2010.]

The oceans slow the rate of climate change by absorbing over a quarter of the carbon dioxide released by the burning of fossil fuels and by storing over 90% of the excess heat accumulating in the climate system. These two changes, along with nutrient input into the oceans from fertilizer use and other pollution, are affecting the marine ecosystem by increasing the acidity of the oceans, decreasing subsurface oxygen concentrations, and increasing coastal nutrient loads. At the same time, ocean changes affect the terrestrial environment, being the primary source of the water vapor that drives global rainfall patterns. Changes in ocean temperatures and currents and in the oceans' interaction with the atmosphere are already altering the frequency, intensity, and distribution of storms, droughts, floods, heat waves, and cold spells. And by 2100, rising sea levels from ocean thermal expansion and increasing ocean mass (from melting glaciers, ice caps, and the Greenland and Antarctic ice sheets) will expose an additional tens of millions of people annually to the risk of coastal flooding.

The result of these relationships between the ocean, atmosphere, and land is that the world will experience climate and ocean changes that continue for centuries. In addition, continuing greenhouse gas emissions are increasing the risk of crossing critical thresholds, with poorly understood consequences. If society is to reduce the risk of major ice-sheet contributions to sea-level rise and of profound changes in marine ecosystems, a sustained reduction of greenhouse gas emissions is an urgent priority. However, society has thus far failed to heed the clear warnings about continuing greenhouse emissions, making the need to adapt to climate and ocean changes unavoidable. These adaptations will become increasingly challenging for many people around the world, particularly the poor, those living in vulnerable coastal communities, those subject to substantial changes in rainfall, and those with few resources or options. Environmental refugees will become a major social change. ❅

Precious Life

[This excerpt is from Howard E. Evans' 1966 book, *Life on a Little-known Planet*.]

…How many persons would not be alive today if we had not discovered penicillin, the improbable product of a lowly green mold? If it is true that half our new drugs are being produced from botanical sources, how can we afford to neglect or destroy any portion of the earth's green mantle? Who can say what obscure plant or animal may someday be precious to us? Are not all precious, since in fact we understand so little about the interdependence of living things, since life itself is the most precious thing of all? The earth has spawned such a diversity of remarkable creatures that I sometimes wonder why we do not live in a state of perpetual awe and astonishment.

The Fly

[This excerpt is from Howard E. Evans' 1966 book, *Life on a Little-known Planet*.]

…Fly-borne diseases are said to have hastened the decline of both Athens and Rome. Sleeping sickness long delayed the civilization of Africa, and yellow fever the opening of the American tropics. And flies are still with us, as a trip to the arctic or the tropics, or to one's own back porch, will confirm. Anyone not fully convinced is invited to visit the Adirondacks in June or a St. Louis alley in September. Students some years ago in China, by the way, showed that in slum districts the average fly carried 3,683,000 bacteria. But take heart: in relatively clean communities he carried only 1,941,000 bacteria.

Integrity of Science

[These are the opening paragraphs of an editorial submitted by 254 members of the U.S. National Academy of Sciences that appeared in the May 7, 2010, issue of *Science*.]

We are deeply disturbed by the recent escalation of political assaults on scientists in general and on climate scientists in particular. All citizens should understand some basic scientific facts. There is always some uncertainty associated with scientific conclusions; science never absolutely proves anything. When someone says that society should wait until scientists are absolutely certain before taking any action, it is the same as saying society should never take action. For a problem as potentially catastrophic as climate change, taking no action poses a dangerous risk for our planet.

Scientific conclusions derive from an understanding of basic laws supported by laboratory experiments, observations of nature, and mathematical and computer modeling. Like all human beings, scientists make mistakes, but the scientific process is designed to find and correct them. This process is inherently adversarial—scientists build reputations and gain recognition not only for supporting conventional wisdom, but even more so for demonstrating that the scientific consensus is wrong and that there is a better explanation. That's what Galileo, Pasteur, Darwin, and Einstein did. But when some conclusions have been thoroughly and deeply tested, questioned and examined, they gain the status of "well-established theories" and are often spoken of as "facts."

For instance, there is compelling scientific evidence that our planet is about 4.5 billion years old (the theory of the origin of Earth), that our universe was born from a single event about 14 billion years ago (the Big Bang theory), and that today's organisms evolved from ones living in the past (the theory of evolution). Even as these are overwhelmingly accepted by the scientific community, fame still awaits anyone who could show these theories to be wrong. Climate change now falls into this category: There is compelling, comprehensive, and consistent objective evidence that humans are changing the climate in ways that threaten our societies and the ecosystems on which we depend. ❅

Many of the experiences of the program have impacted the way I can implement technology. We spent one day working with the digital microscope and software programs. I enjoyed creating a time lapse spreadsheets on crystalline formation, pond water video feedback, comparing photos of plant cells in various saline solutions and using auto spreadsheets to measure areas within a slide image. We were issued a Sony HD GPS-enabled camera that tags your photos with the latitude and longitude position of the camera. The program encourages students to use images that they can relate to in order to develop vocabulary skills and improve documentation of labs. Digital photography gives the student ownership of their explorations. Our assignment at Lake Sheldon, an educational facility, was to take photos at three unique pond locations. These photos were used to present assigned vocabulary terms. I was so excited to search and actually find an alligator during his predation of fish. I look forward to mentoring and working with peers during the next 60 hours of training that include modules, space flight (NASA) and attending the CAST state conference together.

> The principal goal of education is to create men and women who are capable of doing new things, not simply of repeating what other generations have done....We need pupils who are active, who learn early to find out by themselves....
>
> —Jean Piaget

Using Technology to Cheat

[This excerpt is from the October 2009 issue of *Phi Delta Kappan*.]

A poll last spring in Common Sense Media found that more than a third of the teenagers with cell phones (35%) admit to using the devices to find an answer for a test. Of those who use their phones in that way:

- 26% said they store information on a phone so they can look at it during a test;
- 25% text friends about answers during an exam;
- 17% take pictures of the test to send to friends, and
- 20% use their phones to search the Internet during an exam.

Other tech-related findings from the survey:

- Nearly half of the teenage respondents (48%) said the call or text their friends to warn them about pop quizzes.
- Nearly two-thirds of students with cell phones use them during school, regardless of school policies against it.
- Over half (52%) admitted to some form of cheating involving the Internet.
- 38% have copies text from a web site and turned it in as their own work.

Nonacademic Obstacles

[This list of "Nonacademic Obstacles Affecting Academic Performance" appeared in an article by Phyllis Tashlik in the March 2010 issue of *Phi Delta Kappan*.]

Contrary to much of the current rhetoric, nonacademic obstacles can have a profound effect on academic performance.

- History of illnesses (for example, asthma, diabetes);
- Health and physical conditions of family members or caregivers;
- Pregnancies;
- Responsibilities at home as caregivers;
- Responsibilities of after-school and weekend jobs to sustain families;
- Counseling availability outside of the school setting;
- Homelessness;
- Dependence on food stamps;
- History of foster care;
- Language interruption;
- Lack of first-language literacy;
- Continuous state of family crises;
- Anger management issues;
- History of incarceration; and
- History of suicide attempts.

Finding Funds for Projects

April Lanotte [NEST '08]

In this day and age, finding the funds to have great labs can be a huge barrier. In our small, rural school district in Colorado, for example, we have about 275 students in grades K-12 who come from a 525 square mile area. Over half of our students qualify for free and reduced lunches; the tax base here is incredibly small. As a result, my high school science budget is $500/year. That includes all chemicals, glassware, etc. Each year, I travel to MIT for our SEPT/NEST workshops, am inspired and motivated by what I see and what I want to do and then have to return to my school and find some way to accomplish challenging labs on a shoestring budget.

Two years ago, I stumbled onto an educational grant-writing website called www.donorschoose.org. Since then, I have received over $7,000 in lab equipment and supplies. The site is a free website for any public school teacher. On the site, you create an account and then write mini-grants for anything you can think of for school projects—any subject, any grade. From there, people go to the website and fund projects they like. Some people (either individuals or companies) fund entire projects while others donate anything from $5 on up. I have had some amazing people (I've never met any of them) donate to projects for all reasons—some have commented that they were first inspired by high school electrophoresis labs and are now geneticists—others donated in their parent's honor (their mom was a schoolteacher)—and yet others were donations from companies such as HP because a project matched a requirement for projects they wanted to fund.

While I never intended to go into teaching in order to write grants and pound the pavement for science lab funds, at least there is a source for some funding outside of our school and immediate community. There are people out there who believe in our school system and would like to help us out, but rarely have a good outlet for that. I have become inspired by strangers' commitment to what we do and to our students through my experiences with Donors Choose. It doesn't hurt that the website makes it really easy to write these grants, either. (They break the grant-writing process into small sections and tell you what you need to write along the way, so you don't have to be Shakespeare to get the grants written). So, if you have a great idea and need some help funding your project, check out this website. (You'd think I work for them or something!) ❅

Education in a Democracy

[This excerpt is from an article by Mike Rose that appeared in *Educational Leadership* in April 2010.]

…What is the purpose of education in a democracy? The formation of intellectually safe and respectful spaces, the distribution of authority and responsibility, the maintenance of high expectations and the means to attain them—all this is fundamentally democratic and prepares one for civilized life. Teachers should regard students as capable and participatory beings, rich in both individual and social potential. The realization of that vision of the student is what finally should drive school reform in the United States.

American Education

[The following excerpt is from an editorial by Joan Richardson that appeared in the May 2009 issue of *Phi Delta Kappan*.]

At some meetings, the board spent far more time talking about doors and windows than what went on inside those doors and windows. Setting clear goals for student learning was never on the agenda during the years I served my local district.

Shame on me—and shame on us. Too often, American school boards—the first layer of accountability in our system—have avoided making student learning their priority and have not steered school districts in the direction of high performance.

The most egregious example of school boards gone awry has been the inability, or perhaps refusal, of local schools to close the learning gap between white students and students of color. That local failure created an opening for state and federal governments to assert more and more authority over school operations. If local officials had done their jobs, then state and federal officials could never have mustered the political support for such control.

Critical Friends Groups [a.k.a. Professional Learning Communities]

Lorraine Jordan [NEST '10]

It is easy to start a professional learning community at your school. Just look around your faculty at the abundant talent and expertise and you are on your way! It is basically another form of professional development and it is real collaboration with your fellow teachers.

At W.S. Parker Middle School in Reading, MA, our faculty has been following some of the initiatives developed by the National School Reform Faculty (www.nsrfharmony.org: click on the FAQ about Critical Friends Groups (CFG)). Several of our administrators and teachers attended NSRF workshops to learn the protocols for facilitating the CFG discussions. Then they taught these methods to others and now we have three groups that meet regularly once a month throughout the year. We meet in the beginning of the year, decide on the norms for discussion, and then each member is responsible for bringing a topic to one of the meetings.

My CFG was a diverse group of grades 6-8 teachers from all disciplines. In addition, three of us were team leaders for our middle school teams. For my topic, I brought a document that I had written concerning the protocol for discussion of students at a team meeting attended by the guidance councilor, special education teachers and administration. My thought was to really identify what the student needed, develop interventions for the student, devise a timeline, examine the results and make changes, if necessary. At the CFG meeting, the members gave me both warm and cool feedback that helped me to revise the document so that it became a viable tool to help our students. This discussion process was truly an example of teacher collaboration. In addition, the two other team leaders asked my permission to use my document with their own teams. ❅

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