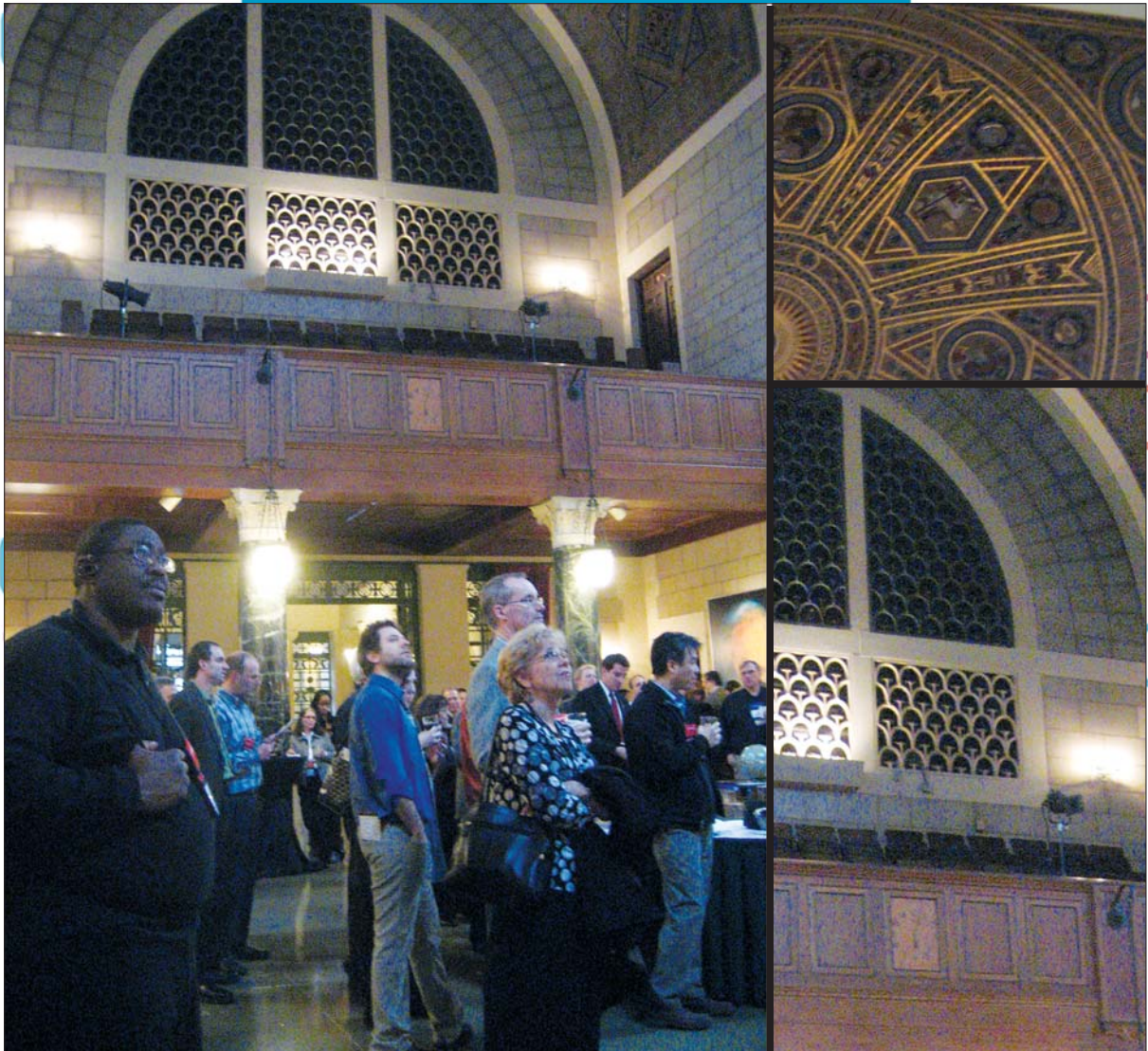


NCSSSMST Journal

Volume 14, Issue 2

Spring 2009



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NCSSSMST educators gather to celebrate the Day of Exploration during the March 2009 professional conference at the National Academies building in Washington, DC.

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Editor's Page

By Dr. Ron Laugen

Welcome to another edition of your NCSSSMST Journal. We hope you find it interesting and useful in your professional life. Rather than being themed, this is a general issue and we introduce some new features as well.

To begin with, we have included three Student Research Papers you will want to read because they all focus on practical problems. Elizabeth Asai and Sharon Cao from the Loudoun County Academy of Science found some interesting differences in radical scavenging activity between eastern and western species of herbs of the same genera. Sarah Lindsey Pace from the Rockdale Magnet School for Science and Technology tried to produce microchips using a plating process on polystyrene sheets. In the third paper, Matt Carpenter from Central Virginia Governor's School wanted to find out if increased levels of UV radiation and temperature might have effects on the dissolved oxygen output from algae in aquatic ecosystems.

The two 2008 Keystone Youth Policy Summits are summarized in this issue – complete reports can be found at NCSSSMST.org

We are pleased to reintroduce several regular columns to our readers– Technology Focus, Arts and Humanities, and Affiliates, as well as to introduce two new ones to you.

In their Technology Focus column, Joe Garofalo and Christine Trinter argue that for students to

develop deep conceptual understanding of mathematical functions, they must be able to create multiple representations of the functions and also be able to meaningfully link these representations. Welcome back to Art Williams and his Arts and Humanities contributions. In this issue, Art summarizes the various humanities 2009 Conference sessions and reminds us of the importance of developing our students' social as well as scientific intelligences.

Our affiliate members are important to our students and us as we collaborate on conferences and other efforts. In his contribution to this issue, Lou Hegyes of the University of the Sciences in Philadelphia explains why he thinks our affiliates' professionals should attend and present at the annual NCSSSMST Professional Conference.

Connecting Consortium Professionals is a new column about our web-based service to you. In this issue we highlight the downloadable presentations from the 2009 Professional Conference.

Also, pay special attention to our newest columnist, Letita Mason. Her new feature, Negotiating the Path, will look at issues related to diversity and inclusion in STEM schools. She invites your contributions and reactions and urges you to use the NCSSSMST.ORG > Connecting Consortium Professionals > Forums to create an ongoing dialog.

Ron Laugen, Ph.D., is Co-Editor of the NCSSSMST Journal and a past president of NCSSSMST. He recently retired as Headmaster of the Conroe ISD (TX) Academy of Science and Technology, where he served for 16 years.

FALL 2009 – Technology Issue Call for Contributions!

We are planning another themed issue for Fall 2009, this time on technology use in NCSSSMST schools. Contributions are invited – deadline is September 1st.

See the inside back cover for more information.

Connecting Consortium Professionals

The new Connecting Consortium Professionals (CCP) section of the NCSSSMST Website is designed for teachers, counselors, administrators, and other professionals at *member* institutions to share and collaborate.

Professional Conferences. We have archived our annual Professional Conferences, starting with 2006 - title, abstract, presenter(s), contact information – under the Professional Conferences tab. Starting with 2008, we have many presentations archived and available for downloading as well.

If you were not able to attend the 2009 Professional Conference in Washington, the following are just some of the presentations available to you:

STEM Student Summer Programs, presented by Joan Barber, et.al, North Carolina School of Science and Mathematics

Tapping the Brain's Funny Bone, presented by Debra Blenis, Florida Institute of Technology

Lessons Learned in the First Two Years, presented by Tim GOTT, Gatton Academy of Mathematics and Science in Kentucky

FACES: An Investigation of Facial Reconstruction to Establish Human Identity, presented by John Goudie, Kalamazoo Area Math and Science Center, MI.

American Déjà Vu: A Thematic Approach to History, presented by Donna Hutchison, Arkansas School for Mathematics, Sciences and the Arts.

Problem-Based Learning 101 for Computer Science, presented by Brian Kelly, Anne Arundel STEM Magnet HS at North County HS, MD.

Panel: From AP to PC – Changing the Way STEM is Taught, chaired by Max McGee, Illinois Math and Science Academy.

Advanced Mathematical Techniques: A Hybrid STEM Course, presented by Jonathon Osborne, Thomas Jefferson HS for Science and Technology, VA

The Stem Cell Research Program at BCA, presented by Robert Pergolizzi, Bergen County Academies, NJ.

Curriculum Center. The Curriculum Center is the place where teachers submit and share unique and interesting projects, lab experiences and lessons. The Center is growing – teacher contributions are vital to its success. Downloads are attached in .doc format for use and adaptation.

The latest project contribution is from Brian Kelly on PBL in computer science. Check it out!

Forums. In Forums professionals can connect with each other to post information and discuss topics of interest and concern. Use Forums to collaborate with colleagues across the Consortium, to interact with Conference presenters, and to discuss current STEM issues.

Check CCP out! We hope these features enhance your life and work as a Consortium professional. Note: you need to have a ncsssmst.org password to access CCP. Contact rlaugen@ncsssmst.org for further information.

Thanks to Mark Ensign and affiliate member Neumont University for continued development and hosting support for CCP.

President's Message

Dr. Jerald (Jay) Thomas

Two unrelated events have led me, over the past few months, to consider the broad influence and potential impact of NCSSSMST member schools. The first was the fall publication of the NCSSSMST Journal alumni issue. The issue featured reflections by alumni of NCSSSMST schools, graduates who had distinguished themselves in their personal and professional lives and who could powerfully describe the imprint of their high school experiences on their lives.

The second was the 2009 professional conference in Washington, DC, at which members of our professional community took part in a day of exploration intended to enhance their roles as professional educators. Faculty, staff, and administrators visited the Smithsonian Institution, the American Psychological Association, the Marian Koshland Museum, and other local sites on a day of professional inquiry.

These opportunities have caused me to consider why our organization is so important in the lives of the students we serve. Just as important, I suspect, is our organizational importance to our faculty and staff, local communities, and our system of education. Our institutional strength and identity, I believe, derive from the intellectual and social capital that we have created among NCSSSMST schools. This idea is well illustrated through two recent conversations.

I spoke last fall with a graduate of the Illinois Mathematics and Science Academy (IMSA) who has since earned two degrees from Harvard. I asked our former student, who grew up in a farming town in southern Illinois, what he might be doing had he not left his hometown to attend IMSA. He said that he likely would have attended a state university and become a teacher in his hometown. He was not dismissing this pursuit as unimportant, but had he not attended a specialized

mathematics and science school, he would not have known to consider Harvard as a college option despite his interest and talent. By connecting with classmates, faculty, alumni, and professional staff at IMSA, otherwise unknown academic and professional possibilities opened up to him.

A similar story, related to me by a fellow board member, involves a student attending the Dearborn (MI) Mathematics and Science Center. This student had distinguished himself by his performance in the Young Epidemiologist Scholars (YES) program. Like the IMSA graduate, this student suggested that he might never have distinguished himself in such a way had he not attended an NCSSSMST school. Both of these stories, however, speak much more broadly to the possibilities for students and faculty created through the NCSSSMST community.

The mission of NCSSSMST is "to create synergies among schools engaged in educational innovation." When I enumerate the impact of NCSSSMST schools, I find myself considering first the successes of our students. The full influence of schools like ours can only be realized, however, when we take stock of the intricate social and intellectual network that exists in our schools, one that allows us to address the other dimension of our mission – the transformation of mathematics, science, and technology education.

Last week, several of my doctoral students spent an hour discussing IMSA students' research projects with several IMSA faculty. One of my students asked a question that I'm sure many of you have heard: "My students aren't like yours. How can I get them involved in research like this?" The response revealed an important insight into the motivation of teachers and students: "Students will eagerly share with you their

Jay Thomas, EdD, is Associate Professor of Education and University Assessment Coordinator at Aurora University and current President of NCSSSMST.

interests. That's where we begin the leading them to an understanding of real inquiry."

So as we assess ways in which we enrich the lives of our students, let us be mindful also of another critical dimension of our work: the development of excellent teaching in and beyond our classrooms. How can we take what we do best and inform teaching and learning at all levels? I have said in many settings that it is not enough to expect that when you put talented teachers

with talented students, good things happen. We must be intentional about understanding this dynamic and ensuring that we are creating opportunities to improve teaching and learning. NCSSSMST, I believe, provides an invaluable dimension to that equation.



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Evidence of Possible Evolutionary Divergence in Plant Genera Based on Antioxidant Properties

Student paper by Elizabeth Asai and Sharon Cao

Abstract

The purpose of this investigation was to determine if three Western species of the *Panax*, *Lycium*, and *Astragalus* genera had antibacterial and/or antioxidant properties, and how their properties compared to Eastern herbs in the same genera. The group hypothesized that when compared, the corresponding herbs would have identical antibacterial and antioxidant properties. An antibacterial disc test was used to determine each herb's ability to inhibit the growth of *Escherichia coli* and *Micrococcus luteus*. Herb and bacteria pairs which were not antibacterial were tested in a UV exposure test, a method used to qualify antioxidant properties. Mixtures of bacterial broth and herbal teas were exposed to UV light, and plated onto agar. Survival of the bacteria was observed. In addition, to determine if color of the herb impacted the protection of the bacteria, Nigrosin, a black stain, was tested under the same UV exposure procedure. In a DPPH test, the color change of the DPPH was used to calculate radical scavenging activity as a measure of antioxidant strength. The corresponding herbs' data were then compared. For the antibacterial test, only the known antibiotic control, Streptomycin, yielded a zone of inhibition. All of the herb and bacteria pairs showed antioxidant properties after UV exposure. The DPPH test found that the herb from the *Lycium* genus had the most radical scavenging activity, followed by the *Astragalus* and *Panax* genera. When compared to the data from Eastern species of these herbs, all three of the Western herbs were found to have greater antioxidant properties, especially in the *Lycium* genus. In the wolfberry trials, the Eastern wolfberry had a radical scavenging activity of 65.0% and the Western herb had 93.1% scavenging activity (Har & Seetoh, 2008).

Introduction

Since the first drug was isolated from a plant in 1803, science has progressed to the point that a majority of our most effective drugs have herbal active ingredients. In an experiment done at the University of Exeter, Martin and Ernst's showed that tea products had matching or better bacterial treatment results when compared to those of generic antibiotics (2003). Another research investigation that used essential oils was done at the University of Utrecht. In this experiment, discs were coated in the aqueous mixtures of thyme oil, oregano oil, bay, and clove and were placed in a zone of bacteria (Burt & Reinders, 2003). The antibacterial progress was measured by taking the diameter of the zone of inhibition. An experiment done at the Jadavpur University in Calcutta, India also analyzed the diameter of the zone of inhibition (Mandal et al., 2000). In this study, Asparagus roots were finely chopped and then made into an aqueous mixture. The zone of inhibition was measured after different concentrations of asparagus were placed on a range of different bacteria cultures. The asparagus was found to have greater antibacterial properties as concentrations increased. One common trait of these investigations is that the majority tested the herbal properties on a range of different bacteria. While extensive research has been done on the antibacterial properties of very common herbs, little has been done to compare antibacterial properties of herbs native to different parts of the world. This investigation aims to directly compare both the antibacterial and antioxidant properties of Eastern and Western Hemisphere herbs. This comparison can be made possible by putting together data collected by students in Virginia, USA, for the Western herbs, and students from Singapore for the Eastern herbs. Both groups had similar experiments so that there was little variation in the experiment method. It was hypothesized that if Western and Eastern herbs were

Elizabeth Asai and Sharon Cao are students at Loudoun County Public Schools Academy of Science in Loudoun County, Virginia.

compared, then herbs with corresponding genera would have similar antibacterial and antioxidant properties. This was thought because it did not seem reasonable that two isolated yet highly related herbs would evolve different antibacterial or antioxidant properties unless there was more stress due to bacteria or oxidative stress on one, but not the other.

Materials and Method

Phase I – Antibacterial Test: Antibiotic Discs

Mueller Hinton agar plates were poured. Two 10 μ L loops of *E. coli* (Sargent Welch WL23601) and two 10 μ L loops of *M. luteus* (Microbiologics 0242P) were plated on agar. The bacteria were incubated for 48 hours at 37 degrees Celsius. Herbal extracts were made with 1g crushed herb and 10 ml 100 degrees Celsius sterile water using each of the three herbs, *Panax quinquefolius*, *Lycium berlandieri*, and *Astragalus newberryi*. Five filter discs per herb received 40 μ L of herbal extract. For the control, Streptomycin discs were used. Blank discs with 40 μ L of sterile water served as the negative control. One colony of bacteria was plated onto each Mueller Hinton agar plate. At the same time, prepared filter discs were placed on each plate. After 48 hours, the zone of inhibition's diameter was measured. If no zone of inhibition was present in all trials of a particular herb and bacteria pair, that combination was used in the next phase, the UV exposure test.

Phase II – Antioxidant Test: UV Exposure

Bacterial broths of *Escherichia coli* and *Micrococcus luteus* were made with 30 ml nutrient broth and two 10 μ L transferred loops of bacteria. Broths were incubated at 30 degrees Celsius for 48 hours. Herbal extracts were prepared with 1g crushed herb and 10 ml 100 degrees Celsius sterile water. Mixtures of 1 ml herbal extract and 3 ml bacterial broth were made in separate Petri dishes. For the controls, 1 ml sterile water or Nigrosin was used instead of the herbal teas. All of the plates were exposed to a UV transilluminator for 3 minutes at 300I. Mueller-Hinton agar plates were poured. One inoculating loop of each post-exposure mixture was plated onto five plates. Observance of survival was recorded after 48 hours of incubation at 30 degrees Celsius.

Phase III – Antioxidant Test: DPPH Test

Herbal extracts were prepared using 1g crushed herb and 10 ml 100 degrees Celsius sterile water. Mixtures of 2.9 ml methanol and 0.1 ml of each herbal extract served as blanks. A mixture of 1 ml DPPH, 1.9 ml methanol, and 0.1 ml 50 % ethanol was made in a cuvette to serve as the control without extract. The color change that occurred in this sample was measured by the spectrophotometer at 517 nm. The radical scavenging activity, a direct measure of antioxidant strength, was calculated using the following formula taken from Cheng Wai Goh-Yip (oral communication, November 2, 2007).

$$\frac{(A_{517}(\text{control without extract}) - A_{517}(\text{sample with extract}))}{A_{517}(\text{control without extract})} \times 100 \%$$

(where A_{517} indicates the absorbance measured at 517 nm)

At a wavelength of 517 nm, a color change of the DPPH is detectable in relation to the radical scavenging activity of the herb. This formula compares the color with herbal antioxidant to the original color without antioxidants of any kind in a percent difference calculation.

Results

Phase I – Antibacterial Test: Antibiotic Discs

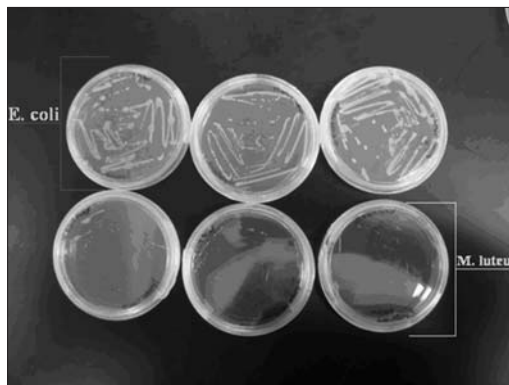
No zones of inhibition from the experimental trials formed around the antibiotic discs when placed in contact with either gram negative or gram positive bacteria, indicating that none of the herbs tested had antibacterial properties.

Phase II – Antioxidant Test: UV Exposure

All herbs tested showed post exposure growth for both gram negative and positive bacteria. As expected, the sterile water control showed no post exposure growth.

Phase II Continued – Antioxidant Test: Color Control

The Nigrosin and sterile water trials showed no post exposure growth, indicating that neither gave the bacteria an advantage against ultraviolet damage.



Post Exposure Growth Dish of *E. coli* and *M. luteus* with Western *Lycium torreyi*

Phase III – Antioxidant Test: DPPH Test

Genus Tested	Western Results			Eastern Results		
	DPPH Blank	Average Absorbance	Radical Scavenging Activity	DPPH Blank	Average Absorbance	Radical Scavenging Activity
Panax	0.678	0.354	47.79%	0.868	0.675	18.50%
Lycium	0.657	0.047	92.89%	0.873	0.283	65.00%
Astragalus	0.717	0.303	57.74%	0.858	0.730	11.20%

Table A: Radical Scavenging Activity Computed for Each Herb

All of the western herbs tested showed considerable radical scavenging activity, especially when compared to those of the eastern species. The *Lycium* genus, or wolfberry, was found to have the greatest levels of antioxidant activity in both species.

Discussion and Conclusion

Our results show that none of the herbs tested were antibacterial due to the lack of the formation of a zone of inhibition. The known antibiotic, streptomycin had a greater effect on the gram-positive bacteria *M. luteus*, rather than the gram-negative bacteria, *E. coli*, which could suggest that the *E. coli* was more resistant to the antibiotic. However, the lack of antibacterial properties allowed the group to use the herbs in phase II since it was known that the herbs didn't inhibit the growth of the bacteria. It was indicated that all the herbs tested had some antioxidant properties due to the fact that the bacteria survived when mixed with the three separate herbal teas, while the control trials all perished with only sterile water. The wolfberry trials showed especially vigorous growth as the colonies were too numerous to count. The results from the Nigrosin experiment showed that color did not provide protection for the bacteria as no bacteria survived in the trial. By using this DPPH test, we were able to find more quantitative results by calculating the radical scavenging activity. After calculating the radical scavenging activity, we were able to observe that the *Lycium* genus showed the strongest antioxidant properties, followed by the *Astragalus* and *Panax* genera. In comparing to a study done by Singaporean students that occurred simultaneously

to our experimentation, radical scavenging activity for same genus herbs were found to be greater in all three Western herbs. The radical scavenging activities of ginseng, astragalus and wolfberry, as quantified using the chemical DPPH were 18.5%, 11.2%, and 65.0% for the Asian species, and 47.8%, 55.3%, and 93.1% for the Western species respectively (Har & Seetoh, 2008). Our group is hypothesizing that different environmental conditions such as a greater risk of oxidation damage posed by sunlight exposure caused the Western species to evolve greater antioxidant properties. This is supported by the fact that the Western species used were native to desert climates, such as in New Mexico and Arizona, while the Eastern species were commonly found in forested area such as Tibet.

The *Lycium* genera had the highest amount of antioxidant properties. All three Western herbs had higher antioxidant properties than the Eastern herbs. Work is currently underway to characterize the proteins, flavonoids, etc. that might be involved in the antioxidant properties leading to evolutionary divergence in these genera.

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Production of Microchips from Polystyrene Plates

Student paper by Sarah Lindsey Pace

Abstract

Currently manufactured microchips are expensive to make, require specialized equipment, and leave a large environmental footprint. To counter this, an alternative procedure that is cheaper and leaves a smaller environmental footprint should be made. The goal of this research project is to develop a process that creates microchips from polystyrene sheets. This was done by printing with ink on the polystyrene plate to create a mask. Then two methods of plating metal onto the circuit, electroless and electroplating, were tested. Time plated, procedure, and ink level were manipulated to achieve the best results.

None of the samples were conductive. After investigation with a SEM, Scanning Electron Microscope, it was found that when the ink was heated, it shriveled and created cracks, or opens, in the circuit in all trials.

Additional research was done to reduce the cracks in the shrinking process. However, the alternate methods did not reduce cracks. A third round of testing altered the method of measuring resistance, but damaged trials and had to be abandoned. Currently, there is no combination of variables that produced a working circuit, but significant advances have been made.

Microchips created from this procedure would be for small scale applications, such as classrooms or home projects. In future research, microchips that could be used in electronics could reduce electronic waste. They could also lower costs of electronic devices, making them available to lower income markets.

Introduction

Currently manufactured microchips are expensive to make, require specialized equipment, and leave

a large environmental footprint. It is estimated that a 32 MB DRAM packed chip that weighs about 30 milligrams uses 1.7 kilograms worth of materials and waste to be produced (Plepys, 2004). If prices to make these chips can be reduced, microchips can be more readily available to the general public and lower the cost of products that use microchips. If alternative methods and materials for low-end microchip production can be researched, a smaller environmental impact can also be made. This research experiment aims to produce a low cost, low impact microchip using polystyrene plates.

Over 2.63 million tons of electronic waste was generated by the United States in 2005 alone (United States Environmental Protection Agency, 2006). Only 12.5 percent of this waste was recycled, with the other 87.5 percent ending up in landfills and incinerators. Using less raw materials to produce more environmentally friendly electronic components could be one way to reduce this waste in our landfills.

This experiment was based on a previous experiment with microfluidic devices created with polystyrene plates done by Anthony Grimes (Grimes et al, 2007). When polystyrene plates were heated, they contracted and became thicker. In doing so, ink printed on the polystyrene from an inkjet printer went from large and flat to small and thick, like a wall. These walls are only several microns tall. In Grimes' experiment, this shrunken polystyrene was used as a negative for a mold to make the microfluidic device. However, in the current experiment, the shrunken polystyrene plate was used as the positive for the microchip.

Currently, microchips are produced through a lengthy process consisting of several steps

Sarah Lindsey Pace is a senior at Rockdale Magnet School for Science and Technology in Conyers, GA.

(Stackhouse, 2003). First comes silicon conversion. Next comes wafer fabrication. Then the wafer is etched with photoresist, a type of chemical that is soluble only when it is exposed to light. Then the finished chip is fixed onto a base depending on how it will be used and shipped off to another manufacturing plant.

The solutions for electroless and electroplating were taken from Nickel, Cobalt, and Their Alloys, an informational guidebook to several aspects of the metals (Davis, 2000). To deposit a metal without electricity, an autocatalytic reduction must occur. The chosen group of chemicals can react at room temperature because it has a lower activation energy. Electroplating is the process of causing a reaction to deposit a metal onto a given surface. This process deposits the metals on the conductive parts of the electrode. This is represented in Table 1.

Electroless			
	One Hour	Three Hours	Six Hours
Shrink Then Plate 50% Ink	3	3	3
Shrink Then Plate 100% Ink	3	3	3
Plate Then Shrink 50%	3	3	3
Plate Then Shrink 100%	3	3	3
Electroplating			
	20 Minutes	40 Minutes	60 Minutes
Shrink Then Plate 50% Ink	3	3	3
Shrink Then Plate 100% Ink	3	3	3
Plate Then Shrink 50%	3	3	3
Plate Then Shrink 100%	3	3	3

Methodology

The independent variables were time plated, ink percent, plating method, and procedure order. The times plated for electroless were three, six, and nine hours. The times for electroplating were twenty, forty, and sixty minutes. The ink was printed either at 50% ink or 100% ink. The plating method was either electroless or electroplating.

The procedure either was plate then shrink or shrink then plate. The dependent variable in this project was the resistance, a measure of conductivity.

To print the polystyrene sheets, a HP Deskjet 5440 was used to print the template for electroless and electroplating. The sheet was printed on two times to build up the layers of ink on the polystyrene. Then the trials were divided into categories based on time plated, ink percent, plating method, and procedure. To shrink the trials, they were placed in a toaster at 145°C for three to five minutes. Electroless plating was done by mixing 50g Nickel Sulfate, 3g of DMAB (N-dimethylamine borane), and 100g of Sodium pyrophosphate into one liter of water. This solution was stirred overnight. Then it was applied to the trials. The solution was washed off with distilled water. Electroplating was done by mixing 200g of Nickel Sulfate, 5 grams of Nickel Chloride, 25g of Boric Acid, and 3 grams of Saccharin in one liter of water under a laminar flow hood. Electroplating was set up by connecting a variable DC power supply to electrodes at the positive (cathode) and negative (anode). It was run at three volts for the allotted time, and then rinsed with distilled water. To test for conductivity, a multimeter was used to measure resistance on the lines of the trial.

When the solutions were handled, proper safety goggles, gloves and aprons were used to protect direct contact to skin and clothes. While the solutions were being handled, adult supervision was present at all times. The solutions were not stored near heat or flame because of evolving hydrogen gas that is flammable. After use, all waste solutions were properly disposed of in a designated waste solution disposal unit.

Data Analysis

On all trials, the ink lines appeared to be slightly green. This was originally concluded to be the slight presence of nickel. It was also observed that contrary to prior knowledge, the ink acted as a mask on the electroless trials, not as a conductive surface for the nickel to plate on. The raised

surface indicated the nickel plating, while the design in ink was bare.

The electroplating samples produced a more uniform plate onto the surface, but were still rough and caused an open (Figure 2). This meant that there was no connection in the circuit. The resistance was infinite because there was so much resistance that the electrons could not pass through. It was seen that the 100% ink worked as a better mask for the electroplating, but was not a complete mask (Figure 3). The red circled area indicated an area that was masked off in ink, but due to the ink not completely covering the surface, was still plated. The black outline showed the actual design on the polystyrene plate.

The results from the multimeter test read that each point of the plate was an open. This showed that all tested combinations of electroless and electroplating did not have a complete circuit. After investigation under the scanning electron microscope, it was determined that there were opens in the circuits, caused by warping of the polystyrene plate when heated. Figure 4 shows one of these cracks on an untreated polystyrene plate.

A second round of testing was conducted, manipulating the shrinking procedure to reduce cracks. Several combinations of uniform heating with a hot plate, heat lamp, and/or weight on the polystyrene plate did not yield a conductive polystyrene plate. A third round of testing manipulated the procedure for measuring resistance. Thin wires were soldered between two points on the polystyrene plate. This allowed for better accuracy as compared to the larger leads on the multimeter. This procedure had to be abandoned because the hot temperature of the solder melted the polystyrene plates. Currently, this procedure is for small-scale applications. This research is most applicable in an educational setting where a student could print out a microchip at home for a lab. With future research, this procedure could be expanded to large-scale applications. Microchips made with this procedure would cost less due to less specialized

equipment needed to produce them. These microchips could lower the production cost of electronic items, making them more available to more diverse markets.

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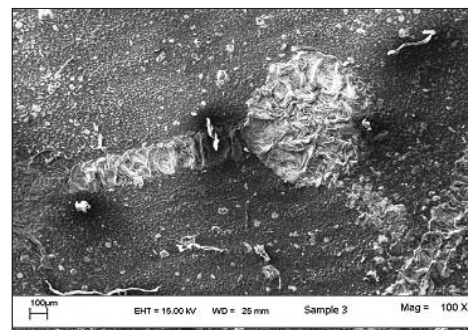


Figure 2. Electroplating, Plate Then Shrink, 20 Minutes, 3 Volts, 100% Ink
(Taken by Dr. Robert Simmons, Georgia State University)

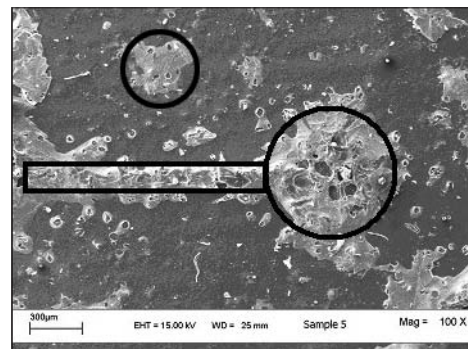


Figure 3. Electroplating, Shrink Then Plate, 60 Minutes, 3 Volts, 100% Ink
(Taken by Dr. Robert Simmons, Georgia State University)

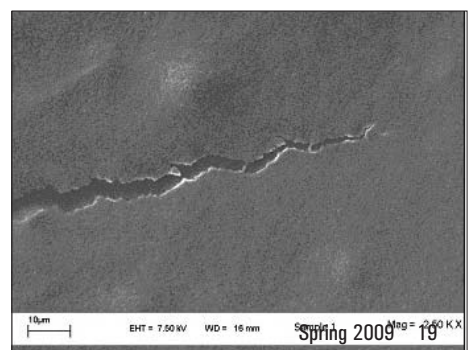


Figure 4. Sample Crack on Polystyrene with No Treatment, Shrunk
(Taken by Dr. Robert Simmons, Georgia State University)

Energy and Obesity – The 2008 Keystone Youth Policy Summits

Summary

Keystone Science School and Keystone Center for Science and Public Policy programs blend learning in the natural world with developing mediation and conflict resolution skills. Since 2004, these two divisions of The Keystone Center in Colorado have partnered with the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST) to offer Keystone Youth Policy Summits (YPS). The Summits have awakened Consortium students to a world of problem solving that incorporates critical thinking and consensus and provided them with the experiential tools to find solutions to issues they will inherit from previous generations.

Two groups of students met during the 2008 Summits. The 2008 topics were *Sustainable Fuels in America* and *Obesity in America*. Participants researched each topic prior to their YPS and came together to meet with experts and to discuss and negotiate policy recommendations. Two reports resulted: the *Student Agreement on Sustainable Fuels in America* and the *Student Agreement on Obesity in America* (summarized below).

Sustainable Fuels in America

The Keystone Science School hosted 39 students from 10 NCSSSMST schools for the Youth Policy Summit on Sustainable Fuels in America in June 2008. During the Summit, participants discussed the environmental, social, economic and political problems associated with current and future fuel usage in the United States. Participants shared research, defined the issues and options, and sought consensus on recommendations. Students next met with experts to develop thoughtful, practical ideas that were presented to The Keystone Center's National Energy Board in October 2008. Through the formation of the

Junior Energy Board sponsored by Duke Energy, the student group will continue to work.

Questions and Issues

Environment:

The extraction, shipment, and consumption of oil have a number of well-known environmental impacts, from damage to fragile eco-systems from extraction and from oil spills, to smog and carbon dioxide emissions from tailpipes. Yet no fuel is perfect and indeed each alternative fuel has its own set of environmental impacts. What near-term, mid-term and long-term fuel mix is best for the environment?

What are the 'upstream' environmental impacts of various fuels (i.e., what is the source of the fuel, and how is it grown or extracted)?

What are the 'downstream' environmental impacts of various fuels (e.g., are fishermen impacted by added agricultural runoff)?

Are some fuels better in terms of climate change? What upstream and downstream impacts must be considered to get a full life-cycle understanding of emissions attributable to a specific fuel?

Equity:

Some fuels may be more useful in concentrated urban areas, where most travel is local and fueling stations can be concentrated in a small area. Others may be better suited to agricultural areas closer to where they are grown. Which mix of fuels creates the greatest social equity in the near-term, mid-term and long-term?

Must everyone have equal access to all fuels?

What does that mean for car and truck and engine manufacturers?

There are environmental justice issues with oil refineries impacting poor communities more than others. Might some alternative fuels adversely affect other communities?

Standards and measurements:

With a goal to significantly reduce use of oil-based fuels, what standards should be set over what time period?

What is an appropriate target over the short-term (4-8 years)? Mid-term (8-16 years)? Long-term (16 years+)?

How will progress be measured?

What are challenges and opportunities to work around them and overcome them?

Recommendations

Short-term Plan Summary (4-8 years):

By 2016, we recommend plans to accomplish the following:

- Decrease foreign oil dependence by five percent;
- Require 20 percent of the nation's gas stations to provide at least one form of biofuel;
- See no increase in the rate of change of carbon emissions;
- Increase fuel diversity;
- Make great strides in research of various fuels and carbon capture and storage;
- Increase public awareness of various fuels;
- Gain accessibility to various fuels in the current infrastructure;
- Make alternative energy a popular and viable option for consumers;
- Augment government support of alternative fuel programs;
- Revise and renew government tax incentives; for up to 150,000 hybrid cars per car manufacturer from the years 2010 to 2015;
- Meet the goal of having 10 percent of all cars to be hybrid vehicles.

Mid-term Plan Summary (8-16 years):

By 2024, our goal is to:

- Develop and implement advanced hybrid electric vehicle technology that reduce environmental impacts;
- Government mandate for Fischer-Tropsch liquids to have carbon neutrality in mature industries;
- Require a minimum of 40 percent of the vehicles being driven in the United States are hybrids with 60 percent of the vehicles sold being hybrids;
- Provide research grants for manufacturers who go beyond the *Energy Independence and Security Act (EISA) of 2007* requiring by the year 2020 the CAFE of each manufacturer must be no less than 35 miles per gallon;
- Implement a household and commercial bio-waste recycling program;
- Meet or exceed the goals of 21 billion gallons of advanced biofuels set by the *EISA* of 2007;
- Fund research for methods to use biofuels, biomass and bio-waste for the clean production of hydrogen and electricity, to convert easily into the future of a hydrogen power based economy.

Long-term Plan Summary (16+ years):

By 2024, our goal is the following:

- 40 percent of cars on the road are hybrids;
- 60 percent of all cars produced by manufacturers are hybrids;
- Research, development and deployment of GTL, CTL and BTL technology, as well as hydrogen.

By 2040 our goal is the following:

- ~ 100 percent of cars on the road are hybrids;
- Continued production of GTL, CTL, and BTL cars, with the goal of ~ 60 percent of vehicles on the road using a mix of these fuels;
- Continued production of hydrogen, with the goal of ~ 40 percent of vehicles on the road using hydrogen.

By 2060 our goal is the following:

- 40 percent of cars on the road are hydrogen;
- 60 percent of cars being produced by manufacturers are hydrogen;

- GTL, CTL, and BTL plants are switched to hydrogen production;
- And by 2080, our goal is that 100 percent of cars on the road are hydrogen.

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Participating Schools

Arkansas School for Math, Science and the Arts, Hot Springs, Arkansas

Brooklyn Technical High School, Brooklyn, New York
Center for Advanced Technologies, St. Petersburg, Florida

Conroe ISD Academy of Science and Technology, The Woodlands, Texas

Illinois Mathematics and Science Academy, Aurora, Illinois

Liberal Arts and Science Academy, Austin, Texas
Kalamazoo Area Mathematics and Science Center, Kalamazoo, Michigan

Roanoke Valley Governor's School, Roanoke, Virginia
Rockdale Magnet School For Science and

Technology, Conyers, Georgia
Science and Mathematics Academy, Aberdeen, Maryland

Obesity in America

The Keystone Science School hosted the second 2008 Youth Policy Summit in August, bringing together 26 students from five NCSSSMST schools to develop consensus-based recommendations on preventing and treating obesity in the United States. Participants addressed the fact that the number of Americans who are overweight or obese is rising even though information about healthy living is available. Students came to the Summit immersed

in the roles of different stakeholders after months of researching questions and issues about obesity. During the Summit they interacted with a panel of experts from government, industry, academia, and civil society. Through fact-finding and iterative negotiations, the participants considered a range of evidence-based strategies to identify approaches to reversing this public health crisis and recommended policies in three areas: information, education and inspiring action.

Questions and Issues

What specifically should be done over the next 10 years, by whom, and by when, to bring about the behavior changes necessary to reduce incidence of overweight and obesity significantly in the United States?

A good deal of information about healthy lifestyles is already available to Americans. What else might they need to know?

Consider dietary guidance from government, school curricula, public health messages, and information from other sources such as physicians, coaches, and dietitians. Consider how such information is currently being used—by whom, and for what purpose? Is it reaching enough people?

What do you recommend be done going forward?

Who would implement any new strategies, and how might they be funded? What educational strategies are needed to help people use this information appropriately? How effective are current efforts?

Consider current education around use of the Food Label and MyPyramid, school wellness plans, school curricula, public health announcements, and information for special populations such as dieters and new parents. What do you recommend be done going forward? Who would implement any new strategies, and how might they be funded?

What other strategies (programs or messages) should be used to motivate and inspire people to act upon this knowledge and change their behavior?

What factors compel people to act on health-related information? Are new messages needed, or environmental changes (such as integrated community and neighborhood design, or greater availability of healthier foods)...or both?

How are messages delivered most effectively? (Factors may include who delivers the message, through what means, with what tone, etc.) Who would implement any new strategies, and how might they be funded?

What research priorities are most pressing over the next 10 years?

Recommendations

Youth Education:

Develop “Health Clubs” managed by high school volunteers for students ages 7-10 that would help prevent obesity by reaching out to students on a monthly basis. Topics covered in the program would include the importance of physical activity and nutrition. High school volunteers, as role models for younger students, would commit to maintaining a healthy lifestyle.

A policy should be put in place to improve the nutrition of school meals and competitive foods. A ten-year, federally funded national school nutrition policy should phase out unhealthy choices and unhealthy competitive foods from schools.

To draw attention to health awareness in schools, each state should have a plan in place to record the progress of students’ physical activity, including semiannual testing beginning in kindergarten. The test results should be published statewide in hopes of setting new physical activity standards.

To better educate students on health and wellness, students should be required to pass a federally mandated, standardized test as a graduation requirement. The test would include topics such as nutrition, family life, and drug awareness.

Community Engagement

In order to encourage healthy lifestyles in communities, an increase is recommended in federal funding for parks, and physical activity guidelines recommended by the American Academy of Pediatrics should be posted in parks for community education.

A federal government fund should be established to support communities in building sidewalks and bike paths. Individual communities would apply for grant money with project proposals beginning in 2010 and projects would be completed by 2020.

Communities should also start intramural sports programs for community members of all ages. The programs would be housed in schools and other public areas; volunteers would serve as coaches and referees.

Motivation from the Media

Commercials with familiar television figures and characters should be used to teach children about healthy living. These figures could spread simple messages, including the importance of eating fruits and vegetables and the importance of regular exercise.

Adult Epidemic

The government should collaborate with colleges and universities to help young adults avoid "The Freshman Fifteen." A computer, using a card swipe system, could help students track how long and how often they go to the gym, and schools could reward active students with prizes.

To reach adults, businesses should collaborate with fitness centers to provide employees with reduced price or free fitness membership, increasing fitness center business, tax relief for businesses and opportunities for physical fitness. Fitness memberships could also be offered through health insurance plans.

Consumerism & Obesity

A "healthy option" symbol overseen by the U.S. Food and Drug Administration should be used to identify healthy products and services. In order to earn the symbol, products should contain essential nutrients and/or low amounts of sodium, saturated fat, trans fat, cholesterol, etc.

The MyPyramid diagram should be placed on all food products to highlight the nutritional characteristics of the item, consumption recommendations and other suggestions to create a balanced meal.

Obesity, Socioeconomic Status and Communities

Food availability and affordability are major factors in affecting the health of families. Since many low-income families use food stamps, 25 percent of food stamp money should be allotted for FDA-approved healthy foods.

Federal grants should be appropriated to build grocery stores across the nation in low-income or rural areas to improve access to low-cost healthy foods.

The private sector should become more involved in maintaining a healthy community by developing privately sponsored gyms and health programs. Food brand icons and television characters could help promote healthy diets and lifestyles.

Public service announcements regarding good nutrition should be more severe and focus more on the dangers of obesity. A mandatory broadcast of federal public service announcements that explain health risks could impact rising obesity rates.

States should mandate that restaurants provide nutritional information. Portion sizes should also be reduced.

Public and private healthcare institutions should offer low-cost nutrition courses for new parents before and after childbirth.

Federal Coordination

Obesity programs are spread across three federal agencies, the Centers for Disease Control and Prevention, the USDA and the FDA. To maximize efficiency, one of these agencies should be chosen to lead efforts in obesity prevention.

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Participating Schools

Alabama School of Fine Arts, Birmingham, Alabama
Alabama School of Math and Science, Mobile,
Alabama

Crooms Academy of Information Technology,
Sanford, Florida

Gatton Academy of Mathematics and Science,
Bowling Green, Kentucky

Thomas Jefferson High School for Science and
Technology, Alexandria, Virginia

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The Effect of Increased Temperatures and Ultraviolet Radiation on Dissolved Oxygen in Ecosystems Primarily Comprised of *Euglena*

Student paper by Matt Carpenter

Abstract

The purpose of this study was to determine whether increased levels of UV radiation and temperatures from global warming have a significant impact on dissolved oxygen (DO) output from the alga, *Euglena*, which affects other organisms in the ecosystem. The original hypothesis stated that if temperature was increased along with exposure time to radiation, DO would decrease. The hypothesis that increased temperatures affected DO was supported. However, the minor differences due to radiation were insignificant.

Introduction

People need to be prepared in the event of a climate change to the extent of global warming. This project is centered on three main concepts: global warming, UV radiation, and *Euglena*, which all impact DO. Global warming has become a major issue over the past few years with the release of data suggesting our actions will not only affect our descendants, but the consequences will also manifest in our lifetime. Greenhouse gases are chemical compounds that allow sunlight to pass into the atmosphere and trap heat as it is reradiated (as infrared) back into the atmosphere. The amount of heat absorbed by these gases should keep the global temperature relatively constant, but an augmentation of these gases is known to trap more heat in the atmosphere and result in elevated temperatures (National Energy Information Center, 2004). Greenhouse gases occur naturally, as in animal respiration, or from burning fossil fuels and other industrial processes (National Energy Information Center, 2004), (NASA, ND.) As coal and other fossil fuels are burned for energy, the amount of carbon dioxide, chlorofluorocarbons and other ozone depleting substances (ODS) emitted into the atmosphere rapidly increases. These compounds become unstable and break apart. The resulting new atoms

break down the ozone. Therefore an increased amount of these gases in the atmosphere accelerates depletion beyond creation, resulting in less ozone, and increased penetration of harmful UV rays (US EPA 2007b).

Aerosols are solids or liquids suspended in a gas. The higher their density in the atmosphere, the better they reflect sunlight back into space. This keeps sunlight from reaching the earth and results in lower ambient temperatures (NASA, ND). Additionally, aerosols also act like greenhouse gases trapping heat already present in the earth's atmosphere, as the cycle of outward heat radiation back to the sun is blocked (NASA, ND.) It is estimated that 3.2 billion tons of extra carbon dioxide released yearly is unable to be conserved by the carbon cycle, causing a rise in the percentage of greenhouse gases. Aerosol particles can affect weather by changing cloud properties. A high concentration of aerosol particles in a cloud causes water molecules to spread out with increased surface area of the cloud. Additionally, these water molecules decrease in size, and decrease annual precipitation according to NASA. Since greenhouse gases remain in the atmosphere for multiple years, there is uncertainty as to the effects of global warming. However, government agencies such as the Environmental Protection Agency (EPA) affirm that global warming is an imminent threat and they estimate temperatures may rise between 1.1°C and 6.4°C by the end of the century (US EPA, 2007a.)

There are three types of UV radiation: UVA (320-400nm), UVB (280-320nm) and UVC (100-280nm) (NASA, ND); the shorter the wavelength of radiation, the higher the potential for harm (NASA 2001). The effects of UVC on humans are unknown, as UVC has not yet reached the Earth's surface. However, UVB radiation is a known cause

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of skin cancer (US EPA. 2007b). It is possible that UVC radiation may eventually affect humans, as it is currently blocked by the degrading ozone. The radiation used in this study was in the UVC radiation range (254nm), not too far removed from UVB (280-320nm). UVB radiation heavily impacts nutrient cycles, and can accelerate the decomposition of colored dissolved organic matter (CDOM). CDOM ideally protects the aquatic ecosystem by reducing the penetration of short wavelength radiation such as UVB and UVC. However, too much radiation can cause CDOM decomposition rates to increase. This allows harmful UV rays to penetrate deeper into the water, resulting in altered nutrient cycles, death of organisms and a depletion of essential minerals (Zepp, R.G. et al. 2007). If the availability of certain minerals is reduced, organisms do not grow as well and the ecosystem becomes unhealthy. Plants can not conduct photosynthesis normally without needed minerals, which results in a decrease in DO (Zepp, R.G. et al. 2003). Decreased DO exacerbates the bleak situation by causing organisms to run out of oxygen. Eventually, DO levels would drop below 5mg/L, the minimum safe standard for certain fish species, resulting in death (University of Florida, 2003.)

Euglena is a unicellular alga. It grows primarily in fresh water (University of Maryland, 1998). A light sensitive eyespot on its anterior draws it towards light, facilitating photosynthesis (University of Cincinnati, Claremont College, 1997). *Euglena* is a model organism as it reproduces asexually, quickly dividing into two new cells at a time (University of Maryland, 1998). It is for this reason that *Euglena* is often used to study the effects of radiation on eukaryotes. *Euglena* is known to grow in nutrient rich environments, and grow well in warm conditions (Constantopoulos, G. and Bloch, K., 1967), (University of Maryland, 1998). Because *Euglena* photosynthesizes, they are a major producer of DO for other aquatic organisms, as terrestrial oxygen must diffuse into the water before it is accessible (Zepp, et al. 2007), (University of Florida, 2007).

DO is an important indicator of water quality in ecosystems because all organisms take part in

either its production or its consumption (State of Kentucky, 2007). DO is produced from two main sources, photosynthesis of aquatic plants and oxygen diffusing into the water from the atmosphere. Most DO is produced from photosynthesis. It is known, that as temperatures increase, DO decreases. At higher temperatures photosynthesis increases in plants. However, organisms are also more active, and need more oxygen than normal, which is not available to them. The solubility of oxygen in water decreases as water temperatures rise (Senese 2007). It is also known that DO changes during the day, peaking at dusk and decreasing until dawn (University of Florida, 2003). DO in a healthy ecosystem should constantly remain above 5mg/L; any amount less and the ecosystem becomes stressed. If readings remain below 5mg/L for an extended period of time, large scale fish kills are possible. Conversely, too much DO is harmful, causing oxygen related diseases among fish in waters with concentrations above 100-110 % (State of Kentucky, 2007).

Because UV radiation and greenhouse gases can alter nutrient cycles that are directly involved in photosynthesis, it is probable that exposure to UV radiation will impact DO as a result of interrupted photosynthesis (Zepp, et al. 2007). But, how big will the impact be?

Materials and Methods

Six 400mL beakers were filled with 400ml of spring water. As water evaporated from the beakers and dropped below 300mL, all beakers were refilled in order to keep water levels at comparable ranges between groups. The *Euglena* was then separated equally into the beakers. Samples were separated into two temperature groups; one at 23°C and the other incubated at 28°C (the predicted temperature difference over the next century (US EPA. 2007a)). One sample from each temperature functioned as the control, and was not exposed to radiation. The remaining two beakers were exposed to UVC radiation at an intensity of 0.6W/m² once a week via an UV radiation lamp. A low dose radiation group was exposed for 24 minutes and 20 seconds, while a high dose radiation group was exposed for 48 minutes and 40 seconds. DO readings (mg/L) were recorded daily using a HACH Sension 156 portable

multi-parameter water meter post radiation. *Euglena* was exposed (weekly) to UVC radiation (254nm) a total of four times.

Results and Conclusions

All statistical tests were performed on DO data collected after Day 11, as a fluke DO reading generated a statistical outlier before Day 11 (Figure 1).

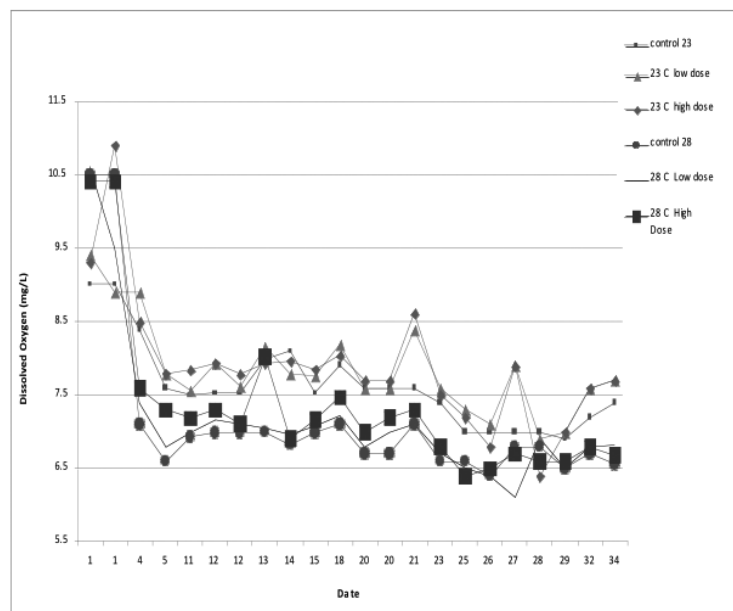


Figure 1. Dissolved oxygen levels per day in aquatic ecosystems containing *Euglena*.

A two sample t-test compared the means of DO data collected from groups grown at 23°C and 28°C, regardless of dosage. A significant difference between *Euglena* grown at these two temperatures ($p \approx 5.20 \times 10^{-16}$, $\alpha = 0.05$) was shown.

Two, one way ANOVAs were performed to compare the difference between the DO from the radiation at each temperature. At 23°C there was not a significant difference observed between the means of DO from *Euglena* exposed to radiation at any dosage ($p \approx 0.23$, $\alpha = 0.05$). At 28°C the same was true ($p \approx 0.17$, $\alpha = 0.05$).

The original hypothesis stated that if temperature and exposure to UV radiation dosage was increased, then DO production by *Euglena* would decrease significantly. The results of this

experiment support that temperature has a significant effect on DO levels produced, while increased radiation dosage does not. The results of this experiment agree with University of Florida findings which show, that as temperature increases, DO decreases (University of Florida, 2003)(Senese 2007). Unexpectedly, increased radiation dosage did not have an effect on the CDOM which should have limited the nutrients available for photosynthesis (Zepp, Erickson, Paul, and Schulzberger, 2007). Preliminary (unpublished) studies by researchers in this field show that decomposition of *Euglena* does not result from UVC radiation. However, if another green algae was present then UVC radiation could have possibly had an effect on resultant DO.

In the future, other types of alga or plankton should be studied to see what the effects of UV radiation are on an aquatic environment especially with regard to humanity's increased concerns associated with global warming.

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Technology Focus: Multi-Representational Approaches to Equation Solving

By Joe Garofalo and Christine Trinter, University of Virginia

Most mathematical functions can be represented in numerous ways. The main representations typically addressed in school, often refer to as “the big three,” are graphical, algebraic, and numerical representations, but there are others as well (e.g., diagrams, words, simulations). These different types of representations “often illuminate different aspects of a complex concept or relationship” (NCTM, 2000, p.68), and each has its own features, advantages, and limitations. For students to have a conceptual understanding of functions, they not only need to understand each representation on its own, but also need to be able to link different representations meaningfully. Solving equations using a function approach, with different representations, can help students learn to better connect representations. Here are two sample activities we use with our pre-service teachers to help them think about teaching with multiple representations.

Activity 1: Solving a “Complex” Exponential Equation

We ask our students to find *algebraically* all solutions to the equation: $(x^2 - 5x + 5)^{(x^2 - 9x + 20)} = 1$. All re-visit the basic rules of exponents. About half of them consider when the base polynomial is equal to one and find solutions $x = 1$ and $x = 4$, and then consider when the exponent polynomial is equal to zero and find solutions $x = 4$ and $x = 5$, thereby arriving at three solutions. The other students find these three solutions in the same way, but also recognize the need to consider the case of $x^2 - 5x + 5 = -1$, and thus find the additional solutions $x = 2$ and $x = 3$. So, the algebraic approach works, but it may not lead to any new insights.

After solving algebraically for all five solutions, we ask our students to solve for x *graphically*, on a graphing calculator. Most students initially do not

appreciate the importance of the window settings. They rely on integer values for their scales without considering the screen’s resolution. They generate graphs similar to the first graph in Figure 1, and again find only the first three solutions (i.e., x -values where the function has a value of 1) found earlier algebraically.

Students are confused as to why only three of the previously found five solutions are evident on the graph. They are generally unaware of the connection between window range and the number of pixels in a screen, and hence do not realize that the pixels and integer solution values don’t “line up” in this window. The second graph in Figure 1, showing all five solutions, was generated using an x range of 9.4 with a calculator having 94 pixels across. Hence, the graphical approach also works well, but only when students choose a window appropriate for the specific task.

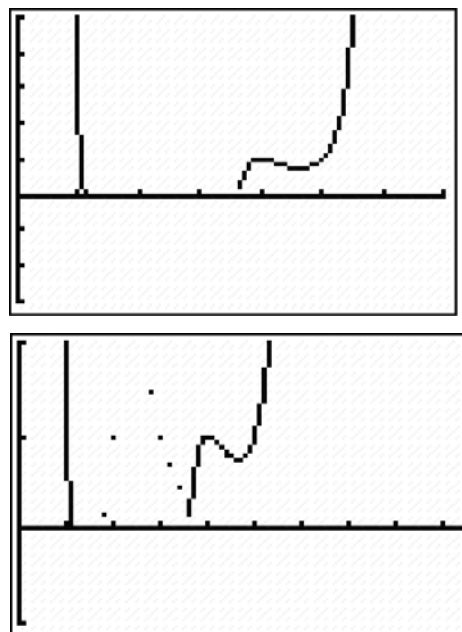


Figure 1: A window with $x\text{-max} = 7$ and a window with $x\text{-max} = 9.4$

Joe Garofalo is Associate Dean for Academic Affairs and Co-Director of the Center for Technology and Teacher Education at The Curry School of Education of the University of Virginia.

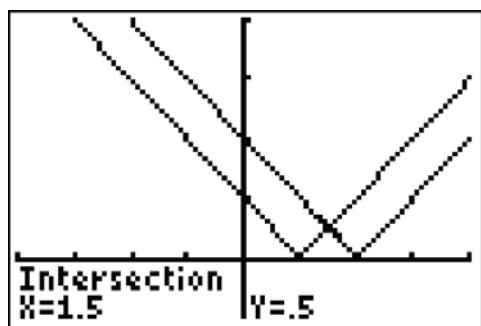
Christine Trinter is a doctoral student in mathematics education and project manager of the Parallax Project at The Curry School.

The real benefit of this activity comes from the class discussions connecting the two solution strategies, exploring the pixel issues, and analyzing the missing pieces of the second graph. This task can be used to address various topics, such as pixels, roots, exponents, domain, range and complex numbers.

Activity 2: Solving an Absolute Value Inequality

We ask our students to solve the inequality $x-1 < x-2$ in as many different ways as they can. They often resort to the traditional *algebraic* method they learned in high school, which involves breaking the task up into several cases. This solution method works, but could take from three to seven minutes of class time and is subject to various types of errors. Worse is the fact that too many students using the case method often lose sight of what is being asked. Hence, the resulting solution may not have any meaning to some students.

Many students use their graphing calculators to generate a graphical solution, as shown below in Figure 2.



A graphical solution to an inequality

A majority of them will find a correct solution using the graphical approach, but others will have a bit of difficulty. A few students will focus on the intersection and give an answer to a different question; others will be confused about how to interpret the graphs to provide the correct answer. And, a few will use a *numerical* approach, either guessing and checking or using the calculator to generate a table. The tabular method can still have

interpretation problems – a student may use an ineffective increment or have trouble with interpreting the table in a way that will yield a correct solution. Note however, that the above difficulties can be capitalized on to create good teachable moments.

Never have any of our students used a pure *verbal representation*; that is, put the task into words. This approach would involve understanding the meaning of absolute value and understanding inequalities. When prompted to verbalize the inequality, students do come up with verbal representations of the tasks such as, “find the set of all x values whose distance from one is less than their distance from two” or “which values of x are closer to one than to two.” At that point they quickly arrive at the solution: all x values less than 1.5. A person with the inclination to use a verbal approach can obtain a meaningful solution in a matter of seconds. This rarely used verbal solution strategy is the most efficient for this type of task. We have found that these activities can be used as springboards for in-depth discussions of various aspects of equations, functions, and problem solving. Also, the activities support the recommendation of the National Council of Teachers of Mathematics that instruction should enable students to “select, apply, and translate among mathematical representations to solve problems” (NCTM, 2000, p.67).

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Arts and Humanities: Humanities at the 2009 Conference

by Arthur S. Williams, Ph.D., Louisiana School for Math, Science, and the Arts

Plato, Aristotle, Harry Potter, Ulysses S. Grant, and—appropriately for Arlington, Va.—Robert E. Lee, were present at the 2009 Professional Conference of the NCSSSMST.

At a meeting designed to explore connections in STEM education, we humanities types were gratified to find eight sessions devoted to the arts and humanities as well as several others with a civic or humanistic component. Integration and inclusion, it seemed, were in the air, embracing not just science, technology, engineering, and mathematics, but philosophy, language, rhetoric, and the fine arts as well.

The diversity of interests and approaches taken in these presentations was striking. Among the presentations offered, Diane Gerard explored teaching Harry Potter along with Plato and Aristotle in a foundation course in Western Philosophy for tenth graders at the Alabama School of Math and Science. Virginia Wilson, Jim Little, and Alison Blaine of the North Carolina School for Science and Mathematics, explained the development of a writing rubric for an Intensive Writing course. A session given by Daniel Moix and Donna Hutchinson of the Arkansas School explored the value Web 2.0 as a tool for teaching the Civil War, while Ronny Risinger of the Liberal Arts and Sciences Academy of Austin discussed the use of amateur radio to enrich humanities teaching. Lisa Rocchio and Francisco Uceda of the Bronx High School of Science explored techniques for teaching languages at STEM schools. Gary Lauter of the University of Tampa talked about the ways that his institution explores relationships among the arts, humanities, and sciences.

Among the sessions that I attended, two seemed of especially far-reaching significance. Susan Owens and her colleagues from the Anne Arundel

STEM Magnet High School in Maryland discussed the development of a required fine arts course that utilizes scientific concepts. As interesting as the course itself was their explanation of the impetus behind it. It seems that stakeholders in their school had complained that engineering graduates were lacking in creativity, and insisted that the arts be included in the school curriculum as a means of fostering innovation and imagination in future engineers. So who still wants to argue that the arts are expendable in education?

Another presentation with broad implications was given by Corey Alderdice and Tim GOTT of the Gatton Academy of Mathematics and Science in Kentucky. Drawing on a book by Daniel Pink, their presentation emphasized the importance of developing the whole brain by incorporating humanistic education, as well as social and emotional nurturing, along with scientific education. “Empathy,” they emphasized, was a quality that they wished to nurture in their science students. Skeptics should read *Frankenstein* by Mary Shelley for an account of what can happen when scientific intelligence is developed at the expense of the social being.

Apart from these individual sessions, the spirit of the humanities infused the entire meeting due to the proximity of Washington, D.C. and the NCSSSMST’s new commitment to shaping educational policy. The humanities, we should remember, have traditionally been preparation for civic involvement. As the organization expands its involvement in public life, it will be calling upon that tradition.

Affiliate Spotlight: Why Should College and University Affiliates Attend NCSSSMST Conferences?

by Louis L. Hegyes, Director of Admission, University of the Sciences in Philadelphia

Back in 2000, I made a very fortunate discovery. I became aware of the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology (NCSSSMST) and immediately realized that this is an organization with goals, desires, and ideas very similar to my own. I haven't missed any of the NCSSSMST professional conferences since.

By attending their annual spring conference, you will have an opportunity to network with our NCSSSMST high school colleagues, present and participate in a variety of conference sessions, promote your institution and programs at the Affiliate College Fair/Reception and develop meaningful relationships that benefit both the high school and affiliate members. I've come back from every professional conference with new friends and ideas. Of course, another obvious benefit is the increased awareness that some of the top high schools in the nation will have of your college or university, which equates to more highly qualified applicants.

All of the NCSSSMST professional conferences that I have attended have been among the most very well organized and interesting conferences that I've attended, and believe me, I have attended many conferences in my thirty plus years in college admissions. The 2009 professional conference turned out to be the best ever. The sessions, location and social arrangements were really fun. I hope to see you at the 2010 conference in Nashville.

Negotiating the Path: Towards Diversity and Inclusion

by Letita R. Mason, Director of Admissions, North Carolina School of Science and Mathematics

*Editor's Note: This is the first installment of a new feature we are calling **Negotiating the Path**, coordinated by Letita Mason. Ideas for future columns, contributions and reactions may be sent to her at masonl@ncssm.edu. She will also moderate the Diversity and Inclusion Forum at NCSSSMST.org > [Connecting Consortium Professionals](#) > [Forums](#).*

Anyone who has not felt the cosmic shift in human consciousness demonstrated by world -wide events within the past nine months would have to be living under a rock. The first African -American President of the United States is sworn into office nearly forty years after the historic *I Have a Dream Speech* at the March on Washington. Bollywood takes Hollywood by storm, sweeping the Academy Awards with a cinematic favorite from India entitled *Slumdog Millionaire*. China opens its doors to the world as it hosts the 2008 Summer Olympics in grandiose style. The world faces economic crises that rival no others seen in modern history.

Our collective paradigm also has shifted, providing us with awareness that our commonalities far exceed our differences. Our global survival then hinges on an appreciation that the solutions to our problems reside within the collective strength of our diversity. However, achieving inclusion is often relegated to periodic infusions of multiculturalism into the mainstream of our organizational culture. And *diversity* is quickly becoming the latest buzzword for an idea that, though politically correct, causes us to dread the discomfort associated with real discourse on the issue.

In a 1997 article entitled *Challenges of Leading a Diverse Workforce*, the authors point out that "internally, old constituencies with large blocks of power, such as boards of directors and senior management, may be uncomfortable with admitting dissimilar outsiders who are likely to challenge the old guard's perceived power, either

explicitly or implicitly." Their research suggests that there are six areas of challenge that leaders must address in order to promote institutional diversity. These areas are:

- **Changed Power Dynamics.** With the infusion of new, diverse individuals who may not fit the traditional organizational mold, traditional constituents may feel an erosion of power.
- **Diversity of Opinions.** As the face of an organization changes, the number and range of perspectives increase exponentially and leaders must synthesize a diversity of opinions from individuals' unique values, cultural grounding, and the resulting accepted behaviors. The challenge for the leader will be to identify and recognize, at least implicitly, the different frames of reference that are represented and to extract common denominators that may serve as a foundation for issue resolution.
- **Perceived Lack of Empathy.** The ability to establish an emotional identification with followers from a variety of cultures is an attribute that distinguishes leaders like Martin Luther King, Jr., John F. Kennedy, and Mahatma Gandhi, who recognized the needs of their followers and incorporated those needs into their convictions.
- **Tokenism, Real and Perceived.** While real tokenism can be avoided by not using quota

systems, perceived tokenism presents a different situation. Where tokenism is perceived, there is a tendency to attribute failures to the individual's gender or ethnic criteria. Leaders are in a unique position to effect changes in attitudes and perceptions toward diverse individuals by actively promoting, defending, or expressing their interests.

- **Participation.** In a diverse workforce, employee participation in critical organizational processes is necessary to enable the organization to capitalize on new, different, and creative ways of thinking. Ensuring everyone has a voice is a critical first step toward a full appreciation of diverse organizational members.
- **Overcoming Inertia.** Inertia will be especially problematic for leaders in organizations in the tolerant stage, because an inordinate amount of time will be spent on the previous five challenges. To tackle the challenge of inertia, a leader must change his or her mindset and have a very strong and clearly communicated organizational vision and goals.

The authors reason that organizations can exist at points along the continuum that reflect relative stages of intolerance, tolerance and appreciation of diversity among organizational members (Joplin et. al., 1997).

NCSSSMST member institutions have had a transformative impact on designing innovative curriculum, research and teaching models in STEM fields, as well as in the fine arts and the humanities. But what will be our legacy? How can we resist the status quo of an exclusive monocultural psychological and contextual framework that devalues differences as deficiencies? "Disruption is difficult because the definitions and trajectories of improvement change. What were valuable improvements of the product that had been unimportant become highly valued" (Christensen, 2008).

Starting nearly three decades ago, our institutions were the disruptive innovation that challenged the status quo by providing public educational opportunities focused on science and mathematics that rivaled expensive private institutional offerings throughout our country. Yet the definitions and trajectories have changed. The U.S. is suffering from a decreased interest in STEM fields. History is able to help identify one culprit of the "educational malaise" our country is negotiating today.

"As Japan reached prosperity, an interesting thing happened, however. The percentage of students who graduated with science and engineering degrees declined. Why did this happen? The answer has little to do with schools themselves, which did not change significantly. Prosperity was the culprit. When Japan was emerging from the ashes of World War II, there was clear extrinsic motivation that encouraged students to study subjects like science and engineering that would help lift them out of poverty and reward them with a generous wage" (Christensen, 2008).

Is it possible that educating groups traditionally excluded from the prosperity equation may hold the answer to renewing the numbers of scientists, mathematicians, researchers, doctors, and engineers in the United States? Could it be that these populations, though initially considered unimportant, will actually become highly valued in increasing our competitiveness globally? It is my hope that those of us in NCSSSMST will continue to demonstrate transformative leadership in meeting the challenges that rob our institutions of the positive benefits greater inclusion and true multiculturalism afford us.

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Many thanks to the following affiliate members for participating in the “meet & greet” event at the Professional Conference in Arlington, VA.

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- Objectives**
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Photographs Photographs are encouraged and welcomed if they are relevant and support the content of the article. Print quality must be a minimum resolution of 300 dpi.

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- ☐ 2 paper copies
- ☐ APA format used for all citations and references cited
- ☐ Electronic version emailed to NCSSSMST National Office

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About NCSSSMST

The National Consortium for Specialized Secondary Schools of Mathematics, Science & Technology (NCSSSMST) was established in 1985 to serve educators and students in the growing number of specialized high schools throughout the United States. NCSSSMST is a forum and clearinghouse for the exchange of information and program ideas among faculty, staff, and students from member schools and affiliated organizations.

The Consortium comprises a network of research and development secondary schools with strong college and university affiliate members. As of May 2009, the 100 member schools and centers located in 32 states enroll more than 37,000 students. Each member school addresses specific needs of its area, and most serve districts or states, depending on their charter. Two associate institutions are in the process of developing new schools. Over 90 colleges and universities are members and participate in program-related activities or sponsor special events.

Brief History Seeking to increase communication among the mathematics, science, and technology specialized schools, four such schools—the North Carolina School of Science and Mathematics, the Thomas Jefferson High School for Science and Technology (VA), the Louisiana School for Math, Science and the Arts, and the Illinois Mathematics and Science Academy—hosted an organizational meeting in the spring of 1985. Representatives from 15 schools attended, and NCSSSMST was founded to foster growth and interaction among similar programs.

Governance NCSSSMST is a nonprofit organization with IRS 501(C) (3) tax-exempt status and is incorporated as a non-stock corporation in the Commonwealth of Virginia. The Board of Directors, composed of leadership from institutional members, meets at least four times a year to establish policy and set direction. The fiscal year is July 1 through June 30. NCSSSMST has implemented a strategic plan, and the board serves as the strategic planning team. The institutional membership elects the Board of Directors and officers of the corporation for three-year terms. The Board employs an Assistant to the President to handle day-to-day business.

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- Membership Profile — biennial report of the Consortium
- WWW site—www.ncsssmst.org—organization's link on the site

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