NCSSSMST Journal

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2010 NCSSSMST Expedition to Nashville

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Contents

On the Cover
The 2010 NCSSSMST Professional Conference, *Expedition to Nashville*, will be held March 3-6 at the Sheraton Music City Hotel. This year's theme is *Tuning in to STEM Education*.

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Editor's Page

By Dr. Ron Laugen

Welcome to the Fall 2009 issue of the NCSSSMST Journal. Last Spring we called for contributions focusing on technology. Our authors responded and, as I hope you'll agree, have given us an issue that paints a dynamic picture of what is happening among NCSSSMST members and affiliates.

President Jay Thomas in his message shares the new NCSSSMST Vision, Mission, and Responsibility statements that have resulted from his leadership of the Board's strategic planning over the last 18 months.

The annual NCSSSMST – Keystone Science School Youth Policy Summit last June focused on reduction of U.S. greenhouse gases. Find out how participants dealt with the tradeoffs of technology, politics, and stakeholders.

Talent Development in STEM Disciplines, coordinated by Dr. Julia Roberts at Western Kentucky University, is a new feature. She presents basic ideas on development based on her research, and challenges us to look beyond our own students to help meet the needs of others. She invites your reactions, questions, and suggestions.

Students from several NCSSSMST schools were provided opportunities to conduct biological research using modern computational and bioinformatics tools at the Jackson Laboratory (JAX) in Maine. JAX faculty, post-doctorals, teachers, and a student share perspectives related to the challenges and successes of the program.

The State of Arkansas charged the Arkansas School for Mathematics, Sciences and the Arts (ASMSA) with starting a distance-learning program in order to share their resources with students in districts across the state. Chris Robbins details ASMSA's work over the last few years to create a cost-effective distance learning delivery system.

In their contribution to *Negotiating the Path*, Darlene Haught and Christopher Thomas of the North Carolina School of Science and Mathematics suggest that residential schools must use technology to provide learning contexts by which students with diverse learning styles and backgrounds can be engaged and flourish.

Art Williams, a "known technophobe" by his own admission in his *Arts and Humanities* column, reminds us that using technology shouldn't be an end in itself.

Cheryl Lindeman in her *Teaching and Learning* column writes about working with students as they use technologies like online resources in new settings – the lab and classroom. Maybe you'll agree with her that your grappling with new technological experiences helps keep you young.

The authors in this issue's *Technology Focus* describe their work with preservice secondary mathematics teachers provided with SMARTBoards who became comfortable and creative in using technology to facilitate learning and understanding.

For an update on technology and college admissions, be sure to read this issue's Affiliate Spotlight.

Robert Malkin of affiliate Duke University writes about Global Public Service Academies for high school students. Participants will employ engineering problem solving strategies to deal with problems in developing countries and have the opportunities to develop appropriate technologies that can make differences in people's lives.

Technology utilization also involves students doing research. Shapiro, Lindeman and Thomas report on the outreach collaboration between NCSSSMST and Society for Science and the Public aimed at enhancing teacher research capabilities. The NCSSSMST publication *Guiding Student Research: Making Research Happen in Your School* was the resource for a 5-day workshop in Washington for ten teachers from across the U.S.

Ron Laugen, Ph.D., is Editor of this issue of the NCSSSMST Journal and a past president of NCSSSMST.
He retired in 2007 as Headmaster of the Conroe ISD (TX) Academy of Science and Technology, where he served for 16 years.

President's Message

Dr. Jerald (Jay) Thomas

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

The NCSSSMST Board of Directors agreed in March of 2008 that NCSSSMST was at a point in its history that it should think hard about its organizational identity. For the past eighteen months, we have been deeply and deliberately engaged in strategic planning. We have not lost sight of our founding principles, nor have we sensed the need to dramatically shift our focus away from what we know our member and affiliate institutions do best. So, as the NCSSSMST community proceeds with its bold and innovative work, I encourage you to be mindful of the new mission and vision that direct our work.

The NCSSSMST Vision

The Consortium will serve as a catalyst for transforming education by empowering students, teachers, and communities to meet the demands of a technologically advanced world.

The NCSSSMST Mission

The mission of NCSSSMST, the nation's alliance of secondary schools and programs preparing students for success and leadership in science, technology, engineering, and mathematics, is to serve our members' students and professionals, to foster collaborations, to inform STEM policy, and to advocate transformation in education.

We also realize that to be a fully contributing member of a scholarly community, each of us has a responsibility to our greater work. Thus, we have also articulated ways in which both NCSSSMST and its member institutions can ensure that our organization can fulfill its mission. These responsibilities are further articulated in the language of the revised mission.

NCSSSMST and its member schools must continue to:

- develop and model transformative courses and relationships in science, technology, engineering, and mathematics;
- prepare students for entrance to and success in postsecondary education;
- provide student research opportunities;
- promote opportunities for career exploration, internships, and competitions;
- develop students as leaders;
- identify, recruit, and support students from under-represented populations;
- encourage, promote, and share emergent ideas and innovations in curriculum, teaching, learning, and technology;
- collaborate with our members to develop and offer special programs, activities and resources to members' students and professionals;
- invite affiliate membership from colleges, universities and other organizations that support our vision and mission;
- function as a clearinghouse of resources and services to new and developing schools and programs that share our mission and vision;
- collaborate with other organizations in order to speak with a unified voice on policy issues.

As pleased as I am with the outcomes of the Board's two years of work in planning, I am even more eager to see how the new Mission and Vision are realized. I invite your comments at jthomas@ncsssmst.org.

Youth Policy Summit: Greenhouse Gas Reductions in the U.S.

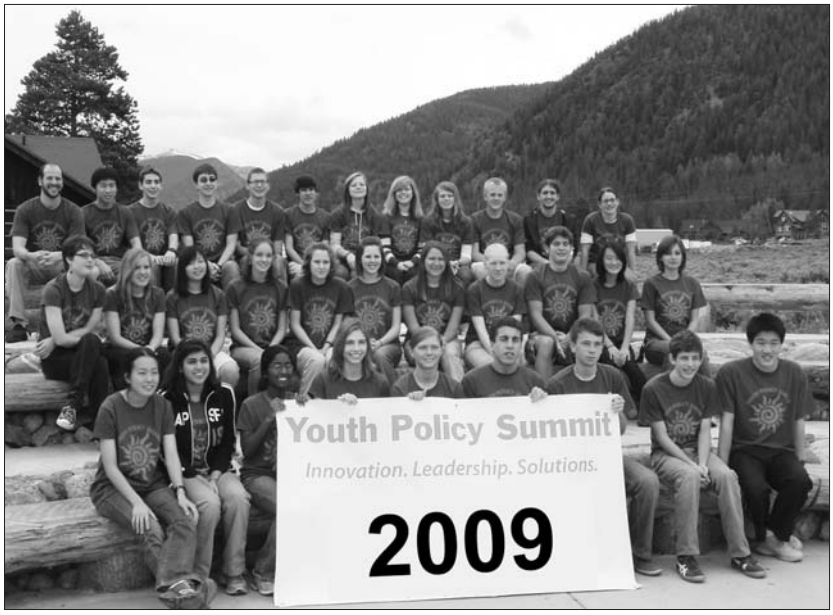
June 15-21, Keystone, Colorado

In June 2009, the Keystone Science School (KSS) hosted the eighth KSS-NCSSSMST Youth Policy Summit. 30 students from 7 member schools from across the country came together in Keystone, Colorado to develop consensus-based policy recommendations on reducing greenhouse gas emissions across the U.S.

During the Summit, students were divided into a diverse group of stakeholder interests. They included electricity generators, building and lighting interests, the transportation industry, agricultural interests, the public sector, and non-governmental organizations.

Their recommendations:

- Analyze the political, economic, social equity, environmental, technical and legal aspects.
- Outline what should be done, and by whom, to bring about the changes necessary to significantly reduce the emissions of greenhouse gases in the U.S., considering three time frames: near-term (4-8 years), mid-term (10-20 years), and long term (up to 50 years).



Economic Overview

Time and time again, economic feasibility has played a crucial role in the quick and effective enactment of major public policies. Feasibility will be the primary driving force behind substantial reductions in greenhouse gas emissions.

Recommendations: We recommend a Carbon Abatement Program (CAP), which combines the advantages of the cap and trade system and carbon taxes, the two main proposed systems of carbon regulation. CAP allotments would be permanent. The EPA would assign 30 percent of the initial CO2 allotments, with priority given to those who have reduced emissions historically. The government would then auction off the remaining 70 percent of allotment certificates to private industry. We also recommend an annual processing fee, 10 percent of the allotment's market price, be levied on all certificates.

Energy Efficiency in Transportation

Together, the transportation and building industries account for 68 percent of energy consumption in the United States (National Science Technology Council, 2008). By doubling fuel efficiency, reducing vehicle miles traveled, and increasing energy efficiency in buildings substantial reductions in greenhouse gas emissions can be made.

Recommendations: We recommend that the government provide incentives to automobile manufacturers to produce vehicles that meet miles per gallon (mpg) standards while maintaining affordability for all. We also recommend the integration

of transit systems into planned communities as a plan of action to reduce vehicle miles traveled. We propose two pieces of legislation to accomplish these goals: a long-term mpg standard, and a national VMT reduction standard.

Energy Efficiency in Buildings

As a sector, buildings consume 40 percent of the United States' energy (National Science and Technology Council, 2008). By incorporating energy efficient practices and technologies, energy use and energy emissions are cut, water is conserved, and waste is reduced, while productivity and health benefits increase.

Recommendations: We recommend that new commercial and residential buildings meet LEED Gold certification requirements and incrementally increase their energy efficiency. We also recommend an education program that promotes energy efficient practices by residential and commercial building occupants and the incorporation of sustainable design and engineering into the building industry's curriculum.

Coal and Natural Gas Power Plants

Coal power plants provide about half of the electricity consumed by American households and businesses with coal production predicted to increase as much as 60 percent in the next twenty-five years (Fossil Energy Office of Communications, 2008).

Recommendations. Since America depends significantly on coal, it is necessary to double the efficiency of all the coal and natural gas power plants across the country. The carbon capture and sequestration system (CCS) should be implemented in order to increase the efficiency of the energy generated and increase the efficiency of capturing CO2. Switching all the coal-fired plants in the country to natural gas would decrease the amount of carbon emission and increase the efficiency of the plant. Benefits of increasing use of natural gas include job creation, natural gas imports and a reduction in coal-related medical costs along with environmental benefits such as increased energy efficiency, preservation of wildlife and protection of terrestrial habitats.

For utilities and their power plants there will be a modified cap and trade system, the Carbon Abatement Program (CAP) economic plan, implemented in order to reduce carbon emissions and increase funding for renewable energies. It is also recommended that coal power plants are retrofitted with Integrated Gasification Combined Cycle technology for Carbon Capture and Storage and all proposed coal power plants be built instead as natural gas power plants with NGCC technology CCS combined once economically viable.

Nuclear Power

Nuclear power is potentially the cleanest of all other power forms with regard to greenhouse gas emissions. Nuclear energy production processes only produce carbon dioxide or other greenhouse gases during the mining and shipping of the uranium ores and not during the nuclear fission (Environmental Aspects of Uranium Mining, 2009). However, nuclear power can be detrimental to the environment.

Recommendations. Under the proposed Carbon Abatement Program (CAP), the nuclear industry would be granted carbon credits, though not as many as other generation technologies. CAP would benefit the power companies using nuclear by generating supplementary capital. While we recommend that the government doesn't endorse the construction of new sites, we are in support of continued funding of nuclear research.

Wind and Solar Power

Wind and solar power will play a large role in diversifying our energy portfolio, as they are two of the most socially equitable sources of electricity of the renewable options that are prevalent countrywide.

Recommendations. We highly recommend the passing of our Renewable Energy Standards. We also support the funding of research to improve the efficiency of solar panels and develop small wind technology for utilization by the consumer.

Two major policies that we believe should be expanded are the Investment Tax Credit (ITC) and

Production Tax Credit (PTC), two federal tax credits that apply to renewable energies. We feel that a Renewable Energy Standard would provide an effective way to increase the prevalence of renewable energy in the United States, thus working toward the goal of more wind and solar power to reduce CO2 emissions. We suggest that the United States government mandate a 25 percent Renewable Energy Standard by 2025 and a 40 percent Renewable Energy Standard by 2060.

Biodiesel and Biomass

Biodiesel, a renewable, clean-burning fuel created from domestic resources, has been identified as a leading candidate to become an alternative fuel. According to a 1998 study conducted by the US Department of Energy and the US Department of Agriculture, biodiesel reduces net CO2 emissions by 78 percent compared to petroleum diesel (National Biodiesel Board, 2009).

Recommendations. The majority of biodiesel is currently produced from farm crops such as soybean, rapeseed, and canola oil. To minimize the food and fuel competition for farm crops, other methods for the creation of biodiesel must be considered. Alternatives such as algae or the jatropha plant are viable options for increased biodiesel production.

We propose additional research in alternative biodiesel sources and a gradual increase in the proportion of biodiesel in commercially sold diesel blends. We suggest that the government works with industry to provide funding for the research to make this technology more viable. We also recommend that the government provide incentives for the biodiesel industry by providing tax breaks or subsidies for farmers who responsibly increase production of biodiesel sources.

Biomass has several important potential applications in this nation's energy production system, principally as an addition to the coal burned in coal fired power plants. Biomass emits the same amount of carbon dioxide during combustion as most fossil fuels, but a large percentage of these emissions are offset by the growth of the plant that produced the biomass.

Conservation Tillage on Agricultural Lands

Conservation tillage provides an immediate option for decreasing atmospheric carbon dioxide. By definition, conservation tillage involves limited preparation of farmland, leaving at least 30 percent of the soil covered by crop residue from the previous growing season (Peet, 2001).

Recommendations. Adoption of these practices on all U.S. agricultural soils has the potential to decrease carbon dioxide emissions. Conservation tillage leads to the capture of a significant amount of these emissions. This occurs because no-till farm lands act as carbon sinks; the overlying crop residue adds carbon to the soil, while the amount of solid carbon lost is minimized due to reduced erosion.

Conclusions

If implemented fully and completely, the suggestions in this proposal would, over a four-decade time horizon, slow, stop and then reverse the trend of increasing carbon emissions in the United States. The primary driving force for these reductions in emissions is a market-oriented cap-and-trade system.

We recognize that our proposal is a compromise, and that it is not a perfect or a complete solution to the climate problem facing us. We offer these policy suggestions as possible catalysts for a shift in our nation's perception of pollution, environmentally friendly lifestyles, and policy making.

Participating Schools

Academy of Science and Technology, The Woodlands, Texas
Alabama School of Fine Arts, Birmingham, Alabama
Arkansas School for Mathematics, Science and the Arts, Little Rock, Arkansas
Gatton Academy of Mathematics and Science in Kentucky, Bowling Green, Kentucky
Illinois Mathematics and Science Academy, Aurora, Illinois
Liberal Arts and Science Academy, Austin, Texas
Thomas Jefferson High School for Science and Technology, Alexandria, Virginia

Sponsors

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American Chemistry Council
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To view the complete report and description of activities of the Keystone Policy Summits, visit www.youthpolicysummit.org.
Many thanks to Annemarie Fussell, Director of the Keystone Youth Policy Summit, and Jeremy Kranowitz, Director of Educational Excellence Programs at The Keystone Center, for their leadership.

Independent Studies in Computational Biology

By Randy Von Smith[1], Deborah McGann[2], Robert Gotwals[3], Renee Symonds[2], Rachael Hageman[1], Peter Vedell[1], Gary Churchill[1]

The Jackson Laboratory (JAX), a private non-profit research institute located in "downeast" Maine, specializes in mouse genetics as a model system for understanding human health and disease. In the summer of 2006, scientists at JAX designed Independent Studies in Computational Biology (ISCB), a program for high school students with exceptional science and math skills to be immersed in ongoing research activity. We hoped that high school students could carry out meaningful biological research using modern computational and bioinformatics tools. The JAX team would provide "as needed" raw data and instruction in the use of analytical tools. The students would contribute and have the experience of working as scientists.

The 2006 participants in ISCB were selected from the Maine School of Science and Mathematics (MSSM), a residential public high school, in Limestone. Video conferencing software allowed the scientists at JAX to communicate regularly with MSSM students. ISCB was then expanded to a second high school, the North Carolina School of Science and Mathematics (NCSSM) in Durham, NC, in the fall of 2007.

Course Content

Computational Biology connects the fields of biology, statistics, mathematics, and computer science to answer biological questions. There are numerous web-based data resources that can be mined for novel discoveries. Bioinformatics methods for analysis have progressed in parallel with the growth of these resources and many computational methods are implemented in freely available software. The wealth of public data and free software tools makes computational biology an attractive area for building mentored research opportunities for schools through distance learning.

To begin, JAX researchers had to teach students how to read scientific literature, participate in journal clubs, maintain research notebooks, write a research proposal, and most importantly, to ask meaningful, answerable questions. Along the way, students were introduced to experimental design and to analysis concepts used in mouse genetics as they were needed to make progress in their research projects.

The entire process of science from the conception of a project through writing a proposal, conducting the research, and summarizing and presenting findings was compressed into two 16-week semesters. The first semester culminated with student teams writing their own National Institute of Health-style research proposals. In the second semester the teams carried out their research projects mentored by JAX post-doctoral trainees. Students quickly learned that in science things seldom go as planned and outcomes are always uncertain. Clear goals and completion of projects are essential and each team wrapped up the year with written and oral reports and a poster presentation.

The JAX team introduced a different broad topic area, such as exploring the link between inflammation and obesity, each year. Fall lectures covered the basics of statistics, genetics, bioinformatics, and computer languages. Volumes of material, including scientific papers and multimedia presentations, were provided for background and students were encouraged to work in teams to divide and master the material and share their knowledge with each other. Time was allocated each week for the students to work with their resident teachers and to discuss the material. Journal club presentations were first given by the faculty and then by the students to survey the scientific literature and to develop student presentation skills.

[1]*The Jackson Laboratory, Bar Harbor, ME*
[2] *Maine School of Science and Mathematics, Limestone, ME*
[3] *North Carolina School of Science and Mathematics, Durham, NC*

Computation was introduced early so that students could apply techniques from the literature to real data. They utilized two major types of data - quantitative trait loci and microarray - to explore their topic area. In quantitative trait loci analysis (Broman, 2001), a trait like blood pressure or glucose levels is measured on a group of animals and genotype data are collected at many locations along their chromosomes. The aim is to identify the genomic regions and ultimately the genes that affect the trait. Using mice and specialized breeding schemes it is possible to produce large data sets that can link together many different traits related to a disease of interest.

A microarray (Churchill, 2002) is a small wafer to which thousands of different types of DNA molecules are attached at specific locations. The microarray measures the expression of genes corresponding to these DNA molecules in tissue samples. An experiment may use several to several hundred microarrays to measure many mice and different tissues. The result can be many millions of informative data points. This type of high volume data requires the students to master computational skills to yield biological discoveries.

A course management system (Moodle, 2009) maintained the material for the current and past year's courses, including scientific papers, class notes, presentations (PDFs and video recordings), data sets, and computer scripts for data analysis. A Wiki built into the Moodle was used for both student research notebooks and for team collaboration. Students recorded their work in electronic research notebooks, maintained a diary of their work, and reflected on how it integrated with their proposed research. Students rapidly gained confidence by giving presentations, writing reviews, and getting feedback on their research notebooks.

In the next sections, the ISCB research experience from the viewpoint of the JAX faculty and mentors, the teachers at MSSM and NCSSM, and the student participants are shared.

Jackson Laboratory Faculty – Randy Von Smith

Tailoring explanations to the audience is the art of scientific communication. Not only did we scientists have to learn how to communicate with high school students, we also had to teach them to communicate with us. Effective communication predominated the early class sessions of the ISCB course. Concentrating on core scientific activities of reading scientific literature, making oral presentations, and keeping accurate records provided the foundation of the course.

We encouraged students to be inquisitive from day one. Our aim was to immerse students in projects and to let their questions determine the content of the instruction. Homework assignments were to pose meaningful questions, ranging from technical details about software tools to broad philosophical questions about the nature of science.

During the year we noticed a progression in the nature of their questions. The early phase was dominated by "what" questions. "What is QTL mapping?" "What is a knockout mouse?" Next we saw the emergence of "how" questions. "How do I open the R software program?" Ultimately, as we hoped, students would ask "why" questions. "Why are inflammation pathways linked to lipid metabolism?" The best questions were the ones that we could answer by saying, "We don't know, but maybe we can help you to find out."

We provided the students with more background material than any one of them could absorb, including dozens of scientific papers, often from the current week's issues of Nature or Science. This forced them to work as teams to communicate what they learned to one another. From this flood of information we asked them to formulate a question and write a research proposal. They were now in the real world of research. The students were part of a team exploring the boundaries of knowledge together with the faculty.

Moving forward, we attempted to provide tools and information that they needed, as needed, to address their research questions. There is a great deal of uncertainty in the progress of science. The answers are not in the back of a book. It is not

always clear what to do, or what will happen when you try something. Getting students to experience this feeling of the unknown was the real achievement for us.

The students adapted to this immersion into scientific culture and came up with project proposals that exceeded our expectations in their novelty and relevance. Student projects included: "Computational Analysis of the Effects of Ptgs2 on Pparg Expression and Cholesterol Transport;" "Computational Study of Mouse Weight;" and "The Effect of Pparg on Insulin Resistance." Most students chose to investigate the interaction of genes and diet with medically important traits such as cholesterol levels or inflammation.

Teaching this class stimulates and enriches our research program and we look forward to continuing to explore and discover with these gifted high school students.

Figure 1: ISCB class in session. Dr. Gary Churchill giving a lecture at High Seas, The Jackson Laboratory in Bar Harbor, Maine.

Maine School for Science and Mathematics – Deborah McGann

I was thrilled at the opportunity for our students to connect with scientists from JAX. MSSM is a small school in rural Maine, hundreds of miles from any large research institution. Except for computer science, our students have traditionally had few opportunities for research. I anticipated the ISCB course would have a great impact on our students, but could not have known how much the experience would influence me as a teacher, reigniting a drive and desire to ask questions and explore. Because I entered the project with little knowledge of computational biology I found myself in a position not unlike that of my students. Still it was obvious that while the students would benefit from the local course structure and support an on-site instructor would provide, in this cutting edge material even the teacher would have to adopt an attitude that we would learn together.

We sat quietly in those first weeks during presentations then spent the remainder of the class hours reviewing our notes and the slides shows, discussing which pieces fit together and what gaps remained. Fortunately we were encouraged to write weekly questions. I provided guidance, as I helped students refine and formulate specific answerable questions. When we began, the student questions were so broad that it would have been difficult for anyone to provide comprehensive answers. Unlike a traditional classroom where my knowledge of the content may not necessitate that student questions be well phrased, this situation forced me to pay close attention to the details students were providing in their queries. With time, they started asking better questions without my input; the in-depth written responses we received to these questions from the scientists at JAX were invaluable.

In addition to the science content, students in this course were exposed to the challenges and thrills of investigation. They were reminded that if it were easy it wouldn't be research. In regard to assignments, the bar was set high. Thus detailed and informative presentations by the scientists were followed by great expectations for the teams. The weekly lectures were interesting and stimulating. However, most critical was the speed at which students were introduced to and began manipulating actual data. Students were captivated by the possibility that they might find an unwritten story while at the same time experiencing an authentic taste of collaborative research.

Each week teams of students were given more to do than any one person could do well, driving the

groups to subdivide the tasks and to rely on each other for support. They quickly found that each possessed different skill sets and that by working together they could accomplish far more. Teams grew out of the necessity of the research and students discovered that these teams included their mentors and teachers, as we were all together now in unexplored territory.

Once the proposals were submitted and the students started completing their own analyses, they were motivated, engaged, and eager to take their research to the next level. Periodically they were asked to present their findings to the scientists at JAX and to their counterparts at the North Carolina School. Although extremely nervous in the fall semester, by year's end their anxiety diminished as their confidence grew. Through this course they had learned to pose answerable questions both to the scientists and to the science; they had experienced the thrill of discovery and of sharing their newly found knowledge with others.

North Carolina School of Science and Mathematics – Robert Gotwals

NCSSM is a two-year residential program for junior and senior high school students from all across the state of North Carolina. As an experienced NSF-funded computational science educator with stints at supercomputing centers and other high-performance computing organizations, I was hired at NCSSM in 2007 to help integrate the computational sciences into existing courses and to start an independent series of courses in computational sciences. The program in computational biology at JAX was a natural and timely fit for the fledgling yet rapidly expanding computational program at NCSSM.

During the 2007-2008 school year, NCSSM's participation in the program included three science students at NCSSM who participated in the program as an overload to their regular courses. They were able to benefit tremendously from the program and produce quality work. The JAX faculty was able to record most of their lectures, providing distance learning separated in both space and time. Our students' abilities and work ethic allowed them to have success in the program, but it was clearly not a sustainable model for students who are "mere mortals."

Partly as a response to the experiences of the 07-08 ISCB program, a new "R" course at NCSSM, Research in Computational Science, was approved for 08-09. This year long course provides support to students who wish to learn and apply the technologies, techniques, and tools of computational science to interesting problems in all areas of study, including the physical sciences, natural sciences, social sciences, humanities, linguistics, etc. In this course, students learn a variety of computing tools, modeling software packages, and scientific visualization resources.
The RCompSci course was partly designed to be a "home" for the four ISCB/computational biology students. They and the other junior students selected for the independent track began their participation in RCompSci at the start of the spring 2009 trimester.

The ISCB students, most of whom are currently taking one or more of the elective genetics courses, spent the trimester learning a wide variety of computational science skills and software packages, including STELLA (a systems dynamics modeling tool), the R statistical package, UNIX, LaTeX math typesetting system, and a variety of scientific visualization software tools (such as Paraview). In addition, these students reviewed the literature and the 2008 ISCB Moodle pages. The goal of the current students is two-fold: to develop a general understanding of computational sciences (with a broad focus) and a beginning understanding of computational biology.

In addition to being better prepared for the JAX activities, these students also had daily dedicated class time to work on computational biology projects. This helped us avoid the "tag-team" approach that we had to take during 2007-08. In addition to their Jackson Lab work, these students continued to learn other topics related to general computational sciences.

Mentor Perspectives - Rachael Hageman and Peter Vedell

Post-doctoral training is a transition period that straddles graduate school and a career as an independent research scientist. In this time, one hopes to step into your own as a researcher, and along the way, harness the skills necessary to be successful. We were concerned for our own research and projects that already needed more time than we had to give. Guiding students with little background through a research project, with the added constraints of virtual communication, seemed like a time consuming and insurmountable exercise.

As a group of postdoctoral mentors, we made some decisions from the beginning that simplified the mentoring process. By sharing computer scripts, strategies, and often the same data sets, we built a repository of resources. For some teams of high school students, we were able to do what we imagine many professors do with their graduate students – we shaped the projects to overlap our own research. The gains at the end of the semester are then seen by both parties.

One group's proposal centered on the effects of Cox-2 (also called Ptgs2), the gene targeted by some anti-inflammatory drugs such as ibuprofen. We were able to link their interests to our own by pointing out the literature supporting the role of Cox-2 in lipid metabolism. From this, the students were motivated to identify the genes and biochemical pathways involved in these processes. Equipped with a list of relevant genes as well as QTL and gene expression data from our own research projects, we asked our students to employ some graphical modeling techniques to investigate the biological questions in their proposals.

Without too much effort, the project took two directions that are of great interest to our own work: lipid metabolism and graphical modeling. With a causal model the students were able to further characterize the role of Cox-2 in the Pparg signaling pathway and to establish a link to lipid processes. Working with little prior knowledge they validated many known relationships among these genes and pathways. This gave them a sense of satisfaction and confidence, not only in the models they built, but also in their ability to use the techniques they were learning.

At the end of the semester, the students wrote their results in the form of a scientific paper and gave an oral presentation. While all of the mentors and students had unique experiences, the positive aspects of this example were shared by all. Three of our students will participate in the JAX summer student program, one of which will follow up on some experimental data that was generated specifically for their project.

The mentor–student relationship was a truly beneficial experience for both sides. Through the process, students acquired valuable research and communication skills. By walking in the shoes of a research scientist, the experience has the potential to shape future college and career decisions. On the other side, we are working to make our experience as post-docs well rounded, aiming to acquire a diverse set of skills that will make us successful.

Communicating complex ideas to young students with minimal background knowledge is a challenge that pulls from many different skill sets. These challenges were met through weekly communication via email, Skype and the teleconferencing system. The written and oral skills necessary to make these interactions successful cannot be picked up by simply attending or giving lectures. Through our interactions with these students, we feel as though we have improved our mentoring and communication skills, while having fun at the same time. The students brought a lot of contagious energy and fresh ideas to these exchanges making the experience both enjoyable and personally rewarding.

Student Perspective– Renee Symonds

HOW did I get here? I asked myself that question many times as I stood beside my poster in the Carl Icahn Laboratory at Princeton University. I was the only high school student in a crowd of PhDs and graduate students discussing the rows of posters on display.

My story starts one August evening in 2007. On the phone was Mrs. McGann, a teacher from MSSM, where I had recently completed my sophomore year. I was surprised by her call, but I was even more surprised by her proposition. She offered me the chance to participate in a relatively new course, Computational Biology. The course was to focus on conducting scientific research. As an aspiring research neuroscientist, the course seemed miraculous and, though I had not yet taken a formal biology course, my teachers thought I was up for the challenge. I was determined to prove them right.

From the moment I entered the classroom, I was inundated with a flood of information. I learned about genes and DNA, how to structure and read a scientific document, the advantages of the mouse as a genetic model, and how to use and analyze Quantitative Trait Loci (QTL), among other things. There was so much to take in that most nights I found myself sitting in my room with my notes, Googling the various words and methods that had been introduced that day.

Gary Churchill from JAX remarked during his first lecture that he planned to throw my classmates and me into the intellectual deep-end of the pool and then teach us how to swim. On reflection, I find that to be the best description of the course. Computational Biology was far different from any of my other classes. I learned to think, work, and learn for myself and for my group more as a research assistant than a high school student. It was my job to get the answers to any questions I had and to keep my notebook and independent research on schedule. I had to swim for myself and was rewarded at the end of the course, knowing I had accomplished something important.

I should have been prepared when I received another phone call from Mrs. McGann summer 2008. I listened in stunned silence to her latest proposal. The Jackson Laboratory would be participating in the meeting of the National Centers for Systems Biology in Princeton, New Jersey, and they wanted me to attend. It was the most exciting and terrifying phone call of my life. But the same determination that had prompted me to join the Computational Biology course also made my choice a simple one: I accepted the invitation. I would attend the conference and represent the Jackson Laboratory's high school outreach program. As part of that representation, I was asked to create a poster describing my research and experience with the Computational Biology course. I worked endlessly on the poster and learned both the joys of well-documented data tables and the trials of peer editing.

In a month, my bags were packed and my poster was sent. I was ready and scared out of my mind. I knew the experience was sure to be a once-in-a-lifetime opportunity and I knew I would enjoy myself, but still my mind churned with worst case scenarios and my stomach knotted in anticipation. Anti-climactically, the plane trip and ride to the hotel were uneventful and I spent the majority of my time listening to and trying to comprehend the conversations taking place around me. Being surrounded by scientists, *real* scientists, was a surreal experience. I wasn't watching popularized NOVA programs, but experiencing the real thing. It was mind-boggling, humbling, and exhilarating all in one.

It is hard to find the words to describe my experience at the conference. As comfortable as I felt with the teachers I had worked with for the past year, I felt out of place. It brought a whole new meaning to what Gary had jokingly referred to as "the deep end," but I was determined to keep swimming. Attending over sixteen hours of lectures and presentations was a grueling experience and I did my best to keep up, taking notes and inventing shorthand abbreviations at top speed.

Despite my best efforts, a lot of information simply went over my head and before taking Computational Biology, I think that would have bothered me more than it did, but in discussions with the scientists at the meeting I discovered that they were also experiencing the same information overload. I realized then that somewhere throughout the course, I had learned one of the most valuable lessons that any aspiring scientist can learn, and that is *how* to learn.

After my journey into the world of scientific research, I sat in the back of my mother's car on the way home, just processing all the information I had taken in - my brain so busy I was barely able to form coherent sentences. I realized then that it wasn't so much about how much information I had missed but what I had learned and what I would take with me to further my own academic interests. I brought nervousness and excitement with me to Princeton, and came back with confidence, twice as much excitement, and most importantly, I knew that I could *just keep swimming*.

Conclusion: A Scientist's Perspective – Gary Churchill

At first, having made the commitment to teach a course for high school students, I was concerned about the impact it could have on my own time, which is always in short supply. A colleague suggested to me, "why not just get them to help with your research?" The idea seemed implausible but, after three successful years of teaching the course, I can see the positive impact that the course has had on my research program, including sometimes taking us in new and unexpected directions.

With its dependence on one-on-one mentoring, the ISCB course is necessarily limited in the number of students that can be accommodated each year. However the impact of the course has come primarily through the intense personal interactions that occur. Recruiting postdoctoral trainees in my lab to take over some of the mentoring allowed us to accommodate a few more students. It also provided valuable training experience for the post-docs. Suddenly I was getting a double benefit from the course and freeing up some of my time without missing out on the fun.

Several of the ISCB students have continued the projects they started in ISCB by participating in the Jackson Laboratory's summer program. Students spend the summer in my lab working with the post-docs and putting final touches on their research projects. This has resulted in two manuscripts that are currently under review in scientific journals. Most former students have moved on to their colleges of choice and some have shown an interest in continuing their studies in computational biology. Whatever area of specialty they gravitate to, our hope is to inspire a few of these students to pursue careers in science.

The experience of mentoring inquisitive high school students in an active research program has energized my entire lab. We plan to continue ISCB next year and although we are not yet certain which direction the research will take, that is the way research goes. We have the freedom to pursue our ideas. That is the joy and challenge of working as a research scientist. We hope that this article will inspire other scientists, teachers and students to jump into the pool of scientific investigation together and swim.

Acknowledgements

Funding was provided by NIGMS GM070683. We would like to thank all of the students that participated in the class over the last three years, the scientists at the Center for Genome Dynamics, and all the scientists at JAX that gave lectures for the class. These included Carol Bult, Allison Cox, Renhua Li, Qian Li, Liam O'Brien, Beverly Paigen, Ken Paigen, Ricardo Verdugo Salgado, Keith Sheppard, Keith Shockley, Shirngwen Tsaih, and Hyuna Yang.

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Talent Development in STEM Disciplines:
A Golden Opportunity for Specialized Secondary Schools

By Julia Link Roberts, Ed.D.

Editor's Note: ***Talent Development in STEM Disciplines*** *is our newest column and will explore issues related to specialized school student talent development in each issue of the Journal. Dr. Roberts invites reactions, questions, and suggestions at julia.roberts@wku.edu.*

Talent development is the business of educators in specialized secondary schools for science, mathematics, and technology. What does talent development in these disciplines look like for children and young people? What role can specialized secondary schools play in creating interest in science, technology, engineering, and mathematics among children younger than those in the special school?

Talent in science and mathematics develops in stages. Creating interest is the first stage. Stage two involves building a knowledge base and developing content-related skills. The third stage is engaging in research, which is characterized by extending learning through probing questions in STEM disciplines and pursuing answers to those questions.

Stage One: Creating Interest. What sparks a student's interest in science, technology, engineering, and mathematics? And what is likely to foster a level and intensity of interest that could eventually lead to the pursuit of a career anchored in STEM disciplines?

These early experiences may begin with a mother or father, aunt or uncle, or a grandparent. These experiences may be walking in the woods to observe and enjoy. They may include visits to children's museums to concentrate on the exhibits that are especially interesting to the child. Or it may simply be the willingness to listen when the child explains in detail something fascinating. They may include the child taking apart an intriguing small appliance and showing how the parts fit together. They may be the encouragement of a fascination with numbers and technology as well.

Educators may spark interests at school as well as through Saturday and summer programs. Teachers who are passionate about their subject matter inspire young people to select career goals in that discipline. Other experiences that motivate students to learn more about STEM fields are found through MythBusters or programs on the Discovery Channel. The possibilities are endless.

Stage Two: Building a Content Base and Acquiring Content-related Skills. This stage of talent development in STEM disciplines involves engaging in building the knowledge base in science and/or math and/or technology and the development of skills needed by experts in STEM disciplines. Where does this happen?

Of course, this learning occurs in school but also extends beyond school walls. Interactions with professionals in the fields of science, technology, engineering, and mathematics can be instrumental at this stage. Saturday and summer programming can provide learning opportunities that allow children and young people to learn about topics that may not be addressed in schools until a later time. Reading nonfiction can open up any discipline for exploration, so access to books and journals can be very important. The Internet offers rich opportunities to explore various topics including hands-on and interactive learning experiences. Competitions such as the FIRST LEGO League and

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bridge building contests provide other opportunities at this level. The key feature of Stage Two in talent development is that the student is exploring content and honing skills needed for learning in STEM fields.

Stage Three: Engaging in Research. This stage in talent development occurs when the young person poses questions in STEM disciplines and executes plans to answer these questions. This stage can begin a lifetime passion for scientific study.

The young person poses a questions or hypothesis and then gets involved in the collection and analysis of data. Mentors become extremely important at this phase of talent development. A match of the child's interests with a mentor can spur the process. For the typical student, the first opportunity to engage in research is a science fair. Once the student learns the scientific method, it can be applied to new experiences.

Few opportunities for ongoing research are available in typical K-12 schools, which highlights a very important challenge that specialized secondary schools of math and science have - encouraging the development of STEM talent among young children.

Ways that specialized secondary schools can facilitate the development of young talent include:

1. Increasing interest in math and science in a local elementary or middle school. Ashland, Inc. provided a grant to the Gatton Academy to encourage students to plan and implement programs for their hometowns. Projects included a Saturday morning with middle school girls with hands-on learning focused on the chemistry of cosmetics and a summer day with elementary children exploring a specific topic in science with interesting experiments. The goal was to increase interest in science and math.

2. Offering summer and Saturday programs for elementary and middle school students to provide opportunities for hands-on, minds-on learning. Such opportunities can be planned and implemented by school personnel and/or the facilities at the specialized school can be made available for others to use for such purposes. A young person's introduction to a topic in a summer or Saturday learning experience may be the beginning of a passion for pursuing the topic into graduate school. Last week I was visiting with two young women who were completing PhD's – one in astrophysics and the other in molecular biology. Each reported that they were introduced to the topics in a summer program when they were seventh graders.

3. Mentoring comes in many forms and, certainly, a student at a specialized secondary school can serve as a mentor for a younger student. Statewide residential schools may be tremendous sources for mentorships across the state and technology makes online mentoring a real possibility. Video conferencing or using Skype can add to the possibilities of mentoring beyond a specific location. Students at residential schools can serve as online mentors for young people who have participated in summer programs and those who live too far away to have face-to-face mentoring. Mentoring can be the "tipping point" for a young person from a background that is underrepresented in STEM careers.

4. Tutoring is also a way for students at a specialized school to have an impact on younger students, such as a one-day-a-week tutoring program at an elementary or middle school. Such a program can provide the boost to get children interested in math, science, and technology and to build their knowledge base. It is amazing what such a tutoring relationship can do to motivate children to pursue learning with greater effort and enthusiasm.

5. Creating opportunities to observe scientists, mathematicians, engineers, and computer scientists at work can be very engaging. The vision of what professionals actually do is very limited for many young people. Visiting businesses or institutions where professionals engage in STEM careers can provide very motivating opportunities for young people. Likewise, arranging for

professionals to come to where the children are to engage in conversations about a specific STEM career can be motivating. But that opportunity won't happen for many children unless someone arranges it.

These suggestions offer a few ways that students, faculty, and staff at specialized secondary schools can play an important role in stimulating talent development in STEM disciplines. These ideas certainly are not exhaustive. There are many other ways for specialized secondary schools to help younger children experience learning in science, technology, engineering, and mathematics. If talent development in STEM disciplines is important for the future, leaders in specialized schools won't want to miss there opportunities.

Who benefits when a specialized secondary STEM school is involved in talent development? The school benefits since they expand the pool of candidates for the school. Children gain when students and staff from a specialized school are involved in talent development. Students in the specialized school gain in leadership skills and by their engagement in service learning. Interest in endeavors focused on the needs of others is fostered by such activities.

Specialized secondary schools can be instrumental in all three stages of talent development – creating interest, building a content base and acquiring content-related skills, and engaging in research. Opportunities are numerous. The question is this: What is the responsibility of the specialized secondary school to look beyond its own student population to create the next generation of engineers, scientists, mathematicians, and specialists in technology? The answer to that question will provide the motivation to increase involvement with talent development beyond the specialized school's own student population.

Distance Education - The Arkansas Experience

By Chris Robbins, Arkansas School for Mathematics, Sciences and the Arts

Frances vandenHeuvel of ASMSA teaching a distance education French class.

When the Arkansas School for Mathematics, Sciences and the Arts (ASMA) opened in 1993, it was envisioned as Arkansas's flagship high school. Established as a residential program for students with high aptitude for math and science (the arts came later), distance learning was not part of the school's mission in any way, shape or form. By 1996, ASMSA's recruitment efforts had been successful enough to draw the notice of administrators in school districts across the state, and while generally supportive of the school and its mission, a few voiced concerns that the school was impacting district test scores and finances by removing very bright students from the district. ASMSA's Office of Distance Education was conceived, in part, as a response to the concerns of those administrators. It was to be a way for the school to give something back to the districts, particularly those in the state's poor and rural communities.

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Funded by a Goals 2000 grant from the Arkansas Department of Education, the Office of Distance Education, or simply ODE as it came to be known, began operation in 1998 and offered high school level coursework in mathematics and foreign languages, both teacher shortage areas in Arkansas. That fall, 228 students took Spanish I, Spanish II and Calculus using the Audio Graphics System (AGS) the school had adopted as its delivery platform. AGS was essentially a desktop sharing tool that allowed students in remote classrooms to see anything the instructor chose to display on his or her computer. The program also offered a shared whiteboard.

In spite of its name, audio was never a strong point of the AGS system, and the audio portion of ASMSA's early distance education classes was conducted by conference call using speakerphones. The result was a teaching environment that provided the basic tools necessary to teach in real time but which did not allow the students and teacher to see one another. While less than ideal, AGS was effective and ASMSA's fledgling distance education program flourished, growing to 729 students by the 2001-02 school year, coincidentally, the first year the program charged tuition (a nominal $269.00 per year for a course). AGS was the department's sole delivery system until 2002-03 when interactive video began to be phased in.

Like many states, Arkansas installed an H.320 video network in the 1990s. Compressed interactive video was a brand new technology then and was a very expensive proposition, with classrooms that could cost upwards of $100,000 to equip. H.320 systems also required a great deal of expensive bandwidth, usually a dedicated T-1 or pay-by-the-minute ISDN lines. In spite of the expense, H.320 video was widely used in telemedicine and, for a time, by colleges and universities, though the emergence of asynchronous distance learning technologies a bit later would threaten to push interactive video from the educational landscape as schools rushed to develop web based

courses that could reach students "any time, anywhere" and much less expensively.

The adoption of H.323 as the video industry's standard transmission protocol promised to change that, making video a viable distance learning platform once again. While not inexpensive, classrooms could now be equipped for about a third the cost of the old H.320 systems and, best of all, content could be delivered over existing internet connections at rates as low as 128 kbs. (ASMSA still transmits at just 256 kbs.) At ASMSA, interactive video was viewed as a logical successor to the AGS system, one that would finally allow students and teachers to see as well as hear one another and one that would drastically reduce the distance education department's increasingly large long distance phone bills.

After successfully piloting video-based instruction in 2002-03 with a converted VTEL Galaxy system that had been part of the Arkansas Video Network (VNET), the decision was made to pursue a series of grant projects to fund the purchase of equipment for ASMSA and its partner schools across the state. To accomplish this, ASMSA developed a grants program that brought together key players from the video industry, the grants writing community and the schools themselves to collaborate on the projects. ASMSA would serve as a clearinghouse for schools seeking distance education equipment and would coordinate with the other members of the grant writing team to prepare the applications. It was an effective approach with a high success rate that between 2004 and 2009 produced eight fully funded Federal grants. Together, those grants have funded the purchase of approximately $6.5 million dollars of videoconferencing equipment, most of which has gone directly to the schools that receive ASMSA's distance education coursework.

By 2006-07, AGS had been completely phased out as a content delivery system, ASMSA's distance education enrollment had topped 2,000, and the department was beginning to be noticed by distance education advocates outside of Arkansas. That same year, the department won the first of four awards from the United States Distance Learning Association when Spanish Instructor Natalie Humphreys was recognized for exemplary instruction. (The department has since won two more USDLA awards for instruction and one for leadership.)

Natalie Humphreys of ASMSA teaching a distance education Spanish class.

Spurred on by the growing out-of-state interest in the program, department members became frequent presenters at regional and national conferences, and it would soon become apparent that there was a potentially large market for ODE's courses outside Arkansas. In 2007-08, ODE began accepting out-of-state students for the first time, with schools in Pennsylvania and Kentucky among the first to enroll. Enrollment that year topped 2,500.

Today, ODE serves approximately 3,700 students and has faculty and students in six U.S. states, Mexico and the United Kingdom. The department employs 33 full-time instructors, about one third of whom work from home or satellite offices, as well as a small administrative and support staff. A self-sustaining program, the department's tuition is currently $300.00 per student for a one-semester course.

As schools across the country seek cost effective ways to add breadth and depth to the curriculum, to serve students in low-enrollment classes, and to ensure certified instructors staff every classroom, ODE's prospects for continued growth appear to be very good. They should remain so as long as the department continues to provide a high quality, affordable service that meets the needs of its partner schools.

Arts and Humanities Column

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

When I first became aware that this issue of the *Journal* would be devoted to educational technology, my first thought was, "Haven't we been down this road before?" My second thought was, "What can I, a known technophobe, possibly contribute on this subject?"

The answer I've arrived at to the first question is, "I'm pretty sure we have, in one form or another, if not over and over again, at least more than once." My answer to the second is another question: "Would a little skepticism about all this techno-worship seem inappropriate to our readers?" And the answer to that, most likely, is "Probably."

Whether or not there has actually been an issue of the *Journal* wholly or mostly devoted to technology in the classroom, I can't recall. Nonetheless, the educational applications of various machines have been a recurring theme of our conferences and publications, and rightly so, at least most of the time. Sometimes, however, I wonder whether preoccupation with the means of education doesn't divert attention from its true ends. Has our organization become the National Consortium of Specialized Schools for the Propagation of Classroom Technology?

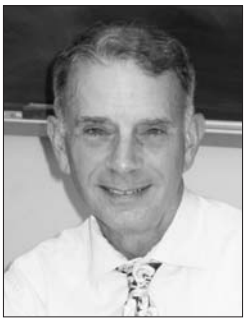
The real challenges of the Consortium, it seems to me, are how best to attract students to the serious study of science and mathematics, how best to help them master the necessary facts and concepts, and how best to develop the critical thinking that cuts across disciplines. To the extent that using technology genuinely promotes these goals, we should employ it. But that doesn't mean that using technology should become an end in itself.

If I seem a little warm on this subject, it may be because memories of my own recent in-service week are still fresh in my mind. There were sessions on Map Works and Power School—overlapping student information systems that threaten to overload the human if not the actual circuits. There was the "uploading" of syllabi on to web pages, and training on "flip cameras," "pod casts," and related software. Missing in this scenario was any attention to the real challenges of teaching students anything serious in any subject. Just what are we supposed to be doing here?

When asked about my own use of classroom technology, I usually respond flippantly, "I unfailingly turn on the lights." I also manipulate the air conditioner—with a screwdriver no less, which I guess makes me a tool user after all. I used to be a big fan of the overhead projector until they became extinct. I am only slowly becoming reconciled to Power Point presentations, though my impression is that they mostly dumb down content and pander to the diminishing attention spans of nearly everyone.

Probably chief among the new technologies relevant to me is the internet, and like everyone else I wrestle with its strengths and weaknesses as a tool for research. Teaching its proper uses and limitations is one of the most difficult teaching challenges all of us face, and there should be serious discussions across disciplines about how to achieve this end. On the other hand, I am deeply impressed by the digitized internet data bases that have transformed library research. Now there's a technology that my students and I can make use of.

Toward the end of *A Short History of Nearly Everything*, Bill Bryson talks about a site in Kenya where, for a million years, our ancestors came to make stone axes. Though made with considerable care, the axes don't seem to have been good for anything. "So," according to Bryson, "we are left with the position that for a million years . . . early people came in considerable numbers to this particular site to make extravagantly large numbers of tools that appear to have been curiously pointless." I may be wrong, but there seems to be a moral here somewhere.



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Teaching and Learning:
Using New Technologies

By Cheryl A. Lindeman, Ed.D.

Did you grow up with computers during your K-12 education? If you did then I am sure you are enjoying the new found technologies for social networking and posting your favorite videos. If you did not and you are currently teaching at an NCSSSMST school, then you know it is part of your life "ready or not." So, I will approach this issue with a sideline view of watching teenagers learn "beyond" their technology comfort zone. As an instructional designer, I enjoy watching students grapple with new learning pathways and gleaning insight into their minds.

Challenge One:
Learning with an online science textbook?
When I had the opportunity to include the online text to Starr, Taggart, Evers & Starr (2009) *Biology- The Unity and Diversity of Life 12th edition*, I thought it was a great way to have the textbook at any location on the planet. I thought, "teenagers are mobile, the text can go anywhere with them." WRONG! They like to carry around the hard cover copy! Instead I see them with color sticky notes all over the pages. So, I decided to ask a student about the sticky notes. "What do these mean?" The student indicated the notes helped her organize the big ideas (already in the text) and it saved notebook paper. "Okay," I thought. Then I noticed another student frantically looking for his text. There was a take home test due online through Google Docs by 11 p.m. I kept to my work and looked up in a few minutes. The student was at the computer ordering the two chapters of the eBook online! "Clever and resourceful," I thought.

Challenge Two:
How do you get the students to use online resources in a meaningful way?
In my teaching experience I've noticed that each year there are less, "oh, wow" comments about Web sites. It seems the students take them for granted. Or, they find the weird sites that are on a mission to change the world. One of my colleagues teaches her whole biology class as an online introductory college biology course. She spends a significant part of her day updating resources, viewing topics on YouTube and incorporating them into her online lessons. Recently, we worked on updating resources for the concepts about the cell. I chose to include the link to the University of Utah's Genetics Science Learning Center (http://learn.genetics.utah.edu/content/begin/cells/scale).

At the end of the class I planned for them to go to the site and check it out. In the first class I had the link up on my computer and told them to view it. In the second class I made a point to talk about "size matters" and it is important to get in their minds about relationships about relative size of cells, organelles etc. "Check out this site and tell me one thing you learned" were the instructions.

It was amazing how the classes approached the online resource. The second class was intrigued by the size of the coffee bean and "gosh a carbon atom is 140 pm (picometers)?" They went through each series and referenced the size section in their texts. Each group made a different comment about the online journey through "size." The first group looked at it very quickly and moved on. The teams spent less than 5 minutes on the resources. The second group found the resource had more "cool" demos and they continued past the end of class.

So, what was different? As the instructor I made a "pitch" for the carefully chosen web resource. The lesson wasn't a full scale "webquest" but a journey into learning through the animations. The students were accountable to give immediate

Dr. Cheryl Lindeman is the Biology/Partnership Coordinator at the Central Virginia Governor's School for Science and Technology, Lynchburg, VA. She is also Executive Director of the NCSSSMST.

feedback about their newfound knowledge. They had to "compete" with their peers to find different information. They decided it was worthwhile to bookmark the site. As the instructor I made an impression in their minds and they started to look at online resources with new " learning glasses."

Challenge Three:
Can my course metabolize with YouTube?
I must admit I felt like I was going through uncharted waters. It was clear my students are cleverer than I am with the resource. Yet I needed to "protect" them from the material that is not PG-13.

I decided to incorporate various autumn leaf videos into the photosynthesis chapter. It was really cool to explore the various videos and I was faced with many "oh, no" thoughts as I went through the various candidates. Then I found a series of videos from around the country and many of them had wonderful music embedded into the collections of digital images.

I chose two of the "Autumn Leaves II" to play at the beginning of the next two classes. Silence was golden as the leaves passed by the screen. The background piano music mirrored the motion of the leaves. There were interesting patterns and beautiful colors. At the end of the segment I quietly asked, "When is it time to leave?" The students had to think for a moment and paused. At that moment I knew their minds were in overdrive.

Our class continued with a discussion about pigments. The intensity of the discussion about pigments and when is it time to leave was rich with in-depth analyses from the textbook reading. We managed to go out of the normal bounds of teaching and learning. It was a great beginning and I plan to add more clips as appropriate. I must confess that the lesson was one of the best I've encountered with a group of bright, young, talented students.

As we continue to update curriculum in our schools, we face challenges. It takes careful searching and evaluation to incorporate meaningful technological experiences in teaching. The exciting benefit is that we get to "grow" with the new platforms and remain forever young.

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 recent Professional Conferences with many presentations archived for downloading as pdfs and ppts.

Curriculum Center. The Curriculum Center is the place where teachers to 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.

Forums. Professionals can connect with each other in the Forums. Post information and discuss topics of interest and concern, collaborate with colleagues across the Consortium, interact with Conference presenters, and discuss current STEM issues.

Check CCP out! We hope these features enhance your life and work as a Consortium professional. Let us know what else would be helpful.

Note: You need to have an NCSSSMST.ORG login and 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.

Negotiating the Path:
Technology Redefines Diversity in Learning Approaches and Audiences

By Darlene Haught and Christopher Thomas, North Carolina School of Science and Mathematics

Editor's Note: This is the second 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.*

The North Carolina School of Science and Mathematics (NCSSM) has provided diversity in educational constructs with its residential program, which is serving as a model for the nation and beyond.

However, *Diversity* not only applies to using a significant toolset of technology applications but also to building these tools into a program that allows a traditional residential school to provide a learning context by which students with diverse learning styles and backgrounds can be engaged and flourish.

NCSSM Online is an online high school program launched in the fall of 2008 to bring the experience of NCSSM's residential program to students throughout North Carolina. As a two-year program designed to capture the key elements of residential learning, NCSSM faculty and staff worked closely to choose and integrate academic technologies that would reflect the uniqueness of both NCSSM and specialized educational programs in math and science. Students remain enrolled in their local school while taking two to four NCSSM Online program courses per year. In this way, NCSSM Online supplements the opportunities available at their local schools.

In this column we outline how the program design allows us to meet the needs of students from diverse educational backgrounds, exposure, and socio-economic circumstances, helping us to build the experience of a specialized science and math residential program online.

Online Programs Build Wider Diversity

Unlike traditional online programs, NCSSM Online has the added advantage of the blended residential component that actually brings these diverse groups together to learn with and from one another. Traditional specialized science and math high schools have used a magnet approach, where students must board at a school that serves a statewide population, or travel to a day school that serves a county or metropolitan region. As a result, magnets self-select students who are willing to break their ties with their school, family, friends, and/or local community/culture to take advantage of unique opportunities in learning. The magnet process may disadvantage students and ethnic populations that live furthest away from the school or have strong community ties, thus impacting the true diversity of the school population.

NCSSM Online's program is designed to extend and diversify its student population base by reaching out to students that would not consider "moving away from home" to its boarding school, especially towards families that must drive long distances (three or more hours) to reach the NCSSM campus. (Some areas of North Carolina are over an eight-hour drive to NCSSM.)

Key Factors to Development

Relying just on a technological approach to building leading edge technology into online courses would not recreate the experience of our residential program. The factors described below have allowed us to develop a strong program that convinces students unwilling to leave their

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Christopher Thomas is Coordinator of NCSSM Online.

communities that they can still receive specialized STEM courses and belong to a cohort of high-potential students. Additionally, these factors also have let us build courses that complement students' learning styles, working better with more independent and visual learners, with the ability to watch course lectures and recordings of live sessions.

Admissions. NCSSM Online has a competitive admissions entry process and requires students stay in the program as a cohort their junior and senior years. This allows students to take a suite of specialized courses and build community by moving through the program as a class. The admissions process ensures we build a cohort of talented students with a record of success and skills in independent learning. The admissions model follows a process that ensures students are chosen equitably from throughout the state.

Orientation. Students are required to attend a three-day orientation at NCSSM, staying overnight on campus. The orientation builds community amongst each entering junior class, reviews the program requirements, and provides practice in using the program's technology. Students also get to meet their future teachers.

Residential Weekends. Each course requires that students visit the NCSSM campus for a weekend once or twice per semester. During the weekends, students complete collaborative or laboratory activities, supplemental academic activities unrelated to their course, and team building activities.

Summer Student Symposium. Rising seniors have the option to participate in a weeklong summer residential program modeled after the NCSSM academic's program's opportunities for extra-curricular studies. The students come together for a think tank approach to studying a current social issue of a STEM nature.

Transcript and Local Partnerships. Students in the program receive a NCSSM transcript reflecting the NCSSM Online courses they completed. NCSSM Online can send the transcript and a program profile in with their college applications. Families also have the option, depending on local school resources and commitment, to have the course appear on their local school transcript and receive time during the school day to work on their NCSSM Online course.

Diverse Technologies. The program requires weekly evening web-conferencing for each course to build community among classmates and to allow teachers to complete collaborative exercises. These sessions are recorded and can be reviewed again by students. Additionally, to assist students with limited high speed internet in their community, the program chose a learning management system that allows the students to work with their course materials offline and online.

Faculty members built innovative features into their courses to recreate online the face-to-face experience of learning. For example:
Using the NCSSM Distance Education video production staff to tape chemistry and physics laboratory demonstrations.

- Designing customized animated tutorials in AP Calculus stepping students through each step of an equation.
- Allowing students to design and run computational chemistry models on our servers and those at East Carolina University in our Medicinal and Computational Chemistry courses.
- Designing customized interactive web applications for students to design and measure the results of experimental set ups in AP Physics B.

NCSSM is leading the way for the 21st century learner by developing this state of the art online program that is enjoying great success with families from across the state.

Technology Focus:
Teaching with Technology - SMARTBoard Use by Beginning Math Teachers

By Virginia Fraser and Joe Garofalo, University of Virginia and Nicole Juersivich, Nazareth College

For years we have been preparing our pre-service secondary mathematics teachers to use various technologies to enhance their teaching of mathematics. Our work with technology has been shaped by a number of guidelines: (1) introduce technology in the context of worthwhile mathematics tasks; (2) use technology meaningfully; and (3) take advantage of the technology to generate representations and connect mathematics topics. Our teachers have been excited about learning new ways to address mathematics concepts and applications and have subsequently been eager to implement technology in their student teaching placements. Unfortunately, they too often did not have access to the hardware and software they needed to do so.

To address this lack of resources, we obtained funding from the US Department of Education, and hardware and software support from Smart Technologies, Canon, InFocus, Texas Instruments, Key Curriculum Press, and Explore Learning to provide each of our pre-service math teachers with a laptop or tablet, projector, SMARTBoard, and appropriate software, allowing them to incorporate technology in their student teaching as they saw fit.

Preparation

Our pre-service teachers take a one-semester course in educational technology and a yearlong secondary mathematics pedagogy course prior to their student teaching. The pedagogy course focuses on problem solving and mathematical behavior, mathematics applications, and meaningful use of technology. Technology experiences emphasize the use of content-focused technology applications, including both content-specific technologies (e.g., Geometer's Sketchpad) and more generic technologies used in content-specific situations (e.g., Excel).

They are also exposed to a variety of model lessons incorporating appropriate educational technologies to enable them to see the potential of technology and develop a vision for their own technology uses. Technology experiences include multiple opportunities to explore mathematics concepts and applications with technology and to practice teaching mathematics with a variety of technologies.

Throughout the pedagogy course and student teaching they have ready access to technology to gain experience in planning, implementing, and evaluating technology use, along with reliable pedagogical and technical support.

Participants and Methods

For several years we studied how our pre-service math teachers actually use the provided technology in their student teaching and the rationales they have for its use. Despite literature and critics claiming that it takes three to five years for a teacher to learn how to incorporate technology appropriately, we found that our teachers with a year and a half of pre-student teaching experiences with content specific technology frequently used technology during their student teaching to generate representations for the purpose of facilitating their pupils' conceptual understanding of mathematics.

What we report here is how the use of technology benefitted those same student teachers during their first or second year of employment as secondary mathematics teachers. We followed six of our graduates who were teaching in Virginia public secondary schools. Three of them were in their first year of teaching and three were in their second year. They were each observed 10 times and were interviewed and debriefed about their teaching with technology.

Dr. Joe Garofalo is Co-Director of the Center for Technology and Teacher Education and Associate Professor of Mathematics Education at the Curry School, University of Virginia.

Virginia Fraser is a graduate student in mathematics education at UVA.

Dr. Nicole Juersivich is an assistant professor in the mathematics department at Nazareth College. She earned her doctorate at UVA.

Results

We summarize our main findings with a number of assertions, each supported with quotes from participants.

1. *The teachers used technology to prepare comprehensive lesson plans, organized through a storyboarding process, easily permitting the incorporation of a variety of resources into one file or one folder.*
   "Technology is the thing that's helping me along. It makes things easier. I have a SMART Notebook lesson page to page and it helps guide me to do what I need to do."
   "... technology is so a part of how I plan that it's a part of how they learn."

2. *The teachers used dynamic representations to promote their students' discovery and generalization, through prediction, manipulation, observation, and interpretation.*
   "When you know you see this stagnant thing in a textbook just sitting there, you can't get an image of calculus in motion or what is it like when you change the polygon's number of sides. You know you can't, those images really help. The moving images really help them realize that math isn't just about this number to this number. It's about how they change.

3. *By using technology-generated representations, the teachers were able to save class time normally needed for manual graphing and drawing.*
   "...at the minimum at least it saves time, it's just more efficient...I can press one button and get three representations right away as opposed to alright let's take a minute and plug in six values for x and see what we get for y. ...at the level that I teach it's getting to the point where that's a little redundant and I'd rather spend my time on harder stuff than just evaluating functions."

4. *The teachers claimed that the accuracy of the figures and graphs generated with technology facilitated their teaching for understanding.*
   "When they don't have to worry about drawing the x and the y and little tick marks, it's so much easier and quicker. ...They're focusing on what they're learning..."
   "It helps me to teach because it enables me to stand back and show something to them and then they can in turn question it and work with it."

5. *The storyboarded lesson files, used in conjunction with SMART Boards, helped the teachers maintain their lesson plan focus.*
   "It helps me keep the lesson flowing so there's not a lot of down time and it helps me transition from one thing to the next."
   "I feel way more prepared for class. I feel more organized. I feel more confident. I feel like my lessons go a lot more smoothly.... Obviously it's the second time I'm doing it so it's also maybe that's a part of it too. But I think the SMART Board has a lot to do with that too."

6. *The digital lesson files, implemented with SMART Boards, promoted sequence flexibility in teaching*
   "It's a quick way for me to adjust my lesson and say ok I can jump over here and do this instead of that and reorder it pretty quickly."
   "So I have a set outline but at the same time I could go to Geometer's Sketchpad. I could go to Explore Learning. It really makes that lesson horizontal and vertical. You can go in any direction."

7. *The digital lesson files created by the teachers were readily accessible and revisable.*
   "In terms of having to make up entirely new lessons, I don't have to do that. I can tweak a thing here and there, which I actually do along the way if I find a mistake because I know I won't remember come next year. I go back right after I teach the lesson and fix or change an example."
   "Digital files are awesome because you can save them. You can manipulate them. You can print, you can e-mail, and you can burn it to a disk, put it on a flash drive."

Conclusions

The benefits of technology use described by beginning teachers parallel the experiences these teachers had with technology as pre-service teachers in our program. Of course, there are also challenges connected with technology use as beginning teachers (e.g., access, colleagues), but the advantages listed above motivate these teachers to continue to use technology in ways that benefit them and their students.

Affiliate Spotlight:
Technology and Admissions

By Amanda Solis and Annemarie Nagle, University of the Sciences in Philadelphia

As a university focused on science and healthcare, University of the Sciences in Philadelphia is at the forefront of change and technology. Yet as we seek to educate prospective students about us we see value in campus visits. Finding the appropriate balance between face-to-face and electronic communication can be challenging.

Social media have become very popular in higher education. E-mail, chats, texting, Facebook, YouTube, blogging, and Twitter now play a significant role in our interactions with students, parents, and guidance offices. Overall, it is imperative that students get the information they need and that they have all the necessary tools to make educated decisions on which institution they will spend their next four, five or six years.

Colleges and universities are relying on more non-traditional ways to communicate with high school students. Facebook has become a hot topic in college admission offices. Many schools are utilizing this tool to gain a sense of community among the students prior to attending the college or university. Schools use it in a variety of ways. Students can "friend" a counselor, become a fan of the college, or even meet their roommate prior to attending college. Some institutions are bypassing Facebook and creating their own customized social networks.

Another recent change in college admissions has been a significant increase in the utilization of video on Web sites, email campaigns, and on YouTube. Providing video allows students, parents, and guidance counselors to see more of the school and exposes students to a broad range of colleges and universities that they may not otherwise get to experience. Many are also utilizing YouTube to convey a side of their school that they were unable to do before – sharing student perspectives, highlighting specific programs offered, and opportunities to see student activities, research or class work.

E-mail, online chats, and blogs continue to have an increased presence on higher education websites and admissions web pages. Much of the information is geared toward an enhanced exchange between current and prospective students, but schools are also layering in a focus on parents and guidance counselors. The trend toward using more technology is certainly interesting and is a very hot topic in higher education, but information must be provided through a balanced communication plan, allowing each student to choose how they communicate with a college or university. At University of the Sciences, our goal is to expose the students to a wide variety of channels that allow them to truly experience the campus – and the use of technology enables us to reach a greater number of students and speak their language.

Amanda Solis is Associate Director for Enrollment Communication and Annemarie Nagle is Assistant Director of Enrollment Communication for University of the Sciences in Philadelphia.

NCSSSMST: Helping Make Research Happen

By Cheryl Lindeman, Martin Shapiro and Jerald Thomas

Background

NCSSSMST has long recognized that its mission extends well beyond the bricks and mortar of its member schools. We have actively sought partnerships and collegial opportunities that allow us to share the good work of our students, faculty, and staff with high schools, middle schools, colleges, and universities.

In 2008, a serendipitous meeting between Cheryl Lindeman, NCSSSMST Executive Director, and a representative from the Society for Science and the Public (SSP) provided an opportunity for NCSSSMST to engage science instructors from non-member schools in an intensive weeklong program designed around the principles presented in the NCSSSMST publication *Guiding Student Research: Making Research Happen in Your School.*

The partnership between NCSSSMST and SSP resulted in 2009 in an engaging workshop that addressed the needs of teachers of students from under-represented and low-socioeconomic status schools from across the country. The SSP Fellows workshop introduced teachers to an array of possibilities for engaging students in STEM research and for enhancing practices for recruiting and retaining students into specialized STEM programs and experiences. The SSP fellows program reached a handful of teachers from across the country, but the longer-term goal is to create an iterative program in which fellows become the instructors for a new generation of STEM instructors in subsequent Fellows programs. The following article summarizes the SSP Fellows program from inception to conclusion during its first year of support from SSP.

Overview

While in contact with the Society for Science and the Public regarding ISEF protocols, Cheryl Lindeman had a timely and promising conversation with an SSP staff member. NCSSSMST was invited to consider an outreach program that it was initiating related to expanding science research opportunities for students. The NCSSSMST publication *Guiding Student Research: Making Research Happen in Your School* provided a focus for the conversation, and, because of SSP's interest in the publication, NCSSSMST was invited to submit a proposal to provide the training for the SSP's inaugural 2009 Fellows workshop, organized around the major concepts presented in *Guiding Student Research*.

NCSSSMST then received an RFP from Jennifer Carter, Director of the Outreach for the SSP, with the following background information:

Society for Science & the Public (SSP), based in Washington, DC, with generous support from Intel, is pleased to announce the launch of its Fellows Program. The SSP Fellows Program provides funds and training to selected U.S. science and math teachers who serve under-resourced students, to enable interested and motivated students to perform high-quality independent scientific research. SSP is dedicated to the achievement of young researchers in independent research and to the public engagement in science. Its vision is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire.

The SSP Fellows Program will attract the most creative and motivated high school science and math teachers in the country. Through a competitive selection process, the Program will provide teachers the financial and training resources necessary to support and inspire the success of their most enthusiastic science students. Fellows may serve for up to four years.

The goal is to enable Fellows to guide students to produce project-based research of the highest quality, such as is selected for SSP's premiere science competition, the Intel Science Talent Search. http://outreach.societyforscience.org/ The Society for Science and the Public accepted the NCSSSMST proposal to design and prepare the workshop, which was to be held July 27-31, 2009, in Washington, DC, and to provide qualified consultant-trainers. The original Guide authors and contributors were contacted and asked to update their original contributions to the Guide and to submit lesson plans.

The following authors provided updated resources for the SSP Fellows Workshop:
John Goudie – The Nature of Research
Jay Thomas – Ethics in Research
Judy Scheppler – Engaging Students in Research
John Kowalski - Making Research Happen
Cheryl Lindeman – Mentorships and Partnerships
Lynda Smith – Communicating Research Findings
All contributors – E-Research

Note: Author lesson plans, such as Lynda Smith's *How Do Scientists Work?* and Jay Thomas' *Potato Chip Study*, may be found at ncsssmst.org > Connecting Consortium Professionals > Forum, available to logged-in professionals.

Ten SSP Fellows from nine different states and very diverse geographical regions (New York to New Mexico) were invited to participate as Fellows in the inaugural workshop. The Fellows teach in schools that serve under-served and under-resourced students – largely low socioeconomic areas. The overarching purpose of the workshop was to assist the Fellows in using the grant to develop research programs for students in their respective schools.

Developing student research capabilities requires providing the appropriate learning opportunities. Three skills form the central theme of Guiding Student Research:

(1) Asking good questions.
(2) Answering these questions.
(3) Communicating the results.

The pedagogy for the SSP Fellows Program followed the NCSSSMST principles of being hands-on and student-centered by placing the Fellows in the role of students. The training was interactive and customized to their backgrounds. Daily exercises paired Fellows from similar schools and with common experiences in small and large group discussions as well as for hands-on activities and planning the implementation of the their responsibilities.

The workshop sessions were designed to allow the Fellows to follow one idea from start to finish. This modeled the manner that would allow their students to pursue a research question. The curriculum for the Fellows Program followed the guidelines of Portland State University, which then granted two graduate credits to them upon completion of the course requirements.

The presenters for the workshop included hands-on activities/discussions and embedded technology in the following subject areas:
Nature of Research and Ethics in Research –Jerald Thomas, Martin Shapiro (Chapters 1 and 2 from *Guiding Student Research*)
Engaging students in Research and Making Research happen with your students –John Kowalski, Cheryl Lindeman and Karen Pikula (Chapters 3 and 4)
Mentoring Student Research, Establishing Partnerships, Communicating Research findings (ISEF, STS), and E-Research –Cheryl Lindeman, Marty Shapiro (Chapters 5, 6, 7, and 8)

There were also "lunch and learn" sessions at which the Fellows discussed the topics of the day with invited speakers. One session, devoted to developing research programs in their schools, included teachers from two local NCSSSMST schools (Poolesville High School, MD, and Thomas Jefferson High School, Alexandria, VA).

In addition to curricular concerns, the program dedicated time for the SSP Fellows to develop their own operational program management plans to address the challenges of teaching and learning in a low-SES community or school. Throughout the

Dr. Cheryl Lindeman is Executive Director of NCSSSMST.

Dr. Martin Shapiro was NCSSSMST President, 2004-2005 and was Editor-in-Chief, Guiding Student Research: Making Research Happen in Your School.

Dr. Jerald Thomas is NCSSSMST President, 2008-2010.

week, Fellows addressed issues such as recruiting and retaining talented students from low-income and under-represented communities, developing contacts within the scientific community, scheduling, and budgeting. Jennifer Carter of SSP selected and modified the management plan for the Fellows. Combining pedagogy and program management provided for an intense week.

Reflections from Fellows

The first iteration of the SSP Fellows Program proved to be a powerful learning experience for both the Fellows and the presenters. They completed reflections at the end of each day of the workshop to document the success of the sessions.

Center Consolidated School, Center, CO
I specifically liked the idea that we are teaching students to be self-advocates - teaching them to go get what they need. We were introduced to the Pickle Lab that I had never seen before. I will use this in most of my classes next year. With 8th graders who hate science because all they have done is read and answer questions, this will be a very powerful tool. We also went over ethics in research and were presented with an idea to teach this concept. The Potato Chip Test will be a very inexpensive and powerful way to reinforce the idea of ethics in research.

Moss Public School (7-12) Holdenville, OK
The Bouncy Ball lab was out of my comfort level. I look forward to using the Logger Pro series vs. the ones we used today. This lab opportunity did lead me to questions that would require research to answer.

Timberland HS, St. Stephens, SC Mentoring Student Research Chapter 5 helped me because I forgot about all the ways that someone can help. I really appreciate the already-made forms. That is sometimes the hardest thing to put together.

Carlsbad HS, Carlsbad, NM A very interesting day. I have found online forums to be very helpful in the past. As an avenue for the exchange of information and ideas, such forums have become invaluable. I am hoping that the Connecting Consortium Professionals Forum proves to be so.

Current Work

At this writing we continue to work with Jennifer Carter, the SSP Director of Outreach. Throughout the 2009-2010 school year, the NCSSSMST coordinator will:

- E-mentor the Fellows with NCSSSMST cadre
- Promote the use of the Connecting Consortium Professionals function at NCSSSMST.org.
- Help the Fellows in designing their research space for projects, providing ideas for partnerships, screening project ideas, and helping answer other questions relating to ISEF guidelines.
- Develop opportunities for the Fellows to visit a NCSSSMST member school during the research project time and/or to use online resources to chat with your students about doing research projects.
- Invite the Fellows to participate in the 2010 NCSSSMST Professional Conference in Nashville so they can share their successes as well as learn from the other teaching research presentations.

Conclusions

NCSSSMST is deeply committed to teaching the research process! The SSP Fellows project is an ambitious, first-generation effort to convene and support teachers who can help change the lives of students in underserved communities who show strong interest in science and math. It is exciting to see that our Guide is the key pedagogical focus of the academic portion of the Fellows' training.

Special thanks to Elizabeth Marincola, President and Publisher of Science News, for her vision, leadership and assistance in helping our best and brightest young minds develop.

Opportunities with the SSP Fellows Program

We look forward to expanding the SSP Fellows program and want to invite NCSSSMST professionals to contribute to this powerful experience. If you are teaching research in your school and are interested in applying to join the 2010 NCSSSMST SSP Fellows Summer Workshop Cadre, mentoring SSP Fellows, or serving with future Fellows Workshop cadres, you are invited to send a letter of interest to office@ncsssmst.org.

Please include information about the following:

- Ability to present hands-on interactive lessons to peers in the areas of guiding student research.
- Willingness to commit at least 1 hour per week assisting a Fellow by means of online communication.
- Commitment to present at an NCSSSMST Professional Conference in the area of teaching research or developing research partnerships. A special concurrent session will be available for this opportunity and a detailed proposal will be required.

The SSP Outreach Program Director, the NCSSSMST SSP Coordinator and the NCSSSMST Executive Director will select members of each SSP Workshop Cadre. They will make their decisions based on SSP's experience and educational background criteria, the applicant's demonstrated ability to teach peers, recommendations, and the commitment to student research. The SSP grant to the NCSSSMST provides for stipends for all phases of the project.

The Global Public Service Academies: A Novel Program for Promoting STEM Studies

By Robert Malkin, Duke University

In 2005, the tsunami that hit Southeast Asia wiped away homes, factories, schools, hospitals, and universities with a tremendous force. Organizations around the world mobilized immediately to help those whose lives were destroyed. Relief organizations sent supplies, professional organizations sent experts, professional societies, including engineering and science professional societies, organized relief drives and sponsored their members' trips to the ravaged area. Many high schools organized relief drives and fundraising efforts as well. And, a few high schools sponsored trips to the area. Part of the reason for all of this effort was the enormous motivating force a tragedy of this magnitude can represent.

When I visited Aceh, Indonesia about one year after the event to view the reconstruction of their hospitals, what struck me was that many organizations approached their aid delivery without any considerations for the basic engineering tasks involved. I saw donated X-ray developing machines that required chemicals that aren't available in Indonesia, electrocardiographs that required 110 volts donated to hospitals that run their electrical outlets at 220 volts, and many other pieces of equipment that were of no value to the receiving hospital.

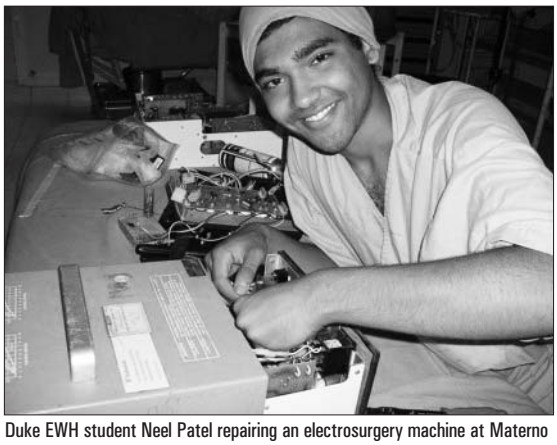
The problem was not a lack of motivation. Nor was the problem the technical challenges of an electrical outlet. The problem was rather simply focusing on the engineering of aid delivery.

The types of problems that I saw are problems that many high school students could understand and could rectify. From this perspective, the tragedy in Aceh – as an example of all technical aid delivery – is an opportunity to motivate high school students to understand and pursue the study of engineering.

Service Learning for Science and Engineering Studies Support

The use of service learning to motivate the study of a subject is not new. Indeed, I have been running The Engineering World Summer Institute (www.ewh.org), now housed at Duke University, for nearly ten years. Duke-Engineering World Health (Duke-EWH) sends engineering students – mostly college juniors and seniors - to hospitals in under-developed countries to repair and install medical equipment. The result has been better facilities and many, many, saved lives. "When we see the students come from the EWH, we are happy because we know improvements are on the way for our hospital," according to Dr. Enrique Alvarado, director of the Children's Hospital (Hospital Infantil Manuel de Jesus Rivera) in Managua, Nicaragua.

Over fifty engineering majors participate every year in the Duke-EWH program. All of the participants complete a one-month training course in language, culture and medical equipment before being assigned to a hospital for a month. Last year, participants repaired nearly $1,000,000 worth of medical equipment.



Duke EWH student Neel Patel repairing an electrosurgery machine at Materno Infantil Mauricio Abdalah, in Chinandega, Nicaragua, a 200-bed, mother and baby's hospital where only 40% of the medical equipment is working. His efforts placed this critical piece of surgery equipment back into service.

Robert Malkin, PhD, PE, is Professor of the Practice of Biomedical Engineering at Duke University; Director, The Global Public Service Academies; and Director, Duke-Engineering World Health. For further information on GPSA, contact him at robert.malkin@duke.edu.

The students who participate also get a unique, hands-on educational experience. "This is an opportunity for me to apply my technical engineering background in an environment that benefits underprivileged children," said student Nicolle Kramer. "It makes me aware of the importance of things that I would otherwise take for granted."

A number of service learning organizations focus on engineering for college students. For example, Engineering World Health (www.ewh.org) focuses on biomedical engineering. Engineers Without Borders (www.ewb-usa.org) focuses mainly on civil engineering students. Engineers for a Sustainable World (www.esustainableworld.org) has summer experiences for engineering majors. Similar organizations also exist in some of the sciences.

My position is that these organizations support the study of science and engineering rather than promote it because the participants are college students who have already selected their majors. What is needed is a program that encourages students to select science and engineering majors in the first place.

The Global Public Service Academies

The Global Public Service Academies (www.gpsa.us) is patterned after the successful Duke-EWH program but it is specifically designed for high school students. GPSA is a summer experience targeted at high school sophomores and juniors, aimed at students who are interested in health careers, including doctor, nurse, pharmacy, biomedical engineering, dentistry and many other fields. Massachusetts Institute of Technology (MIT) and Florida Gulf Coast University (FGCU) in Fort Meyers are our partner institutions.

A GPSA participant's experience begins on a college campus a few days before departing the U.S. Students learn to facilitate several screening measurements (height, weight, temperature, blood pressure, heart rate, vision screening, etc), to conduct post-care consultations (patient advocacy), to understand how to conduct problem identification interviews, and how to frame scientific and engineering problems. They also complete some introductory cultural and language training.

Then the entire group (students, faculty from MIT and FGCU, myself and program staff) departs for Calhuitz, Guatemala. Calhuitz is a peaceful Mayan village in the hills of Guatemala. Very poor and steeped in tradition, the indigenous Mayans are struggling to bring modern medicine to their village. This is a place where high school students can really make a difference.

Participants will spend about three weeks in Guatemala working in a health clinic or hospital. During this time, students take language classes in the morning as well as a technical class. In the afternoons, students either: 1) facilitate waiting room screenings; 2) shadow a physician; 3) conduct post-physician consultation; 4) conduct research activities or engineering problem development with one of the university professors; or 5) perform traditional volunteer tasks. Teams rotate every few days.

The engineering problem identification component of the program is unique, entailing identifying and documenting the needs of individuals with disabilities. Once the students have documented the research projects, class time will be used for discussing each case and to help the students summarize their project. When they return home, students interested in pursuing their project as a science fair entry (or equivalent) will be provided the opportunity to work with a university mentor, a faculty member, or a senior engineering student to carry out a prototype development. Some funds are reserved to help support returning students continued work.

The Benefits of Service Learning to Promote STEM Studies

GPSA participants will get a deeper and more meaningful experience because they will be working in a developing world to make a difference, not just studying it or watching tragedies transpire on the news. Students will also tangibly improving healthcare conditions in the developing world. As with the Duke-EWH program, we anticipate being able to report their impact on the hundreds of patients seen and problems solved.

Institutional and Associate Members

Alabama
Alabama School of Fine Arts - Russell Science Center
Alabama School of Mathematics & Science

Arkansas
Arkansas School for Mathematics, Sciences and the Arts

California
California Academy of Mathematics & Science

Connecticut
Science & Technology Magnet HS of Southeast Connecticut
The Greater Hartford Academy of Mathematics and Science

Delaware
The Charter School of Wilmington

Florida
Center for Advanced Technologies
Crooms Academy of Information Technology
Middleton High School

Georgia
Academy of Mathematics, Science & Technology at Kennesaw Mountain HS
Academy of Research and Medical Sciences at South Cobb HS
North Springs High School Math/Science Magnet Program
Rockdale Magnet School For Science and Technology
The Advanced Academy of Georgia
The Center for Advanced Studies at Wheeler High School
The Gwinnett School of Mathematics, Science and Technology

Idaho
Treasure Valley Mathematics & Science Center

Illinois
Illinois Mathematics and Science Academy
Proviso Mathematics and Science Academy

Indiana
Indiana Academy for Science, Mathematics & Humanities

Kentucky
Gatton Academy for Mathematics & Science in Kentucky

Louisiana
Louisiana School for Math, Science & the Arts
New Orleans Charter for Science & Mathematics High School
Patrick F. Taylor Science & Technology Academy

Massachusetts
Massachusetts Academy of Mathematics & Science

Maine
Maine School of Science and Mathematics

Maryland
Anne Arundel County Public Schools*
Blair Science, Mathematics,Computer Science Magnet Program
Eleanor Roosevelt Science and Technology Center
Oxon Hill Science & Technology Center
Poolesville High School Magnet Program
Science and Mathematics Academy at Aberdeen
Science and Technology Center at Charles Herbert Flowers High School

Michigan
Battle Creek Area Mathematics & Science Center
Berrien County Mathematics & Science Center
Dearborn Center for Mathematics, Science & Technology
Kalamazoo Area Mathematics & Science Center
Lakeshore HS Math/Science Center
Macomb Academy of Arts and Sciences
Macomb Mathematics, Science & Technology Center
Mecosta-Osceola Math/Science/Technology Center
Romeo Engineering & Technology Center
Sanilac County Science & Mathematics Center
Utica Center for Math, Science and Technology
Williamston High School - Math and Science Academy

Mississippi
Mississippi School for Mathematics & Science

Missouri
Missouri Academy of Science, Mathematics and Computing

New Hampshire
Academy for Science & Design**

New Jersey
Academy of Allied Health & Science
Bergen County Academies
Biotechnology High School
Communications High School
Dwight Englewood School
High Technology High School
Marine Academy of Science & Technology
Marine Academy of Technology and Environmental Science
Morris County Academy for Mathematics, Science and Engineering
Red Bank Regional HS Academy of Information Technology & Finance
Science Park High School
Union County Magnet High School

New York
Brooklyn Technical High School
High School for Math, Science and Engineering at The City College
Manhasset High School
Queens HS for the Sciences at York College/CUNY
Staten Island Technical School High School
Stuyvesant High School
The Bronx High School of Science

North Carolina
North Carolina School of Science & Mathematics

Ohio
Hathaway Brown School

Oklahoma
Great Plains Technology Center**
Oklahoma School of Science & Mathematics

South Carolina
Dutch Fork High School
South Carolina Governor's School for Science & Mathematics
Spartanburg County School District Six*
Spring Valley High School

Tennessee
School for Science & Math at Vanderbilt**
Tennessee Governor's Academy for Mathematics & Science

Texas
Academy for Science & Health Professions Conroe ISD
Conroe ISD Academy of Science & Technology
John Jay Science & Engineering Academy
Liberal Arts and Science Academy of Austin at LBJ HS
Texas Academy of Mathematics and Science

Utah
Academy for Math, Engineering & Science
NUAMES
SUCCESS Academy

Virginia
Bayside High School Health Sciences Academy
Central Virginia Governor's School for Science and Technology
Chesapeake Bay Governor's School for Marine & Environmental Science
Loudoun County Academy of Science
Maggie L. Walker Governor's School for Govt. and International Studies
New Horizons Gov. School for Science and Technology
Ocean Lakes High School Mathematics & Science Academy
Piedmont Governor's School for Mathematics, Science and Technology
Roanoke Valley Governor's School for Science & Technology
Shenandoah Valley Governor's School
Southwest VA Governor's School for Science, Mathematics & Technology
The Mathematics & Science High School at Clover Hill
Thomas Jefferson HS for Science and Technology

Washington
Camas Academy of Math and Science

Members as of November 30, 2009
*Associate schools in planning stages.
**Affiliate School Membership

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 November 2009, the 100 member schools and centers located in 31 states enroll more than 38,000 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 has IRS 501(C) (3) tax-exempt status and is incorporated as a non–stock corporation in the Commonwealth of Virginia. The institutional membership elects the Board of Directors of the corporation from institutional member leadership for three-year terms. The Board meets four times a year to establish policy and set direction and employs an Executive Director. The fiscal year is July 1 through June 30. NCSSSMST has implemented a strategic plan and the Board serves as the strategic planning team.

Membership

NCSSSMST membership is extended to public and private secondary schools, colleges and universities, organizations, and individuals whose primary interests are congruent with the mission of the Consortium.

Categories for membership are as follows:

Institutional Membership — Open to specialized secondary schools or schools with specialized centers located in the United States that have nonprofit status and primary objectives congruent with the Consortium's mission.

Associate Membership — Open to specialized secondary schools or programs which, upon enrolling students, have primary objectives congruent with the Consortium's mission and will meet the requirements for institutional membership.

Affiliate Membership — Open to colleges and universities, businesses, associations, summer programs and agencies that have demonstrated an interest in and support for the Consortium and whose work furthers the mission of the Consortium. Affiliate member categories include: college and university; nonprofit organization; private business or organization; government agency; school outside of the U.S.; summer science programs; middle school; other school not qualifying as an institutional or associate member.

Individual Membership — Open to persons who have demonstrated an interest in and support for the Consortium or whose work furthers the mission of the Consortium.

The benefits of membership include an annual student conference, annual professional conference, an Issues and Connections conference series, student research symposia hosted by colleges and universities, summer institutes, and the following publications:

- Newsletter — published three times a year
- NCSSSMST Journal — a juried forum (published twice a year)
- Membership Profile — biennial report of the Consortium
- WWW site—www.ncsssmst.org—organization's link on the site

Corporation Business Office

NCSSSMST, 3020 Wards Ferry Road, Lynchburg, VA 24502; 434-582-1104; FAX 434-239-4140

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March 3	Pre-Conference Diversity Symposium
March 4-5	Concurrent Sessions, Affiliate Meet & Greet
March 6	Plenary Session on STEM Education sponsored by Siemens Foundation

Advanced Registration continues through January 22.
Registration Deadline: February 22

Co-Host Schools	The Gatton Academy of Mathematics and Science in Kentucky Tennessee Governor's Academy for Mathematics and Science
University Sponsor	Vanderbilt University

Visit www.ncsssmst.org for tentative schedule, registration and updates.

2010 NCSSSMST Expedition to Nashville

Upcoming Opportunities for NCSSSMST Educators

June 23-25 Summer Institute on strengthening relationships between Midwest schools and affiliates.
Hosted by Missouri University of Science and Technology, Rolla.
Theme: "Working together for the benefit of our students."
Registration will begin March 15 and is limited to 75 participants. $50 registration fee, possible travel stipends.

July 12-14 Summer Institute: STEM Studies and College Admissions for Teachers and Counselors.
Sponsored by Olin College of Engineering, Worcester Polytechnic Institute and Massachusetts Institute of Technology. Registration will begin March 15. Limited to 25 participants, one representative from each school. $50 registration fee; other expenses covered by the sponsors.

Summer Opportunities for NCSSSMST Students & Teachers

June 6-9 Annual Research Symposium hosted by Stevens Institute of Technology, Hoboken, NJ
Online registration will be in January 2010.

June 13-19 National Keystone Policy Summit at the Keystone Center in Colorado
NCSSSMST schools preregister by Dec. 11. Email office@ncsssmst.org to see if there are slots available.

NCSSSMST
National Consortium for Specialized Secondary
Schools of Mathematics, Science & Technology

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