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2014-2015 Newsletter

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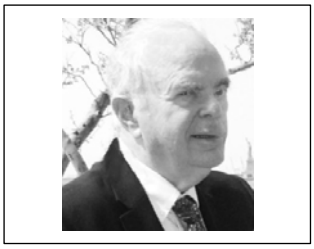
STEM ED

FROM THE DIRECTOR

MORTON STERNHEIM

The Dog Did It: STEM DIGITAL (Digital Images as Scientific Data)



"The dog ate my floppy disk" was the tongue-in-cheek explanation why a teacher did not submit her assignment in a summer institute some years ago. In the case of STEM DIGITAL, a dog was the catalyst for a million dollar grant.

It all began several years ago when I attended a NASA Principal Investigators meeting and met John Pickle, then at the Museum of Science in Boston and now at Concord Academy where he teaches physics and other subjects. John had developed some engaging hands-on materials that let you explore the properties of light, both visible and infrared. He had also written a software package called Analyzing Digital Images (ADI) and some related programs. These exploited the fact that digital images are more than illustrations. They may contain a wealth of spatial, spectral, intensity, and temporal information that represents valuable scientific data.

I forgot about John until I bumped into him a couple of years later. John was visiting his sister and walking the dog noted above in my neighborhood. We talked about working together and ended up writing a proposal to the NSF Innovative Technology Experiences for Students and Teachers (ITEST) program. The first proposal did not get funded, but the second one did. Now ending, it was called STEM DIGITAL, the acronym for STEM Digital Images in Geoscience Investigations: Teaching Analysis with Light.

Image analysis plays a large role in the workplace and offers excellent career opportunities. Digital cameras are powerful tools for inquiry based curricula, classroom research, and learning about image analysis. They have become ubiquitous as their prices plummet and capabilities improve, making them affordable for classroom use. However, teachers and students mainly use digital images for documentation: creating PowerPoint presentations, handouts, posters, etc. There are good examples in the educational literature of how to use digital imaging as an investigative tool, but these are seldom seen in classrooms.

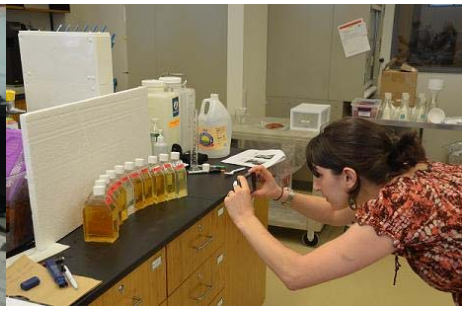
STEM DIGITAL showed how digital image analysis can be applied to environmental quality issues in ways that can readily be introduced into STEM courses, engaging students and encouraging them to think about related careers. The project developed research agendas that employed a variety of image analysis tools. The air quality theme, led by Co-PI Steve Schneider (Astronomy), focused on carbon dioxide and ozone. The water quality theme, led by David Reckhow (Environmental Engineering) looked at the role of plant biomass on drinking water quality and at options for water treatment. Arsenic is listed as number one in the US in terms of environmental contaminants that pose a potential threat to human health; research topics included the identification and mapping of local arsenic contaminated sites, bioremediation possibilities, and arsenic in rice and other foods. This expanded on the impressive arsenic outreach program of Julian Tyson (Chemistry). Staff member Jennifer Welborn (Amherst Regional Middle School) introduced an experiment to see the effect of a changing environment on crayfish color. Another application was based on intensity measurements. In the Arctic, melting ice or snow exposes water or tundra, decreasing the reflection of sunlight or the *albedo.* This is one reason climate change is greatest in Polar Regions. The teachers compared the albedos of turf, asphalt, and other surfaces. They also measured gravity with the ancillary Movie Tracker program.

There were three cohorts of about 30 teachers who attended one week summer institutes in 2011, 2012, and 2013. Another group of 15 teachers took an online version of the program in the fall, 2013 semester. Participants came from all over the country and taught the range of middle school science and technology subjects. They and their students developed many creative applications. For example,

- *One teacher had students analyze photos of their eyes. They discovered, for example, that blue eyes are not purely blue.*
- *Another teacher used the Movie Tracker program to measure the speed of generator blades to determine the efficacy of blade designs.*
- *A student in an afterschool science club used ADI to study the effect of increasing CO_2 on **Aiptasia pallida,** used as a model organism for a study of coral bleaching.*
- *Two seventh grade girls dove in the Caribbean during their February vacations. With the aid of their fathers, they photographed color samples at various depths and used ADI to study the relative attenuation by the sea water of incident light colors.*
- *A teacher had students use ADI to measure the leaf coverage of tree canopies.*
- *The albedo activity was found online by a teacher who was **not** in the program. She started a global network of people measuring the albedos of a wide variety of surfaces in their areas.*

The ADI software is available without charge for non-commercial use at www.umassk12.net/adi. Curriculum materials are online at www.umassk12.net/digital.





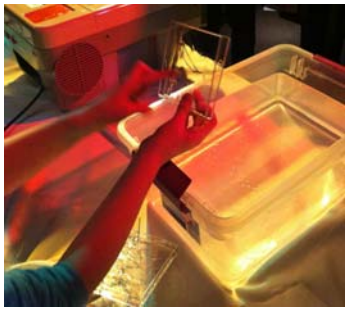
A Scientist Walks Into a Bar…and presents at SciTec Cafe

By Kathy Aidala and Sarah Byrne, Mount Holyoke

How are bubbles, geckos, the Higgs boson, and a good night's sleep all related? Scientists are exploring those topics and more in our community! Everyone from 6-year-old budding scientists to retired professors crowd into the Amherst Brewing Company once a month to fulfill their scientific curiosity and meet the scientists exploring groundbreaking territory.

The goal of SciTech Café is to bring together scientists and the general public into an informal setting to share their research. Too often, science is presented as a fact-based discipline, and there is little, if any, communication between those who do the science and anyone outside the academic community. SciTech Café strives to share scientists' excitement about their research with those who have little or no background. Science is not a passive subject, and the audience is expected to ask questions throughout the evening. Those who ask the best questions receive a prize.

SciTech Café held its inaugural event in September 2012, with monthly events that quickly began drawing a crowd of about one hundred people. SciTech Café was founded by Kathy Aidala, a physics professor at Mount Holyoke College, who organizes it along with Sarah Byrne. Funds are provided by Community Based Learning at Mount Holyoke, and by the National Science Foundation through individual grants, the Center for Hierarchical Manufacturing and the Materials Research Center on Polymers at the University of Massachusetts, as well as the Center for Integrated Quantum Materials based at Harvard University and MIT. Join us for our next event,: "Dark Matter/Dark Energy" with Professor Gary Felder on February 23rd at 6pm. See our website, www.scitechcafe.org, for more information and to sign up for our email list.



Update on the Five College Public School Partnership

By Marla Solomon, Director of the Five College Public School Partnership

In 1985, the Five College Consortium founded Five College Partnership Programs, a joint effort to support K-12 public education in western Massachusetts and, in particular, the professional development of public school teachers. The Partnership's activities include professional development programs for teachers, identifying resources for K-12 educators, building college-community-school collaborations in areas of mutual interest, and strengthening the link among educators across western Massachusetts and from kindergarten to college. The Partnership marks its 30th anniversary this year!

Although the Partnership's content focus includes all K-12 curricular areas, STEM education has been and remains a key element of our programming. Our current STEM program is in mathematics. In 2011, the Western Massachusetts Mathematics Partnership (WMMP) formed, with support from a National Science Foundation (NSF) Math Science Partnership planning grant. The Western Massachusetts Mathematics Partnership is a network of ten higher education institutions and eleven public school districts, ranging from large urban districts to small rural ones, dedicated to improving mathematics teaching and learning. Through the WMMP, faculty from grades K through 16 collaborate in professional learning communities and institutes on math and math teaching. Algebraic thinking and the vertical progression of Common Core Standards of Mathematical Practice through the grades have become the focus of the WMMP's work in response to regional needs identified during the two-year NSF-funded planning and professional development period.

Since January 2014, the WMMP has been organizing professional learning communities on algebraic thinking each semester. We launched three new professional learning communities (PLCs) in fall 2014, one each in Amherst, Easthampton, and a new WMMP PLC location, Westfield. 80 educators from 16 school districts and four institutions of higher education participated. Each PLC is facilitated by either a pair or a trio of educators representing the elementary, secondary, and post-secondary grade levels. We consider the enrollment levels in our PLCs as a sign that WMMP's on-going work is valuable to the region's educators. The way we produce the work is equally important, as we aspire to genuine collaboration between K-12 and post-secondary educational institutions. The WMMP planning group is comprised of K-16 mathematics educators and the PLCs are financed by resources from the Five Colleges matched to a per-teacher contribution from school districts. We are grateful to the school district administrators for their close collaboration and support.

The WMMP is initiating a new funding proposal and long-term partners remain committed. Spring PLCs are in the works. If you are interested in participating in a future WMMP PLC or summer institute or if you would like to receive WMMP news, please join the WMMP listserv.

If you have ideas about additional ways the Partnership can support STEM education, please contact Marla Solomon at msolomon@fivecolleges.edu.

Nobel Laureate Sheldon Glashow Speaks at UMass

By Morton Sternheim

Nobel Laureate Sheldon Glashow spoke at UMass on October 1, 2014. An audience of almost 300 people filled Hasbrouck 20 for an engaging talk entitled "A Parable of the Pure and the Practical – Why We Must Pursue Basic Scientific Research." This event resumed a Physics Department program of lectures by distinguished visiting scientists.

Glashow is the Higgins Professor of Physics, Emeritus, at Harvard, and is now the Metcalf Professor of Mathematics and Physics at Boston University. In his talk for the general public, he noted that politicians and opinion makers argue stridently that governments and universities should invest only in such areas of research that are likely to result in immediate and specific benefits, through wealth enhancement or job creation. They find undirected curiosity driven research in basic science to be useless and unaffordable luxuries that consume resources rather than promoting economic growth and human welfare. This talk showed how wrong they are by offering many illustrations of the impact of such undirected research.

He started by giving an example from a letter to the Economist: "Fundamental physicists would be hard-pressed to point to anything useful that was directly dependent on their theorizing... It is far more important that we encourage our `best brains' to solve real problems and leave theology to the religious professionals."

His response: *Had Faraday, Rontgen and Hertz focused on solving the "real problems" of their day, we would have waited much longer for electric motors, X-rays and radios … Quantum Mechanics was invented by dreamers such as Bohr, Heisenberg, Schrödinger, Pauli and Dirac. They had no start-ups or marketable products in mind. Yet today quantum mechanics underlies at least one third of the world's economy!*

Glashow presented long lists of Nobel Prize winning and other discoveries that led to advances in many fields. In medicine, these ranged from the 1894 discovery of X-rays that led to CAT scans and the 1953 understanding of DNA to gene therapy. In information technology, the 1888 discovery of radio waves led to wireless communication, and the 1947 invention of transistors to the computer revolution. The 1839 discovery of the photovoltaic effect led to solar panels, Einstein's 1916 general relativity theory to GPS satellite technology, the 1938 discovery of nuclear fission to nuclear power, and the 1969 development of charge-coupled devices to digital cameras. Cyclotrons were created for pure research: to study the basic building blocks of matter. But these and other particle accelerators contribute directly to wealth creation and human welfare. Some 30,000 accelerators operate today for industry and medicine: Ion Implantation, Material Processing, Particle Beam Therapy, Medical Isotope Production, Food Irradiation, Nondestructive Inspection etc. Energy loss due to "synchrotron radiation," once a problem at electron accelerators, is now a multi-billion dollar enterprise. Synchrotron light has many applications to science, medicine, engineering and industry. About 80 of these large, expensive and sophisticated light sources are deployed in over 20 countries.

A last minute addition to the program was Glashow's participation in an evening panel discussion. The Amherst Cinema screened *Particle Fever* as part of an ongoing Science on Screen series. Physics Department faculty members Carlo Dallipiccola, Stephane Willocq, and Ben Brau were scheduled to give expert insight into the question: What can the Large Hadron Collider and the Higgs boson tell us about the universe? Glashow graciously agreed to join them in answering questions from a sold out theater seating about 200 people.

Introducing, Charlana Simmons, New Director of Student Success and Diversity, UMass, CNS

By Charlana Simmons

The current landscape in higher education demands that we become more savvy and competent as professionals who will work with an ever changing population. The College of Natural Sciences at the University of Massachusetts Amherst has attempted to do just that by creating the Director of Student Success and Diversity position.

This position is designed to support the college in its efforts to increase the recruitment, retention, and student success of students from diverse backgrounds, specifically underrepresented minority, first-generation college, low-income, and transfer students. This goal is to be achieved through the development of programming and support for students designed to ensure that they have every possible opportunity to be successful as undergraduates at UMass. Since August, I have worked diligently to develop relationships across the campus that will aid me in that mission.

To provide some background about me, I have a Masters degree in Secondary English Education and a Bachelor of Science degree in English Literature. I am a high school English teacher, by trade and certificate. I received both of my degrees from the University of Rochester in Rochester, New York where I grew up. I am currently pursuing a Doctoral Degree in Higher Education, partially begun also at the University of Rochester.

I have worked in higher education for over seven years and spent most of that time managing federally and privately funded research and scholarship programs for college students who are first-generation, low-income, and underrepresented minority. Working with diverse populations of students is both my passion and my area of expertise. I credit this to my own background as a college student. When I arrived at the University of Rochester as a budding 18-year-old student I was also a low-income, underrepresented minority (which consequently I remain so), and first-generation college student. I went through a number of challenges that were specific to my intersecting identities. Fortunately I was also a student in the Higher Education Opportunity Program at Rochester and received all of the support and guidance that I needed to be successful in college and beyond.

Understanding that times have changed over the past decade or so requires that I stay abreast of the most recent literature in higher education. And it is through my past experience and current research in higher education that I work to create a holistic network of support for diverse students in STEM. Through partnerships across the campus, this vision is starting to come into focus. Through my office, I am triaging and supporting diverse students who find themselves in crisis and helping them develop student success plans, developing a new Student Success Workshop Series that features support with finding and acquiring summer research experiences, receiving guidance on the best methods of studying in STEM, and creating paths to graduate school.

The goal is to wrap as many arms around students as possible to provide them with support. In the future, we plan to become more proactive by developing scholarship programs for diverse students majoring in STEM who find themselves in the “murky middle” of the GPA spectrum after their first semester here at UMass. These programs will provide intensive intrusive academic advising, scholarships to off-set the rising costs of higher education, tutoring, mentoring, and access to high impact opportunities (research, internships, and senior projects). I am looking forward to a successful career here at UMass with the goal of increasing the retention and graduation rates of students from diverse backgrounds!

Science and Engineering Saturday Seminars

January 24. (Rescheduled for April 11) Producing Electricity with Solar Cells. Rob Snyder and Chris Emery, STEM Ed. This seminar will focus on transforming the energy of visible light into electrical energy using photovoltaic cells. Background information and activities suitable for modification for use in middle and high school classrooms will include: measuring how much electricity is produced by photovoltaic cells, using spectrometers to measure the energy of photons of visible light, experimenting with the tilt and direction of photovoltaic cells and determining the efficiency of photovoltaic cells.

January 31. **Data driven learning.** Mariah Hamel, Plot.ly. In this workshop we will focus on ways to use data in science and math classes that fosters interdisciplinary thinking. We will use a tool called Plot.ly, a versatile, free, online graphing platform that helps students graph and analyze data.. Examples from physics, biology and statistics will be used to illustrate how data and technology can enhance learning. Bring a laptop (with Google Chrome) if you can; a tablet with a browser may be ok.

February 7. Interdisciplinary Science Connections. **AT AMHERST COLLEGE BENESKI MUSEUM** Fred Venne. The museum will serve as the backdrop for a seminar that looks at best practices in science curriculum integration. It hosts a collection of over 200,000 specimens from around the world and across time, 1,700 of which are on display. The museum allows participants to examine concepts like evolution, change over time, adaptation, extinction and Earth history. The seminar will provide opportunities at its interdisciplinary nature and how it connects Anthropology, Biology, Chemistry, Physics and Geology. Participants will examine connections with other aspects of the curriculum including literacy, math and social science. We will have an in-depth guided museum visit and an opportunity to explore field guides specifically designed to get the most out of a museum experience. Bring a camera if you can.

February 28. Introduction to Scratch Programming. John Heffernan, Williamsburg Schools. Learn the free Scratch programming language for use in both in-school and after-school settings. Scratch allows students in grades 3 and up to learn the fundamentals of programming in an easy and fun way. Scratch 2.0 is completely web-based. No programming experience required. Bring a laptop if you can; a tablet probably will not work.

March 28. How to Build and Teach Case Studies in Science. Scott Auerbach, Chemistry. Engaging and enlarging the enthusiasm of talented students towards learning science, technology, engineering, and mathematics remains a grand challenge at all levels of education. The Integrated Concentration in Science (iCons) Program at UMass is addressing this issue by challenging multi-disciplinary teams of science and engineering majors to design solutions for current problems of global significance. Essential to the iCons pedagogy is the use of open-ended case studies. Good case studies often involve compelling problems, substantial marbling among technological and sociological components, and rich sources of data for analysis. Developing useful case studies remains a difficult balance of pushing students out of their comfort zones without overly frustrating them. In this workshop, we will apply the iCons case-study approach to teach how to develop case studies, based on real-world problems of interest to the workshop participants. This workshop is intended for people who wish to incorporate a unit of integrated STEM into an existing STEM course, or to build an entire integrated STEM course. Participants will gain experience applying "contextualized reverse design," starting from learning goals, moving towards assessment strategies, and planning educational activities—all in the context of real-world problems with substantial STEM components. Each participant should leave the workshop with the beginnings of an iCons case study that suits their particular educational and real-world interests.

April 11. Makeup date for "Producing Electricity with Solar Cells"

May 2. Recall for those registered for graduate credits. ** Hasbrouck Lab **

Graduate credit option: There is a charge of $300 for 3 graduate credits plus a $45 registration Sci 697A (Cont ed) or 697 F (University). This is in addition to the $120 STEM Education Institute fee. Teachers may obtain credit for the seminar as many terms as they wish, but only 3 credits may be applied to UMass Amherst degrees. A lesson plan and a book report will be required for those enrolled for graduate credit. We will have Continuing Education registration forms at the first seminar.

Questions: Mort Sternheim, mort@umassk12.net, 413-545-1908, www.umassk12.net/sess

Online seminar registration and payment:
www.umassk12.net/ sess/register.html. Required for everyone whether or not they are registering for graduate credit.

Calendar of Events

Spring 2015 STEM Tuesday Seminars

STEM seminars are held at 4PM on the first and third Tuesdays of each month in Hasbrouck 138. All are welcome; no reservations are needed, and there is no charge. Parking is available in the Campus Center Garage.

February 3
Luk Hendrik
AECERN, Woods Hole Oceanographic Institute
"Mobile Platform for Data Capture and Use in the Class and Beyond"

February 17
Michael Barnett
Professor of Science and Education, Boston College
"Seeding the Future: Creating a Green Collar Workforce"

March 3
Leslie Schneider
InterLACE
"InterLACE, Physics Teaching Software"

March 24
Beth McGinnis-Cavanaugh, *STCC,* **Dave Hart,** *UMass*
"Team Through My Window"

April 7
Debbie Carlisle
PhD, Education, UMass
"Developing Students Spatial Skills in General Chemistry"

April 15
Valerie Barr
Professor, Union College, Computer Science
"Disciplinary Thinking, Computational Doing: Promoting Interdisciplinary Computing While Transforming Computer Science Enrollments"

Nanotechnology Professional Development Institute

Monday to Friday, July 13- July 17, 2015 at UMass Amherst:

- Funded by the National Science Foundation
- Sponsored by the STEM Education Institute and the Center for Hierarchical Manufacturing
- Middle and High School Science, Math, and Technology Teachers
- $75/day stipends ($375 total), materials, parking, some meals
- Housing (new air conditioned dorms) for those outside the commuting radius
- Graduate credits available at reduced cost; free PDP's (Professional Development Points)

Website: www.umassk12.net/nano. The application deadline is April 1, 2015.