Did you know that common nails, paper clips, and some brands of organic rice contain arsenic? That is what was discovered by students participating in the Science, Technology, Engineering, and Mathematics Research Academies for Young Scientists or STEM RAYS project, one of 16 Academies for Young Scientists that NSF has funded to see if “Out of School Time” experiences will increase student interest in STEM courses and careers.

The STEM RAYS program, led by Morton M. Sternheim (UMass STEM Education Institute), Allan Feldman (UMass School of Education), and Brian Adams (Environmental Science, GCC) is approaching its midpoint. It started in January, 2007 with an 11 school pilot program and was scaled up last fall. Originally planned to end this December, it will continue for two more school years with the aid of some re-budgeting and a $312,000 Pipeline grant from the Department of Higher Education.

Last year about 200 students at 18 schools in grades 4-8 participated in two-hour, after-school clubs. They and their teachers – who are mostly classroom teachers from their own school – conducted “authentic research” in collaboration with a college professor. Each group worked in one of five research areas: Arsenic in the Environment, Connecticut Watershed Studies, Birds, Air Quality, and Weather and Climate.

This year the areas will be Birds, Global Environmental Change, Engineering and Design, and Sustainability and Alternative Energy. (See inside for a list of teachers, schools, and faculty mentors.) Weeklong summer academies at GCC have given 40 students similar experiences in 2007 and again this year.

The original $800,000 NSF grant supported schools in Franklin County and involved faculty from UMass and Greenfield Community College.

The Pipeline grant brings in Smith College as a partner and funds the addition of the Amherst and Northampton middle schools.

Allan Feldman and his graduate assistant Kelly Pirog are studying the impact of this model for Out of School Time science.

continued on page 3
Twenty-nine middle school and high school teachers from nine different states attended a one-week Nanotechnology Summer Institute on the UMass Amherst campus in July. Sponsored by the STEM Education Institute and the Center for Hierarchical Manufacturing, and funded by the National Science Foundation, this Institute explored a variety of ways in which nanoscale science and engineering can be integrated into middle school and high school classes.

Coordinated by Morton Sternheim, STEM Ed Director, and Mark Tuominen, Director of the Center for Hierarchical Manufacturing, the Institute was held July 7th to July 11th. Each day of the Institute included lectures by the Nanotechnology staff or other UMass professionals, followed by a number of hands-on activities. Time was provided to discuss the teaching implications of each activity, and connections were made to both state and national standards.

Teachers were introduced to many laboratory activities and experiments that would be adaptable in middle and high school classrooms. One of the activities during the institute included a very simple activity with oleic acid in a solution that spread across the surface of a container of water to form a nanoscale thin film. This was an example of a nanoscale self-assembly process. Teachers studied nanostructure as it applies to sunscreens and UV rays, gelatin diffusion, electro-deposition, and nano medicine. Several powers-of-ten activities helped teachers get a grasp on the concept of nanoscale, and they studied and attempted to make a model of an Atomic Force microscope. Working in small groups, teachers also researched and discussed societal and ethical issues of nanotechnology.

Teachers had many opportunities to interact with UMass researchers who are investigating the various aspects of nanoscale science and engineering. Neil Forbes (Chemical Engineering) examined the delivery of nanoscale medicines to cancerous tumors. This was a follow-up to an interesting activity developed by Professor Forbes and staffer Terry Dun that used digital photographs to study the diffusion of food coloring into gelatin over a period of days, modeling the absorption of nano-medicines in body tissues. The experiment used computers to measure the diffusion from the photos, a nice example of using technology to facilitate an experiment.

Jonathan Rothstein (Mechanical Engineering) discussed the impact of nanotechnology in his research involving the benefits of nanoscale science and some of the more practical applications of nanotechnology, like making a ship sail faster or making a bulletproof vest stronger. Economics Professor William Gibson discussed the societal issues involved with nanotechnology regarding safety and medical concerns and the role of the government in this new industry. Discussion that followed these presentations by UMass researchers provided opportunities for teachers to gain a better understanding of the concepts and processes associated with nanoscale science and engineering.

Teachers also viewed several video and 3D animation modules that are under development at the Center for Hierarchical Manufacturing at UMass Amherst. These multi-media modules have the capacity to provide a link between the classroom activities that are common to middle school and high school STEM programs and sophisticated and complex nanoscale science and engineering processes. The feedback that teachers provided to the CHM staff will help them refine the modules to be more effective educational media for middle and high school STEM students.

Measuring diffusion with a digital camera and a computer

Continued on next page
During the institute, teachers began the process of developing nanoscale curriculum materials for their middle school or high school STEM programs so that their students can develop an understanding of and interest in nanoscale science and engineering processes. An online forum will be used for participating teachers to post lesson plan ideas with each other and to discuss nanotechnology topics.

Participants provided the staff with daily feedback on the content and logistics of the Institute which will guide the staff in planning the program for 2009. Comments at the end of the week were very positive about the experience. All of this year’s presentations, handouts, and lectures are available online including PowerPoint presentations enhanced with the actual audiotape of the lectures which accompanied the presentations.

Next summer’s institute will be held July 20-24, 2009. See www.umassk12.net/nano for more information.

They have ample data to demonstrate that the teachers, who with a few exceptions have no background in scientific research, have learned a great deal. It is much harder to determine the effect on the children in any quantitative way.

There is, however, considerable anecdotal information indicating a great deal of student enthusiasm and excitement. To cite one example, on a recent morning, 10 children voluntarily came to school 90 minutes early to see what effect the time of day has on bird populations. They have been doing this once a week for several weeks. They are comparing morning and afternoon observations, along with traffic and weather data, in an attempt to learn what factors impact bird populations. They and the other bird club members are also collecting data for the national Cornell Feeder Watch program.

STEM RAYS ends each year with a Saturday morning research conference at the UMass Campus Center at which students use posters, PowerPoint presentations, and other means to share their results. Parents and other relatives and friends attend. The displays are impressive and reflect considerable sophistication and effort.

The parents reported that their children and they themselves had learned a great deal from the program. Whether this will translate into increased interest in STEM courses and careers is still an open question.

Learn more about STEM RAYS at www.umassk12.net/rays.

Participants’ Comments:

Working in small groups gave us a good chance to bond and share ideas with teachers of similar and dissimilar backgrounds, and we learned a lot from the give-and-take.

I came into the institute with almost no knowledge of nanotechnology, and came out with a wealth of information, and the desire to learn more.

I can implement nanotechnology lessons into my curriculum easily and introduce some interesting nanotechnology careers to my students for consideration.

Staff, participants and more photos on page 5
This summer, STEM Ed hosted a new one-week science-teacher education program for teachers to study the Polar Regions and climate change in association with the International Polar Year (IPY). Supported by the National Science Foundation and the Climate System Research Center (CSRC) at UMass Amherst, IPY STEM Polar Connections was an initiative to integrate activities associated with the International Polar Year into the middle and high school curriculum. This curriculum development and professional development program was held at UMass Amherst from July 7th to July 11th.

Thirty-two educators from eleven states attended, including three from California and one from Ontario, Canada. Participants living outside the commuting distance stayed in the new UMass air-conditioned dorms. A stipend was offered to participants along with the opportunity for reduced credit costs or free professional development points.

**SUMMER INSTITUTE PARTICIPANTS**

Melinda Bell, Biology/Chemistry/Environmental Science, Flagstaff Leadership Academy, Flagstaff, AZ
Debra Brice, Science, Chemistry/Physics/San Marcos Middle School, San Marcos, CA
Jan Davagian, Life Science, Sutton Middle School, Sutton, MA
Tom Davidson, Environmental Science/Biology/Astronomy, Amherst Regional High, Amherst, MA
Susy Ellison, Earth Science/Environmental Science, Yampah Mountain High, Glenwood Springs, CO
Vickie Funk-Sheley, Life Science, Hermosa Middle School, Farmington, NM
Gary Gandolfi, Technology, Hillside Middle School, Northville, MI
Lollie Garay, Earth Science, Redd School, Houston, TX
David Gorril, Environmental Science/Chemistry, Barnstable High, Hyannis, MA
Joseph Hockin, General Science, Deer Park Public School, Toronto, Ontario, Canada
Reina Horowitz, Chemistry, LaGuardia High, New York, NY
R.M. Hungate, Science/Chemistry/Physics, Lee High School, Lee, MA
David Kalpin, Math/Science, Hamilton-Wenham Regional High School, Hamilton, MA
Maggie Kane, Astronomy/Ecology, Prescott Mile High Middle School, Prescott, AZ
Wayne Kermensi, Project Based Learning, Mohawk Trail Regional High, Shelburne Falls, MA
Todd Kline, Physical Science, Citrus Hill Intermediate, Corona, CA
Catherine Longley-Cook, Earth Science, Wilson Middle School, Natick, MA
Melissa Martin, General Science/Environmental Science/Astronomy, Northbridge High School, Whitinsville, MA
Joseph Mullett, Physics/Biology, South Middle School, Westfield, MA
Norma Neely, Science Instructor/Facilitator, A dair County R-2, Brashar, MO
Dora Nelson, Biology/Environmental Science/Ecology, Carolina Day School, Asheville, NC
Mary Anne Pella-Donnelly, Life/Earth/Physical Sciences, Chico Junior High, Chico, CA
Andrea Skloss, Science, Brundrett Middle School, Port Aransas, TX
Cappy Smith, Professional Development Dept., Texas Parks and Wildlife, Corpus Christi, TX
Jill Smith, Environmental Science/Physics/Chemistry, Port A ransas High, Port A ransas, TX
Johnnie Smith, General Science, Lamar Intermediate, Sinton, TX
Louise Smith, A II Subjects, A dair County R-2, Brashar, MO
Mary Swigert, Astronomy/Physics, Jupiter Community High, Jupiter, FL
Susan Tully, Earth Science/Math, Pingree School, Hamilton, MA
Jeff Weston, Biology/Physics/Chemistry, A thol High, A thol, MA

Led by STEM Ed Director Morton Sternheim, and Professor Julie Brigham-Grette, an internationally known geologist, the Institute’s staff also included climatologist Professor Ray Bradley, retired high school teachers Rob Snyder and Holly Hargraves, Project Manager and science educator Marie Silver, researcher Dr. Kate Devlin, and graduate student Beth Caissie. A combination of lecture, discussion, and a variety of hands-on activities during the week were packed with opportunities for learning and curriculum development.

Topics for the institute included climate change and its impact on Polar regions and the world, Polar flora and fauna, the history of Polar exploration, the politics of the Arctic and the Northwest Passage, and personal anecdotes of actual research conducted by Drs. Brigham-Grette, Bradley, and Devlin.

One key focus of the Institute was the data showing that climate change is happening much more rapidly in the Artic, and to some extent in the Antarctic, than in temperate areas.

A second was the remarkable evidence that atmospheric carbon dioxide levels are their highest in more than half a million years. In addition, almost half the participants had prior experience with programs focusing on climate and/or polar regions, with most of them having actually visited the Arctic or Antarctic. Time was provided for presentations from those teachers so they could share their experiences with the whole group.

**PARTICIPANTS’ COMMENTS:**

This was an exceptional workshop and well worth my long travel to get there.

I am now able to put together a well organized and informative unit about the polar regions and climate change.
Teachers were introduced to sets of STEM Polar Connections Modules that emphasized the process of scientific inquiry, and they explored a variety of proven techniques for effective teaching, including inquiry-based teaching, cooperative learning, and methods for formative assessment of student learning.

The project is committed to an extensive program of dissemination of these modules by the staff and by the teachers. By the end of the institute, the teachers were beginning to make plans for implementation of new lessons into their curriculum and for the development of workshops and presentations for other teachers in their districts, or at state or national venues.

Teachers provided overwhelmingly positive feedback about this new institute and expressed appreciation to the staff for the well organized and interesting material, including an impressive amount of material put online on the Institute’s website, http://umassk12.net/ipy. The IPY Institute will be offered once more next summer, June 28 - July 2, 2009.
This is the final academic year of this very useful scholarship program. It enables UMass undergraduates and recent graduates to complete their preparation as science or math teachers. Undergrads can receive two years of support, and grad students one year. Recipients must teach two years in an underserved district somewhere in the U.S. for each year of the scholarship.

The original program provided for awards of $7500 to $10,000. Since tuition and fees total at least $10,000, this required students to find other ways to cover their remaining expenses. Last fall the ground rules were revised so that the minimum is now $10,000, and the maximum is the full cost of education, thus allowing us to make awards of up to $20,000.

This change has increased the appeal of the scholarships. We are now supporting students who would not otherwise be able to enroll in the certification program, or would have taken longer to complete it because of the need to work at part time jobs. This is especially important for many community college transfers and nontraditional, older students.

All the funds in the $500,000 program have now been spent or committed to a total of 31 students. They will play an important role in improving science and math education in our middle and high schools.

More information about the program is online at www.umassk12net/bridge.

Congratulations to the following Noyce Scholars for late fall 2007 through 2008. (This year marks our completion of the program: all scholarship monies have been awarded under the National Science Foundation grant.)

2007-2009 NOYCE SCHOLARS BY MARIE SILVER

Ms. Jennifer Smith - Ms. Smith was a transfer student from Holyoke Community College to UMass to finish her degree in biology. She completed her first year at UMass and has received a second year of scholarship assistance. Her goal is to become a high school biology teacher. She is a first generation college student and was an honors student while attending community college.

Ms. Courtney Bergquist - graduated from UMass with a degree in biology and is currently enrolled in the 180 Days in Springfield Program at UMass to obtain her Masters Degree. She plans to teach middle school science.

Mr. Jason Defuria - is an undergraduate at UMass majoring in biology. He plans to teach high school biology and will be completing his student teaching in spring 2010.

Mr. Diem Phuc Ho - was enrolled in the 180 Days in Springfield program and received a Masters in Secondary Teacher Education. He teaches biology at Central High School in Springfield.

Mr. Phuong Thi Ho - was enrolled in the 180 Days in Springfield program and received a Masters in secondary teacher education. She teaches chemistry and biology at Central High School in Springfield.

Ms. Mary Wigmore - has returned to UMass after spending many years as a field forester and watershed manager. She is an undergraduate mathematics major at UMass and plans to teach high school mathematics.

Mr. Marc O'Neil - was a community college transfer student and graduated from UMass with a major in astronomy. He is enrolled in the STEP program and plans to teach middle school science. He is currently student teaching at Great Falls Middle School.

Mr. David Hamilton - was a microbiology major at UMass and graduated in 2006. He taught chemistry at Brookline High School for a year and is attending UMass for his graduate degree in Secondary Teacher Education.

Ms. Jessica Eaton - is an undergraduate mathematics major at UMass and has served as a teaching assistant and tutor in the Math Department at UMass. She will graduate in 2010 and plans to teach high school math.

Ms. Donna Fowler - was a transfer student from Greenfield Community College and went on to graduate from UMass in 2006 in mathematics. She is currently teaching high school math at Turners Falls High School and is enrolled in the STEP Program to obtain her Master's Degree.

Mr. Brian Hydefrost - is a transfer student from Greenfield Community College interested in teaching mathematics. Prior to returning to college he worked for several years as an organic gardener.
Conference on Alternative Certification for Science Teachers: Lessons Learned

As we reported last year, STEM Ed and the School of Education held a national conference entitled “Science, Technology, Engineering and Math - Alternative Certification for Teachers” (STEM-ACT) on May 5-7, 2006 in Arlington, Virginia. This is the third conference STEM Ed had managed for the National Science Foundation (NSF) in Arlington. Funded by a NSF $200,000 grant, the conference brought together about 70 researchers, policymakers and practitioners. It was a working conference, with all the attendees presenting papers or offering prepared responses to the presentations and with everyone taking part in closing sessions designed to extract the main points of the discussions.

It became very clear early on that the term alternative certification is ambiguous. To some, alternative certification programs are those designed to respond to teacher shortages by putting career-changers and others into classrooms more quickly than “traditional” teacher education programs. Others use this designation for anything other than a four-year undergraduate certification program. There is a myriad of alternative teacher certification programs in existence at national, state, and local levels, designed for substantially different populations of teacher candidates, and with various programmatic features. The consensus at the conference was that there needs to be a continuum of teacher preparation and support programs to serve the varied needs of schools and of preservice and in-service science teachers.

Another key point that emerged is that much of what is believed about the quality of teacher certification programs, in general, is not supported by any evidence. It was also noted that both supporters and critics of alternative certification base their opinions on a very thin research base. Clearly much more research is needed.

The highlights of the conference have been reported at annual meetings held by the National Association for Research on Science Teaching (NARST), the Association for Science Teacher Education (ASTE), and the American Association of Colleges of Teacher Education (AACTE). There has also been a report delivered at an NSF Discovery Research K-12 (DR-K12) Principal Investigators meeting and a paper published in the Massachusetts Association for Supervision and Curriculum Development Perspectives.

Three “white papers” addressed to the research, policy making, and practitioner communities have been produced and are available, along with a summary, at www.stemtec.org/act/whitepapers.htm.

Alternative Certification for Science Teachers: White Papers

STEM Ed and the School of Education organized a National Science Foundation funded conference on alternative certification for science teachers that was held in Arlington, VA, May 5-7, 2006. About 70 representatives from three communities attended: researchers, policy makers, and practitioners or providers. The conference was designed to facilitate a significant exchange of information, which was then synthesized to produce white papers on the three threads of the conference, i.e., policy, practice, and research.

One goal of the conference was to identify key issues related to the alternative certification (AC) of science teachers to support a more systematic study of AC efforts. A second goal was related to the extensive research programs on science teaching and learning that have been funded for 30 years by NSF and other agencies. We now know a great deal about the teaching and learning of science in schools. What is not known, however, is how to incorporate this knowledge into AC programs. Therefore, a guiding question of the conference was “What do we know and what more do we need to learn about how to incorporate the results of research on science teaching and learning into alternative certification programs?”

The three white papers on policy, practice, and research are now available, along with an executive summary. They are available online at http://www.stemtec.org/act/WhitePapers.htm or, while supplies last, in print form from STEM Ed.
Limiting the scope of the content covered in any individual course allows for a more focused study of each topic. And although this format sometimes slows down the pace of instruction, it does allow for the opportunity for students to revisit material during the semester and build on previously developed understanding. Experience has shown that teachers’ confidence in, and enthusiasm for subsequently teaching the material increases, as a result of this approach.

Although all course designs are informed by the Learning Standards of the Massachusetts Science and Technology/Engineering Curriculum Framework, instruction and activities in the courses place an emphasis on helping students to first identify and understand the key concepts (or “big ideas”) associated with the physics content.

Course assignments typically include the development of teaching/learning materials where the big ideas provide a link to the grade level appropriate LS’s in the Frameworks. A common set of goals for these courses is to:

- Increase students’ understanding of science content topics including energy, electricity and magnetism, light and sound – and their confidence in preparing and teaching this material in the elementary school class room;
- Make explicit connections between the science content of the course and teaching/learning methods that may be used in the elementary classroom;
- Link the “big ideas” of the course content with relevant Learning Standards in the Massachusetts Frameworks for Science and Technology/Engineering, and the National Science Education Standards.

Courses have typically been offered in the late afternoon/evening and depending on the number of class sessions during the semester meet for times ranging from 2.5 to 4 hours. Each class meeting involves 2 - 3 “investigations” or lab activities around which the physics content is presented and discussed. This provides opportunity for students (teachers) to learn in a context similar to that which they will then be able to use with students in their own classrooms.

When engaging in hands-on activities, students typically work in groups of 3-4, and although groups are formed randomly, within several weeks of the start of class all students tend to become contributing members regardless of their previous science background. Once teachers/ students have some initial understanding of the material being studied, elements of the inquiry process – observation, posing and pursuing the answer to a question – is followed. Formative assessment tools, including quick-writes, “exit questions”, and sample problem solving are utilized during each class meeting. Homework assignments are designed to ensure some reflection on
PV STEMNET (the Pioneer Valley Science, Technology, Engineering and Mathematics Network) spent this past year organizing the Network’s Steering Committee and Advisory Board, pursuing additional grant funding, sponsoring STEM 2008 summer academies for middle and high school students and graduate-level, professional development programs in STEM for area teachers, and creating a strategic plan for the future.

In the Fall of 2007 Network members came together to pursue additional Department of Higher Education funding under the Teacher Quality Initiative. Grant proposals were submitted by regional groups in the Network. Funded through this initiative was the STEMRAYS project, a partnership between UMass, GCC, Smith College, area businesses, Franklin County school districts, and Amherst and Northampton public schools.

Summer academies were held for Holyoke and Springfield middle and high school students that focused on providing participants with an introduction to STEM subjects. These programs are part of a Pipeline grant initiative overseen by the Massachusetts Department of Higher Education.

These programs offered students hands-on opportunities and related field trip activities designed to provide STEM exposure and to develop career interest in these fields. The academies were held at Holyoke Community College under the direction of Carl Satterfield and Ken White, and at American International College under the direction of Jack Barocas and Esta Sobey.

In addition to these two student programs, five professional development programs in STEM for middle school teachers were sponsored by the Network and funded under a federal grant administered by the Massachusetts Department of Elementary and Secondary Education. Electricity/Magnetism, taught by Mort Sternheim and Chris Emery, was offered through the Physics Department at UMass, and Trigonometry/Calculus, taught by Ileana Vasu and Alex Alvarez, was offered by the UMass School of Education.

Other courses sponsored by the Network were Engineering Technology, taught by Mary Ann Connors and Tom Kress at Westfield State College, Physical Science, taught by Karl Martini and Jim Fownes at Western New England College, and Chemistry, taught by Carl Satterfield and Chevy Seney at Holyoke Community College. Teachers participating in these programs came from approximately 25 school districts in the region.

With the Network’s establishment of a Steering Committee, discussion for the year was focused on development of a Strategic Plan. A subcommittee consisting of Mort Sternheim (UMass), Allan Feldman (UMass), Janice Doppler (Gateway Regional), Anne McKenzie (LPVEC), Helen Gibson (Holyoke Public Schools), and Zvi Rozen (consultant to the DHE), began work on a vision and mission statement and goals for the Network.

The results of the subcommittee’s work is listed below.

**NETWORK VISION**
The Pioneer Valley PreK-16 Science, Technology, Engineering and Mathematics Network (PV STEMNET) will become the primary regional organization for STEM education in the Pioneer Valley.

**MISSION**
The mission is to improve STEM education by fostering an environment of equitable collaboration and a coordinated effort among a variety of constituencies: K-12 schools, workplace, and higher education.

**GOALS**
- Work in partnership to determine the needs and priorities of the Pioneer Valley region,
- Help Network partners to secure future funding
- Increase awareness of and interest in STEM education and careers,
- Develop and sustain the Network Membership in the Network is extensive. Public schools, charter schools, parochial schools, institutions of higher education, and many area businesses are partners.

For information on joining the Network contact the Network’s Principal Investigator Allan Feldman (pvnet@umassk12.net) or the Project Manager Kathy Baker (kbaker918@aol.com). Also, see our web site, www.umassk12.net/pvnet.
The Arsenic Project: Creating Authentic Research Experiences for First-Year Undergraduates

by Julian Tyson, Department of Chemistry, University of Massachusetts

Julian Tyson’s arsenic project is an outstanding example of integrating research into multiple levels of teaching.

Introduction  UMass’ mission is to provide an affordable and accessible education of high quality and to conduct programs of research and public service that advance knowledge and improve the lives of the people of the Commonwealth, the nation, and the world. I think that every tenure-system faculty member of such an institution should strive (a) to contribute to both the undergraduate and graduate teaching mission, (b) to publish the results of a relevant research program, and (c) to reach out to students at early stages and encourage them to continue their education to the bachelor’s level, doctoral level and beyond. I view this latter activity as crucial for faculty in the STEM disciplines, given that the US is facing a gathering storm in terms of (a) the country’s position as a world leader in science and technology, and (b) the economic benefits that accrue from such a leadership position. For the conscientious faculty member, there are clearly time constraint issues. How is it possible to contribute meaningfully to the teaching, research and outreach missions of the institution and still have time to eat and sleep? My perspective on this conundrum is to find ways to integrate research with teaching and learning. I recognize that this may not be possible for every faculty member, but one goal for this aspect of the arsenic project is to show that it can be done.

Over the past four years, I have been experimenting with the integration of research with teaching and learning with the goal of investigating the extent to which one faculty member can create authentic research experiences for large numbers of students (both undergraduate and earlier) that motivate them to continue with their study of STEM subjects and to seek out further research opportunities. The activity is designed to provide elements of an authentic research experience, including the opportunity (a) to become familiar with the relevant big picture, detailed background, and previous work done, (b) to conduct a series of experiments in which the designs of the later ones can be based on the outcomes of earlier ones, (c) to draw conclusions, summarize the findings, make suggestions for further work and (d) create a written document containing the material of interest to the broader community. Other features of an authentic research program included are: (a) inexperienced workers work alongside the more knowledgeable workers, from whom they can obtain guidance and information as needed; (b) participants are part of an active community of scholars who meet to discuss their findings and to examine critically new knowledge in the field; and (c) participants take some responsibility for the design and implementation of the experiments.

Topic and program  There are two issues to consider: the research topic and the program structure. Environmental issues catch students’ attention as there is often a personal health connection. I have found that issues surrounding the environmental and analytical chemistry of arsenic compounds have been very suitable as the basis for the student’s investigations. The bio-geochemical cycling of arsenic is one of my own research interests and so the students’ participation is described as joining my research group. This means that I assign the topics on which each group works.

Participants sign up for a one-credit semester-long honors colloquium in which 2 - 4 first-year undergraduates work with 1 - 2 juniors and a graduate student mentor. Over 300 undergraduates have participated to date; about 75% are first year students. Themes include the leaching from pressure-treated wood and movement in the soil, the uptake by plants and insects, the removal from contaminated drinking water and reliable determinations at single digit microgram per liter concentrations with low-cost, portable measurement technology.

Impact  Students who participated in 2005-6 filled out a questionnaire at the end of the semester. They were very satisfied with the experience. Here are typical comments:

This project was extremely informative and interesting and I would recommend it to anyone, especially first-year students looking for a place to start getting research experience.

I really enjoyed working as part of a group on the arsenic project. It was very interesting to me, and I learned a lot about the hard work that doing research requires. Overall, it was a positive experience, and I would enjoy doing more research in the future.

I really feel that this project has made me more confident in seeking out other laboratory activities and research in the future. I feel I have benefited tremendously by having my first lab experience in an environment with friends and others who were in the same position, as well as the ideal balance between close supervision and freedom to perform the lab work. I hope other students will have the opportunity in the future to benefit as I have from this project.

I have not followed what has happened to the participants in terms of seeking out other research experiences or staying in sciences. I am certainly writing more letters of

continued next page
FALL 2008
SPECIAL HALF DAY PROGRAM COSPONSORED BY THE STEM ED INSTITUTE
NOVEMBER 22 9:30 AM - 1 PM
UNIVERSITY OF MASSACHUSETTS AMHERST

VIRUS STRUCTURE, VIRUS EVOLUTION AND THE DARWIN BICENTENNIAL
A hands on computer workshop; PDPS, parking, and snacks provided

JONATHAN KING, PROFESSOR OF MOLECULAR BIOLOGY, MIT
Free but space is limited; advanced registration is required. Go to: www.umassk12.net/sess/darwin.html

FALL STEM TALKS
REFRESHMENTS AT 3:45
PRESENTATIONS AT 4:00
PLEASE PARK IN THE GARAGE.

November 4 USING PALEOMAGNETISM TO TELL THE AGE OF DEEP-SEA SEDIMENTS: LESSONS FROM THE SCHOOL OF ROCK
MARK LECKIE, DEPT. OF GEOSCIENCES, UNIVERSITY OF MASSACHUSETTS AMHERST

November 18 USE YOUR HANDS! GEOLOGIC CLASSROOM AND FIELD ACTIVITIES WITH DEAF HIGH SCHOOL STUDENTS
MICHELE COOKE, DEPT. OF GEOSCIENCES, UNIVERSITY OF MASSACHUSETTS AMHERST

December 2 AN EINSTEIN FELLOW’S MIRACULOUS YEAR
KATHLEEN GORSKI, WILBRAHAM & MONSON ACADEMY

SPRING 2009
- DESIGNED FOR SCIENCE TEACHERS; NEW TEACHERS ARE ESPECIALLY WELCOME
- FIVE SATURDAYS/TUEDES; 8:30-1, UMASS AMHERST
- EDUCATIONAL MATERIALS, REFRESHMENTS, PARKING, PDPS INCLUDED
- ADVANCE REGISTRATION IS REQUIRED; CAPACITY LIMITED
- COST $30 PER SESSION, $120 FOR ALL FIVE SESSIONS
- 4 PDPS PER HALF DAY SESSION; OPTION FOR 3 GRAD CREDITS AT REDUCED COST WITH EXTRA WORK

February 7 THE BIOLOGY OF THE POLES
MARIE SILVER, STEM EDUCATION INSTITUTE. As part of UMass’ participation in the International Polar Year research effort, curriculum has been developed for the K-12 teacher. Participants will learn about the unique life forms found in the Arctic and Antarctica. Hands on activities will include animal and plant adaptations to cold climates, plant succession following glacier recession and phenology (recording plant life cycles and correlating it to environmental change).

February 28 NANO TECHNOLOGY
MARK TUOMINEN, PHYSICS DEPARTMENT AND CENTER FOR HIERARCHICAL MANUFACTURING. Another in a series on nanotechnology; previous attendance is not required. The atomic force microscope (AFM) allows researchers to map surfaces at the atomic level; a multimedia module shows how this is done, and a hands-on activity models the AFM. Nanomedicine is explored via a diffusion experiment and a presentation.

March 7 USING BIRDS TO TEACH BIOLOGY
BRUCE BYERS, BIOLOGY. Observations of organisms in their natural environments can spark a lifelong interest in biology. Charismatic organisms are especially well suited to this role. For example, birds are conspicuous inhabitants of urban, suburban, and rural environments, and are intrinsically appealing to almost everyone. They are easily observed at feeders and elsewhere, and engage in a variety of fascinating behaviors. We will share ideas for inquiry-based activities and exercises centered on observations of birds that address key elements of the Massachusetts Curriculum Frameworks for science, especially Frameworks related to ecology and evolutionary biology.

March 28 WHERE ON EARTH ARE YOU?
ROB SNYDER, STEM EDUCATION INSTITUTE. Explore the wide range of applications of Global Positioning Systems (GPS) that include indicating your elevation, latitude and longitude on Earth’s surface, guiding you to a specific set of coordinates, collecting data that can be used to map important features such as a water shed or a wetland area, or calculating a value for Earth’s circumference.

April 4 TRAFFIC ENGINEERING AND THE EVERYDAY WORLD
MIKE KNODLER, CIVIL AND ENVIRONMENTAL ENGINEERING. This workshop introduces students to basic traffic engineering principles; emphasis on the safe and efficient operation of intersections. More importantly the sociological impacts of transportation on everyday life will be explored in detail. Over 40,000 people are killed each year on U.S. roads, many at intersections. Further, increasing traffic volumes has led to congestion requiring improved vehicle movement efficiency at intersections. Topics are: vehicle, operator, and roadway characteristics; traffic control; roadway capacity; geometric design objectives and plan formulation; demand forecasting; and economic, social, and environmental evaluation. The workshop features several hands-on activities that can be adapted for all grade levels.

May 2 WEATHER CANCELLATION MAKEUP
May 9 RECALL FOR THOSE REGISTERED FOR GRADUATE CREDIT

GRADUATE CREDIT OPTION
There is a charge of $300 for 3 Continuing Education credits, and a $45 registration fee 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.

Register with Continuing Education or the UMass Graduate School. QUESTIONS: Mort Sternheim, mort@umassk12.net, 413-545-1908. www.umassk12.net/sess/register.html Required for everyone whether or not they are registering for graduate credit.

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Creating Authentic Research Experiences for First-Year Undergraduates

recommendation for students seeking admission to summer research (REU) programs. The number of undergraduates undertaking individual independent studies in my own research group has increased significantly from one to two a semester to five to seven. Many of these have gone onto graduate school.

Other facets of the program
As well as the semester-long undergraduate research projects, I have also been able to create summer REU-type experiences for underrepresented minorities from other institutions. So far, nine undergraduates and two high school students have participated. In the summer of 2008, a middle school teacher participated in a research experience that will result in further work by her students. This is, in some ways, where the program started, as the first arsenic project activities, other than research by my graduate students, were done by middle school teachers and students participating in the NSF-funded Graduate Students in K-12 Education (GK-12) program that was known locally as STEM Connections (2002-05). With the help of a no-cost extension and funds from another NSF grant and UMass, the arsenic projects continued for another year with two teachers. The arsenic topics have also been incorporated into the STEM RAYS after school science clubs and summer academies. The responses from the juniors are much the same as those from the first-year students, and those from the graduate students show benefits in terms of their professional development as teachers, mentors and researchers.

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CALENDAR  FALL 2008/Spring 2009

FALL PROGRAMS
VIRUS STRUCTURE, VIRUS EVOLUTION AND THE DARWIN BICENTENNIAL - special half day program
JONATHAN KING, PROFESSOR OF MOLECULAR BIOLOGY, MIT
Saturday, November 22  9:30-1, University of Massachusetts Amherst

FALL STEM TALKS:  3:45 PM refreshments, 4 PM talk. Hasbrouck 138.
Parking is available in the garage.
November 4 USING PALEOMAGNETISM TO TELL THE AGE OF DEEP-SEA SEDIMENTS:
LESSONS FROM THE SCHOOL OF ROCK
MARK LECKIE, DEPT. OF GEOSCIENCES
November 18 USE YOUR HANDS! GEOLOGIC CLASSROOM AND FIELD ACTIVITIES WITH DEAF HIGH SCHOOL STUDENTS
MICHELE COOKE, DEPT. OF GEOSCIENCES, UNIVERSITY OF MASSACHUSETTS AMHERST
December 2 AN EINSTEIN FELLOW’S MIRACULOUS YEAR
KATHLEEN GORSKI, WILBRAHAM & MONSON ACADEMY

SCIENCE & ENGINEERING SATURDAY SPRING SEMINARS
February 7  THE BIOLOGY OF THE POLES  MARIE SILVER, STEM EDUCATION INSTITUTE
February 28  NANOTECHNOLOGY  MARK TUOMINEN, PHYSICS DEPARTMENT AND CENTER FOR HIERARCHICAL MANUFACTURING
March 7  USING BIRDS TO TEACH BIOLOGY  BRUCE BYERS, BIOLOGY
March 28  WHERE ON EARTH ARE YOU?  ROB SNYDER, STEM EDUCATION INSTITUTE
April 4  TRAFFIC ENGINEERING AND THE EVERYDAY WORLD  MIKE KNODLER, CIVIL AND ENVIRONMENTAL ENGINEERING
May 2  WEATHER CANCELLATION MAKEUP DATE
May 9  RECALL FOR THOSE REGISTERED FOR GRADUATE CREDIT

PLEASE SEE PAGE 11 FOR DETAILS.