Abstracts

ARIZONA STATE UNIVERSITY

Poster 1

PI: B.L. RAMAKRISHNA
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Discipline: Engineering

Implementing the NAE Grand Challenges

In October 2008, the National Academy of Engineering identified 14 Grand Challenges for engineering to address in the 21st century in order to improve life on our planet. These Grand Challenges provide a platform that allows for lesson development within state and national STEM standards while also addressing the most pressing science and engineering challenges worldwide. In partnership with local teachers, Arizona State University's GK-12 fellows developed inquiry-based lessons based upon those Grand Challenges that best aligned with their respective research areas. Incorporating these lessons into K-12 classrooms ignite interest in STEM and provide the benefit of exposing students to current and future issues facing communities around the world. The lessons pertained to concepts underpinning the engineering of better medicines, future engineering tools, improving urban infrastructure, personalized learning, sustainable energy systems, and clean water. Fellows benefited from this approach to lesson building by bringing their respective research expertise to a public educational forum. K-12 student participants gained insight into the fellow's research while also being exposed to engineering challenges that they will face within their lifetimes. The broader impact of these lessons was promotion of an understanding of engineering from a societal perspective for students and teachers while allowing the fellows to communicate their research.

Poster 2

PI: CHARLES REDMAN
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Discipline: Sustainability Science

Sustainability Science for Sustainable Schools

ASU's Sustainability Science for Sustainable Schools program engages graduates students in sustainability with high school teachers to develop sustainability projects and curriculum at their schools. Crossing disciplinary boundaries and co-creating knowledge are a focus of sustainability science and our projects. This poster will highlight some of the projects that have been co-developed with graduate students and high school teachers that impact curriculum, campus and community.

ARKANSAS STATE UNIVERSITY

Poster 3

PI: JENNIFER BOULDIN
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Disciplines: Ecology, Environmental, and Earth Sciences

ASU Graduate Students Enhance Communication Skills and Science Education in the Arkansas Delta

Interest in science careers begins during the early years of a child's education. Enhanced science curriculum in grades 6-8 in six area public schools is facilitated by NSF. Our GK-12 program targets rural public school districts in the Arkansas Delta region which are represented by diverse ethnic student populations. In the first two years, 2,381 public school students have been exposed to enhanced science learning. Graduate Fellows team-teach one day per week with their two Mentor Teachers to enhance the science environment and strengthen Mentor Teachers' content knowledge and experience. Hands-on learning for the students is directed by the Fellows based on their research experiences. Lesson plans written by the Fellows are aligned to the Arkansas Science Curriculum Frameworks, and spark excitement and inquisitiveness in the students. Increased understanding of their research and improved communication skills are obtained by the Fellows while middle school students are introduced to cutting-edge science curriculum. Lesson plans are available to classroom teachers for further use and facilitate continued enhanced science curriculum to encourage student interest in STEM careers.

Contact: Kevin Keen, kevin.keen@smail.astate
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences

ASU's GK-12 Program - Land Use, Land Cover, and Biodiversity in the Mississippi Embayment

Our 2011 program consists of four Master's and four Ph.D. students. The diversity of the fellows' research is highly conducive to direct incorporation into the classroom as well as stimulating interest in STEM careers. **Amanda White** (M.S. candidate) is quantifying population dynamics of stored product insects at a rice mill in northeast Arkansas. Amanda has simulated her research in the classroom by having students determine the number of imitation insects caught in pseudo traps and then displaying the data in various visual formats. **Chris Foshee** and **Jeremy Everitts** are Master's students studying the ecology of Mallards and Swainson's Warblers, respectively. Each utilizes radio telemetry and quantifies habitat quality which they directly incorporate into the classroom with hands-on soil texture and composition activities, radio telemetry, and lessons emphasizing the importance of habitat conservation and restoration. **Kevin**

Abstract

Keen (Master's candidate) has taken students to his nearest research project, the Bearitage Research and Learning Facility for scientific investigations including benthic insect sampling, radio telemetry, and herpetological studies. **Jonathan Stanley** (Ph.D. candidate) is monitoring the changes in vegetation and mice and rattlesnake populations due to prescribed fire regimes in the Ouachita Mountains. He has devised lessons involving dichotomous keys and mark-recapture simulations to convey critical aspects of proper biological identification and population dynamics. **Katie Lisko** (Ph.D. candidate) is studying vitamin C metabolism in rice. She involves students in conducting plant growth experiments while imposing abiotic stresses to determine the effects of added vitamin C. **Teresa Brueggen** (Ph.D. candidate) is assessing chemical, biological, bacteriological, and physical water quality changes in response to implemented best management practices on agricultural lands in the upper Strawberry River watershed. Teresa has conducted erosion experiments as well as activities involving mock benthic collections and analyses to determine the health of the model collection site. **Mauricio Solis (**Ph.D. candidate) is describing the carrion feeding insect fauna that visit pig corpses in rural and forested areas in northeast Arkansas to increase the regional knowledge of necrophagous species used in forensic entomology. Mauricio has implemented dichotomous keys in the classroom which play a pivotal role in the accuracy of his research data. He also has students observe behavior of various insects and emphasizes the importance of all biota.

BOISE STATE UNIVERSITY

Poster 4

PI: KAREN VISKUPIC
Contact: Brian Stark, brianstark@u.boisestate.edu
Kerry Riley, Brian Stark, Emily Hinz, and Micah Scholer
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences, Geology and Geography

The Benefits of Outdoor Learning in STEM Education

One question often posed by K-12 students is "How does this relate to the real world?" Outdoor education offers an effective method to incorporate STEM into the curriculum, challenge and stimulate students in a tangible way, and demonstrate the application of knowledge learned in classroom settings. The Foothills Learning Center and the Morrison Knudson Nature Center are environmental education centers located in Boise, ID where the focus is on "learning outside." Boise State's GK-12 Fellows are serving at these centers to offer biology and geoscience expertise, develop inquiry-based learning opportunities that focus on local issues with outdoor themes, serve as mentors for students and teachers interested in science, and to help students understand how science shapes their world. One lesson that exemplifies the benefits of learning outside is a rock cycle lesson, which utilizes the proximity of the learning center to a geologic field setting. Students extend their knowledge of the rock cycle to answer questions about the ancient Lake Idaho, which is an important geologic feature in the area. After learning proper data acquisition methods, students go to large rock outcrops and make observations, collect evidence, and formulate interpretations based on the evidence. Students use a modern stream channel to help understand the past geologic record. The geology lesson demonstrates to students the methods that the geoscience fellows use in their own research. Another example is the "Kids in the Creek" lesson, which provides students the opportunity to explore biology and hydrology within the context of a river ecosystem. Students are equipped with a net and bucket and instructed to investigate a shallow section of the Boise River to see what organisms they can find. They are provided with little background information, which promotes self-discovery and inquiry-based learning. The lesson culminates with students sharing their findings and a discussion of how the organisms they encountered have adapted to their environment, their significance to river ecosystems, and how human activities can impact these organisms. By formulating hypotheses based on their observations, students are exposed to some of the core principles of the scientific method. They experience the process of an actual field scientist, formulating questions based on their own observations of the natural world.

Contact: Stephanie Wyler, stephaniewyler@u.boisestate.edu

Fellows in the Foothills Bring Current STEM Research to Environmental Education

Boise State's GK-12 Project pairs fellows with local learning centers including the Foothills Learning Center (FLC). FLC is uniquely situated in the sagebrush steppe ecosystem that surrounds the city of Boise and comprises much of the Southwest Idaho landscape. This allows visitors to observe many native plants and animals as they learn about the environment. Another great aspect of FLC is its geological features of sandstone cliffs and creekbeds. There are three fellows at FLC. Each graduate student prepares a weekend public education event as well as a lesson that will become a permanent class offered at the learning center. Kerry Riley, a Geomorphologist, studies how Pleistocene era fire events caused debris flows which are preserved in the rock record. Sedimentation is a major process of debris flow events. Her lesson teaches about soil types and sedimentation events, and her public education class will inform about how to be fire smart. Emily Hinz, a geophysicist, uses forms of energy, such as sound waves, to check for underground contaminants. Her lesson teaches about the rock cycle. She's also teaching the public about how flooding events can shape the landscape. Stephanie Wyler, a molecular biologist, studies the physiological process of liver regeneration. She lesson teaches about toxins in the environment, particularly dioxin, and her public education class is an introduction to ethnobotany.

Contact: Brian Deis, bddeis@gmail.com
Disciplines: Ecology, Environmental and Earth Sciences

Abstracts

Integrating Research into the K-12 STEM Curriculum Through an Environmental Education Center Partnership

Having the opportunity to be paired with the Boise WaterShed allows three Boise State Fellows to increase science content and appreciation for a diverse range of students. Fellows in the Earth and Biological Sciences have developed STEM activities that integrate their own research with local and regional science issues, thus making the content relevant and applicable. A fellow researching microbial biofuels has developed activities that explore the positive aspects of microorganisms in the environment. Students gain an appreciation for the important role of microbes in decomposition, nutrient cycling, bioremediation and renewable energy production. This message is brought home when students cultivate microorganisms from their surroundings. Another fellow has developed lessons about groundwater contamination that utilize geophysical research of subsurface contaminant plumes. Middle and high school students study methods to locate contamination plumes along with the latest science in remediation efforts. Students then locate contamination plumes using a combination of traditional methods (drilling wells and testing pH) and geophysical methods (mapping conductivity structure with a multimeter) in a model subsurface. Finally, students discuss local contamination plumes and efforts in remediation of these plumes via microbial degradation. This lesson shows students how the latest science in groundwater contamination is directly related to their local neighborhoods and how they interact with their own environments. A fellow researching seismic exploration. has developed a lesson that increases student awareness about local geothermal energy and the diverse ways we use this form of energy besides the commonly thought of electricity generation. Through a study of world hotspots, students develop an understanding of the common geologic settings in which we find geothermal resources. They build their own hot water geysers in order to develop their understanding of heat transfer and phase change. Each of these lessons bring university research into classrooms.

BOSTON UNIVERSITY

Poster 5

PI: BENNETT GOLDBERG
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental and Earth Sciences, Engineering, Physics

Boston Urban Fellows Focus on Advancing Science at English High School

The Boston Urban Fellows GK-12 program has focused on two main objectives this year: 1) concentrating the fellows' efforts in one high school to promote a long-term partnership that helps improve student interest and performance in the STEM classrooms; and 2) developing a sustainable approach to place STEM graduate students in local schools, with fellowship funding being shared by the university, departments, and advisors. This year's cohort of fellows included five graduate students who integrated with teaching staff at English High School, an urban school within the Boston Public School system. These fellows specialize in a range of disciplines, including Biomedical Engineering, Immunology, Marine Biology, and Mechanical Engineering, and brought their expertise to the Biology, Chemistry, and Physics classrooms. The Boston Urban Fellows worked with their collaborating teachers to design new class demonstrations and experiments related to their graduate research, bringing topics such as lipid synthesis, microarray imaging, and animal behavior research into the classroom. The fellows embraced the role of experimental experts and worked to teach their students the importance of the scientific method both in the classroom and in their lives. Additionally, individual fellows initiated after-school activities related to their interests, such as recruiting students for an Ocean Sciences Bowl team, starting a Robotics Club, taking a field trip to BU research labs, and organizing MCAS test prep sessions. By concentrating on one school, fellows, teachers, and advisors were able to work together to increase student participation in science classes and programs, as well as enrich classroom teaching methods. This project also demonstrated that additional graduate students could take advantage of the opportunity to teach science in the community by sharing a one-year fellowship that was supported financially by both the GK-12 grant and principal investigators. This allowed high school Chemistry students to learn from two different fellows, while permitting each fellow the flexibility to work both in the classroom and in their research labs. In the future, BU hopes to extend its collaborations in the science department at English High School by continuing to integrate graduate students and teachers, with a long-term goal of enhancing student interest in pursuing scientific careers.

Poster 6

PI: SUCHI GOPAL
Contact: Valerie Pasquarella, valpasq@bu.edu
Disiciplines: Computer Science and Information Management, Geology and Geography

Topographic Mapping in Google Earth: When Two Dimensions Become Three

Massachusetts Grade 6-8 Earth and Space Science Curriculum requires that students "recognize, interpret, and be able to create models of the earth's common physical features in various mapping representations, including contour maps." In practice, students typically understand the general principles of contour mapping, but often struggle with visualizing the features of two-dimensional contour maps in three dimensions. To better establish the connection between flat contour maps and actual terrain, topographic maps can be

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viewed as layers in Google Earth. This activity succeeds in both engaging students and clarifying difficult visualization concepts, and the overall response from the students has been very positive. USGS contour maps covering the entire United States are readily available via a free downloadable Google Earth application, making it possible for students to explore the topography of virtually any place in the country. In addition, contour maps of other regions can be manually added using simple Google Earth image overlay functionality.

Contact: Caroline Polgar, polgar@bu.edu
Discipline: Biological Sciences

GLACIER: Global Change in the Classroom

My research examines the effects of climate change on the timing of when leaves emerge in the spring in Concord, MA. Leafing out of trees is extremely sensitive to temperature, and thus is a good proxy for studying the effects of climate change. Concord is an ideal location for this research because of the existence of unanalyzed records of phenological observations collected by Henry David Thoreau from 1852 to 1860. My collaborators and I are comparing current leaf-out dates of 43 plant species with the first-leaf dates as recorded by Thoreau for the same species. In 2009 and 2010, plants leafed out an average of 18 days earlier than during Thoreau's time. This change demonstrates that current warmer temperatures are leading to a significant advancement in the onset of spring compared to the 19th century. While we are learning from the past, we are also interested in future changes. To that end, we have planted seedlings of four native plant species at the Boston Area Climate Experiment (BACE) site, an experimental climate change facility. At BACE, research plots are exposed to different temperature treatments to determine how plants will respond to different climate change scenarios. In 2010, we saw significantly earlier leaf out in seedlings planted in warmed plots than those in ambient conditions. These results suggest that changes in the onset of leafing are likely to continue as the climate continues to warm. Climate change is the overarching theme of GLACIER GK-12 project, which fits well with my research and is an important topic to incorporate into science education at all levels. Some themes that my partner teacher and I have tried to reinforce through the school year is that science is not a stand-alone subject, that everyone can contribute to real science investigations, and that many of our personal choices have environmental consequences. We have incorporated science into math, reading, and writing classes. This fall students learned about bird identification and behavior. They used this knowledge to make observations and form questions about birds in the wild, as well as to submit bird sightings to a citizen science project run by Cornell University. In math we have used global and regional temperature records to learn how to graphically represent data by making line and bar graphs. In writing class the students write up their science investigations in a modified scientific paper format. Art projects have included posters in which students encourage others to act environmentally responsible. In the spring we will once again participate in a citizen science project. In cooperation with the rest of the classes in the GLACIER project we will be monitoring the leaf out dates of several common tree species at different schools. We will also submit these data to Project Bud Burst, a national phenology network.

BROOKLYN COLLEGE

Poster 7

PI: WAYNE POWELL
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Disciplines: Ecology, Environmental and Earth Sciences; Social and Behavioral Science

SASEE: Science Attitudes and Self Efficacy Evaluation

A common goal of educators is to make meaningful connections between science concepts and daily life, bringing relevancy to science. Brooklyn College's GK-12 initiative, City-as-Lab, utilizes the city's parks and other outdoor spaces as laboratories and sources of relevant scientific investigations for five New York City public schools participating in the Small School Initiative. Fellows bring their individual research expertise into the classroom, including the disciplines of psychology, archaeology, biology, chemistry, geology, and physics. Additionally, psychology Fellows are collaborating on a multi-school study exploring the effects of place-based and inquiry-based learning. The Science Attitudes and Self Efficacy Evaluation (SASEE) compares student efficacy in science, student attitudes toward science, and student environmental attitudes between classrooms with and without a GK-12 presence. Using SASEE, the psychology Fellows have uniquely integrated their work into the classrooms to create a unifying investigative collaboration between themselves, the physical science Fellows, the participating GK-12 teachers, and students in answering the simple question: What is effect of the City-as-Lab on students in the science classroom?

BROWN UNIVERSITY

Poster 8

PI: TIMOTHY HERBERT
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Disciplines: Engineering, Geology and Geography, Physics, Engineering

Mechanisms for Incorporating Research into Brown's GK-12 Program

Brown's GK-12 Program supports up to nine graduate fellows per year, who work directly with the Providence Public Schools. "Physical Processes in the Environment" aims to find unique ways of incorporating research into the K-12 classroom experience. Three successful initiatives will be described in this poster: 1) A summer research experience for K-12 teachers

who work in labs of Brown faculty and engage in cutting edge research projects. Weekly group meetings provide the opportunity to improve communication skills, assess summer progress, and make effective podium and workshop presentations. During the final week of the program, participants present their summer research through a formal mini-conference presentation. Teachers often work with Brown Fellows and faculty to bring this research knowledge back into their K-12 classroom. 2) In the academic year, classroom activities designed and delivered by Fellows have often been tied to their PhD research. Examples will be presented for each of the 2010-2011 Fellows. Along with these research-based activities, organized laboratory visits and outreach events on the campus have further allowed Providence students and teachers to witness graduate fellow research first-hand, to take advantage of science facilities at Brown, and to help bridge the gap between K-12 students and the college experience. 3) Fellows have organized a scientific conference at our partner elementary schools where Brown professors and graduate students participate in what seems like a fairly normal activity for them--presenting their research in a scientific conference format. For the elementary students, however, this day is certainly out of the ordinary. It begins with a keynote address in the school auditorium. Next, students rotate from classroom to classroom, visiting three scientific talks of their choice. For the students and Fellows, this conference has been the capstone of the year. Each of these activities serve as an example of the enthusiasm for science that we have learned is shared not only among the country's best researchers but also by our K-12 students and teachers. Through our GK-12 program, we hope to continue to kindle this new relationship between the country's eager learners and its prominent scientists.

CALIFORNIA STATE U, LOS ANGELES

Poster 9

PI: NANCY WARTER-PEREZ
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Disciplines: Computer Science, Engineering

Changing Students' Attitudes about STEM

GK-12 Fellows in the IMPACT LA Program at California State University, Los Angeles have been changing middle school and high school students' attitudes about STEM by bringing their research into the classroom. As visiting scientists and engineers working with partner math and science teachers in East Los Angeles classrooms, fellows are engaging students through demonstrations, videos of research laboratories, discussions about both historical and cutting-edge STEM innovations, and through fun hands-on research-related activities. In high school algebra I and II, geometry, and pre-calculus classes, students learn about how precision and scale are important math concepts for controlling the huge James Web Space Telescope, how images are really just two-dimensional matrices of pixels or macroblocks, that you can apply functions on matrices to embed digital watermarks in images or to track an object in a video sequence, and how computer scientists can program computers to perform these functions. In middle school pre-algebra math classes, students are reviewing positive and negative numbers with batteries and solar panels in series and learning how ultra violet light can be used to purify grey water in homes for water conservation. Eighth-grade physical science students are learning about ways to identify proteins for cancer research in a fun activity that also teaches them about surface area, friction, and forces. We have found that having fellows in the classroom conducting these types of activities has changed students' perception of engineers and scientists. From our 2009-10 evaluations, there was a significant positive change in students' perception of what engineers do (build/make/invent increased 20%) and a positive change in how students describe scientists and engineers as smart (+6%) cool/awesome (+8%), and creative (+4%).

CENTRAL WASHINGTON UNIVERSITY

Poster 10

PI: CAREY GAZIS
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Disciplines: Ecology, Environmental, and Earth Sciences

Yakima WATERS Project: Watershed Activities to Enhance Research in Schools

The Yakima WATERS Project integrates interdisciplinary watershed science research and related classroom activities and fieldtrips into K-12 classrooms in central Washington State. Each of the eight WATERS teams includes a graduate student fellow, a faculty mentor and a lead K-12 teacher, who collaborate to integrate authentic research into existing curricula. The Yakima WATERS theme provides a framework to educate K-12 students to meet the future challenges of managing the economically and ecologically important Yakima watershed. Graduate students are selected from four graduate programs: Biology, Chemistry, Geology, and Resource Management. This interdisciplinary collaboration allows WATERS teams to incorporate a variety of graduate student research topics and provide a real world context for inquiry-based learning. For example, middle school students from Cle Elum, WA have become an integral part of a Biology fellow's thesis project, which examines the seasonal movement patterns of Western Toads (Anaxyrus boreas) adjacent to Interstate 90 (I-90). Dedicated students accompany the fellow in the field several times a year and participate in radio-tracking Western Toads. This research is a subset of a larger multi-agency project studying vertebrate movement in the vicinity of I-90, with the goal of improving construction of habitat connectivity during highway expansion projects. Student participants are also filmed and interviewed during fieldwork. A documentary will be assembled by other students

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in the class to educate community members about the importance of wildlife conservation and demonstrate the middle school's connection with local environmental issues. Another particularly unique graduate fellow project integrates river research with math curriculum in a community-based learning environment. Eighth-grade math students in Selah, WA investigated temperature, conductivity, and discharge in multiple water samples across seasons in an effort to improve their understanding of data analysis and engage them in gathering data for real world application. This data will be provided to the city of Selah for Department of Energy mandated regulation. In addition to these projects, fellows have integrated elements of their research into classrooms through water chemistry analysis, amphibian ecology and disease, microclimate mapping, and human land use. Through the Yakima WATERS program, students are exposed to a variety of scientific problems and research topics. We aspire to underline the relevance of science research by promoting an understanding of the importance of the Yakima watershed and integrating graduate fellow research into the K-12 classroom.

CHRISTOPHER NEWPORT UNIVERSITY

Poster 11

PI: GARY WHITING
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Disciplines: Computer Science, Environmental Science

Linking Watershed Interdisciplinary Science Education with a Web-based GIS Interface

Our project places Fellows into 9th-12th grade Earth Science and Ecology classrooms where they implemented an interdisciplinary approach to an environmental question: What is the health of the local watershed and what events and actions influence it? The WISE (Watershed Interdisciplinary Science Education) project integrates GIS technology and computer science, basic and applied biology (entomology and ecology) and chemistry. The broad goals for our project are: (1) to broaden the contextual framework of the graduate Fellows' research, (2) to enhance the Fellows ability to effectively communicate how science works, (3) to bring the excitement of doing science into the high school student's lives, and (4) to have these students apply their findings to directly benefit the environment and society. One of the basic themes of our program is water quality and the local environment. The quality of water runoff from our urban environment significantly affects our surrounding Chesapeake Bay habitats. Because of the variety of environments within the Newport News peninsula, the small ponds and lakes that receive runoff from the students' backyards provided excellent field sites for them to explore landscape properties and their effects using spatial mapping techniques and analyses. Our Fellows trained and helped the high school students design experiments to sample sedimentation rates, nutrient concentrations, and insect populations within small local urban lakes located within the school neighborhoods. Our computer science Fellows implemented a GIS application that is suitable for high school students. This application was developed as a Web interface that is both appropriate for non-GIS-experts and easily accessible from schools. Using the application, high school students input their sampling site GPS coordinates, measure environmental variables, and then analyze this data spatially on the maps displayed by the application. One of our goals is to make this GIS software interface a freely available development library that other GK-12 schools and universities could use to support the implementation of their own GIS applications.

COASTAL CAROLINA UNIVERSITY

Poster 12

PI: CRAIG GILMAN
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Julie Barker, Katie Eyring, Nick Henke, Grant Lockridge, Christopher Smith, Daneille Tarpley, Caitlin Wessel
Discipline: Environmental Science

GK-12 Fellows Linking Marine and Wetland Research with Science Education in Coastal South Carolina Schools

A highlight of our GK-12 program is involving teachers and students in local coastal science projects. All GK-12 Fellows are active researchers in the Coastal Marine and Wetland Studies graduate program. Integrating the Fellows thesis research is an important component of our program. All Fellows are required to develop some lesson plans based on their original research, which focus on the local coastal environment, and have been able to bring their teachers and students to their research sites. One option for teachers in the program is to participate in summer research with their Fellow. The teachers who complete 120 hours of research on the Fellow's thesis project earn three graduate credits and an increased stipend. The teachers assist the Fellow in designing experiments, collecting data in the field, and analyzing data in the laboratory. Aside from aiding in the progress of the graduate students' thesis work, this opportunity allows for much dialogue, planning, and collaboration between the Fellow and the teacher on ideas to incorporate the research into the classroom.

COLORADO SCHOOL OF MINES

Poster 13

PI: BARBARA MOSKAL
Contact: Kevin Wood, kewood@mines.edu
Disciplines: Chemistry and Chemical Sciences, Nanoscience, Physics

Renewable Energy: Teaching for the Future

The GK-12 Learning Partnership seeks to increase student and teachers awareness and excitement with respect to STEM, through collaborations with Colorado School of Mines and the National Renewable Energy Laboratory. The poster presentation focuses on the research of Kevin Wood and Dr. Pylypenko, and the delivery of this research to the eighth grade classroom. Kevin's Master's and PhD research focuses on improving the methanol oxidation reaction of Pt-Ru electro-catalysts through doping funtionalization of the carbon support network in Direct Methanol Fuel Cells. Although this may seem like a complicated topic to incorporate in the 8th grade classroom, straightforward applications bring it to life for the students at East Middle School in Aurora, CO. During one chemistry unit, Kevin introduced the basic principles of catalytic reactions through the use of Potassium Iodide (KI), Hydrogen Peroxide (H2O2), and dish soap. When KI is added to the H2O2, it acts as the catalyst and rapidly breaks down the H2O2. As the peroxide breaks down, it releases oxygen just as the catalyst separates electrons from the methanol to be used as electricity. The result from KI and H2O2 mixture produces a showy outpouring of small yellow colored soap bubbles (from the oxygen and soap). The implementation of this experiment in the classroom is simple. For students, however, this experiment illustrates an important research topic--the investigation of a renewable energy source. It is well known, even to young students, that our traditional forms of energy are not sustainable and that our reliance on these energy sources contributes to increasing tensions between the US and other nations. Additionally, the students had the opportunity to collaborate in teams while investigating this emerging research topic. The poster will illustrate, through creative instructional interaction, renewable energy can become a catalyst to excite students' interest in STEM.

COLORADO STATE UNIVERSITY

Poster 14

PI: TOM, CHEN
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Engineering, Mathematics and Statistics

Transplanting a GK-12 Collaborative and Multidisciplinary Bioengineering Research Program Internationally

The Colorado State (CSU) GK12 Biosensor project is focused upon determining the concentrations of specific chemicals in living tissue with biologically relevant resolution for where they are located and the time course of their release and movement. This goal stems from a need to understand the communications among cells during embryonic development to direct appropriate brain formation. The project focuses on building an integrated biosensor system to provide a realistic method to achieve this goal. The project at CSU incorporates research fellows in electrical and computer engineering, biology, chemistry, and mathematics to tackle this challenge. The team is trans-disciplinary in nature and fellows merge their multiple perspectives toward a single goal of a functional device. The overall research theme under the GK-12 project provides a unique opportunity for all fellows to understand the nature of research among different disciplines and how to work together with a stronger degree of understanding than in normal graduate training. This unique structure synergizes different disciplines within CSU and also resources and collaborations outside CSU. There have been clear benefits to "transplanting" our project structure and experience internationally. This poster highlights our experience in broadening an existing collaboration between CSU and the University of Ljubljana, Slovenia, from the area of veterinary medicine and biomedical science to a multi-disciplinary research project of integrated biosensors mirrored at the University of Ljubljana. Through discussions among investigators in the US with a lead collaborator at the University of Ljubljana, additional investigators in Engineering and Mathematics were identified in Slovenia. Our project served as the catalyst for introducing people in Slovenia who did not know each other previously. Following our successful interaction, the Slovenian group has continued to work together. Key aspects of the process included an existing successful international partnership, advance preparation of the students, deliberate discussions of communicating science in an international environment, and cultural lessons. Establishing connections with high schools while in Slovenia has made it possible to create sustaining interactions with international high school science classrooms and GK-12 science classrooms in Fort Collins. The event was capped scientifically by a multi-disciplinary research symposium that was published in the Journal of Slovenian Veterinary Research. This experience has lead to more well-rounded training for fellows who will be better prepared for global collaborating in a 21st century world.

CORNELL UNIVERSITY

Poster 15

PI: MICHAEL SHULER
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Discipline: Engineering

Concept-oriented, Peer-based Learning in the Classroom Using Clickers

Implementing pedagogical techniques that emphasize learning over memorization and that provide tutor-like interactions with teachers is important, but difficult to achieve in large classes. Student understanding requires the development of a solid intuitive picture of basic principles and how things fit together to explain complex phenomena. Concept oriented and peer-based learning emphasizes core concepts, dispels misunderstandings, as well as encourages the sharing of knowledge and ideas between students in a reciprocal manner. We have implemented this learning approach in

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some biomedical engineering undergraduate courses here at Cornell University. This teaching strategy, as well as its implementation using electronic "clickers," was demonstrated to GK-12 teachers during Cornell's summer GK-12 workshops. Electronic clickers are a useful tool to facilitate peer-based learning in the course lecture because they provide an anonymous way for students to participate in challenging questions. Many of the GK-12 teachers purchased electronic clickers for their classrooms, implemented this teaching strategy, and reported improved student understanding on conceptual and quantitative questions, as well as greater retention of concepts. A typical lecture that uses this approach is centered around conceptual questions that go to the heart of student misunderstandings as well as to the key ideas in the subject. Interspersed during the lecture a multiple-choice or open-ended conceptual question is asked, and the students respond using electronic clickers (multiple choice) or by writing an answer in their notebook (open-ended). After committing to an answer by themselves, students then turn to their peers and discuss their individual answers, trying to convince others that their answer is correct. The students then answer again. Students frequently revise their initial answer based on the discussion with their peers. With a well-designed question about half the students answer correctly individually, but over 80% answer correctly after discussing the problem with other students. This peer-based learning allows students who do not understand a concept to learn from someone who just learned it and understands some of the incorrect lines of reasoning. In addition, the students who initially "get" a concept have an opportunity to deepen their understanding through teaching their peers. It is important that the questions are appropriately challenging--students can't teach each other if too few understand, and there is no point in spending class time on a concept that most of the students in the class have already grasped. For multiple-choice questions, it is also important that the "right" wrong answers are presented as options-- these incorrect responses should be based on common student misconceptions, which are often only gleaned from listening to student discussion of a question.

CUNY THE GRADUATE CENTER

Poster 16

PI: GILLIAN SMALL
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Disciplines: Ecology, Environmental, and Earth Sciences

Authentic Environmental Science Research Experiences in New York City High Schools

Now in its third year, the CUNY Science Now GK-12 Program has developed a range of Authentic Research Modules (ARMs) that are currently being taught in the University's College Now Program and in New York City High Schools. Fellows' STEM research in plant sciences, adaptive genetics, biopsychology and behavioral neuroscience, and population dynamics of urban owls has informed the curriculum, content, and focus of each ARM. The authentic research modules provide high school students with an opportunity to think like scientists and have a genuine research experience. The modules also have specific components that focus on basic literacy and computational skills. This poster highlights the authentic research experiences that CUNY GK-12 Fellows and Teachers are currently implementing in Environmental Science classes in three New York City high schools. It also presents an overview of the project's interdisciplinary focus on the living urban environment as a research theme for high school students. By investigating their own backyard and developing research projects on some aspect of their urban environment, students become engaged in research, learn science process skills, gain content knowledge, and improve overall science literacy.

DREXEL UNIVERSITY

Poster 17

PI: ADAM FONTECCHIO
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Discipline: Engineering

Catalyzing STEM Education via the NAE Engineering Grand Challenges

Nine teams composed of a College of Engineering Fellow paired with a teacher from the School District of Philadelphia, and one team composed of a Fellow and two teachers began intense work in July 2010 to develop engineering-based modules for inclusion in the high school curriculum. These modules serve to enhance the math and science education of high school students through the context of the National Academy of Engineering (NAE) Grand Challenges, www.engineeringchallenges.org, while concurrently illustrating the global nature of these societal issues. The teams have implemented their modules into the otherwise very prescribed traditional science curricula of five area high schools. The schools selected provide a good opportunity to bring engineering perspectives and a contextual framework for the study of math and science to a student population generally underrepresented in science and engineering. Modules are typically derived directly from each fellow's research and laboratory activities and matched with one or more relevant NAE Engineering Grand Challenges. From there they are adapted to their students' grade level to generate excitement about engineering and in the fellow's field of study. Teachers have developed new perspectives on innovative ways of teaching science. Fellows, in turn, have learned to meet the challenges of a high school classroom and have gleaned insight and experience by teaching to an audience much different than their traditional peers. The fellows, teachers and their students have all discovered the excitement of math and science when explored through hands-on interactive exercises and experiments. As a result, students have been exposed to science and engineering in ways that both complement and enhance the standard

curriculum. This poster illustrates a variety of the creative module lessons developed by each of the fellows during the first months of the program and provides some evidence of the impact the GK-12 program has had on the high school students. Topics on the current poster include urban hydrology and environmental regulation, restoring and improving urban infrastructure, population dynamics, oil spill clean-up, water treatment and clean water access, solar and alternative energy, preventing nuclear terror and the art of science writing.

EAST TENNESSEE STATE UNIVERSITY

Poster 18

PI: GORDON ANDERSON
Contact: Gordon Anderson, andersgk@etsu.edu
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences, Mathematics and Statistics

Science First! Graduate Research in the Elementary School Classroom

Eight fellows in the GK-12 program at ETSU bring aspects of their research into pre-K through 5th grade classrooms at North Side Elementary School. Their research projects include various aspects of graph theory, studies of the northern social spider, *Anelosimus studiosus*, fossil endocarps of Symplocaceae from the Gray Fossil Site in east Tennessee, analysis of the extinct cat *Panthera atrox* and its phylogenetic relationship to other pantherine cats, a study of ground sloth material (*Megalonyx jeffersonii*) from a cave in Alabama, and analysis of the bone crushing behavior of the dire wolf (*Canis dirus*) using dental microwear texture analysis. Fellows have made use of an outdoor classroom and fossil dig pit constructed as part of the GK-12 project. The dig pit contains a cast of a large, Miocene rhino skeleton and students have worked together to unearth the skeleton and encountered bones and remains from other animals that were common during this time. The pit gives students a unique, hands-on experience and allows them to live the life of a fossil hunter for a day. One fellow has brought her cat and dinosaur research into the kindergarten classroom. Students learned about living and extinct cat species and played cat bingo to help them identify different types of cats. She also brought in lion and tiger skulls, and compared them with her work on *Panthera atrox*, the American lion. A second fellow brought in skulls from the Pleistocene era and discussed the ecology and morphology of the giant short faced bear, Smilodon (saber tooth cat), wolves and hyenas. Her research focuses on the dire wolf, where she discussed with 4th and 5th grade students how to determine if it consumed bone or not. In talking about her research, she also addressed the state standard on Biodiversity and Change, which involves adaptations, extinction, ecosystems and animal interactions. In 3rd grade, another fellow addressed the same standard with the skulls of a coyote, deer, and house cat with a focus on adaptations and thriving, threatened, endangered and extinct species. One fellow created mini lessons to teach first graders the concepts and skills used by paleontologists. His weekly lessons involved hands on activities and problem solving that built on each other over the year. The students learned to use tools such as sequence stratigraphy, mineralogy, and relative dating to find answers to complex questions. Math fellows introduced students to graph theory, including Hamiltonian and Eulerian cycles. In a 4th grade lesson on geometric patterns, they introduced the concept of a fractal as a self-similar geometric shape comprised of infinitely smaller copies of itself. They discussed the historical aspects of fractals, and modern day applications, and the students created their own Sierpinski Triangle fractals and assembled them into a larger Sierpinski Triangle.

EMORY UNIVERSITY

Poster 19

PI: PATRICIA MARSTELLER
Contact: Jordan Rose, jrose14@emory.edu
Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences

Still Teaching after GK-12: PBL and Authentic Research in Undergraduate Education

A central goal of the PRISM GK-12 program is to instill pedagogical skills in graduate fellows that endure beyond their time as K-12 classroom partners; specifically, their ability to transfer Problem-Based Learning (PBL) pedagogy to undergraduate classrooms and to connect their research to classroom experiences. We present examples of successful PBL pedagogy utilized by two alumni who are now faculty at universities in the metro-Atlanta area. Carpenter Desai's experience as a Fellow using PBL in high school has prepared her to engage undergraduates in introductory and upper-level chemistry courses, demonstrating the interdisciplinary nature of chemistry as it relates to biology, medicine, and industry. Similarly, Turner has built on her experience as a Fellow in middle school physical and earth sciences, where one of her PBL cases included concepts and methods from her own research in skeletal archeology. Turner has constructed and implemented a PBL-based laboratory curriculum for undergraduate Biological Anthropology. Lab modules cover topics including population genetics, primate conservation, evolution of the stress response, high-altitude adaptability, and ancient diet. Student evaluations overwhelmingly praise these labs as engaging and instrumental in their comprehension of course content; Turner's class has also recruited students to the anthropology major. Carpenter Desai developed novel PBL laboratory modules for Instrumental Analysis and Biochemistry courses, including one centered on the content of energy drinks as an entré into gas chromatography-mass spectrometry and high-performance liquid chromatography analyses. This case became a starting

Abstract

point for student-led research projects in her lab, the results of which were presented at a 2010 professional conference. Carpenter Desai also uses her graduate research experience in biomaterials engineering as the focus of PBL case studies on elastin and reflectin-based protein materials design in her undergraduate research lab. The training imparted through the PRISM NSF GK-12 Graduate Fellowship has clearly helped both professors to make their undergraduate courses more engaging and student-centered, through a valuable transfer of PBL techniques from K-12 to undergraduate classrooms. Moreover, PBL pedagogy has enabled Fellows to adeptly integrate research and classroom experiences. These alumni are not unique among PRISM Fellows, demonstrating not only the short-term efficacy of the PRISM program, but also its long-term efficacy in shaping undergraduate instruction, as its fellows become academic professionals.

FLORIDA ATLANTIC UNIVERSITY

Poster 20

PI: DONNA CHAMELY-WIIK
Contact: Shawn Wilder, swilder6@fau.edu
Disciplines: Chemistry and Chemical Sciences, Geology and Geography, Physics

Crossing Borders: Black Holes and Water Quality to High School Chemistry

Our GK12 program pairs eight graduate fellows from biology, chemistry, complex systems, environmental science, geoscience and physics backgrounds with eight high school teachers of biotechnology, chemistry and environmental science during this academic year. The fellows introduce themselves into the classroom via a video that illustrates their typical work day and by giving a presentation about their research. Throughout the year, curriculum related demonstrations, presentations and labs are used to further introduce the fellows' research and to ground lessons by exemplifying scientific practices. Some fellows bring in their research equipment (e.g. automated micropipettes, water samplers and dissolved oxygen probes) to further stimulate the students. Many fellows have been placed in classes outside their primary academic discipline and this has yielded many benefits for the fellows, students and teachers. Students have been able to observe firsthand how omnipresent their lessons are throughout applied scientific fields. We present three fellows' research topics (from geoscience and physics) and how they have influenced and been implemented into chemistry classrooms. The fellows summarize their research projects as: The creation and analysis of improved initial data for simulations of binary black hole mergers; Performing a geochemical and biological analysis of Little Lake Worth, an artificially deep lake with thermal stratification, by assessing how pollutants and weather impact the lake's water quality; Exploring the ramifications of a linear algebraic approximation technique that represents almost geometrically symmetric objects. We also present some of the more notable observations from our other fellow/teacher pairs. Finally, we note that even though no student is currently involved in a research project, several students have expressed interest in volunteering in their fellow?s lab during summer and there are planned research projects for the latter part of the school year.

FLORIDA INSTITUTE OF TECHNOLOGY

Poster 21

PI: RICK TANKERSLEY
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Disciplines: Ecology, Environmental, and Earth Sciences

Cool Breeze, Hot Sand

My research focuses on the larval release and larval behavior of Petrolisthes armatus the green porcelain crab based on different tidal and light/dark cycles. My lesson plan design team focused on the light/dark or day/night cycle in developing a lesson for students which incorporated the theme of my research. The day/night cycle impacts people directly and causes daily changes in weather patterns. To address the impact of environmental cycles, specifically the day/night cycle, we developed an inquiry-driven, hands-on lesson where students design their own experiment to learn about land and sea breezes. Our students are familiar with the beach environment, breezes, and afternoon thunderstorms. Therefore, understanding local weather patterns like land and sea breezes has direct impact on the students? activities, mainly outdoors.Our lesson plan goal is to teach students how, where and when land and sea breezes are formed. The three to four day lesson begins with students designing their own experiment to determine differential heating of materials commonly found on the beach using an infrared thermometer. Students also analyze data from a local weather station, view two demonstrations and a video discussing that land and sea breezes occur where a temperature difference exists between air over the land and sea. The lesson has proven very effective, evidenced by correct answers to the assessment questions, in helping our 5th and 6th grade students understand how land and sea breezes are formed.

GEORGE MASON UNIVERSITY

Poster 22

PI: RAJESH GANESAN
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Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences, Engineering, Mathematics and Statistics, Physics

SUNRISE: Schools, University 'N (and) Resources In the Sciences and Engineering

The SUNRISE project poster highlights the Fellows' current research and provides several examples of how GK-12 fellows brought their research into the K-12 setting. The examples include: 1) studying properties of most superconductors in which students are shown how the fundamental, underlying properties are used in Electronic Structure calculations to help explain and predict the quantum mechanical superconducting trend, 2) the environmental triggers and public policy regarding breast carcinoma, 3) stochastic modeling and a lesson on the statistics based prediction, 4) identification of molecular targets for Francisella biofilm formation, 5) noise reduction for improved Cathelicidins: A Family of Antimicrobial Peptides, 6) computers in Mathematic "Synthesis Cells," 7) hydrodynamic model of atmospheric capture by Charon with applications to Extrasolar Giant Planets, and 8) population structure of river herring. The fellows underwent two month-long training during summer before they began their classroom visits in fall. The training included learning about curriculum development, expressing their research and understanding of STEM topics in simple terms, successful teaching methods and classroom management skills, and the science standards of learning. Some examples of how the above research translated into classroom lesson include: The students were required to recreate the oil spill on a small-scale using vegetable oil and cocoa as the oil. They then had to try to clean the oil off of the wildlife, in our case, bird feathers. We discussed the harm the oil spill had on the environment and the effects the wildlife, both flora and fauna, had to endure. The 6th grade students at Hutchison Elementary School explored the related notion of Habitability by researching the physical characteristics of selected bodies in our solar system and then comparing them to what they had created as criteria for habitability. They then conferred with each other and chose the most suitable body to explore. In another school, students were asked to determine the age of a hickory shad (Alosa mediocris) by measuring fish length and applying it to a length at age plot. Students experienced the annular properties of hard body parts, similar to ageing trees by counting annuli (rings) on images of the fish otoliths (earstones) and prepared slides of fish scales.

GEORGIA SOUTHERN UNIVERSITY

Poster 23

PI: LAURA REGASSA
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Discipline: Biological Sciences

Molecular Biology Initiative Program: Linking Fellow Research to Hands-on Activities

The Molecular Biology Initiative partners MS-level fellows with teachers at high schools in rural southeast Georgia. The fellow-teacher teams work together throughout the year to generate hands-on classroom activities that include aspects of the fellows' research and that address biotechnology Georgia Performance Standards. The activities highlighted in this presentation involve research conducted in the areas of fly immunity, population genetics, and physiological ecology. Activity materials are available on the program website (www.georgiasouthern.edu/mbi).Each team developed their own approach for infusing fellow research into their high school classroom environment. CASE 1. The fellow is working to identify the genes that confer protective immunity to house flies; these flies internally transport bacterial pathogens without any apparent adverse effects. The fellow-teacher team decided to develop a fly genetics laboratory module. The basis for this module was the dihybrid fruit fly crosses familiar to most biology students, but the team decided to update this activity to include aspects of molecular genetics, polymerase chain reaction (PCR), restriction enzyme analysis, agarose gel electrophoresis and bioinformatics. CASE 2. The fellow-teacher team developed a DNA structure/function module that drew consistent parallels between the fellow's research on scrub lizard population genetics and the in-class activities. Although the high school students were unable to use a reptile in their study or do a large-scale field study, the fellow made the connections for the students and discussed the ethical limitations involved in conducting research in the environment. CASE 3. The fellow conducts research on fish physiology and how the environment can elicit physiological changes. The fellow used her expertise to develop learning modules centered on an outdoor aquatic classroom, in collaboration with her partner teacher. The pond-related activities examine water quality parameters, biodiversity and gene flow. This particular approach has been expanded to a second school, with the intent of sharing data and information among students at the two schools. Each of these unique, team-generated strategies successfully infused fellow research into the high school classrooms.

IDAHO STATE UNIVERSITY

Poster 24

PI: ROSEMARY SMITH
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences, Engineering, Geology and Geography, Mathematics and Statistics

Tracking Successful NSF GK-12 Graduate Student-Teacher Partnerships in Southeastern Idaho

Since 2004, the GK-12 Program at Idaho State (ISU) has fostered a three-way partnership between ISU, local industry and K-12 schools intended to improve science education and science literacy in Southeast Idaho. The program has annually placed 10-11 graduate students from ISU into K-12 science, math and engineering classrooms for ten hours per week for an entire school year. As the ISU GK-12 projects has matured, evidence shows that inquiry-based activities that are linked to

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the graduate Fellow's research specialization have been successfully integrated into the curriculum while involving K-12 students in locally relevant issues in science and engineering. Several graduate fellows have formally disseminated their creative contributions in the peer-reviewed educational literature. Here, we take a retrospective case history approach to document the characteristics of several successful graduate student K-12 partnerships that have emerged after nearly 7 years of project development. The relationship between the former Fellow's research and the classroom contributions are outlined. We have found that successful Fellows were among our top graduate students academically; they also received support and assistance on the NSF project from their graduate advisors, and they were partnered with teachers and school principals who were open to new ideas and showed a willingness to let unconventional learning experiences occur on their campuses. We continue to assess the impact of the GK-12 Fellowship on the careers of all the participating graduate students, endeavoring to follow their progress after their graduate degrees.

INDIANA U PURDUE U INDIANAPOLIS

Poster 25

PI: KATHY MARRS
Contact: Carly Redelman, cvasher@iupui.edu
Carly V. Redelman, Misty A. W. Hawkins, Gregory G. Anderson, Kathleen Marrs
Discipline: Biological Sciences

Biofilms, Pond Water, and Cystic Fibrosis: Inquiry-Based Instruction in the High School Science Classroom

Bacterial biofilms are microbial communities capable of growing in many different environments with destructive effects. Growth in a biofilm confers upon the bacteria a much greater resistance to antimicrobial agents than individual growth. Thus, biofilms are very difficult to destroy. In order to understand the basis of this increased resistance, we are investigating the molecular effects of antimicrobials on biofilm formation of the human pathogen Pseudomonas aeruginosa, which forms biofilms on non-living surfaces as well as in the lungs of cystic fibrosis (CF) patients. By forming P. aeruginosa biofilms on cultured human CF-derived airway cells, we found that antimicrobial treatment affects numerous genetic pathways, including virulence-modulatory factors. Thus, antimicrobial treatment of biofilms results in a complex series of molecular interactions. Because biofilms are implicated on both living and non-living surfaces, inquiry based integration of biofilm research into high school classrooms was introduced using environmental biofilms. The students collected pond water as an inoculum and successfully grew biofilms on plastic plates. These biofilms grew from the environmental bacteria naturally found in the pond water. They stimulated their biofilms with two common household antimicrobials of their choice that they hypothesized would affect biofilm levels. Treatment data was recorded and presented to their peers. They found that certain antimicrobials, such as bleach, dish soap and bathroom cleaner, were effective at destroying biofilms and other antimicrobials, such as mouthwash and hand sanitizer, were ineffective. To demonstrate the effectiveness of inquiry based education, an 8-item scale was employed, comprised of two subscales measuring knowledge of biofilms and experimental design. The scales showed an increase in total posttest scores over total pretest scores. Similarly, knowledge of biofilms and experimental design increased. Furthermore, our laboratory exercise stimulated two senior students to voluntarily study pond water biofilm formation and dissemination as a capstone senior project. Our findings indicate that an inquiry based lab activity is an effective way to teach students about biofilms and experimental design.

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Amy Smith, Brooke Furge, Dr. Lenore P. Tedesco
Disciplines: Geology and Geography

Discovering the Science of the Environment: Plant Health and Nutrient Evaluation

(IUPUI's GK-12 program partnered with the Center for Earth and Environmental Science's (CEES) Discovering the Science of the Environment (DSE) program to provide a state of the art, mobile, no cost, outdoor environmental science education program to Central Indiana 4th-9th graders. This program utilizes a mobile resource trailer equipped with interactive technology tools, web interface, and GIS mapping abilities to provide an interactive, inquiry-based, hands-on learning environment capable of teaching students a variety of environmental science topics in urban, woodland, wetland and riparian environments. As an Earth Science Master's student, my thesis research involves assessing the processes of nutrient removal in wetland ecosystems. My project involves assessing the effectiveness of a bioretention swale in removing nutrients and herbicides from agricultural runoff. I related this research to the DSE program and created a unique Plant Health and Nutrient Evaluation program. During this program, students evaluate overall plant health by examining the availability of the environmental components (sunlight, water, and nutrients) that plants require to survive. Using Vernier LabQuest scientific handhelds and soil and plant tissue nutrient test kits, students measure sunlight percentage, sunlight intensity, soil moisture, soil percolation rate, soil texture, soil pH, and soil and plant tissue nutrients. Collected data is analyzed and conclusions are drawn as to whether or not the surrounding environment provides a sufficient amount of sunlight, water, and nutrients for the plant?s survival. Teachers participating in the DSE program are able to choose which program best correlates with their student?s grade level and current curriculum content. All DSE programs include four main components: An introductory activity to provide a background for learning and assess student knowledge base, a detailed tools explanation to familiarize students with the field investigation equipment, an interactive mobile resource trailer activity to enhance student understanding of program content, and a field investigation using scientific hand-held

data collection and recording devices. The Plant Health and Nutrient program includes all components and will be offered indefinitely by the DSE program at IUPUI CEES.

Contact: Forest Andrews, foandrew@iupui.edu
Disciplines: Biological Sciences, Chemistry and Chemical Sciences

Enzymes are Cool!

Conveying this sentiment to my Integrated Chemistry and Physics (ICP) students at Southport High School has been a difficult yet rewarding task to say the least. Between the Indiana Academic Standards and the sheer number of the students coupled with the lack of proper bench space it has been somewhat tricky to incorporate my work as enzymologist directly into the classroom. However, through a close collaboration with my teaching partner we have developed a biphasic lesson plan in which we incorporate many aspects of what Indiana deems ICP students should be taught, as well as incorporating fundamental techniques needed for a biochemist, i.e. pipetting, purifying, assaying, etc. In the first phase the students are introduced to the concepts of proteins and follow a scheme to purified lysozyme from chicken eggs bought from a local grocery store. In the second phase we introduce catalysis, and the students are shown using their own purified lysozyme how enzymes are nature's catalysts by performing a spectrophotometric assay following the decrease in turbidity caused by the breakdown of Micrococcus lysodeikticus cellular wall.

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NFAT Expression and Localization in the Mandibular Precursor of Ts65Dn Down Syndrome Mice

Down syndrome (DS) is caused by three copies of human chromosome 21 (HSA21) and is the cause of a wide variety of abnormal phenotypes including cognitive impairment, craniofacial dysmorphology, and cardiac defects. Craniofacial abnormalities include a reduction in mandible size and a small oral cavity leading to feeding, breathing, and sleeping problems in individuals with DS. The presence of three copies of human chromosome 21 in individuals with DS results in alterations in genome wide gene regulation and many developmental pathways. The Ts65Dn mouse model contains three copies of nearly half of the genes found on HSA21, and exhibits a craniofacial phenotype similar to what is observed in humans with DS. Ts65Dn E9.5 embryos exhibit a smaller mandibular precursor and fewer number of neural crest cells compared to euploid mice, suggesting the altered mandibular phenotype is established early in development. DYRK1A is a kinase critical during development and has been found to be significantly upregulated in various tissues in humans with DS as well as the Ts65Dn mouse model. Our preliminary evidence suggests that Dyrk1A is overexpressed in the mandibular precursor of E9.5 Ts65Dn embryos. It is believed Dyrk1A negatively regulates the nuclear localization and activation of a transcription factor (Nfatc) critical to a number of signaling pathways relating to cell proliferation and bone development. Preliminary results of immunohistochemical analysis show changes in the cellular localization of Nfatc between trisomic and euploid embryos at E9.5. Further studies will be conducted to identify the cellular localization of Nfatc at E13.5, as well as to determine the direct effects of Dyrk1A upregulation on Nfatc, to gain a better understanding of the molecular mechanisms contributing to the craniofacial phenotypes observed in individuals with DS. Students in the classroom will use several laboratory techniques to analyze the E13.5 Ts65Dn mandibular precursor. Instruction will be provided and the students will carry out a combination of polymerase chain reaction (PCR), immunohistochemistry, and expression analyses to test whether trisomy causes altered Nfat expression in the mandible of E13.5 trisomic vs. euploid embryos. Statistical analyses will used to determine the hypothesized Mendelian inheritance of the extra chromosome and differences in gene expression between Ts65Dn and euploid embryos.

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Julie Crewe, Brooke Furge, Dr. Lenore P. Tedesco
Disciplines: Ecology, Environmental, and Earth Sciences

Discovering the Science of the Environment: Air Quality Assessment

IUPUI's GK-12 program partnered with the Center for Earth and Environmental Science's (CEES) Discovering the Science of the Environment (DSE) program to provide a state of the art, mobile, no cost, outdoor environmental science education program to Central Indiana 4th-9th graders. This program utilizes a mobile resource trailer equipped with interactive technology tools, web interface, and GIS mapping abilities to provide an interactive, inquiry-based, hands-on learning environment capable of teaching students a variety of environmental science topics in urban, woodland, wetland and riparian environments. As an Earth Science Master's student, my thesis research involves spatially analyzing the impact of mercury emissions from point sources in an urban area. I related this research to the DSE program and created a unique Air Quality Assessment program. During this program, students assess local air quality by monitoring their surrounding environment for the presence, absence and/or concentration levels of the six primary air pollutants including: ozone, particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. Students collect weather data and monitor for pollutants utilizing a variety of measurement tools including: Vernier LabQuest scientific handhelds, relative humidity sensors, temperature sensors, anemometers, Sensidyne handheld gas detectors, ozone indicator strips and lead detection swabs. Collected data is analyzed against the Air Quality Index and conclusions are drawn about the local air quality. Teachers participating in the DSE program are able to choose which program best correlates with their students' grade level and current curriculum content. All DSE programs

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include four main components: An introductory activity to provide a background for learning and assess student knowledge base, a detailed tools explanation to familiarize students with the field investigation equipment, an interactive mobile resource trailer activity to enhance student understanding of program content, and a field investigation using scientific hand-held data collection and recording devices. The Air Quality Assessment program includes all components and will be offered indefinitely by the DSE program at IUPUI CEES.

Contact: Misty Hawkins, miahawki@iupui.edu
Discipline: Social and Behavioral Science

Learning about the Connections between Depression, Stigma, and Obesity

Depression has been associated with increased risk of obesity, especially in adolescent girls. In addition, obesity is associated with increased risk of developing depression. My research focuses on understanding the bidirectional relationship between obesity and depression. Our lab is currently developing a project which will examine one possible mechanism behind the depression-obesity relationship. In particular, we will use eye-tracking equipment to measure attentional biases to food-related stimuli. Depressed individuals may attend to food cues more often or more strongly than non-depressed individuals. If this hypothesis is supported by our findings, this bias towards food in depressed individuals may provide one explanation for why depression leads to later obesity.Results. Since we are in the preliminary stages of developing the project, no results are available; however, previous research has demonstrated attentional biases towards food cues in obese individuals compared to non-obese individuals. In order to teach students about the relationship between depression and obesity, students engaged in an interactive presentation and took a test measuring their own attitudes toward obese individuals. First, students took a survey examining their ideas about (1) whether emotions can lead to obesity, (2) whether obese individuals experience discrimination, and (3) whether tests exist that can measure our implicit (i.e., unspoken) attitudes towards people. Second, students took part in an interactive presentation in which they were shown scientific data that depression leads to obesity and vice versa. Students were asked to think about the roles that stigma and discrimination may play in causing obese individuals to develop depression. Students were also informed about the Implicit Attitude Test (IAT), a standardized test which measures individuals' unspoken biases toward different groups of people by using reaction times. Lastly, the students took the "weight" version of the IAT which compares their personal attitudes towards thin versus obese people. Students were encouraged to discuss whether the test showed that they had a preference for thin people and how accurate they thought the test results were. They also completed a second survey which examined how their ideas about depression, obesity, and tests measuring attitudes may have changed in response to the activity.

Contact: Erin Kennedy, ermkenne@iupui.edu
Erin M. Kennedy, Mark Duncan, Kathy Marrs, Robert E. Minto
Disciplines: Chemistry and Chemical Sciences

Laboratory Activities used to Incorporate Organic Chemistry into the AP Chemistry Curriculum

Organic Chemistry is a very complex subject, which is about the reactivity of compounds containing carbon. Carbon is essential to life, and organic chemists try to understand how different carbon compounds react on a molecular level. This subject frightens many college chemistry majors, and is usually a class that overwhelms many students. Using the GK-12 program as a stepping-stone, we believe that we can introduce high school students to some of the fundamentals of organic chemistry through a variety of laboratory activities. We have shown the students how to perform some basic chromatography techniques on organic compounds, while relating this topic to many of the standards that are already present on the AP or sophomore Chemistry curriculum. We have also demonstrated that organic reactions generally involve different functional groups, and have even done a lab exercise making one functional group: esters. This reaction encompasses knowledge of equilibrium, polarity, organic nomenclature, and acid/base chemistry. Students have even done column chromatography on compounds that I need purified; they need to have knowledge of the fundamentals of polarity, and retention factor. We believe that introducing the students to these concepts early will make them less afraid of the subject if and when they encounter it during college.

Contact: Kathleen Marrs, kmarrs@iupui.edu
Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences, Geology and Geography, Physics, Social and Behavioral Science

The GK-12 Program at IUPUI : Developing Young Scientists in the Classroom

IUPUI's identity as the Life-Health Science Campus of Indiana University has resulted in a number of biomedical projects developed by our GK-12 fellows, their teacher partners, and the students at local ethnically and culturally diverse high schools, in this third year of our program. Biology students in two schools are examining the pathology of Cystic Fibrosis and developing ways to disrupt the formation of bacterial biofilms in a novel assay developed by a GK-12 fellow, her research advisor, and her teacher partners. A GK-12 fellow studying craniofacial development in a mouse model of Down Syndrome has introduced statistical analysis and a genotyping assay into another Biology course in the same school. A GK-12 fellow doing research on Fetal Alcohol Syndrome has allowed students to see the potent effects of alcohol on embryonic development first-hand, using zebrafish embryos as a model organism for vertebrate development. A developing awareness of the importance of Health Psychology is being introduced to students by another GK-12 fellow, allowing students to examine their own physiological response to stress

as they develop an awareness of the mind-body connection. One fellow's research on neuroinflammation and targets for chronic pain treatment has allowed high school students to study the sensory system in a novel way. GK-12 fellows in chemistry and physics classes have worked with students and teacher partners to investigate biochemical enzyme assays in chicken eggs, purification of anti-cancer agents from fungi, and the biological physics of membrane proteins. Other fellows in the Discovering the Science of the Environment Program are working with classrooms to study water, air, and soil quality in outdoor classrooms or even in whole-school test sites. Led by three GK-12 fellows in the School of Public Health and the department of Earth Science, high school and middle school students have examined cellular respiration performed by soil microbes, measurement of lead levels commonly found in urban soils, and the effects of cyanobacteria on water clarity and purity. This model, where GK-12 fellows and teachers work together through development of activities that allow for experimentation and exploration, allows students to experience the way that new knowledge is generated in science.

KANSAS STATE UNIVERSITY

Poster 26

PI: CAROLYN FERGUSON
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Beyond the Text: Educating Students About Real-World Applications of Chemistry (Ola Alawode - Chemistry)

High School science courses place very limited emphasis on light chemistry (photochemistry). Educating K-12 students about the use of light energy is advantageous because of the considerable scientific research ranging from therapeutic uses of light energy for targeted destruction of cancerous cells to the trapping of sun energy as a source of renewable energy. My research focuses on studying the mechanism of decomposition of potential light-activated anti-cancer prodrugs, tetrazolethiones. While these compounds have found widespread use in industries, there is still limited understanding about their mode of decomposition. Also, it is critical to account for all photoinduced product(s) within the chemical reactions if tetrazolethiones would be a suitable prodrug. The experiments to determine the mode of decomposition for tetrazolethiones were carried out in a Rayonet photochemical reactor and the results were analyzed using UV spectrometry, Nuclear Magnetic Resonance (NMR) and Laser Flash Photolysis, which helped to determine the mode of decomposition for tetrazolethiones. Thus far, our studies have revealed the vital intermediates as well as accounted for most of the products produced.In order to enrich a high school chemistry course, an activity incorporating a portion of this research was designed. A field trip to chemistry department at Kansas State University provided the opportunity for the students to work with Rayonet photochemical reactor, where they were able to generate different photo-products and using NMR as a tool they were able to analyze their sample and determine what chemical compound was formed. Also, the students carried out thin-layer chromatography of analgesics and synthesis of fragrant esters, so as to learn important chromatographic technique widely used by organic chemist as well as hands-on learning of types of reactions. Student knowledge of the above stated activities were evaluated using a pre-post assessment test. Future activities involve use of ultraviolet light to convert provitamin-D3, 7-dehydrocholesterol, to Vitamin D3, to mimic the formation of Vitamin D3 in the skin.

The EIDRoP NSF GK-12 Program in Russia: A Botanical Expedition to Siberia (Susan Rolfsmeier – Biological Sciences)

An international project was developed to advance research by Fellow S. J. Rolfsmeier on the plant genus Lappula (family Boraginaceae). The genus Lappula is very diverse in Eurasia with a smaller number of species occurring in North America. Some of the North American species have been considered the same as the Eurasian taxa, but these hypotheses have not been tested through comparative morphology, and the evolutionary relationships between the North American and Eurasian species are unknown. Goals of Rolfsmeier's dissertation research include a revision of the taxonomy of North American Lappula with consideration of Eurasian material, and development of a molecular phylogeny for the genus that will be used to study evolutionary and biogeographic patterns between North America and Eurasia. A plant systematist colleague at the Central Siberian Botanical Garden, S. Ovchinnikova, is highly knowledgeable on Eurasian Boraginaceae. International travel was undertaken with the goals of 1) developing an ongoing research collaboration with S. Ovchinnikova, 2) studying museum material held in Russian herbaria (in St. Petersburg and at the Central Siberian Botanical Garden), and 3) field collecting material for herbarium specimens and DNA studies. GK-12 fellow Rolfsmeier, her GK-12 partner teacher and her faculty adviser all traveled to Russia in the summer of 2010 (a two week joint visit, followed by three additional weeks for Rolfsmeier). Activities in Russia included herbarium and field study, meetings and interactions with Russian botanists, a meeting with a Russian biology teacher, and exchange of information and scientific specimens. Ongoing work includes lab and herbarium research by Rolfsmeier using materials obtained during the trip, continued electronic communication with Ovchinnikova, and incorporation of the international collaborative research experience into activities in the classroom of the GK-12 partner teacher. An overview of the project is presented, including information on project development, research, partner roles, U.S. school-based activities, ongoing work, and recommendations for GK-12 teams interested in developing international projects.

Molecular Views of Health and Disease (Elizabeth Ploetz – Biological Scences, Chemistry and Chemical Sciences)

Abstract

High school anatomy and physiology students explore the link between the molecular level and the state of health or disease via the study of protein biochemistry and the tools of computational chemistry. The material presented is currently being implemented throughout the academic year wherever it naturally coincides with the standard course curriculum. First, students completed tactile and kinesthetic activities to learn fundamental protein biochemistry. Second, students used computational approaches to better understand three diseases in which protein abnormalities lead to pathophysiology. Students used a computer program called STARBiochem (created at Massachusetts Institute of Technology) to understand the mechanism of protein aggregation involved in Alzheimer's disease and Sickle Cell anemia. Students also learned about the Molecular Dynamics (MD) simulation technique and performed their own short MD simulations of a protein involved in the destruction of the islet beta cells of the pancreas using the NSF's high performance computers (TeraGrid). The methods, strengths, and weaknesses of the approach are presented. The fellow is a graduate student in physical chemistry who brought one of her three areas of research into the classroom: the study of a bacterial molecular chaperone, ClpB, that helps to unfold aggregated proteins. The impetus for conducting this research is the lack of understanding of the general principles by which certain proteins aggregate in a wide variety of diseases. Through the completion of the activities we have developed, we believe that the students are better prepared to understand the importance and relevance of this research.

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PI: MITCHELL NEILSEN
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Disciplines: Computer Science and Information Management, Engineering

Project INSIGHT in the K-12 Classroom

Sensor technology is increasingly becoming an ubiquitous part of our everyday lives, a trend that is expected to continue, with sensor devices becoming smaller, more accurate, and more interconnected. It is important to introduce students to this technology at an early age, not just to promote familiarity with how they operate but also to develop an understanding of how they can be utilized. Project INSIGHT seeks to bring current research in sensor technology into our K-12 classrooms by pairing graduate fellows in the Computing Science and Biological and Agricultural Engineering with diverse classrooms around the state of Kansas. Examples of this collaboration include: (1) Bringing custom-built stream sediment sensors used to monitor streams in military bases across the U.S. into the classroom, then comparing sensor readings against manually collected samples in the field, (2) Building sensor feedback loops in Lego Minstorms NXT robots, (3) Developing Android applications utilizing built-in sensors of cellpones, (4) Instrumenting athletes with GPS, accelerometer, and pulse sensors and analyzing collected data, (5) Building interactive computer programs with Scratch, and (6) Instrumenting an "Egg drop" with accelerometers to determine the relationship between acceleration and packing methods in preserving an egg dropped from a height. Through hands-on lessons working side-by-side with INSIGHT Fellows, K-12 students are developing an understanding of sensor technology and how it is used in their lives now and how they can participate in the research leading to its future.

MICHIGAN STATE UNIVERSITY

Poster 28

PI: THOMAS GETTY
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Discipline: Biological Sciences

Kellogg Biological Station's GK-12 Project Brings Authentic Research Experiences to K-12 Partners through BEST Plots Research Network

Last fall, students and science teachers working with ecology graduate students at Kellogg Biological Station (KBS) planted the seeds for the BEST-- BioEnergy SusTainability Schoolyard Research Network. The network includes >300 research plots at 22 schools in 11 districts in six counties in SW Michigan. Schoolyard research plots were planted with switchgrass and native prairie seeds (both potential biofuel crops) and mimic long-term, collaborative research taking place at KBS. Faculty, staff, and graduate students are collaborating with teachers on experimental design, research protocols, and curriculum development. Over the next five years, students will make observations and take measurements about biodiversity, productivity, and soil quality to answer the question, Can we grow our fuel and our flowers and butterflies too? Lessons on scientific Claims, Evidence, and Reasoning (CER) use fellows' research and data sets to teach valuable decision-making skills that will be used when evaluating data collected in the 'BEST' research network.

MICHIGAN TECHNOLOGICAL UNIVERSITY

Poster 29

PI: ALEX MAYER
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Disciplines: Ecology, Environmental, and Earth Sciences

Connecting Watershed Science Research and the Classroom: Year 1 of GK-12 Global Watershed

In the GlobalWatershed GK-12 program, graduate Fellows conduct research in watershed science topics within a range of geographical, hydrologic, ecological, and cultural contexts, while working with middle and high school teachers to create lesson plans and activities that transfer this knowledge to their students. The goals of the program include (a) expanding traditional STEM graduate student training to encompass improved teaching and communication skills and to help

graduate students gain a greater appreciation of the context of their research, and (b) enriching STEM learning and instruction in local middle and high schools, as well as a K-12 school system in Sonora, Mexico, by translating state-of-the-art watershed research to the local middle and high school level. In the first year of the program, Fellows have been placed at three middle and high school sites. Two classes have been designed for the Fellows to learn about lesson plan development and delivery; classroom management; state-of-the-art science instruction, such as inquiry-based learning; and communicating complex scientific issues to the general public. The Fellows delivered a series of lessons derived from the Michigan Environmental Education Curriculum Support program, tailored to their research interests and the curricula in their respective classrooms. Year 1 Fellows' research interests include wetlands science, natural resources management, conservation biology, and fisheries biology. The Fellows incorporated elements of the scientific research process into lessons and classroom activities associated with their own research. The Fellows also developed field activities to demonstrate watershed science topics relevant to their research. The fellows are currently developing teaching units, consisting of a series of inquiry-based lesson plans, that are based on their research topics.

MIDDLE TENNESSEE STATE UNIVERSITY

Poster 30

PI: ANTHONY FARONE
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Discipline: Biological Sciences

Collaborative Research Proposal Development, Peer Review and Mock Study Sections in a High School Science Classroom: A Case Study

Modern high school science curricula often incorporate student research projects aimed at 1) reinforcing general principles of the scientific method, 2) introducing students to sophisticated instruments/techniques, and 3) cultivating student inquisition in an experiential learning environment. Independent (guided) student research can also meet local, state and national Science Education Standards (Dye, 2009). However, student research projects can be overly ambitious and disorganized, leading to inefficient use of time and materials, as well as imbalanced participation in group settings. Here, we describe supplementary (preparatory) activities designed to help students focus their research topics/approaches, narrowly define roles and responsibilities of partners and effectively allocate available resources. Students from two upper-division elective science classrooms (n=60), in which an GK-12 TRIAD fellow was involved, were selected to participate in the development of collaborative research proposals (including introduction, hypothesis, objectives, expected outcomes, literature review, methodologies, budget and timeline), peer review panels and/or mock study sections. The fellow's research focuses on comparative genomics of guinea fowl and students were chosen from animal science classes. Early assessments of the impact of these pre-project activities suggest that student researchers participating in proposal development are more likely to: 1) narrowly define feasible hypotheses, objectives and methodologies, 2) manage working relationships with partners, 3) hold themselves and partners accountable for individual responsibilities, and 4) develop cost-effective strategies for conducting research projects. Students serving on proposal review panels demonstrated an improved capacity for literature review, successfully addressed issues of feasibility and budgeting, and gained a more accurate understanding of real-world science evaluation processes. In all, inclusion of these activities may add days or weeks to a high school student research-training program. However, their positive impact on inquiry, organization, participation and efficiency (time and money) make them an attractive supplement to standard student research.

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Discipline: Biological Sciences

Using the Scientific Method and Scientific Inquiry to Develop Diagnostic Skills for Health Science Students

The Medical Diagnostic class at Hillwood H.S. in Nashville is part of the Health Science curriculum. Students in this class receive an introduction to the medical laboratory and are taught to perform and interpret clinical laboratory tests. The steps involved in patient care, from the initial observation to the final treatment, closely mirror the steps of the scientific method. A TRIAD GK-12 fellow whose research focuses on biosensor development for the detection of foodborne pathogens is currently in the classroom to introduce more laboratory and research activities. Enriching the understanding and application of the scientific method as well as developing the skill of scientific inquiry will aid students in correlating test results with disease states. In addition, the students will also gain an appreciation for medical research as a potential career option. In the beginning of the school year the GK-12 TRIAD fellow used a simple MandM and Skittles lesson plan to re-introduce the scientific method with a focus on hypothesis development. A "How to make a Peanut-Butter and Jelly Sandwich" exercise was then used to demonstrate the level of detail and clarity needed in both patient charting and scientific communication. Using these initial exercises as an invaluable foundation, the class has since advanced to more laboratory-related exercises.

Contact: Kim Sadler, ksadler@mtsu.edu
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Assessing Interactive Responses in Litter Decomposition in Mixed Species of Sugar Maple, Oak sp. and Tulip Tree: An Example to Introduce Research in a One Period Class

The study was used to introduce high school students to the scientific method and research techniques. The study design

Abstract

is based upon that of an NSF GK-12 TRIAD fellow currently assisting with introducing research to the high school biology classrooms. The focus of the fellow's research is litter decomposition. In the study introduced in the classroom, the fellow had conducted the synergetic and antagonistic effects of three different local tree species for the previous ten months. Students were shown all the parts of the research process while explaining to them the steps of the scientific method and the results obtained. After the presentation, the students were asked to write the hypothesis for the research based on the information given. They were also asked to help with the last measurement for the study. The students worked in pairs, and each pair received a litter bag with the sample which they had to measure properly as part of the study. The students were highly engaged and were extremely careful with their measurements. Tables and graphics were prepared to compare the data collected by the students to that of the researcher. Students in the classroom have since developed their own biology research projects with hypotheses, methods and materials, and are currently working on collecting data for these projects.

Contact: Tiffany Saul, tnb2a@mtmail.mtsu.edu
Discipline: Biological Sciences

Engaging High School Students in Original Scientific Research

Students in Middle Tennessee high schools are learning about scientific research first hand. NSF GK-12 TRIAD Fellows from a variety of scientific disciplines offered at Middle Tennessee State University and Tennessee State University are sharing their own research interests with students. The Fellows are using their own research experiences to mentor students of participating classes. Two TRIAD fellows whose research focuses on comparative studies of reptiles and comparative forensic anthropology are currently working with high school students in elective ecology and biology courses to develop research projects. Working in small groups, the students have selected topics, developed questions, researched literature, and collected data for their projects. Group projects include a variety of topics such as behavioral and environmental studies in the lab and the field. By being involved in the entire process, students have developed the ability to ask research questions, examine the research of others, and have a greater understanding of the scientific method. Research groups are currently learning how to present their experimental results in a written form and in a visual presentation. This research process, along with involvement from local biotechnology industry partners, has allowed the participating students a real-world look at science in application.

MISSISSIPPI STATE

Poster 31

PI: KAREN MCNEAL
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Disciplines: Engineering, Geology and Geography, Physics

INSPIRE Classroom Connections of STEM Research in Rural Mississippi

The INSPIRE project at Mississippi State has paired ten graduate Fellows from Engineering, Geosciences and Physics with five local teachers from grades 8-12 to bring exciting new inquiry and technology experiences to the classroom. The areas of research of the first cohort of Fellows are Industrial and Systems Engineering (Human Factors and Ergonomics); Mechanical Engineering (Magnetostrictive Particles and Composite Sensors); Physics (Medium Energy Particles); Geology (Hydrogeology, Biogeochemistry); Meteorology (Agricultural Irrigation and Groundwater Levels); and Geospatial Information Systems (Wildfire Prediction and Prevention). Every two weeks the Fellows submit a lesson plan they have developed through communication and collaboration with their partner teacher and through which they strive to incorporate differing facets of their research. Fellows have also ventured into classrooms that are not their home classroom to expand their influence and expertise in their scientific field to engage even more students in the STEM fields. The lesson plans are published on the INSPIRE homepage at www.gk12.msstate.edu, separated by subject area and grade level, and for anyone to access as free public resources. Two INSPIRE Fellows and one teacher have traveled to Poland and Australia and have developed lesson plans for use in the classroom incorporating their field research conducted while in these countries. One classroom is in the process of creating a dialogue with a classroom in Poland through email based on partnerships formed by the Fellows. Other ways the Fellows have incorporated their research into the classroom is through the use of scientific instruments, technology and hands-on materials they find helpful in their field of study. Examples include handheld SkyMaster weather stations, GPS units, rock/mineral samples, Optical Spectrometer, portable Scanning Electron Microscope, Inclinometer, Soil Moisture Probe, Google Earth, ArcGIS Explorer, and WebTOP 3D interactive graphics system (http://webtop.msstate.edu/). We will showcase the Fellows areas of research and lesson plans linked to their research fields that have been created for and used at our participating schools.

MONTCLAIR STATE UNIVERSITY

Poster 32

PI: KEN WOLFF
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Mathematics and Statistics

Bridging the Gap: Connecting the Cutting-Edge Lab with the Middle School Classroom

Integrating mathematics and science in every lesson is the goal of the Montclair State's GK-12 STEM Project, www.csam.montclair.edu/gk12/lessons.html. Pairs of Fellows, consisting of mathematics and a science graduate students,

are partnered with seventh or eighth grade mathematics and science teachers in an effort to supplement and enhance the curriculum in urban-suburban school settings. In conjunction with their partner Fellow and cooperating teachers, each Fellow creates and co-teaches lessons designed to communicate their research to the middle-school students. Each lesson highlights the interdisciplinary nature of research in the mathematical and scientific fields by demonstrating the overlapping techniques and tools required in each domain. Moreover, each Fellow's research advisor visits the middle school to share his or her research stories. Four field trips, including an international videoconference, help demonstrate real world applications. The Fellows' research topics and their lessons, which are designed to translate these complex ideas into the classroom, include: (1) Environmental Influences on Mollusk Embryonic Development: Traveling Marine Zoo, Mixture and Concentration Investigation, pH Mystery, (2) Applied Abstract Algebra: Chutes and Ladders Game, Magic Squares, (3) Conformational Changes in Dihydrofolate Reductase Enzyme: The Perfect Fit, How Many Combinations Are There? (4) Applied Graph Theory: Human Complete Graphs, Traveling Volcano Salesperson, Social Networking Graphs, Let'ss Build a Roller-Coaster, (5) Characterization of Ovarian-Specific Gene Expression: What Does DNA Look Like?, From Peas to You: Mendelian Traits, (6) Epidemiological Models: Tag-You're Sick!, Periodic Puns Game, (7) Effect of Growth Factors on Neurite Development: Cell Classification, Counting Cells, and (8) Magnetoviscosity in Ferrofluids: Viscosity and Density, Area Under A Curve, Non-Newtonian Fluids, Magnets and Ferrofluids, The Ideal Gas Game.

NEW JERSEY INSTITUTE OF TECHNOLOGY

Poster 33

PI: BRUCE BUKIET
Contact: Chinyere Ofoma, cofoma@njit.edu
Caroline DeVan, Chinyere Ofoma, Nicholas Carlson, Sita Damaraju, Raj Jaswal, George Magou, Matthew Manzi, Xiang-xin Meng, Jennifer Zalk, Robert Friedman, David Lubliner, Bruce Bukiet
Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences, Mathematics and Statistics, Physics

An Innovative Use of Technology: Enhancing Inquiry-based Learning in STEM Fields

New Jersey has a very structured curriculum for its public schools. At the high school level, there are specific topics that are required for each subject along with general skills that can be gained throughout the curriculum. These skills include critical thinking, computational and mathematical proficiency, and an understanding of the scientific method. When working with teachers in the classroom it is important that our lessons integrate well into the existing curriculum, enhancing both the subject knowledge gained as well as the skills learned. How might we achieve this dual goal? Here we offer examples and suggestions based on our work with the Computation and Communication: Promoting Research Integration in Science and Mathematics (C2PRISM) GK-12 Project at New Jersey Institute of Technology (NJIT). Our project seeks to increase interest and competency in urban high school students in STEM disciplines in the Newark Public School system in Newark, NJ. This project has placed graduate students from engineering, biology, chemistry, computer science, physics and mathematics into classrooms as model scientists and content experts. A particular interest of our project has been enhancing the existing curriculum by incorporating computational tools and graduate research into the classroom environment. To this end we have been using Vernier instruments that are able to measure a range of physical, chemical and biological processes and Algodoo, a computer program that allows students and educators to create models for the classroom in order to illustrate abstract concepts with easy to understand simulations. This computational toolkit has been used as a part of classroom demonstrations and inquiry based labs and science fair projects covering topics such as heart rate and blood pressure, photosynthesis and respiration, calculating absolute zero, measuring wind power, and illustrating basic algebra using motion detectors and simulations. The main challenge to using this equipment in the classroom has been finding ways to complement existing lessons while avoiding interfering with a strict statewide curriculum. We have met this challenge through creative lesson planning and collaboration with our teacher-partners. Graduate students are also able to integrate their research into lessons, providing examples of real-life applications for new knowledge and in some cases even bringing the students into labs at NJIT, where they were able to perform independent research projects.

NEW MEXICO STATE UNIVERSITY

Poster 34

PI: ENRICO PONTELLI
Contact: Michael Harris, mharris@nmsu.edu
Michael Harris, Ben Wright, and Jharrod LaFon
Discipline: Computer Science

Web-Based Simulations in the Classroom

In order to encourage 6th-12th graders to be interested in STEM topics, computer science in particular, we are developing several classroom modules that are designed to engage students and integrate computational concepts such as simulation, data manipulation, and visualization with traditional science curriculum. Among these modules are Python programming, visualization of astronomical concepts, and the subject of this poster, simulation and demonstration of potential and kinetic energy. This particular module is the demonstration of a hydroelectric power plant. The hydroelectric plant was chosen because it has elements

Abstract

involved in many different areas specified by New Mexico Grades Science Standards at multiple grade levels. These include Earth Science, Energy, Newtonian Physics, and Technology and Society. Additionally, a hydroelectric power plant has many elements that can be simulated in varied ways. Our simulation initially focuses on differences in potential energy relative to height of stored water and how it relates to the amount of power generated by the dam. Simulation software is built using Javascript and HTML5. Web technology was chosen over locally installed applications due to the constrained computer environment at local schools. Public school computers are restricted so that nothing can be installed or changed without administrator approval. With a web application, however, students can use the simulation software with the web browser already installed on their classroom or home computers. Additionally, the simulation can be run on mobile devices such as the Apple iPod Touch and iPad, which several local schools have access to. Classroom labs consist of several parts spread over class sessions. In the first, students are given a short demonstration of a physical model of a hydroelectric power system and work with the teacher on guided group experiments to discover how the height of released water affects power generation. In the second, students are shown the simulation software and use it to repeat the physical experiments in silico. In the third part, students compare the results from their virtual simulations with those from the physical experiments and try to resolve the differences between them. We will present reactions by students and teachers to this kind of integrated virtual/physical lab, as well as the benefits, challenges, and future improvements regarding the use of web-based simulation software in a classroom setting.

NORTHERN ARIZONA UNIVERSITY

Poster 35

PI: CATHERINE UECKERT
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Discipline: Biological Sciences

Biotechnology in the Classroom: Real World Connections

Biotechnology Integration Opportunities for Teacher Education and Content (BIOTEC) is from Northern Arizona University (NAU) in Flagstaff, AZ. Our poster focuses on the research of the fellows and how they have been successful in incorpotating it into the classroom on a regular basis. The theme of our project is biotechnology and the fellows and teachers have been working very hard to develop standards based lessons that emphasize the fellows research while integrating biotechnology as a central theme for instruction.Outside of the classroom our second year fellows have projects that include the following: developing web based lessons with their partner teacher, a biotechnology club for high school students at NAU, enhancing the link between NAU and the K-12 classroom with a series of guest speakers, and designing a problem based learning project to examine the manufacture of biofuels.

NORTHWESTERN UNIVERSITY

Poster 36

PI: VICKY KALOGERA
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Discipline: Computational Thinking

Bringing Computational Thinking to Traditional High School Science Classes

Computational thinking involves designing systems and solving problems by drawing on concepts fundamental to computer science. Reach for the Stars works with seven PhD candidates from Northwestern University who use computational thinking in their research. These researchers have been placed them in an assortment of traditional 7th -12th grade science classrooms. The work of four of these fellows will be highlighted in this poster. **Tom** is a computer scientist whose research involves modeling objects moving through a fixed network. He has taught physical science students to abstract each artist from a hip-hop network into a single mathematical object and study the relation between them using tools from network science. Students did research looking at a data set of hop-hop collaborators and proposed conjectures regarding network structure and its relation to actual musician success. **Meagan** is a computational astrophysicist, using computer simulations as a tool for studying the dynamics of star clusters containing many stellar mass black holes. Meagan has introduced her students to one technique important to computation thinking--making complex estimates--by teaching high school biology students about the Drake equation. This introduction to the basics of probability theory will be revisited later in the year when the students study genetics. **Dan** is a physicist whose research involves using molecular dynamics and Monte Carlo simulation techniques to study soft matter physics. In both his chemistry classroom and research, colloidal particles and their interactions are a natural analog to molecules and intermolecular interactions. Dan has introduced this to his high school students through an open-source Java applet for 2D molecular dynamics and modifying it to include Janus particles. **Jason** is an astrophysicist studying the theory and application of smoothed particle hydrodynamics. His hands-on projects have allowed physics students to run simulations for projectiles using excel and analyze observational data using simulations explore black holes. These programs have allowed the kids to see the connection between experiment (observation), theory and computer simulations. Computational thinking involves designing systems and solving problems by drawing on concepts fundamental to computer science.

Abstracts

OHIO STATE UNIVERSITY

Poster 37

PI: RICHARD MOORE
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Disciplines: Ecology, Environmental, and Earth Sciences

Bringing Research into the Classrooms of the Sugar Creek Watershed

The fellows in the Ohio State Fellowship Program bring a diverse interest in ecological and sustainability issues to the classroom**. Julia Barton** brought her work with an urban, muslim Somali refugee community in Columbus, OH to a predominantly Amish classroom. Their discussion of the Somali diaspora and culture helped students widen their worldview and learn more about themselves and each other. **Keely Davidson-Bennett** studies the impacts of watershed urbanization on stream hydrology and biology. She has tied her research to the classroom by using stream examples to teach food webs, the organisms found in streams and what they need to survive. **Darlene Florence**, whose research takes her to Kenya, uses technological differences between agriculture in Ohio and Kenya to address the eighth grade standards of understanding technology, specifically historical advancements in agriculture and how constraints present within a culture and community affect adaptation of agricultural technologies. **Chuck Goss'** research focuses on the interaction between riparian forests and streams in agricultural watersheds. His research has been incorporated into the classroom by creating lessons that inform students about macroinvertebrate functional feeding groups and the role of leaf litter in aquatic food webs. **Marc Hyntka's** research focuses on local food systems and is incorporated into the classroom as it relates to energy, water issues, and resource scarcity at a local level and in relation to the impact it has on the community and the students today and in the future. **Ryan Hottle's** project with the students was to bring India, where he has conducted research, into the classroom and to turn the classroom into a world of real world problem solving. **Katie Martin** quantifies changes in ecosystem dynamics across eastern hemlock forests of central Appalachians due to the invasive insect, hemlock woolly adelgid. Her high school students follow her research experiences through a blog, and have incorporated plant ecology through an experimental native biodiversity garden and forest research on maple sap flow. **Adam Selhorst** studies carbon sequestration potential and climate change mitigation capability of turfgrass systems, and the effect of management practices on net soil C sink capacity. His high school students designed and implemented their own study expanding results of his work to determine the affects of turf proliferation on community water quality.

OHIO UNIVERSITY

Poster 38

PI: TIAO CHANG
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Computer Science and Information Management, Engineering

Boat of Knowledge in Science Classroom (BooKS): Fish Kills

The Boat of Knowledge in Science classroom (BooKS) has conducted water sampling trips in the Ohio River, in which activities of "Fish Kill" have been discussed. As one of the BooKS graduate fellows with civil engineering background, I have been paired with Gallia Academy High School's 9th grade Biology teacher, Keith McGuire. Keith and I have worked hard to incorporate activities into the lesson plans that peak students' interests in science, technology, engineering and mathematics. One such activity students performed this fall was the Fish Kill Activity. Students were first introduced to what a fish kill is, some possible causes of a fish kill and how to interpret all of the evidence from a fish kill by performing water quality tests. Next, students were given background information of a particular site where a fish kill was reported. They were then broken into groups and assigned to four stations throughout the classroom. Three stations represented upstream sites from the fish kill and one represented the actual fish kill site. Each station was equipped with a photo representing what that site looked like, an actual water sample and a list of test results taken from the site. Students had to record the water observation, pH level, Nitrate level, Phosphate level and dissolved oxygen level given at each station. Once each student had rotated to all four stations, they were asked to analyze their results and conclude what caused the fish kill.

Boat of Knowledge in Science Classroom (BooKS): Water Quality Index

In order to evaluate the water quality of different water bodies, the National Sanitation Foundation developed the Water Quality Index (WQI) as a standard method in 1970. The index is a 100-point scale that specifies water quality level based on measurements of nine parameters. A weight factor is assigned to each parameter depending on the impact of the parameter on the total water quality. A series of Q-values are also assigned to each parameter to indicate its quality based on the measurement. This method has been adopted by the Ohio River Valley Water Sanitation Commission (ORSANCO) for assessing the water quality in the Ohio River and eight out of these nine parameters are used for calculation. The students at Tri-County Career Center in Ohio conducted an on-boat sampling activity on the Muskingum River and calculated the WQI in October 2010. While testing water chemistry parameters and calculating the water quality index is an

Abstract

excellent activity for students to learn how to estimate the quality of various water bodies, it may be difficult for some to understand the meaning of Q-values or weight factors. A follow-up lesson/activity "Creating an Index" was developed to help students with this subject. In the activity, students were divided into groups. Each group chose 5 parameters that they considered to be the best health indicators and created a health index by assigning Q-values and a weight factor to each parameter. After designing their health index, each group performed physical exams on 3-5 volunteers to assess their overall health using the index form. The students who performed this activity are from the health-tech field. Hence, by connecting the water quality index to something that they are familiar and experienced with, the students had a better understanding of the weighting factors, the Q-values, and the water quality in general.

PENNSYLVANIA STATE UNIVERSITY

Poster 39

PI: RENEE DIEHL
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Discipline: Physics

Towards a Phase Diagram for Accreting Neutron Star Crusts: Total Energy Calculations of Close Packed Lattices

Neutron star crusts are somewhat less exotic than their cores, but may still play an important role in observable astrophysical phenomena, such as glitches in the periods of rotating, magnetic neutron stars known as pulsars. Material from a nearby companion star can be sucked into a neutron star by its gravitational pull and undergo nuclear fusion, giving rise to a complex crustal composition. In the outer crust, the various species exist not as atoms but bare nuclei immersed in a relativistic gas of electrons. In this regime, the crystallization of these species into multi-component close-packed lattices is possible. Physical properties of these lattices would be different than those of the alternative, single-component lattices, and might validate or invalidate models for neutron star crust quakes, heat transfer, and other phenomena. Here we show the results of total energy calculations for candidate crystal lattices, in the form of phase diagrams for an accreting neutron star crust. Aspects of this research has been introduced to 2nd graders at Philipsburg Elementary School as part of the CarbonEARTH GK-12 project. Through astrophysics-related projects students have learned about star life cycles by making posters, and they have taken a field trip to the Breazeale Reactor at Penn State to learn about nuclear (fission) energy. Another ongoing project, related more to the solid-state physics part of this research, involves making ball and spring models of crystals to study the phenomena of order and wave motion.

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Disciplines: Ecology, Environmental, and Earth Sciences

Integrating Green Infrastructure Theory and Practice Into Junior High Classrooms

The US faces a looming water infrastructure crisis. A growing body of research nationwide suggests outdated, compromised, and increasingly frail storm drainage systems progressively contribute to local and downstream flooding, waterborne chemical and nutrient pollution, combined sewer overflow contamination, and decreased groundwater recharge. At the same time, water infrastructure demand is rising with population precisely when climate models predict greater variability in precipitation intensities, frequencies, and runoff volumes over time. Meanwhile, crumbling US water infrastructure continues to decay, with additional hundreds of billions of dollars of municipal repair shortfalls forecast over the next decades. To address these growing challenges, I study a transformative new approach "green infrastructure" as a method to supplement aging and overtaxed domestic drainage networks. Green infrastructure (GI) refers to an array of novel, low-impact, and ecologically-based urban design strategies intended to retrofit communities with broad scale and site-specific runoff management installations, such as green roofs, rain gardens, bioswales, and urban greenways. Specifically, my research quantifies how specific spatial configuration and GI network pattern could best mitigate urban flooding and pollution. I hypothesize that (a) GI installations will infiltrate greater runoff than conventional urban land cover types; (b) GI networks could maximize urban water retention and pollution control.I translate this research into the classroom by integrating the teaching of GI principles, practices, and theory with an as-planned architectural project. I work with Philipsburg-Osceola Junior High students in Philipsburg, PA to help students design a school renovation and expansion plan to transform their district's former elementary school into its future junior high. Throughout this project, students will explore materials and construction methods for green roof, bioswale, and other GI installations; quantify the water retention and energy-saving capabilities of their GI designs; and learn the broad scale benefits of GI application. This GI unit is part of a larger class effort to involve students in designing their new school, and will incorporate architectural practices, interior and exterior spatial design, and resource-saving site planning. Students will also be involved in basic energy modeling and research of green building design techniques and exploring possible alternative energy sources for their new building. During this process students will collaborate with the project architect, school administration, and the District advisory board. They will report their findings in their school newspapers and websites and to local media, and will formally present their recommendations to the Philipsburg-Osceola School Board.

Contact: Abbey Tyrna, aat145@psu.edu
Discipline: Geography

All Living Things are Connected by Water: Establishing Watershed Stewardship through Scientific Understanding in Elementary Classrooms

All living things on earth are connected by water. Individual actions shape the quality and quantity of water that flows through the hydrologic cycle. To grasp the concept of a water-connected planet, fifth-grade students at Philipsburg Elementary School are investigating the water cycle and exploring first-hand the processes that keep the same old water cycling through space and time. A deep understanding of the water cycle will lay the foundation for discovering the many hydrologic avenues that connect humans, animals, and plants. Using hydrologic connectivity as the overarching theme, students will also become conscious of the impacts that water users have on each other, the global distribution of water, and current and on-going efforts to conserve and distribute water to sustain life on earth. One such technique that will be explored is the use of wetlands to store and filter storm water. Students will build off the foundation established in the classroom to investigate and compare two storm water treatment wetlands in their watershed community. Using their fieldwork and classroom knowledge as their guide, the students will also design their own water treatment habitat (also known as a rain garden) for their school. The constructed rain garden will work to clean and store water while providing a habitat for aquatic bugs and amphibians. The rain garden will embody the intellectual growth of the students, provide an outlet of expression, and facilitate watershed stewardship while showcasing their heightened awareness that all living things on earth are connected by water.

POLYTECHNIC INSTITUTE OF NYU

Poster 40

PI: VIKRAM KAPILA
Contact: Vikram Kapila, vkapila@poly.edu
Disciplines: Engineering, Mathematics and Statistics, Physics

Enriching K-12 Science and Math Education Using LEGOs

Although robotics competitions such as the FIRST LEGO League (FLL) provide compelling opportunities for learning and skill-building to students, their extracurricular nature has not made the use of robotics more central to K-12 STEM education. Moreover, the potential for explicitly exploring science and math principles using robotics-based activities remains largely untapped in K-12 schools. In fall 2010, we conducted an online survey of New York City FLL coaches and received 43 responses. According to survey respondents, over 50% do not use robotics in their classrooms, and only a small number provided explicit, meaningful examples of their use of robotics in STEM classrooms. Yet, increasingly, educators have been seeking to transition robotic design experiences from an after-school activity into classroom. Many STEM principles are inherently incorporated into performing simple tasks with a robot, especially in physics and math. The LEGO Mindstorms platform offers a variety of components to engage students' creativity and allow the application of teaching strategies such as scaffolding and problem-based learning. Judicious integration of sensors engages students' understanding since it allows connecting an abstract concept to a tangible measurement performed by students. Finally, the variety of sensors available with the LEGO robotics platform permits the acquisition and processing of a multitude of physical stimuli arising in science subjects that often require separate, standalone equipment. This poster will present several LEGO-based science and math activities developed by engineering graduate Fellows in partnership with K-12 teachers. These activities are grade appropriate, address pertinent learning objectives, and adhere to the learning standards of the city and state. For example, The Mechanical Advantage, Acceleration due to Gravity, and Fluid Flow Rate activities were conducted in 5th, 8th, and 9th grade science classes, respectively. Similarly, About Accuracy and Approximation, Pi, and Means, Modes, and Medians lessons were conducted in 5th, 6th, and 9th grade math classes, respectively. To measure the effectiveness of these lessons, pre- and post-lesson assessment surveys, consisting of content and evaluation questions, were administered to all participating students. This poster will provide overviews of: these lessons, assessment of their effectiveness, and dissemination of these activities to over 100 teachers through a day-long workshop.

PORTLAND STATE UNIVERSITY

Poster 41

PI: LINDA GEORGE
Contact: Patrick Edward, patrick.edwards@pdx.edu
Disciplines: Ecology, Environmental, and Earth Sciences

Cascades To Coast GK-12: Enhancing STEM Education through Environmental Sustainability

The Cascades to Coast GK-12 project has established partnerships between Portland State's School of the Environment and three Oregon school districts toward the goal of enhancing middle, high school and graduate STEM education around the theme of environmental sustainability. The project's geographic breadth, from Oregon's Cascade Mountains to the Pacific Ocean, provides an opportunity to create a learning community across diverse school districts and ecosystems. Fellow teaching activities include: testing different methods for naturally removing invasive species in a wetland, designing and building the most effective structure for mammal tracking, testing the water quality of an urban stream near and comparing results to streams in the Cascades and Coast Range, visiting salmon-bearing streams in the Cascades to observe salmon migration and collect macroinvertebrates, and measuring and recording daily weather conditions in the Gorge and comparing to Willamette Valley weather. Project activities include: the development of an interactive web page, called Ask a Scientist that allows students to post questions directly to environmental researchers and share their answers with other project

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participants, a collection of inquiry-based curriculum available online, and an interactive environmental spatial data set.

RENSSELAER POLYTECHNIC INSTITUTE

Poster 42

PI: DEBORAH KAMINSKI
Contact: Kristen Sikora, sikork2@rpi.edu
Disciplines: Ecology, Environmental, and Earth Sciences, Engineering

Innovative Ideas for Bringing Graduate Level Research to the High School Classroom

The DAEE Program fellows have been very successful in the classroom. They have encouraged their high school students to pursue the sciences and have used their own research and innovative technologies to do so. For example, **Nathan Rabideaux's** research on the influential relationship between climate and humans has proven to be a very interesting topic to his earth science students. He has introduced them to climate science and stratigraphy as well as how the geologic timescale for dating rock has been developed. He and his partner teacher, Cindy Sargent, have developed activities that better illustrate some of these concepts. One activity was a Skittle Core lab. Skittles (candy) were baked into a brownie and the students learned how to take core samples and determine population density. This introduced the students to paleoclimatology and paleoceanography. Second year fellow **Melanie Derby's** research on condensation heat transfer in square, triangular and semi-circular mini-channels has been of interest to her students. She showed them her research results in order to begin a lesson on uncertainties. The students saw her test section and had a discussion on the importance of testing in engineering. The students will use this knowledge in order to conduct tests and perfect a marble sorter that they are building as a class. Because of these activities, Melanie's students have a better understanding of research techniques and how to learn from one's mistakes in order to improve a project. **Erica Sherman's** research involves the application of fluid mechanics principles to the human body, particularly the voice box. Erica employs Digital particle Imaging Velocimetry in her research so she wanted her students to use similar experimental techniques in the classroom. She has also introduced advanced design and production technology to her students. Students came up with their own production ideas and were then guided through the experimental process. The students were also shown advanced manufacturing techniques such as Computer Numerical Control lathes and mills as well as investment casting. Students researched various manufacturing techniques and then created posters demonstrating these methods to the rest of the class. Erica's students were given a tour of RPI's Advanced Manufacturing Network where they saw some of the same techniques they had researched. It is hoped that they will be able to use the facilities at RPI to construct their own solar heaters.

SAVANNAH STATE

Poster 43

PI: CAROL PRIDE
Contact: Carol Pride, pridec@savannahstate.edu
Disciplines: Ecology, Environmental, and Earth Sciences

Enhancing Ocean Literacy through Infusion of Estuarine Research into K-12 Classrooms

The GK-12 Ocean Literacy Program at Savannah State University and the Skidaway Institute of Oceanography is enhancing ocean literacy in a coastal community while building the communication skills of marine science master's degree students. Georgia students are typically only taught oceanographic principles in 6th grade earth science classes. Our program is striving to expand exposure to oceanography in Savannah, GA schools from Kindergarten through 12th grade. In 2009-10, the GK-12 Ocean Literacy graduate students are engaged in 5 diverse academic settings: an elementary marine science lab, a Montessori middle school, a high school with an International Baccalaureate Program, a high school with a new medical emphasis, and the school district's outdoor education center. Fellow research areas are focused on regional estuarine environments, with emphasis on anthropogenic influences on the estuary and resident organisms. The GK-12 fellows' projects include: a study of larval fish uptake and export in ballast water; the relation of bottlenose dolphin begging behavior to local fisheries practices; strand feeding behavior of bottlenose dolphins; the microbial communities of bottlenose dolphin spleen tissues; variability of a wastewater treatment plant effluent plume in the Savannah River estuary; and the use of endemic phytoplankton for tertiary wastewater treatment and potential biofuels production. Each fellow is integrating his/her research into the classroom with the assistance of their professor and their teacher mentor. Their research and its integration into each academic setting are further documented in this poster.

ST. JOSEPH'S UNIVERSITY

Poster 44

PI: KAREN SNETSELAAR
Contact: Karen Snetselaar, ksnetsel@sju.edu
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences

Bringing Elements of Plant Physiology and Global Climate Change Research into a Second Grade Classroom

The research conducted in Dr. Clint Springer's Plant Physiological Ecology lab at Saint Joseph's University focuses on the effects of global climate change on the structure, function and life cycle of plants. Three members of this lab are

GK-12 fellows, and each fellow's research addresses a different aspect of plant physiology and how it is affected by environmental variables. Elements of the research have been incorporated into the second grade year-long unit on Systems and Cycles. In the fall, second graders study the Earth as a system and important cycles associated with it, such as weather and changing climate. In the spring the students learn about plants and their interactions with the environment. Students' understanding of cycles and systems is expanded when applied to living organisms they encounter daily, and fellows are able to incorporate elements of their research into the lessons. These include environmental effects on plant flowering and how disease and water stress affect plants. The fundamental concepts of each fellow's research are simplified in a manner that makes them accessible to the students, while at the same time adhering to the Pennsylvania second grade science standards.

STEVENS INSTITUTE OF TECHNOLOGY

Poster 45

PI: CONSTANTIN CHASSAPIS
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Discipline: Engineering

New Jersey Alliance for Engineering Education: Promoting Innovation and Inventiveness

The Stevens Institute of Technology GK-12 Program supports the New Jersey Alliance for Engineering Education (NJAEE), a partnership to promote the integration of engineering innovation, invention, and problem-solving within mainstream STEM curricula. Recruited from various engineering and science disciplines, the research projects of all GK-12 Fellows fall with the area of Multiscaled Engineered Systems. In their role Fellows provide high school STEM support, with an emphasis on the delivery of modules based on their research and its relationship to, and use of, STEM fundamentals covered at the high school level. Lessons developed to date have covered topics such as environmental remediation of hazardous materials, cell-biomaterial interactions, microchemical reactors, plasma chemistry, and nanotechnology. For example, a past NJAEE Fellow was pursuing the use of interference lithography to pattern uniform nanoscale surface features over large areas. Such surfaces have potential application in a wide range of areas, including friction-free surfaces for drag reduction and nanostructured surfaces for control of the interaction of biological cells on a prosthetic implant surface. To support a high school Physics classroom, the Fellow adapted his research in interference lithography to design and develop simple experimental methods that measure the speed of light using common, everyday items such as a microwave. Other examples of experimental systems that NJAEE Fellows have designed and built include a wind tunnel, a fractional distillation apparatus, and a homemade spectrometer. It is in the context of the Fellows' cutting-edge research topics that the students see the applicability and excitement of high school science, and how through innovation and invention science can be engineered into devices and systems that they may encounter in everyday use. As part of the NJAEE, the GK12 Fellows and High School teachers have participated in a series of professional workshops covering subjects such as Patents, Innovation, and Communication Skills. Within the context of the NJAEE the Fellows then have the opportunity to practice and expand these professional skills; for example, by conducting a technology review covering issues related to issued patents and commercialization efforts in their research area, which is then presented within the high school class. In this manner the NJAEE is piloting new ways to augment the traditional technical focus of graduate science and engineering education by facilitating the development of additional attributes and skills that our graduates will need to become the next generation of technology leaders and innovators. In addition, through interactions of the Fellows within the partner classrooms the NJAEE is able to enhance the content technical knowledge of the teachers while providing successful young scientists and engineers as role models for the students.

TEMPLE UNIVERSITY

Poster 46

PI: SHOHREH AMINI
Contact: Erin Graham, erin.r.graham@temple.edu
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences

Sea Anemones, Global Climate Change, and Food Science: What's the Connection?

Global climate change is profoundly affecting marine ecosystems. Excess carbon dioxide (CO_2) in the atmosphere has caused a rise in air and seawater temperature. In addition, atmospheric CO_2 equilibrates with seawater, lowering the pH of oceans worldwide. Like terrestrial plants, many photosynthetic marine organisms rely on CO_2 for photosynthesis. Photosynthetic dinoflagellates (zooxanthellae) are single-celled organisms that form the foundation of coral reefs. Zooxanthellae live in symbiosis with a number of marine invertebrates including coral, anemones, clams, and sea slugs, where they perform photosynthesis to supply both themselves and their host with nutrition. Increasing temperature and CO_2 may disrupt this symbiosis and cause major changes to the marine ecosystem. As a GK-12 fellow, my research focuses on examining the effects of elevated sea water temperature, increased CO_2, and reduced pH on the symbiotic relationship between sea anemones and zooxanthellae. I am partnered with a teacher from the School District of Philadelphia who teaches Food Science and Meat Science courses for grades 9-12. Although there may not be a clear connection between my research interests and the Food and Meat Science curricula, we (my partner teacher and I)

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have developed several lessons that successfully extend topics of my research into the Food Science classroom. This poster describes a few of these lessons, including determining the effects of increased CO2 on photosynthesis, and examining the role of symbiosis in ruminant animals.

Contact: Michele Grinar, mgrinar@yahoo.com
Discipline: Ecology, Environmental, and Earth Sciences

Using the Vernier Proscope High Resolution Digital USB Microscope for Oil Spill Study

Four Vernier Proscopes were purchased for classroom use at Franklin Learning Center, but time constraints had, up until recently, prevented staff from exploring appropriate and exciting activities for which the technology could be used. Meanwhile, a dedicated pair of sophomores chose the topic of oil spill remediation for their science fair entry and visited several teachers to gather ideas for data collection. Through these visits we discovered the Proscopes, and the AP biology teacher allowed us the use of one with the request that we give an instructional seminar on its installment and use to the staff after we performed our experiments. The Proscope is a device that has a gun-like appearance. It is a camera attached to a magnifying lens with a built in light. This device is interfaced with a computer that has had the Proscope software installed, and allows students to record magnified objects. The scope can be used by itself as a dissecting microscope or in conjunction with a compound microscope to record images magnified from ten to one thousand times. Still images, videos, and time lapse photography can be recorded with the software program. My students, after conducting background research, chose to use the scope in conjunction with a compound microscope with a 400X magnifying lens to record still images of seawater-oil mixes that had been treated with different remediation agents. This device, while simple and easy to use, provided my students with an exciting data collection tool that they, after learning about its installment and use, could use unassisted. They have shown a marked increase in interest in their project, and have conducted in-class tutorials on the Proscope's use for other students. I also conducted a tutorial with four other science teachers, so this technology is now accessible to the entire student body. One of the benefits of using the Proscope in class is that an experiment with Daphnia magna is now possible. Typical dissecting microscopes require the use of a separate light, and its intensity often caused the zooplankton to die before students could accurately record its number of heart beats in a given time. The Proscope will allow students to observe the Daphnia under a low intensity light, while recording video of its heartbeat. This will allow students time to conduct the experiment without concern for the Daphnia as well as the opportunity to count the heartbeats from video, eliminating the potential for mistakes. Maintaining the Proscopes, keeping their attachments organized, and installing the software on multiple computers have been challenges myself, science teachers and IT staff have encountered and solved through peer-based inquiry and teamwork. The Proscope went from sitting on a closet shelf to being used in innovative ways as a learning tool in a matter of days, and the use of this technology has been a catalyst for making data more accessible and increasing student interest in science.

Contact: C. Grier Sellers, cgsellers@temple.edu
Discipline: Biological Sciences

Teaching About Microscopy and Chloroplast Endosymbiosis in High School Biology Classes

A recently discovered, but incompletely described Antarctic dinoflagellate retains chloroplasts (and in some cells, nuclei) obtained from its haptophyte algal prey, Phaeocystis antarctica for several months. Such long-term retention is as yet unexplained in this species, which may serve as a model of an early stage in chloroplast endosymbiosis. Experiments are underway or planned to explore the possibility that it can feed on bacteria, retain chloroplasts from other haptophyte and cryptophyte species, and on the duration of maintenance of functional foreign nuclei and chloroplasts. In another experiment, morphological and physiological changes in the dinoflagellate are studied during the six months continuous light or darkness found in its habitat. Phase Contrast, DIC, Confocal, and epifluorescence microscopy have been used in the course of these experiments. Transmission electron microscopy will be employed to characterize the ultrastructural topology of retained organelles in the dinoflagellate and to compare their morphology to their native state in P. antarctica. Scanning electron microscopy will also be used to study the feeding process in detail. Classroom Application: An interactive power-point presentation was employed to demonstrate basic microscopy concepts, including magnification, resolution, and contrast, and their practical importance. Students were not only introduced to the compound light microscopes they use, but also to other microscopes used in modern biological research. The uses, advantages and disadvantages of these different microscopes were discussed and illustrated with photomicrographs. Three other power-point presentations described differences between prokaryotic and eukaryotic cells, the endosymbiotic origins mitochondria and plastids, and the evolution of oxygenic photosynthesis and aerobic respiration in prokaryotes. Lab exercises provided students with experience in using the compound light microscope, and knowledge of its parts and their functions. Observations of wet mounts from a culture of the cyanobacterium Anabaena, a hay infusion containing the ciliate protist Colpoda, and of chloroplasts in the plant Elodea served to reinforce what students had learned about the differences between prokaryotes and eukaryotes, and the origin of chloroplasts from cyanobacteria. Careful observation of living material was encouraged by requiring students to make detailed color drawings of what they saw under the microscope.

TEXAS STATE UNIVERSITY SAN MARCOS

Poster 47

PI: JULIE WESTERLUND
Contact: Julie Westerlund, jw33@txstate.edu
Discipline: Biological Sciences

Secondary Student Attitudes towards Science after GK-12

This study examined the relationships between Project Flowing Waters GK-12 Fellows (resident scientists), students and science teachers in five partnerships. In 2009/10, data was gathered from multiple sources; fellows' weekly journals, secondary student pre and post surveys that utilized the NSF SWEPTS study Anonymous Student Attitude Survey (http://www.sweptstudy.org/instruments.html) and open-ended questions for students concerning the resident scientists, science, and the San Marcos ecosystems. The survey was administered in pre/post test fashion. Matched pre and post student attitude surveys were obtained from five partnerships. There was a positive significant difference ($p < .05$, paired T test) in pre/post test scores concerning "Beliefs about Science Work and Careers" in three of the five partnerships surveyed. The impact of GK-12 fellows and their connections to the secondary school classrooms and students is addressed.

TEXAS TECH UNIVERSITY

Poster 48

PI: DOMINICK CASADONTE
Contact: Gabriel Ramirez, gabriel.g.ramirez@ttu.edu
Disciplines: Engineering, Mathematics and Statistics, Physics

Accelerometers in Space

Micro-machined accelerometers are a quickly becoming commonplace sensor both within the commercial sector and scientific community. Accelerometers are utilized in many areas including personal health, entertainment, automotive safety, and space travel. With regard to space travel, these sensors have had several specific roles that include spacecraft velocity measurement, impact notification, relative gravity measurement, as well as monitoring astronaut activity profiles. Using long-term space travel to Mars as a teaching device, we proposed to introduce these specific space oriented applications of accelerometers to students at the secondary level while connecting key math and physics concepts. Drawing from GK-12 Graduate Fellow research experience, we adapted the Freescale ZStar3 Development Kit for classroom use. The ZStar kit is small, inexpensive and utilizes Zigbee wireless transceiver technology. A USB dongle pairs with a mobile end device, powered by a small coin battery, on which a tri-axial digital accelerometer resides. Demonstration software was provided by Freescale that displayed wireless signal power, dead reckoning tilt, and real-time g-force graphs of all three axes. We introduced the wireless accelerometer system and other similarly developed devices to the classroom by placing them in athletic foam balls and by attaching them to the waist of participating subjects. Students were given hands-on access to the devices, which were robust to shock and electrostatic discharge. The balls were used by the students to study constructs of motion, while the human participants generated novel data that was used to study personal activity profiles. The real-time data was recorded and stored into spreadsheet software where it was investigated with basic statistics and analytical geometry techniques. The activity profiles in particular were categorized statistically and the students were asked to comment on features and their correlation to specific human motions. Upon completion of the module, students were able to make basic physics/math connections such as rate of change and velocity/acceleration measurement. They were also noted to be aware of state-of-the-art data analysis with regard to human motion and activity monitoring. By introducing an everyday technology in a visionary way, we endeavored to demystify many common devices such as the Wii Remote and the iPhone while planting seeds for potential innovative development of motion sensor technology.

UNIVERSITY OF ALABAMA

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PI: BETH TODD
Contact: Beth Todd, btodd.eng@gmail.com
Discipline: Engineering

GK-12 Sustainable Energy Systems at the University of Alabama

GK-12 Sustainable Energy Systems is a partnership with the Sumter County School District and the existing Alabama Math, Science, and Technology Initiative (AMSTI) to enhance the education of STEM graduate Fellows and STEM education for middle and high schools. The two major goals of this project are to (1) increase the professional caliber of our STEM graduate students and equip them with the skills and experiences to become future leaders in academia and industry; (2) provide resources and support for the newly formed State of Alabama high school Engineering Academies and create materials that integrate engineering applications into existing high school and middle school science and math courses. The multi-disciplinary theme of the project, Sustainability in Energy Systems, includes transformative research on alternative and traditional energy resources and systems, including renewable resources in consideration of their environmental impact. This poster focuses on the research by each of our current fellows in topics as varied as hydrocarbon emissions reduction, biomedical systems, and

Abstract

pure mathematics. Several of the fellows have developed classroom modules to complement their research, for example, one fellow has developed a fluidic muscles lab for middle school science students to complement his research. These and other activities/lessons related to the fellows' research are being developed and implemented on an ongoing basis.

UNIVERSITY OF ARIZONA

Poster 50

PI: JOCELINE LEGA
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Disciplines: Mathematics and Statistics

Results of the G-TEAMS Project

We present an overview of some of the activities of the G-TEAMS (Graduate Students and Teachers Engaging in Mathematical Sciences) project at the University of Arizona Department of Mathematics. G-TEAMS fellows bring their mathematical expertise into a year-long partnership with local mathematics teachers. The teachers help the fellows learn to communicate effectively with non-technical audiences. Such reciprocal interactions between teachers and fellows are the backbone of a successful GK-12 program. We explore the effects of these two goals on the people involved through examples of what each fellow has learned from their teacher partner(s), and what each teacher has learned from their fellow. We also share some lessons that fellows have learned form their students, and student reactions to having the fellows in the classrooms. In particular, we illustrate how fellow's research colors these interactions. G-TEAMS fellows come from diverse research backgrounds--from biomedical engineering to abstract algebra--work with a broad range of students, and partner with schools in Tucson and Casa Grande, Arizona. Three fellows are working at the elementary level, two with middle schools, and four at high schools.

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PI: KIMBERLY OGDEN
Contact: Kimberly Ogden, ogden@arizona.edu
Discipline: Engineering

Water and Energy Systems: The Key to the Future of Arid and Semi-Arid Regions

Arid and semi-arid regions in the southwest US are experiencing rapid population growth raising concerns regarding sustainable management of land, water and energy resources. The goal of this GK-12 is to bring innovative research in water and energy resources to the classroom. This is achieved by developing and delivering a high school level course built around instructional modules in water and energy engineering as well as junior high level modules for integrated science courses. Each module represents an application of ongoing research at the University of Arizona. The research modules will be drawn from the energy and water research centers including: AzRISE, Arid Lands Institute for Bioenergy, EFRI: Infrastructure Development, NSF/SRC/Semetech ERC for Environmentally Benign Semiconductor Manufacturing, and the IUCRC NSF Water Quality Center. The graduate fellows come from a variety of engineering disciplines and participate in a teaching methods/communication course prior to working with the schools. The teachers are instructed on the basic concepts and implementation of engineering modules and gain content knowledge in engineering principles. The teachers are drawn from regional junior high and high schools. This presentation highlights a teacher/fellow team that is working together in a high school classroom. The teacher is responsible for teaching engineering courses at a variety of levels. The fellow is studying civil engineering.

UNIVERSITY OF ARKANSAS

Poster 52

PI: ART HOBSON
Contact: Morgan Ware, meware@uark.edu

The University of Arkansas GK-12 Program, K-12, I Do Science "KIDS": Scanning Electron Microscope in the Classroom

We present the University of Arkansas K-12, I Do Science program. For the past two years we have embarked on an experiment to bring a portable Scanning Electron Microscope into the middle school classroom. We will present several example lessons in which we have attempted to use this high technology piece of equipment to address the specific topics listed in the state curriculum. In addition, we will show how we have adapted this microscope for travel and have taken it to many different sights with great success allowing middle school students the opportunity to actually operate something that most people never even see.

UNIVERSITY OF CALIFORNIA, DAVIS

Poster 53

PI: JEAN VANDERGHEYNST
Contact: Larry Joh, ldjoh@ucdavis.edu
Discipline: Engineering

Developing Future RESOURCEs for STEM Communication and Training

The Renewable Energy Systems Opportunity for Unified Research Collaboration and Education (RESOURCE) program pairs UC Davis Ph.D. engineering students working on renewable energy technologies with Sacramento-area 5th and 6th grade teachers to develop new science curriculum.

Products include lessons and activities on general energy concepts (what is energy, renewable vs. non-renewable energy, climate and environmental impacts) and on each Fellow's specific research. Fellows serve as role models for children from diverse cultural backgrounds and hope to spark interest in Science, Technology, Engineering, and Mathematics (STEM) studies. **Sherry Blunk's** research looks at the thermal decomposition of biomass to produce renewable energy and value-added products. Additionally, the solid waste generated from this process is being evaluated for novel uses, including the remediation of contaminated soils. Sherry's students explore acid-base chemistry, pollution mapping, environmental lifetimes, and the idea of zero-waste or cradle-to-cradle systems. **Aubryn Cooperman's** research at the Aeronautical Wind Tunnel is focused on the aerodynamics of wind turbine blades, specifically, novel methods for blades to respond to wind gusts. She is working with her students to build anemometers and wind vanes to characterize the wind around their school. The activity shows some of the measurement techniques used at wind farms and gives a sense for the variability of the wind resource. **Nate Kingsbury** genetically-engineers tobacco plants post-harvest to produce and recover enzymes that are important in the industrial conversion of biomass to biofuels. Nate teaches 5th graders about tobacco's small bio-factories called cells and their machinery called proteins. He emphasizes how STEM curriculum gives bioengineers the tools they need for technology that can contribute to a sustainable future. **Ingrid Leth's** research is focused on the growth dynamics and optimization of Agrobacterium tumefaciens, a bacterium used to induce transient expression of proteins in plants. A major area of application is the production of cellulose-degrading enzymes for biofuel production. Ingrid is working with her students to learn about microbial growth, production of products such as ethanol, and the role of microorganisms in the environment. **Chao Wei Yu's** research focuses on modifying the chemical and physical properties of agricultural wastes to turn them into useable energy sources for thermal processes. He is working with his students to build a filtering box to separate candies by size. He also teaches activities related to properties of solids and liquids to give students a better understanding of how to perform experiments using scientific methods.

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PI: SUSAN WILLIAMS
Contact: Susan Williams, slwilliams@ucdavis.edu
Disciplines: Ecology, Environmental, and Earth Sciences

Framework for Open Inquiry: Independent Research Projects in Local Environments

The K-12 goal of CAMEOS (Coastal, Atmospheric, and Marine Environmental Observing Studies) is to facilitate independent research in middle and high school classrooms. Fellows provide scaffolding for students to develop their own scientific questions, hypotheses, and methods, implement their research plans, and ultimately present their findings at a research symposium. This open inquiry approach is inspired by fellows' research in the fields of ecology, evolution, oceanography, applied mathematics and computer sciences. Authentic scientific exploration and discovery, grounded in local California habitats, sharpens creative and critical thinking skills in students. Observational and organizational skills develop during sampling design and analytical, mathematical, and visual skills are built during data analysis and interpretation. For example, during a field trip to study stream environments, students first collect physical and biological data with standard assessment techniques under the guidance of fellows and teachers. Students then do background research on a topic of their choice and modify these methods to answer their own scientific questions. The open inquiry process culminates in symposium presentations, which require teams to practice linguistic, visual, and interpersonal skills. The CAMEOS curriculum enables students to collaborate on original research, explore their local environments, and think as scientists.

UNIV. OF CALIFORNIA, LOS ANGELES

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PI: TERRI HOGUE
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences, Engineering, Geology and Geography, Physics

What Is My Message? UCLA SEE-LA GK-12 Fellows Bringing their Research to Los Angeles Classrooms

The third year GK-12 program at UCLA, Science and Engineering of the Environment of Los Angeles (SEE-LA) places graduate fellows in two pairs of urban middle and high schools within Los Angeles Unified School District (LAUSD) and Culver City School District (CCUSD) to act as scientists-in-residence. Fellows are partnered with master science teachers in their respective classrooms and spend two-days per week interacting with students and the school community at large. Over the course of their fellowship year, GK-12 fellows are charged with developing three inquiry-based lesson plans, including a at least one lesson related to their research. Fellows integrate their research into classrooms throughout the year in several ways: 1) introductory presentations about their research or research field, 2) discussions about scientists in general (who, what, where, debunking stereotypes), 3) lessons based upon the fundamental science concepts underlying their research, 3) lessons based upon applications that show research relevance, 4) lessons drawing upon or illustrating ways of thinking, approaches, or methods associated with the research, and 5) sharing professional activities associated with the process of being a scientist. In addition, all of our Fellows act as guest speakers about their research at other classrooms and/or schools. They create a

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poster about themselves and their research to be left in the classrooms/school, and they develop a web site that describes their research, and can be used as an ongoing communication tool with students throughout the year. We will highlight the research of two Fellows and provide examples of how they translate their research to the classroom within the above framework. We also provide an overview of how our program helps Fellows develop their communication skills and distill the relevant messages they wish to convey about their research for a given audience.

UNIVERSITY OF CALIFORNIA, SAN DIEGO

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PI: MARTIN CHRISPEELS
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences

Effective Integration of Research into the High School Science Classroom

University of California San Diego (UCSD) is a top research university in a city with a high school population that is highly diverse and largely underrepresented in the sciences. Doctoral candidates at the university, through the Socrates GK-12 STEM Fellows in Education, have brought their cutting edge research to classrooms across San Diego County by creating inquiry-based lab activities in collaboration with local teachers. These projects are in four main disciplines: Biology, Biochemistry, Bioinformatics, and Chemistry. These projects are highlighted in our poster and include guiding medical chemistry students through the drug discovery process, engaging biology students in the synthesis of algal biofuels, and using bacteria to express a fluorescent protein of choice, among others. The Socrates Fellows program is currently in its third year and many of our fellows have had a unique opportunity to work with the ScienceBridge teacher professional development program. Three inquiry-based projects have been chosen by teachers to be adopted into their curriculum based on their creativity, simplicity, and relevancy to the high school curriculum. These projects are Sense-able Smells (using sense of smell to teach organic chemistry), RNAi (using nematodes to demonstrate properties of RNA interference), and Ocean Acidification (using a real-world study to demonstrate the deleterious effects of increased atmospheric CO2 on ocean chemistry.) Our fellows also have had the opportunity to teach to an informal audience through participation in the San Diego Science Festival--a large science expo for the general public. This year, fellows are designing and implementing two booths?the first developed in conjunction with high school students as part of their respective science clubs; the second developed by the fellows to highlight model organisms and other models used in scientific research, including their own doctoral work.

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

Poster 57

PI: GREG GILBERT
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Disciplines: Ecology, Environmental, and Earth Sciences

SCWIBLES: Santa Cruz - Watsonville Inquiry-Based Learning in Environmental Sciences

The SCWIBLES GK-12 program at the University of California, Santa Cruz (UCSC) aims to increase diversity in the environmental sciences by increasing the academic success and career opportunities for students in the Environmental Science and Natural Resources (ESNR) Academy at Watsonville High School. Watsonville High School is located in an agricultural community in California's central coast that primarily serves low-income Latino students, a third of whom are learning English as a second language. The ESNR Academy has an innovative educational structure that creates a career-focused pathway to postsecondary education and jobs in the regionally relevant fields of agriculture, environmental management, and green technology. Graduate students in the environmental sciences from UCSC integrate their research into hands-on science training for both teachers and high school students. Fellows develop inquiry-based curriculum in 10th- through 12th-grade classes in English, biology, green careers, environmental horticulture, and marine biology, including projects like 1) a year-long, field based research project at a local national estuarine research reserve, 2) a semester-long experimental module to investigate how genetics and environment contribute to variation in plant traits, 3) a water quality module that challenges students to design their own filter apparatus while learning about human and environmental health, and 4) a biodiesel project where students gain hands-on experience producing biodiesel in the laboratory and help manage a long-term initiative to produce fuel using a 40-gallon reactor. SCWIBLES also provides professional development for teachers through a summer research fellowship program. A summer workshop kicks off this research experience with an intensive introduction to field-based inquiry projects with University of California faculty. Teachers then apprentice to graduate student fellows who are working on their dissertation research or related projects for hands-on research experience. Workshops at the beginning and end of the summer program focus on training fellows in the California educational standards and in integrating their research interests and experience into curriculum development.

UNIVERSITY OF CINCINNATI

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PI: ANANT KUKRETI
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Disciplines: Computer Science and Information Management, Engineering, Physics

There was a Big Bang - Can You Still Hear it?

We introduce students to the worlds of electrical and computer engineering through a Homemade Radio Telescope. Concepts explored include the fundamentals of the big bang, black body radiation, and signal processing. We will demonstrate a homemade radio telescope outfitted to connect to a computer running Octave (the open-source alternative to Matlab). We highlight the unique ability and challenges both conceptually for students and in implementation for teachers.

UNIVERSITY OF COLORADO BOULDER

Poster 59

PI: DEBORAH GOLDBERG
Contact: Jessica Feld, jessica.feld@colorado.edu
Disciplines: Computer Science and Information Management

eCSite- Engaging Computer Science in Traditional Education

The eCSite GK-12 is designed to bring greater understanding of Computer Science and Computational Thinking to students in K-12 schools. Computing, Computational Thinking and Computer Science have become essential to many fields, but this fact has not been communicated clearly to the public. In particular, K-12 students and teachers are largely unaware of the current ubiquity of computing and the revolution that computing has had on different areas of science. There are two ways this is apparent--the dramatic decline in the students directly entering computing related majors and, equally important, the limit integration of computing into existing curricula. We have developed an approach to this problem that we feel has great promise. Rather than seeking to draw students into computing courses in school, we plan to bring computing into the courses that students are already taking. Because computing has become so important in so many fields, importing a meaningful exposure to computing into students' studies in other fields can be done without compromising existing learning goals. For example, biology students can learn about the role of computing in sequencing genetic materials in a way that enhances, not diminishes, their grasp of the biology. Increasingly, "Computer Science" is an interdisciplinary field that encompasses researchers with backgrounds in biology, physics, psychology, applied math and other disciplines; combined, they form the core for the development of the cyberinfrastructure that has contributed to the advancement of many fields. Computer science graduates must learn to articulate their contribution to science and appreciate their role in that process. The eCSite program is ideally situated to address this problem, by training a cadre of computer scientists who have learned how to communicate about what they do to intelligent students and teachers who are not insiders in their field.

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PI: LESLEY SMITH
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Disciplines: Biological Sciences, Computer Science and Information Management, Ecology, Environmental, and Earth Sciences

Project EXTREMES

Project EXTREMES (Exploration, Teaching and Research for Excellence in Middle and Elementary Science) is a collaboration among the Boulder Valley School District (BVSD), the University of Colorado's Cooperative Institute for Research in Environmental Science (CIRES), and the Departments of Ecology and Evolutionary Biology and Computer Sciences. The project enhances the acquisition of STEM skills by fourth and fifth grade and middle school students in the more socioeconomically diverse BVSD Schools by studying the ecology of extreme environments. Project EXTREMES is also facilitating the professional development of its nine Graduate Fellows as science communicators in the face of the shifting demands of today's scientists. Highlights of the program include field trips to saline marsh and alpine tundra ecosystems, after-school science clubs, and the incorporation of Fellows' research into standards-based curricula. Fellows will leave the project after two years with the experience and skills necessary to better communicate science to a broad audience while BVSD students will be exposed to scientific research in a tangible and meaningful way. Collectively, Project EXTREMES participants hope to infuse the partner schools with a passion for science while rendering STEM disciplines accessible to all.

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PI: JACQUELYN SULLIVAN
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Discipline: Engineering

Connections to the Classroom: Graduate STEM Fellows in K-12 Apply their Research to Create and Teach Hands-on Engineering Design Curriculum

The TEAMS (Tomorrow's Engineers creAte. iMagine. Succeed.) Program provides an opportunity for PhD engineering students to bring their research into K-12 classrooms. Graduate STEM Fellows in K-12 integrate their research into K-12 settings through the creation of engineering curriculum that is taught in summer workshops for youth and in classrooms throughout the academic year. To broaden impact and increase sustainability, their research-based curriculum is published online at TeachEngineering.org, a free, digital library of standards-based engineering curricula, accessed by more than 60,000 users per month. At the start of their Fellowship, Graduate STEM Fellows attend a pedagogical training and gain experience in teaching hands-on engineering activities to elementary, middle and high school students. Fellows are also

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introduced to advances in our knowledge of how people learn and standards-based curriculum design. A summer of hands-on teaching experience follows, giving Fellows the confidence and skill needed to effectively teach in classroom settings during the academic year. In August, Fellows attend a teacher professional development workshop with their partner teachers (teachers from schools in which they will teach during the academic year). Teachers and Fellows work in groups to brainstorm a math and science Wish List--a list of concepts that students struggle with on the statewide accountability tests--which are then woven into the curriculum as learning objectives. This activity affords early buy-in with teachers since it aligns with their goal to provide quality lessons that meet stand standards. Finally, Fellows present their research to teachers to provide the context of how it can supplement their classroom teaching. We will provide a list of the Fellows' research topics and a description of their research-based curriculum currently being developed.

UNIVERSITY OF COLORADO DENVER

Poster 62

PI: MICHAEL JACOBSON
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Disciplines: Biological Sciences, Computer Science and Information Management, Ecology, Environmental, and Earth Sciences, Engineering, Mathematics and Statistics

The University of Colorado at Denver (UCD) GK-12 Transforming Experiences Project

The mission of the GK12 Transforming Experiences Program is to create mutually beneficial relationships between graduate students, middle school teachers, and middle school students. Graduate students benefit by being forced to enhance their communication skills to the point where they can communicate high level concepts in science and math to an audience with little to no background or experience in that particular subject. Middle school teachers benefit by having an extra content resource available in the classroom and by having lessons and materials available for their students that might not have been available otherwise. Middle school students are introduced to high level concepts in math and science at a young age and are exposed to positive role-models that encourage them to further their careers in math and science through higher education. The GK-12 program is focused on demonstrating to middle school students that math and science are interrelated disciplines with a high degree of overlap. The primary method for communicating the relationship between these subjects is the interdisciplinary lesson. Half of the lessons produced by UCD GK-12 fellows are interdisciplinary in nature and are co-developed and co-taught by both the science and math fellow. In this fashion, students are not only exposed to the material, but get a chance to see graduate students in math and science working together to accomplish a common goal. nterdisciplinary lessons are developed in the context of a Transforming Experiences Learning Community (TELC) comprised of one science fellow, one math fellow and the lead teachers with whom the fellows have been placed. TELCs are overseen by a group of individuals acting as 'communication enhancers' who offer advice and guidance for making all lessons as effective as possible. The UCD GK-12 project is committed to producing high quality growth experiences for middle school students and graduate students alike.

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Discipline: Engineering

The ChemE Car Club: An Introduction of Engineering to Everitt Middle School

Engineering can be defined as the practical application of math and science. In middle school, students are taught how to solve mathematical equations and about the facts of the pure sciences, but they are not often exposed to the use of this knowledge to solve real world problems. To give students an opportunity to apply their knowledge to a real-world problem of interest, the ChemE Car Club was developed for 7th and 8th grade middle school students. During this multi-week project, each team of students was required to create a detailed engineering drawing, following design requirements and obtaining approval before construction of their cars, exposing them to mechanical engineering design. In addition, students learned about chemical engineering through the requirement that their cars must be powered using a chemical reaction. The project concluded with a competition among teams to see which group?s car was able to come closest to traveling a distance of 20 feet. To ensure sustainability of this project, detailed presentation materials and templates were created so that a teacher without engineering experience would still be able to introduce these topics through this project. In the UC Denver Transforming Experiences project, teams of math and science fellows are placed within a middle school. At Everitt Middle School, the science fellow is working on a M.S. degree in mechanical engineering, and his research is to create a device capable of assessing the condition of lubricating oils in machines such as automobiles. A sensor has been created to analyze the properties of the oil and determine the condition of the oil and the oil's ability to perform its designed task. The ChemE Car Club draws from many different aspects of this research. Perhaps the largest contribution from the research is the design process students used to develop their cars. The structure of generating ideas, sketching a design, drawing a final design and building the final product based on those designs is a process at the core of engineering. Emphasizing this process is very important when exposing students to engineering and problem solving. In addition, engineering requires the application of mathematics as a tool. The math fellow at Everitt is working on a Ph.D. in biostatistics, and her research applies mathematical processes to solve problems in clinical trials. Students were exposed to using math as a tool throughout the project, in both designing and powering their cars.

UNIVERSITY OF CONNECTICUT

Poster 63

PI: DOUG COOPER
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Discipline: Engineering

Introducing Connecticut Technical High School Students to Energy Sustainability

The GK-12 project at the University of Connecticut, started in August 2010, is fostering an innovative, creative spirit in technical high school students and providing valuable curricular enrichment to the classroom experience by using hands-on educational tools. As conventional energy sources become increasingly taxed by growing worldwide demand, the idea of sustainable engineering is gaining considerable focus within research, industrial, and commercial ventures. In fact, the research projects of UConn fellows are aimed towards advancing technology in fields like bio-fuels, engineered osmosis, fuel cells, and hydrogen combustion in the hope of decreasing our dependence on coal, oil, and natural gas. However, to continue moving forward, a new generation of students will need to be recruited and trained in the disciplines of science and engineering. Technical high school students have traditionally been underrepresented at four-year universities, primarily as a result of reduced academic preparation, but the technical skills derived from these institutions can be a valuable base for an engineering education. Students in CT technical high schools are prepared for careers in technology via a combination of academic classes and technical training in a shop of their choice. Shop choices available to students interested in an engineering career include Computer-Aided Drafting and Design, Biosciences and Environmental Technology, Pre-Electrical Engineering and Applied Electronics, and Manufacturing. Hands-on projects led by eight graduate fellows and twenty partner teachers at eight technical high schools in CT have exposed approximately 700 students to different sustainable energy technologies. The focus and setting of each project are tailored to the interests of the graduate fellow and partner teachers as well as to the resources of the school. Projects range from the construction of wind turbines and electric cars to hydroelectric demonstrators and green houses, in addition to contests encouraging students to come up with their own sustainable energy ideas. Within the framework of these projects, the graduate fellows present learning modules on many fundamental engineering topics including problem solving, energy production, engineering physics, and mathematical tools for engineers. It is the goal of fellow-led projects that participating students will gain an appreciation for the drive towards energy sustainability as well as consider an engineering education in the future.

UNIVERSITY OF FLORIDA

Poster 64

PI: DOUG LEVEY
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Discipline: Engineering

Science Does Not Suck!

In middle school, engaging students in the sciences can often be frustrating for both the teacher and the student. The theories behind middle school sciences are far more complex than elementary school science, but not as detailed as high school science. So, the question then becomes, How can you excite, inform, but not bore students? The approach that I believe best answers this question is to use the world around them to explain the science in front of them. While learning terminology and bookwork are important tools to learning, they should be a complement to classroom experiments and presentations. To a middle school student, science can be quite intimidating because it requires critical thinking, something that they are not used to. By connecting this abstract thought of what absorbency is to its importance in paper towels testing; you introduce the student to the term as well as an application in an everyday setting, thereby making science “real” to them. By having scientists and engineers give presentations in the classroom, you connect faces with professions. Research indicates that middle school is a period where many students forever lose interest in science. I believe that we can excite students about science by showing them how relevant it is to their daily lives.

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Disciplines: Biological Sciences, Ecology, Environmental and Earth Sciences, Engineering

Incorporating Research into Middle School Classrooms Through Module Creation

University of Florida's SPICE (Science Partners in Inquiry-Based Education) encourages its graduate Fellows to incorporate their research in two main ways. The first is in how the fellows introduce themselves to the classroom. On the first day in the classroom, the SPICE fellows give a short talk about who they are and their experience as a scientist. Many of the fellows have traveled widely for their research, and they make sure to highlight those experiences to the students. It is a way to show that scientists don't have to be in a laboratory. The second way is through the development of a module consisting of two to four lesson plans that each fellow must complete. For the modules, the fellows strive to incorporate aspects of their research into the lessons in a way that still covers relevent standards for each grade level. This can be challenging when biology graduate students have to teach physical science or engineering students have to teach biology, but the fellows have found creative ways to make it work. In

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this poster we showcase various modules created by UF fellows and how they connect to their research. These modules are available online at : http://www.spice.centers.ufl.edu/Modules.html.

UNIVERSITY OF HAWAII

Poster 65

PI: MONIQUE CHYBA
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Disciplines: Mathematics and Statistics

SUPER-M: Mathematical Treasures from the Hawaiian Islands

T. Holmes works in universal algebras, on representing finite lattices as congruence relations and analyzing the tractibility of constraint satisfaction problems. These topics are introduced to students using examples from integer arithmetic and visualizing equivalence relations as graphs. **H. J. Kim** works in coding theory, developing group codes using complex permutation groups acting on the unit sphere in C, and establishing their efficiency for encoding and decoding. Her classroom activities are related to reflections and discussions about the thought process involved in math research. **J. Marriott** works in optimal control theory, studying the optimal control of quantum dynamical systems. This field is applied to robotics, and this is the method used to translate optimal control theory into classroom lessons and activities. The math-based robotics material gives students a hands-on experience. **A. Lau** works in Elliptic Curve Cryptography, studying isomorphism groups of points on elliptic curves over varying prime fields. She is looking for a "good prime," which would lead to a more efficient method of encryption. She brings her work to students by introducing cryptography concepts. **J. Rader** works in control theory, modeling the interactions of embryonic stem cells, the growth factors/inhibitors they produce, and structures called fractones that determine what the cells do. He does math modeling with the students and shows how high-level math research applies to what they are learning. **E. Reckwerdt** works in the cross between algebra, algebraic topology and coarse geometry. His focus in algebra is on patterns and forms. He brings this to his classes through activities which require abstraction: pattern recognition, pattern forming, and understanding why patterns work in various situations. **B. Thompson** works in number theory and arithmetic dynamics. She looks for post critically finite points, rational periodic and preperiodic points of a particular function. Her questions are about integers and rational numbers, easy to relate to students. She has also discussed and proved facts about finite groups**. J. Verrette** studies de Rham cohomology theory. By means of functors, a problem concerning surfaces is changed into a homological algebra problem concerning abelian R-modules. Her students use knot diagrams, investigate classic mobius strip with one edge, CW complexes, and learn about Euler's formula.

UNIVERSITY OF HOUSTON

Poster 66

PI: PRADEEP SHARMA
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Disciplines: Ecology, Environmental, and Earth Sciences, Engineering, Mathematics and Statistics, Nanoscience

University of Houston GK-12 Program: The Science Behind Harry Potter

The objective of our program at the University of Houston is to provide engineering graduate students engaged in state-of-the-art nanotechnology related research to learn the articulation of complex scientific and engineering issues in a GK-12 classroom environment through direct immersive interaction with students and teachers via interactive modules of the sort proposed in the book, The Science Behind Harry Potter. For example, Harry Potter's invisibility cloak is used to motivate the study of optics. Here, we present our attempts to enrich secondary school science curriculum through a series of unit plans and activities. Some examples of how these ideas were implemented into the classroom include the following: (i) The students were asked to make a list of magical tools found in Harry Potter and their use. These tools were discussed as a class. The students were very excited about the idea of a tool as the class transitioned into discussing weather tools. (ii) The Latin roots present in the magical spells spoken in Harry Potter were identified. These same roots were then recognized in biology and chemistry vocabulary words. (iii) While studying plate tectonics and earthquakes, the students were shown pictures of earthquake induced building collapses. The students learned how earthquake engineers design buildings to withstand earthquakes and were able to correctly identify where structural elements of buildings should be placed for maximum earthquake damage prevention. Through our collaboration with the British University of Egypt (BUE), our International component was launched in summer 2010. One Fellow conducted research for a month with Egyptian faculty and researchers. A profile article of this international exchange is featured on the GK12 website at: http://www.gk12.org/international-profiles/university-of-houston-innovations-in-nanotechnology-and-nanosciences/. The international collaborative effort is expected to be a significant enriching experience for Graduate Fellows who will not only benefit from the expertise of top scientists of Egypt but also learn to do science in a cultural environment quite different from that of the US. In summer 2011, two Fellows and two Teachers will conduct international research abroad.

UNIVERSITY OF IDAHO

Poster 67

PI: BARBARA WILLIAMS
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Disciplines: Ecology, Environmental, and Earth Sciences

Integrating Research into the Classroom

We present an overview of our effective four-part approach to assuring the fellows' research gets incorporated into their classroom teaching.We needed to address the following issues: 1) Fellows need to determine how their research and particular content expertise fits into the secondary curriculum; 2) Teachers need to understand the content expertise the fellow brings to the classroom and how it relates to various parts of the curriculum they teach; 3) The teaching partners need to work together to integrate the fellow's research/content expertise into the curriculum to enhance student learning; and 4) Students need exposure to scientists to expand their understanding of who scientists are and what scientists do. The following four strategies were implemented during our summer courses and institutes to address these issues: 1) conceptual mapping of fellows' research and expertise; 2) alignment of concept maps with curriculum by teacher and fellow teaching partners; 3) fellows produce a video which introduces their background and research; 4) each fellow develops a visiting scientist lesson related to their research which may be presented to any participating teachers' classes.

UNIVERSITY OF KANSAS

Poster 68

PI: DENNIS LANE
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Disciplines: Biological Sciences, Chemistry and Chemical Sciences

Two Case Studies of Project-Based Instruction Lessons for Middle School Girls at a Week-Long Summer Camp: DNA Extractions and Water Chemistry Analysis

During the Middle School Science Academy (MSSA), GK-12 fellows were introduced to short-term project-based instruction (PBI) lesson plan design and implementation in collaboration with middle school science teachers and 6th-8th grade Girl Scouts. As science mentors for the MSSA, graduate students gained insight into the importance of effective science communication in an unusual and informal setting. The teachers were re-introduced to the concepts of open-ended research problems through simple experiments. Basic points of research process including question development, data collection, data analysis, and result communication were discussed and carried out. GK-12 fellows facilitated the process of inquiry, even in areas outside of their specialized content area. Following the inquiry-based lessons and the discussion of authentic research, the graduate students and middle school teachers together designed six new PBI lessons from the ground up, which were used for a science camp with fifty Girl Scouts at the University of Kansas field station. Two of these lessons, "DNA: A Microscopic Polymer in a Macroscopic World" and "Oh! O2 Oxygen" are presented as case studies. In the DNA lab, the Girl Scouts explored the correlation between amount of DNA and size of fruit in wild and domesticated strawberries. For the water chemistry group, O2 sensors were used to explore the relationship between dissolved oxygen and environmental factors in ten man-made lakes at the station. The purpose of the lessons was to engage the girls in thinking to promote question-asking. Because of this, the graduate students and teachers tried to allow for a degree of fluidity and student-led discussion. Each of the groups of middle school girls interacted with both the scientist mentors and the teachers at least twice throughout the week, and the camp ended with a formal oral presentation session where the girls presented their results to their peers. Scientific journaling, the fluidity of scientific progress, and the importance of communicating results were all emphasized throughout the week. Graduate students gained practice in informal scientific communication. Middle school teachers learned about the progress of scientific research and its role in the classroom. Middle school girls participated in an optional summer camp highlighting the diverse questions scientists ask, as well as the process of and fun that can be had while doing science.

Contact: Branden Stone, bstone@math.ku.edu
Discipline: Mathematics and Statistics

Online Mathematical Collaboration with Google Apps

Google Apps was used to create personal websites for posting solutions to mathematical problems, video lectures created by the students, and for collaboration between three separate classes and grades. A domain was purchased from Go Daddy and a Google Apps account was created. Each class divided into groups of 3-4 students, and each group had an email address and the ability to create a website through the Google Apps account. All work was done on iMac computers running Snow Leopard. Once a week, mathematical problems and instructions were emailed to the groups. Groups were required to use Google Apps to create a website and then post solutions to the problems online. Each group was also assigned a topic on which to produce a five minute video presentation for the other students using iMovie. An inter-class online journal was created with a list of projects on it. Each project was given an RSS feed to which the groups subscribed. The weekly objective was to analyze any project and give a new conjecture, a question furthering the problem, or a solution. Each group submitted work to the GK-12 fellow and accepted work was published on the project's page; the RSS feeds were then updated. Once a week, the students checked their RSS reader (via Google Apps) to see any new

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progress on their problem made by other classes. Each conjecture, question, and solution was credited to the first group to post it; no repeats were allowed. This exercise gave the students an understanding of how mathematical research is developed. The students learned how to ask interesting mathematical questions and to conjecture what the solution might be through construction of examples. Many times the solutions to the questions asked were above the capability of the students, but they were able to understand the problem and guess the outcome. The main problem encountered in this project was keeping the students focused on the mathematics. They were very interested in creating websites and working with iMovie, but lacked the same motivation for solving problems. However, posting their work online and being able to show it to their friends and family kept them working. Another problem was that many students could voice their opinion about a problem, but had a very hard time articulating the opinion by writing.

UNIVERSITY OF LOUISVILLE

Poster 69

PI: CHRISTINE RICH
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Disciplines: Chemistry and Chemical Sciences, Physics

Building Communication Skills: GEMS Strategies Facilitate Science Discourse in the K-12 Classroom

The primary goal of the GK-12 program is to improve the communication skills of graduate Fellows. The venue for honing this invaluable skill is in the K-12 classroom where Fellows learn to frame complex STEM concepts in a way that is understandable to both teachers and their students. Fellows' communication with the students is critical, but we believe it is equally vital to build communication skills of science teachers and student scientists in the classroom. Beginning with workshop training and continuing throughout this 7th year, individual GEMS Fellow-Teacher Science Teams have coalesced around stimulating student discourse. Discourse is a form of interactive written or oral communication that can be used to demonstrate student learning as well as make apparent any misconceptions/misunderstandings that still need to be addressed. GEMS Teams have explored many formats for science discourse: teacher-student, teacher-Fellow-student, and student-student. Teacher-student discourse is the most common practice seen in classrooms. It is teacher-guided and incorporates a variety of learning strategies/assessments such as claim evidence reasoning (CER) statements (Krajcik and McNeill). In GEMS, this approach has been adapted to include the Fellows. The teacher-Fellow Teams stimulate discourse by "tag-teaming" in larger student groups or by co-teaching in two smaller groups. Student-student discourse, where the teacher and Fellow function as facilitators rather than directors, is much harder to achieve, but is the ultimate goal that GEMS Teams aim to accomplish this year. An example of how to engage novice students and promote student-student discourse would include Page Keeley's Commit and Toss assessment paper-ball fights where students answer an open response question, peer-review student work, then work in small groups to discuss and formulate the best answer before sharing out.

UNIV. OF MASSACHUSETTS LOWELL

Poster 70

PI: KAVITHA CHANDRA
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Discipline: Physics

Selective Thermal Emission from Patterned Steel

Chemical sensing and defense applications often require inexpensive or disposable sources of mid-infrared, single-wavelength light. Periodically patterned metal films have been shown to possess unique optical properties resulting from the excitation of electromagnetic waves bound to the metal surfaces that can fit this application. The periodicity of the patterned surface can be designed to selectively enhance the outcoupling of these waves into free-space emission when the steel is heated. Selective thermal emission at a wavelength of 10 ?m has been realized from rolled steel substrates exploiting a subwavelength patterning method. Inexpensive and rapid processes have been developed to prepare and pattern the steel to provide wavelength-selective thermal emission with intensity 2.6 times greater than the emission from unpatterned steel. We investigate changes in the selective thermal emission due to alterations in the geometry of the patterned grooves as well as measuring the temperature dependence of the selective emission effect. Finally, angular analyses of the selective emission and thermal imaging have been utilized to illuminate the nature and strength of the thermal selectivity of these structures. Elements of this research have been presented to the ninth grade physics students at Lowell High School, in Lowell, MA., who are participating in the GK-12 Vibes and Waves in Action project. To date, practical laboratory experiments investigating thermal energy and conduction have been executed by the students to solidify their understanding of thermal interactions and infrared light. Additional experiments exploring wave mechanics have laid the ground work for a thorough understanding of light as a waveform. Further demonstrations and discussions have connected these topics to the graduate research and possible future developments of similar mid-infrared devices.

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Discipline: Engineering

Porous Nanoparticles: A Unique Platform for the Enhancement of Electrochemical Sensing and Its Integration with GK-12 Education

This research addresses the fabrication of porous metal nanoparticles and investigates their performance as electrochemical sensors. Electrochemical sensing is important due to the reliable, fast, and inexpensive analytic results. Porous nanoparticles are of particular interest due to their increase in surface area to volume ratio compared to solid nanoparticles of the same size and macroscale particles. The changes in catalytic properties that occur at the nanoscale also play an important role in this application. Due to the large surface area that porous nanoparticles have compared to the volume, these nanoparticles can be used as catalysts. Porous metal nanoparticles can be used to enhance the sensitivity and selectivity of the electrochemical detection of chemicals, such as serotonin, glucose, and hydrogen peroxide. These porous metal nanoparticles are fabricated using a conventional galvanic replacement reaction, in which a more cathodic (positive) metal replaces a more anodic (negative) metal. The seed particle, aluminum or tin, is replaced by the following metals; nickel, iron, cobalt, platinum, palladium, gold, and silver. One of the main obstacles to overcome is oxidation of the particles during and after fabrication. The presence of oxide could affect the performance of the nanoparticle as a sensor. Characterization techniques become important to determine the composition as well as structure of these nanoparticles. Scanning electron microscope, energy dispersive x-ray spectroscopy, X-ray diffraction and atomic emission spectroscopy are used to paint a clear picture of these porous nanoparticles.The fabricated porous nanoparticles will be studied to optimize the sensor. The experimental set-up for the electrochemical detection consists of a working glassy carbon electrode, modified with the porous metal nanoparticles. A silver-silver/chloride and platinum electrodes are the reference and counter electrodes, respectively. A simple cyclic voltametry test will record the current as a function of the voltage, which is applied to the system. Each chemical has a certain potential that an oxidation and reduction reactions will occur and is a "fingerprint" for the chemical. A cation exchange membrane, Nafion, will seal the nanoparticles to the surface as well as help enhance the selectivity. Preliminary results show that nafion impedes the detection of anionic molecules, ascorbic acid and uric acid, but increase the sensitivity of cationic neurotransmitters, serotonin. Therefore, a nafion/porous nanoparticle surface could increase the sensitivity and selectivity of serotonin and other chemicals. This year I have been working with two honors phsyics classes consisting of seniors and juniors in high school. With these particular classes I decided to focus on two units; nanotechnology and spectroscopy. Nanotechnology has been a big buzz word for many years and is the area of my research; however, most high school students do not know what it is and this became the starting point. The nanoscale is difficult to visual since it is not visible to the human eye. In order for the students to understand how small nano actually is they did dimensional analysis of objects that they can visual the size of and converted the size to nanometers. For example, how many nanometers make up the diameter of the human hair (70 mircometers)? This gave the students more of a visual to go along with the word nano. From there we discussed why researches want to study nanotechnology. This lead to the two characteristics of nano; property changes at the nanoscale and the increase in surface area to volume ratio as size decreases. To demonstrate the property changes at the nanoscale the students learned about nanogold and observed the color changes that take place at the nanoscale. Nanogold was chosen to show optical change at the nanoscale because visual changes, such as color, are easier to demonstrate. A mini nanoproject is an ongoing project throughout the semester. The groups of students were asked to investigate different areas of nanotechnology research and will be giving a short presentation to their peers. This project lets the students explore and understand the many applications of nanotechnology as well as practice key skills such as communication and teamwork. Throughout these lessons I gave talks about my research. We discussed the nanoparticles and their fabrication as well as my use of atomic emission spectroscopy to determine the elements present.The other unit that was brought into the classroom is spectroscopy because some of the characterization techniques use the concept of spectroscopy and it worked will with the physics curriculum. The first lesson in the spectroscopy unit was a hands on activity in which the students built spectrometer using diffraction grating and cardboard. The students were not asked to follow a set of direction. Instead had two or three spectrometers to base their designs off of. This lesson was to spark the students' interest and inquiry. In the coming months the students will be breaking apart the pieces of the spectrometer to understand how it works. This will cover concepts of diffraction grating, waves, interference, light, and how elements emit different wavelengths of light. This will be done with hands on activities and discussion and will be driven by the students' inquiry. The unit of spectroscopy is usually not covered in high school physics classes due to time constraints and with these lessons the students will learn something that they normally do no.

UNIVERSITY OF MIAMI

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PI: MICHAEL GAINES
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Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences

Dig It: A Collaborative Research Project Across Science Made Sensible Schools

Students at all four Science Made Sensible (SMS) middle schools will conduct a collaborative research project comparing soils sampled from a variety of urban neighborhoods in Miami-Dade County. First, to engage students in the research project, they will watch an educational animated movie created by BrainPop called "Soil, It's more than Dirt." To introduce the lesson, the fellow-

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teacher pair will ask the class, Why is soil important? The fellow-teacher pair will write key points on the board throughout the student-driven discussion. To explore what plants need for growth and survival, students will watch a short Planet Earth time-lapse video of a plant growing in the jungle. The fellow-teacher pair then will introduce the soil collaborative project. Students will be asked to bring natural soil samples from their neighborhoods to the next class period. The classroom will be divided into teams of four. Each team of four students will receive a copy of the experimental procedure, a data sheet, and a set of soil handouts provided by BrainPop to use as a reference. Each team of students will be assigned a soil sample from a location unknown to the students and will measure pH, nitrogen, phosphorus, and potash level of their sample. Students then will hypothesize about the effects of these variables on plant growth. Wisconsin Fast Plants (Brassica rapa) seeds will be planted in each team's soil sample. Miracle Grow soil will serve as the control. Students will measure plant height daily for a period of two weeks. Teams will post their data on the classroom blog and elaborate on their findings. We will evaluate learning gains by having student teams present their hypotheses and results to the class. Presentations will be followed by a group discussion of research findings. Finally, the extension will utilize soil samples from our SMS international research project on soil microbial diversity in South Africa. Students will use the same experimental design to examine plant growth in South African soil.

UNIVERSITY OF NEW ENGLAND

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PI: STEPHAN ZEEMAN
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Kelly Pennoyer, Kylie Bloodsworth, Michelle Bozeman, Caitlyn Little, Vanessa Maples, Elizabeth Prochaska, L. Jay Williams, Charles Tilburg, Susan Hillman, Henrietta List, Stephan Zeeman
Disciplines: Biological Sciences, Ecology, Environmental, and Earth Sciences

Connecting Universities and Schools Through Place-Based and Inquiry Lessons

Seven Graduate Fellows work in classrooms in southern Maine through SPARTACUS, a GK12 project at the University of New England (UNE). The SPARTACUS project focuses its work on ensuring the science taught in the classroom is authentic inquiry and connected to place-based research. The majority of the lessons are tied to the investigation of the land-ocean interface at the Saco River in Southern Maine. Students are guided by Graduate Fellows in their examination of water use and water quality in the Saco River, in the investigation of invasive crabs in the near shore area, in the exploration of increased species reproduction through fisheries management, and in the determination of the reasons for sturgeons' return to the Saco River. Graduate Fellows connect their students and the community to active scientists and undergraduate students at UNE. They bring equipment to the schools used in research at the University. They bring organisms they are studying in their research. They host university professors and a Fulbright scholar who speak about their research projects. They bring students to campus where they have attended university classes ranging from neurology to chemistry to marine science. Graduate Fellows have attended other classes to describe their own research and their path from grade school to university. Graduate Fellows plan inquiry-based science to help allow students to drive their own learning. Graduate Fellows are able to incorporate place-based examples through their own research into the classroom. When studying genetics, they are asking questions about marine organisms found in Southern Maine, when studying ecology they are searching for answers on why invasive species are found locally. By making science classes relevant to the students, making them place-based, Graduate Fellows are connecting UNE to the schools and changing their views on science in society and local community. Here, we document these changes through observations, conversations and questionnaires by the host teachers, fellows and students.

UNIV. OF NORTH CAROLINA GREENSBORO

Poster 73

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Transforming Minds in a Transitioning Community

Nine graduate students from the departments of Geography, Chemistry and Biochemistry, and Biology at the UNC Greensboro use a common waterway, known as the Greenway, to explore science with students from three Guilford County Schools (Montlieu Elementary, Welborn Middle, and Andrews High). The Greenway serves to connect the three schools and the poster will use the stream/greenway to depict both the physical and conceptual base of our project. While each fellow's, or Resident Scientist's, research is not specific to the Greenway, each resident scientist uses the Greenway as a venue to expose students to urban ecology and bring students out of the classroom to involve them in real hands-on science. The resident scientists have been able to relate their research to other scientific disciplines, to the curriculum and standard course of studies, and position this in a global context of ecological research and issues. While fellows are building rapport with students in the classrooms to engage their students in science, they are also building projects that will have a lasting impact on the schools. The elementary students are building a butterfly garden to understand biological diversity, middle school students are tapping maple trees for sap production, and high school students are taking measurements of soil content and changes

in water flow on the Greenway. Resident Scientists are starting after-school environmental clubs and participating in science fairs to further their students' understanding of the scientific method, science, and related careers. Students from both the middle and high schools have measured biodiversity, turbidity, dissolved oxygen concentration, pH, and temperature of the stream to determine water quality and health. Elementary school students are discovering plant cycles and what it takes to create an urban habitat.Resident scientists are building a website for data communication so that changes in the Greenway over time can be documented for the community and other teachers and students will be able to tap into GK-12 data. As we are in the first year for the project, data on the effectiveness of the project is limited. However, we do know that Resident Scientists are making an impact on high school students. The participating high school is on block scheduling so students that participated in first semester only were surveyed at the end of the semester. Overall, the comments from student evaluation surveys indicate that resident scientists and teachers are having a positive impact on students' learning experiences. These preliminary findings suggest that the fellow-teacher pair has had a positive impact in the classroom and further that the professional development opportunities provided to the resident scientists is helping them transition their science into the classroom.

UNIVERSITY OF OKLAHOMA

Poster 74

PI: MARK NANNY
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Discipline: Engineering

Extending Fellows' Expertise Beyond GK-12 at the University of Oklahoma

Two challenges facing GK-12 programs are: (1) extending the Fellows' STEM expertise to teachers and students outside of the GK-12 program, and (2) establishing a sustainable K-12 outreach program lasting beyond NSF support. The Summer Engineering Academy (SEA) at the University of Oklahoma, which is part of our Engineering in Practice (EiP) GK-12 program, addresses both issues. SEA is a two-week program open to all high school teachers and students. It is aimed at: (a) continuing the professional development of Fellows and high school teachers (SEA Week 1), and (b) engaging high school students in authentic, inquiry-based curricula that utilizes engineering to teach key science and mathematics concepts (SEA Week 2). Engineering applications are experienced through field trips, real-world data collection activities and WebQuests. SEA 2010 topics included flight dynamics and controls (aerospace engineering), solar power and panels (electrical engineering), and greenhouse gasses (environmental engineering). In preparation, Fellows, EiP teachers, and faculty select topics related to Fellows' research, and then develop curricula aligned with National and State curriculum standards. During the first week of SEA, Fellows lead teachers through complete lessons including hands-on activities, field experiences, and WebQuests. At each lesson's end, the learning experiences are summarized and used to facilitate pedagogical discussions addressing the research base guiding authentic, inquiry lesson development. Each teacher then selects a specific lesson to teach to the high school students during the second week. Pre-and post-SEA data are collected to determine each lesson's effectiveness. For maintaining SEA activities beyond NSF GK-12 funding, we have established a cohort of STEM students prepared through a formal, 3-credit hour course "Science, Engineering and Mathematics Outreach for STEM Majors" offered by the College of Engineering. Endowed competitive scholarships are awarded to upper undergraduate and graduate engineering students demonstrating outstanding interest in engineering education through participation in such activities as SEA. Our poster will illustrate the SEA format, present the 2010 SEA curricula, discuss integration of Fellows' research and SEA curricula, and highlight our efforts establishing future SEAs. SEA curricula are available at http://www.ou.edu/content/coe/centers/seed/k12engineeringcurricula/highschoolcurricula.html

UNIVERSITY OF OREGON

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GK-12 Sustainability--Impacting Teachers with Low- and Middle-science Skills

The University of Oregon GK-12 project, Intrastate Partnerships for Improved, Sustainable K-12 STEM Instruction in Remote Schools, collaborates at the elementary school level using a school-wide model. UO GK-12 Fellows work with every teacher and in every classroom within our partner schools to increase teachers' knowledge and facility in using inquiry-based methods for teaching elementary science. Whereas the experience by elementary students of reading and math is highly standardized, the experience of science by students is greatly dependent upon their teacher and can vary widely by year. Our observation is that elementary teachers who are less comfortable with science topics and inquiry-based teaching spend less time teaching science. Pre-and post surveys of student interest in science showed increases among students with low initial scores and particularly among students of teachers who were coded as "low science" (teachers who spent little time on science and hands-on activities), suggesting that the extra resources offered by UO GK-12 help both teachers and students most in need of support. It follows that having Fellows engage teachers with low- and middle-

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skills can raise the bar for entire schools into the future. This serves to expand the UO GK-12 program's 'K-12 footprint.'

UNIVERSITY OF PUERTO RICO

Poster 76

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Disciplines: Biological Sciences, Chemistry and Chemical Sciences, Ecology, Environmental, and Earth Sciences, Nanoscience

From Hectares to Nanometers: GK-12 Multidisciplinary Explorations of Tropical Ecosystems and Functional Nanoscience: Bringing Research into the Classroom

This GK-12 project builds a strategic interdisciplinary partnership between the University of Puerto Rico's Institute of Tropical Ecosystem Studies and Institute for Functional Nanomaterials, which together provide doctoral research projects to over eighty PhD students in chemistry, biology, chemical physics, and environmental science. It will strengthen 7th-9th teachers and students' scientific knowledge through multidisciplinary explorations of tropical ecosystems and functional nanoscience, while improving graduate students' abilities to communicate and teach science. This GK 12 project provides training and experience to graduate students to prepare them to be leaders and to communicate and collaborate effectively with colleagues and peer reviewers as well as with teachers, students, and the general public. It also provides training and experiences to teachers in 7th-12th level to broaden their science content knowledge and have a better understanding of nano and environmental sciences. Fellow-teacher teams work together to develop and implement interdisciplinary educational materials that brings research into the classroom that has a connection to the curriculum. Modules on the topics of: states of matter and phase transition, sampling techniques of particulates in the environment, protein solubility, properties of materials, laboratory techniques at the nanoscale, and the use of yeast as model organism, among others have been successfully developed and implemented impacting more than 900 students in nine schools. These modules will be available electronically via the PR-GK-12 website, htt://gk12.upr.edu, and will be incorporated into the Pre-Service Teacher Science Methodology Course, impacting future teachers and their students.

UNIVERSITY OF SOUTH FLORIDA

Poster 77

PI: TAPAS DAS
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Discipline: Engineering

Delivering Novel Education Materials from the Classroom to the Nation

STARS (Students, Teachers and Resources in the Sciences) GK-12 program at the University of South Florida aims to improve the pedagogical and communication skills of graduate STEM fellows while infusing science and engineering concepts in the elementary school curriculum. STARS partners with the School District of Hillsborough County, FL in an effort to reinforce STEM in the education system. STARS's primary strategy is to explore different avenues of collaboration between its fellows and the K-5 education community. This partnership encourages the professional development of graduate students through the creation of captivating, interactive and educationally rich materials based on the fellow's own graduate research and aimed for incorporation into the K-5 classroom. The impact of these innovative lesson plans can be seen on a local, regional and national level. On the local level, STARS fellows work directly with teachers and students to facilitate STEM education by bringing their lessons directly into the classroom. On the regional level, STARS fellows develop research-inspired lesson modules which are delivered to K-5 educators during county wide professional development workshops. At these workshops, a broad spectrum of teachers is empowered with the scientific background necessary to properly conduct the lessons and activities developed by the STARS fellows. Furthermore, STARS fellows bring these creative and groundbreaking activities and lessons to the national level by submitting them to the peer reviewed Teach Engineering digital library, where they become readily available to teachers throughout the nation. This poster showcases a research-driven lesson module focusing on water and wastewater treatment processes and science. The lesson module, titled: "Let's Get Wet: Dirty Water in the Mushroom Kingdom," uses characters from the Mario Brothers video games to deliver an entertaining, and science intensive lesson with engaging activities. In the module, fellows tie their ongoing research to topics such as particle removal with flocculants and filters, the removal of salts using osmosis and the use of bioreactors with the traditional science covered in the classroom.

UNIVERSITY OF SOUTHERN MAINE

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Jefferson Gaynor, Heidi Tait, J.G. Kinyua Gikonyo, Kelly Cochrane, Elizabeth Cope (Fellows); A.-K. Ng, S. C. Pelsue, G. Fletcher, K.D. Moulton, J.L. Jamison, S.M. Duboise (Faculty and Staff)

Maine ScienceCorps GK-12 Fellows Connect Graduate Research, International Collaboration, and Electron Microscopy Resources with Rural High School Student Projects

Maine ScienceCorps GK-12 Fellows at the University of Southern Maine (USM) continue to facilitate efforts of rural high school teachers in bringing research-based active learning into classroom experiences of students. Most participating teachers with support of Fellows and project staff successfully sustain classroom research projects and then as a culminating event in April bring students to USM's annual Thinking Matters Symposium to present their research in a poster session. The research-based classroom project process is often linked with Fellows' graduate studies and research and sometimes with international research and education collaboration of the project and USM researchers with University of Nairobi and NASA collaborators in studying microbes and viruses in hypersaline and alkaline habitats of the soda lakes of Kenya's Great Rift Valley. The international collaboration has connected directly with graduate research of several GK-12 Fellows and has afforded international research and education experiences to five graduate Fellows and one participating teacher. The varied expertise and interests of GK-12 Fellows that include molecular microbiology, genetics, immunology, and cancer biology are reflected in the projects and classroom emphasis of the Fellows. Engagement of USM scientists and graduate students with K-12 education increasingly occurs in an interconnected framework of efforts that includes NIH-NCRR and NASA funded projects in addition to NSF and USM supported work. A framework for sustaining Maine ScienceCorps efforts is organized as NanoDiscovery Labs (http://nanodiscoverylabs.org) in which the USM Electron Microscopy Core Facility is a key component. During 2010-2011, a portable scanning electron microscope (SEM) has been brought into classrooms of participating schools distributed across Maine to support classroom projects focused on microbial diversity. In sustained efforts of the Maine ScienceCorps, we expect to increasingly emphasize using resources of Nanodiscovery Labs and building informal STEM education through an active community partnership to establish a non-profit science and technology center near the university. This Center for Science Technology and Human Innovation will include Maine ScienceCorps and Nanodiscovery Labs in an ongoing commitment to broadly sustain integration of research and STEM education and to connect Maine scientific research communities with K-12 educators, students, and the general public.

UNIVERSITY OF SOUTHERN MISSISSIPPI

Poster 79

PI: SARAH MORGAN
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Discipline: Polymer Science

Molecules to Muscles: Integrating Interdisciplinary Research into High School Classrooms

Connections in the Classroom: Molecules to Muscles (C2M2) is an interdisciplinary research theme used as a vehicle to increase relevancy of science coursework to High School students. Research improving human performance transcends the boundaries of individual scientific disciplines and requires seamless communication between biologists, chemists, biochemists, materials scientists and engineers. In relating their research advances fellows are able to develop lessons and activities that are appealing to high school students. This poster provides examples of successful research-based activities. A lesson and field trip to introduce to the basics of prescribed fire and longleaf pine ecology was introduced by a biology graduate fellow. Prior to the field trip, students learned about the fire triangle, discussed attitudes about forest fire, participated in a fuel burning demonstration, and were taught about plant and animal adaptations to fire in the longleaf pine forest. During the field trip, students completed a scavenger hunt to focus their observation of the forest and to reinforce ecology concepts and vocabulary. Students used simple equipment to compare plants, animals, soil, and physical properties of burned versus unburned areas. After the field trip, students were able to distinguish burned and unburned areas of the forest and differentiate between destructive wildfires and beneficial prescribed fire. Another graduate fellow in biology looks at the influence of hormones on physiology and behavior. A laboratory exercise was developed that examined the impact of adrenaline on heart rate of Daphnia magna. This hands-on activity allowed students to observe that adrenaline elevates heart rate, which is part of the 'fight-or-flight' response that humans experience when frightened or excited. A graduate fellow in polymer science developed a lesson to illustrate the differences in Natural vs Synthetic Polymers. A synthetic nylon was compared to a naturally made amino acid based protein, which is extracted from milk. Since both of these polymers share the same linkage, students are able to compare and contrast the two types of polymers. Another project was inspired by the recent BP oil spill in the Gulf of Mexico. Selected water soluble polymers have the ability to encapsulate insoluble materials such as drugs or oil. The students explored the properties of water, oil, and molecules that fall into the categories of water and/or oil soluble materials. The students compared and contrasted oil encapsulation versus oil absorption and which method of clean up was the most environmentally friendly.

UNIVERSITY OF TEXAS ARLINGTON

Poster 80

PI: MINERVA CORDERO
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Disciplines: Mathematics and Statistics

The NSF GK-12 MAVS Project: Integrating Lessons in Mathematics into the K-12 Classroom

The purpose of the GK-12 MAVS Project (Mathematically Aligned Vertical Strands) is the creation of a seamless

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transition in mathematics that spans the school curriculum and bridges to research-level mathematics. It involves mathematics research faculty, graduate students, teachers, administrators, and K-12 students. The vertical team concept is the overarching model for carrying out our project goals. Every summer at the MAVS Project Professional Development Institute (MAVS PDI), each fellow and mentor teacher pair develops a sequence of six research mathematics lessons. The integration of research mathematics and school mathematics is initiated via a process of examining national and statewide mathematics standards documents, studying the mathematical vertical alignment in the school district, and creating concept splashes that reflect the fellow's mathematical research and the mathematics that each mentor teacher must teach over each of the six six-week intervals of the school year. A focus on active learning strategies, problem solving, and fidelity to the underlying mathematics guides the development of the research lessons. As a result, the lessons fold into the mathematics curriculum in a seamless way by incorporating both the fellow's research and the mathematics that would have normally been going on in the school classroom at that time. The lessons are taught by the fellow at approximately six week intervals throughout the school year.This presentation will highlight the classroom research lessons implemented over the MAVS project years 2009-2011. The pairings of research mathematics and school level mathematics showcased in these lessons include: commutative algebra and Algebra II, inverse problems and Algebra I/Geometry, noncommutative algebra and 8th grade mathematics, applied mathematics/computational neuroscience and 7th grade mathematics, finite geometries and Algebra I/Geometry, invariant theory and precalculus, mathematical biology and Algebra I, partial differential equations and 8th grade mathematics, and mathematical statistics and 8th grade mathematics.

UNIVERSITY OF TEXAS EL PASO

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PI: AARON VELASCO
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Disciplines: Ecology, Environmental, and Earth Sciences

The GK-12 Scientist in Residence at Early College High School

The University of Texas at El Paso (UTEP) GK-12 program, Science for a Sustainable Future: Developing the Next Generation of Diverse Scientists, engages 9 graduate students per year to build their science and teaching portfolios and develop their leadership skills. The Fellows serve as Scientists in Residence in Early College High School (ECHS) classes in a predominantly Hispanic community. ECHS reaches out to young people currently underrepresented in higher education, enabling them to earn up to two years of college credit in addition to their high school diploma. UTEP has just completed its first year and the role of Scientist in Residence has grown from being viewed as an assistant teacher to a science role model on the campus. Fellow Gena Esposito collaborates with Biology teacher Diana Lara at the Mission Early College High School in the Socorro Independent School District. Together they bring Gena's research and experiences into the classroom where students see Gena as an invaluable source of information and come to her with their scientific questions. Gena's research is on the genetic diversity of aquatic invertebrates in isolated desert ponds. She is focusing on two macroinvertebrates: an active disperser that has a winged adult stage (such as dragonflies) and a species that cannot easily disperse (such as snails). By sampling several times a year in ephemeral ponds, a permanent spring, and the nearby Rio Grande, she hopes to determine the source population for the ephemeral ponds as well as whether cryptic speciation may be occurring in genetically isolated populations. In addition to her current research, she has participated in projects to study the picoplankton in the Gulf of Mexico, scorpion phylogenetic relationships, and tiger shark populations in Western Australia. In Diana's freshman Biology class, Gena's research experiences are easily translated into the classroom and allow her to utilize research in every lesson regardless of the topic. For example, while the students were learning about protists and algae, Gena used her previous experiences with phytoplankton to develop an where students observed pond water and algae under dissecting scopes and were able to examine field equipment from Dr. Lougheed's Aquatic Ecology lab at UTEP. Gena also helped the students learn about how tagging studies help to estimate population size by using goldfish to represent the tiger sharks she captured in Western Australia. As another example, students, most of whom have never seen aquatic animals in their natural habitat, are learning about invertebrate life cycles. Growing up in the Chihuahuan Desert, few students have ever seen natural freshwater bodies. To help them learn more about freshwater invertebrates, they are currently rearing the crustaceans Triops (Order: Notostraca) in a small fishbowl . The students can observe the incredible growth rate of these organisms and see them molt their exoskeletons almost daily. They are also able to gain an understanding of the requirements for life for water-dwelling animals. There are plans to setup an aquarium in the classroom where dragonfly and other aquatic insects can mature and eventually be released. Also, the students have begun ongoing experiments on plants. Working in groups of 4-5, they designed and setup controlled experiments on plants and will maintain their experiments and collect data. After four weeks, the groups will present the results to the rest of the class. These lessons and other Fellows' lesson plans will be developed further and be available for use by other educators on the UTEP project's website.

UNIVERSITY OF TOLEDO

Poster 82

PI: CAROL STEPIEN
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Disciplines: Ecology, Environmental, and Earth Sciences

University of Toledo GK-12 Fellows Incorporate STEM Research into High School Classrooms

Our program, Graduate Fellows in High School STEM Education: An Environmental Science Learning Community at the Land-Lake Ecosystem Interface at the Lake Erie Research Center, partners eight teams of graduate students, teachers, and 430+ high school students/year (28% minorities and 23% low-income). Faculty and graduate students represent three University of Toledo colleges and four departments (Environmental Sciences, Geography and Planning, Civil Engineering, Chemical and Environmental Engineering). Objectives are to: 1) Generate high school student enthusiasm for science careers by engaging them in hands-on research into environmental problems and sustainability, 2) Exchange knowledge and pedagogies between graduate fellows and teachers resulting in cutting-edge environmental science content and increased teaching and communication skills, and 3) Develop hands-on solutions to environmental problems along schoolyard stream ecosystems feeding the Great Lakes. Our team meets together with environmental professionals and the public in monthly learning community events, including a public lecture series and nature walks. State-of-the-art research is conducted by our eight graduate fellows in aquatic and community ecology, environmental sustainability, alternative energy, fish epidemiology, algal biology and nutrient limitations, and glacial geology. The fellows mentor the high school students in an annual Student Watershed Watch sampling program, sampling water quality and macroinvertebrate assemblages from schoolyard streams. Fellows design and lead innovative lessons, activities, and videos to bring their research into the classrooms, many centered around this watershed theme. These are developed into kits for wide use by other schools and in nature camp settings; kits contain supplies and directions (written lesson plans and You-Tube and Teacher-Tube videos). All high school classrooms participate in our annual high school student research poster show, mentored by the fellows, and most enter the regional and state Science Fairs, with many of our high school students winning. Over the 2.5 years of our program, our fellows have published 20 papers in peer-reviewed journals and given 93 research presentations crediting NSF GK-12 support. Our fellows bring their research into the classrooms to mentor high school students and most importantly, to build young citizens who are engaged with their natural environment.

UNIVERSITY OF WASHINGTON

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Helping High School Students Achieve at the College Level: An Innovative Partnership

The Ocean and Coastal Interdisciplinary Science (OACIS) GK12 program has partnered with the University of Washington's Office of Educational Outreach to help high school Marine Science students achieve at the college level. Building on the university's 29-year-old "UW in the High School" (UWHS) outreach program, OACIS teachers and fellows now teach college-level Marine Science courses to high school students in their own classrooms. Since the partnership began in 2009, 196 high school students have enrolled in OACIS / UWHS Marine Science courses. All 34 students registered last year earned college credit. This partnership offers many advantages. High school students and OACIS teachers gain UW privileges, including access to libraries and online research materials. The students also gain advanced study skills and familiarity with the level of achievement that will be expected of them in college, while learning in a familiar classroom, rather than from an unfamiliar professor in a new environment. Perhaps most important, high school students earn college credit for a body of work--including class participation and homework as well as tests--rather than for performance on a single day's standardized exam. The OACIS GK12 fellows are uniquely positioned in this partnership to serve as role models to the students, ambassadors of the university, academic coaches, and co-instructors who are intimately familiar with the course material. The university also benefits by identifying and grooming highly motivated students for recruitment. More than 20% of students who take a UWHS course matriculate to the UW after high school graduation.

UNIVERSITY OF WYOMING

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PI: DON ROTH
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Serving an Entire State - The University of Wyoming Science Posse

The Science Posse allows graduate students to introduce research and draw attention to "hot topics" in the fellows' area of expertise. We bring these topics into classrooms all across the 97,105 square miles of the Equality State. Since its inception in 2006, the Science Posse has traveled to 19 of Wyoming's 23 counties to work with teachers and students in 51 schools, making scientists and research real concepts to Wyoming students. This poster will demonstrate the Science Posse?s ability to bring the relevance of science to a large number of students. We highlight one fellow's project in particular, which focused on aquatic invasive species and tapped into the increased concern around the state about the issue.

Abstract

VIRGINIA INSTITUTE OF MARINE SCIENCE

Poster 85

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An Analysis of Middle and High School Students' Perception of Scientists (Year 2): Does Exposure Influence Students' Perception of Science?

The Draw a Scientist Test (DAST), implemented for the past 50 years, investigates how K-12 students perceive science and scientists. As part of the Virginia Institute of Marine Science (VIMS) GK-12 PERFECT program, four fellows implemented a modified version of the DAST in their classrooms. Current research shows the US ranks 25th of developed nations in Math and 21st in Science as documented in the PISA 2006 study. As a result, President Obama has called for "making improvement[s] of STEM education over the next decade a national priority." The overall goal of this ongoing project is to improve upon previous DAST rubrics and develop a novel approach for analyzing student perceptions. Four GK-12 fellows (2 male and 2 female) surveyed 215 students in 2 schools (urban and suburban) ranging from 7-12 grade. Each student was asked to imagine and draw a typical scientist. Three questions were then asked of the student, regarding the drawing that included: 1) In two sentences, describe what your scientist is doing in your drawing, 2) List 3 words that come to mind when you look at your scientist, and 3) What do you think scientists do on a typical day. Each drawing was analyzed using a modified DAST rubric to capture various aspects of each image, which include personal characteristics, symbols or research, gender, etc. Key modifications to the VIMS DAST rubric included the addition of experimental location (lab vs. field) and highlighting key marine science characteristics (boat, scuba, etc). Our results indicated that across the schools, there was a considerable increase in positive drawings after five months of GK-12 Scientist in Residence exposure. In addition, the female fellows noticed a substantial increase in the female/male ratio after female scientist interaction. Conversely, the two male fellows saw no significant change in the female/male ratio. Other trends observed in the analysis include word choice description of a typical scientist, career choice depicted in the drawings, location of experiments, and other general characteristics of the images. Overall, the VIMS PERFECT GK-12 fellows found students' perceptions of scientists had a positive increase both in the images drawn and word choice after being exposed to their Scientist in Residence after a semester in the classroom.

WASHINGTON STATE U VANCOUVER

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Partners in Discovery of the Columbia River Watershed GK-12 Project: Digging Deeper into Science and Inquiry

The Partners in Discovery of the Columbia River Watershed GK-12 project pairs Washington State University Vancouver (WSUV) Environmental Science graduate students with 6th-9th grade science teachers for year-long, one-on-one collaborative partnerships. Our goals are to bring the Fellows' research and expertise into the classroom and to support the partners as they teach science through authentic inquiry. An emergent focus in our project for 2010-11 is "Digging Deeper into Science and Inquiry." As each Fellow-teacher pair has examined their curriculum to find explicit linkages to the Fellows' research area, we have begun to dig deeper into science content, deeper into the scientific inquiry process, and deeper into the societal and educational relevance of scientific research for Fellows, teachers and middle school students. Across these three dimensions, the Fellows are digging deeper into their thesis/dissertation topics to identify the concepts and questions that underlie their research, gaining new appreciation for their subject as well as building their skills in communicating fundamentals of science and inquiry to middle school students. The Fellows and teachers are digging deeper into their curriculum to identify the big ideas, particularly around change in the Columbia River watershed, and using formative assessment and collaborative reflection to develop pedagogical approaches to help students learn these important concepts. And finally, by providing students with authentic field-based and classroom-based research experiences in the watershed, middle school students are digging deeper into what it means to be a scientist, and how their actions and choices impact the natural world around them.

WICHITA STATE UNIVERSITY

Poster 87

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Extending the Research Training Tower to Precollege Students

One goal of our GK-12 program has been to extend the research training tower to high school students and their teachers. Research scientists are traditionally trained through

a system of peer mentorship, where more experienced trainees pass on their knowledge, their wisdom, 'the salt', to the next generation. Through the organization of 'Pass Me the Salt' research clubs in Wichita public high schools, GK-12 graduate fellows are teaching precollege students and their teachers the keys to successful primary research, central to careers in biology. Open-ended research brings the excitement of discovery and the sense of accomplishment that changes student and teacher attitudes towards their roles in the endeavor of science and careers in the sciences. Teams of fellows, students, and teachers investigate problems from field ecology to clinical medicine, seeking to generate publishable data. The research is done in the high school science classroom with support from the university. Several projects are bearing fruit in the form of presentations at national and regional scientific meetings that include high school students and teachers as authors and presenters. The most developed projects have been submitted to and accepted by mainstream scientific journals. While our successes have been great, we encountered significant challenges during this process, including issues of scheduling, recruitment, retention, and in communication and logistics between teachers and graduate fellows. The lessons learned here may help other groups develop similar programs in their districts.

WORCESTER POLYTECHNIC INSTITUTE

Poster 88

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ASSISTments at Home and in Class: Blending AssessMENT and Instructional ASSISTance

Our GK-12 graduate student fellows are computer scientists, who along with other students and faculty at WPI, work on building and researching data from ASSISTments. ASSISTments is an online formative assessment platform that facilitates, among other things, formative assessment in the classroom. Another way to think of it is as a website with a blend of assessMENT and instructional ASSISTance. Our cooperating teachers are using ASSISTments with the help of the fellows to collect instant data on their students. The students in these classes are getting instant feedback on their homework, class work and assessments. One GK-12 teacher says, “My students are doing homework on ASSISTments every night now. I am beginning each class viewing reports, and working on issues highlighted by the reports. This routine is driving my instruction. I wonder: HOW did I do this before? Did I just hope I was on target?” In our poster we will focus on the challenges of getting ASSISTments running. We will address how students will gain access to computers, how teachers will develop classroom routines that hold students accountable and how to overcome the challenge of working with teachers who have limited technology backgrounds. We will report on the many different routines the Fellow/Teacher teams have developed to use ASSISTments. Here are two examples: Auburn Middle School teachers Kim Moran and John Bastien with Fellow Matt Dailey: Kim and John use ASSISTments for their warm up at the start of each class. Students read the problem off the electronic white board, get the answer and then the entire class checks their answers. On Friday, the students go to the computer lab with fellow Matt Dailey and take a 4-problem quiz on ASSISTments. Each problem is similar to one they did in class that week as a warm up. When the students have finished Matt collects the data, using the code he wrote, which allows him to assign new problem sets to students depending on whether they got a problem right or wrong. They have to finish the new assignments on ASSISTments at home. Oak Middle School teachers Jen Dufault and Kevin Denolf with Fellow Zach Broderick: Jen and Kevin periodically give their students open response questions with ASSISTments, usually for homework. When the students go to the lab they reflect on their writing using a feature written by Zach Broderick. The teacher selects a few essays and sends them back to the students for grading. The students grade the selected essays at the computer and give a reason for their grade. They then have a classroom discussion, usually lead by Fellow Zach Broderick.