URL: http://www.noao.edu/education/noaoeo.html

ED51D-05 1120h

The QuarkNet Collaboration

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QuarkNet is a long-term high school education project, supported by NSF and DOE and carried out by a collaboration of university and laboratory research groups. These research groups are part of major international particle physics experiments, including those at CERN in Switzerland, Fermilab in Illinois, and SLAC in California. Goals and Objectives:
A major goal is to engage students and teachers in authentic scientific research; they gain a first-hand understanding of research and its application in the inquiry method of learning. Teachers enhance their content knowledge, increase their abilities to solve science-related problems, engage students in scientific inquiry, and develop responsibility for their own professional development. Students learn fundamental physics and are motivated by current research questions as they analyze real data. A second goal is to engage particle physicists with current issues in science education, including their understanding of the National Science Education Standards and local science education needs and what constitutes age-appropriate content. Project Design:
Working with physicists nationwide, we have established a project framework with three program areas-teacher research experience, teacher development programs, and online resources and inquiry-based activities. Eight-week research appointments allow teachers to experience scientific research first-hand. In teacher institutes the next summer these teachers and scientists lead a group of teachers through a short research scenario lasting two to three weeks and assist them in creating similar scenarios for their students. When fully implemented QuarkNet will support centers associated with 60 particle physics research groups at universities and laboratories in the U. S. The QuarkNet website provides:
- Experimental data for use in inquiry-based activities.
- Opportunities for communication and collaboration among physicists, teachers and students.
- A place for students to publish and share their ideas.
- Resources including background information, simulations, ideas for data analysis, inquiry activities, etc.
Future Scope:
Many students are engaged in research in their schools, but in the second five years, we will add a student component to the summer research experience.

URL: http://QuarkNet.fnal.gov

ED51D-06 1135h INVITED

Evaluation of Teacher Research Programs

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Science education reform advocates students learn science the way it is done. But, few science teachers get the experience of "doing science," so are not well acquainted with scientific inquiry. Several programs for teachers have been conducted that bring teachers into laboratories to work with scientists. Over several years evaluating such projects, (e.g., the Department of Energy Teacher Research Associates Program, Fermilab's QuarkNet program and the National Optical Astronomy Observatories' Teacher Leaders in Research-Based Science Education program) common elements that make the programs successful have emerged. ("Success" means teachers provide students with authentic scientific inquiry experiences.) Common elements include some form of follow-up after the initial research experience, constructive interactions with research scientists, and providing teachers with a global view of how the specific research they are doing fits into a larger picture. Evaluation of these programs has included obtaining multiple perspectives from scientists, teachers and their students, data on classroom implementation, and data on changes in classroom practice as a result of teachers engaging in a research experience. The evaluations provide insight into how best to provide formative and summative feedback for such programs, how scientists can most effectively provide teachers research experiences, and factors that promote transferring knowledge into the classroom to best address science education reform.

ED51D-07 1150h INVITED

Developing Authentic Research Experiences Using EarthScope Data

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EarthScope, a decade-long experiment to understand the formation, structure, and evolution of the North American continent, will carry-out active investigations in nearly every county in the US. The excitement of a huge science experiment in one's own backyard piques interest, but teachers need resources and professional development experiences to capitalize upon this excitement and create opportunities for their students' learning. The EarthScope Education and Outreach Network will provide the interface to make EarthScope science, and the advanced technology and modern approaches used to understand Earth, relevant and beneficial to K-16 educators vested in advancing Earth science education. Three obstacles must be overcome for success in carrying out authentic EarthScope research in the classroom. First, scientists and teachers must work together to identify relevant and developmentally appropriate research questions for the target audience. Second, teachers will need professional development experiences that engage them in authentic research and that provide support for introducing a similar research experience in their own classroom. Third, the outcome of the research experience must have value to the scientist, teacher and student to motivate sustained participation by all.
The dense array of seismometers being deployed in the USArray component of EarthScope will permit students and the public to see first-hand Earth's dynamic response to both human and natural events in their hometown and around the country. Targeted local experiments will make EarthScope's scientific investigations and discoveries relevant for educational efforts on a region-by-region basis. Combining the real-time seismic data streams from USArray with data and instrumentation from the growing US Educational Seismic Network (USESN) opens up endless possibilities for student-centered research. In this paper, I will discuss the lessons learned from eight years of leading a high school educational seismology program in Arizona and how those lessons can be applied to developing research experiences for teachers and students within EarthScope and USESN.

ED51D-08 1205h INVITED

Building a Global Science Education System to Undertake Genuine Astrophysics

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The Hands-On Universe (HOU) Project has developed powerful tools for students to undertake and model aspects of professional astronomy research. Building on a slowly evolving International Virtual Observatory and a network of small telescopes, plus other data bases of professional grade astronomy images, student can undertake many of the activities and processes of modern astronomy. This system has met with good enthusiasm from teachers and astrophysicists from around the world, and over 1000 teachers have been trained in HOU oer the past decade. We have developed scalable teacher training tools, and endeavor to scale our professional astrophysics scientific collaborators, who are essential for on-going support and inspiration.

URL: http://handsonuniverse.org/

ED52A MCC: 3012 Friday 1340h

Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom III *(joint with OS, P, C)*

Presiding: **S K Croft,** National Optical Astronomy Observatory**; S M Pompea,** National Optical Astronomy Observatory

ED52A-01 1340h

Solar Astronomy as a Means to Promote Authentic Science Research in a Teacher Professional Development Program

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Teacher Leaders in Research Based Science Education (TLRBSE) is an NSF-funded Teacher Enhancement Program hosted by the National Optical Astronomy Observatory (NOAO) in Tucson, AZ. Consistent with national priorities in education, TLRBSE seeks to retain and renew middle and high school science teachers. Within the exciting context of astronomy, TLRBSE integrates the best pedagogical practices of Research Based Science Education with the process of mentoring. One means by which participants are provided training in astronomy content, pedagogy, image processing, research and leadership skills is through a 15-week distance-learning course and an in-residence, two-week institute at Kitt Peak National Observatory and the National Solar Observatory (NSO). Throughout the program, teachers work with professional astronomers and education specialists. At the in-situ, two-week institute, teachers are the researchers on one of four research projects, including solar astronomy. Preparation for the solar project dictates much of the design of the program (e.g., development and feasibility testing of the observing program, the reduction and analysis software, the preparatory documents for the teachers). The program design of the solar project is centered on teachers experiencing the scientific process. Initially through a staff-facilitated guided inquiry and then on their own as a team, the teachers propose a research question and discuss alternative hypotheses. They operate the solar telescope and take, calibrate, reduce and analyze the data. Teachers interpret and report results to their peers and pundits. Ultimately the observing experience and knowledge gained by the teachers is transferred to the classroom, where students learn science by doing science. Staff astronomers and education specialists provide continuing support with the goal of sustaining a professional learning community that outlives the research experience. Further observing experience is available during the academic year. Students submit research papers to the RBSE on-line journal. Teachers and their mentees present at national NSTA meetings. These aspects of the solar project, outcomes, lessons learned and future directions will be described. The TLRBSE Program is funded by the National Science Foundation under ESI 0101982, funded through the AURA/NSF Cooperative Agreement AST-9613615. NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

URL: http://www.noao.edu/outreach/tlrbse/

ED52A-02 1355h

Positive Outcomes of a Teacher Professional Development Program Promoting Science Research in the Classroom

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This presentation will focus on the experiences of a middle school science teacher from Brownsville, TX who attended the NSF-funded Research Based Science Education program during the summer of 2000. RBSE, sponsored by the National Optical Astronomy Observatories based in Tucson, AZ, provided attending teachers the opportunity to interact with and receive instruction from professional astronomers, both at the NOAO facility in Tucson, and at the Kitt Peak Observatory. Teachers were provided with raw astronomical data collected by astronomers and then trained in the use of image processing software for data analysis. Upon returning to the classroom in Brownsville, a research-based after school program was initiated by the teacher for four interested students. The students were given background on the research projects, taught to use the software, and then developed their own research questions in each of the three areas of RBSE: a search for novae in the Andromeda galaxy; an analysis of the number and area of sunspots; and an investigation into spectra of Active Galactic Nuclei. Students came to the classroom after school daily during a large part of the year and generally would work for one to two hours processing and analyzing data. Completed research projects were presented in a variety of formats including: competition at the Brownsville School District, Rio Grande Valley Regional, and Texas State science fairs; publication of professional-style research articles in the RBSE journal; and poster presentations at Research Day at the University of Texas-Brownsville. The students have won numerous awards at all levels of Science Fair competition, have been the subject of three local newspaper articles, and two of them have accelerated their academics to the point of graduating from high school in only two years and have received full college scholarship offers. The students today credit their RBSE experience with increasing their interest level in science, helping them to understand the scientific method and research, and developing the self-confidence that has enabled them to pursue greater academic and personal goals.

ED52A-03 1410h

Research Based Science Education: Bringing Authentic Scientific Research into the Secondary Classroom

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Teachers and students at Northview High School in Brazil, Indiana have the opportunity to engage in authentic scientific research through our participation in two national projects, TLRBSE and PEPP. Teacher Leaders in Research Based Science Education (TLRBSE) is a teacher professional development and retention program coupled with authentic scientific research projects in astronomy. Teacher-Leaders are trained in research-based pedagogy and serve as mentors to less experienced colleagues and work with students to develop science research methods and research projects for the classroom. Astronomical data collected at Kitt Peak by astronomers and teachers is made available on CD for classroom use. Northview is in its second year as a TLRBSE school. The Princeton Earth Physics Project (PEPP) trains mentor teachers in fundamentals of research in seismology. Teachers and students then gain hands on experience in science research through operation of a research quality seismic station sited at the high school. Data from the Northview seismometer are stored locally and also transmitted over the Internet to a database at Indiana University. Students have access to local data as well as seismic databases accessible through the Internet to use for research projects. The Northview Seismic Station has been in operation since 1998. In this presentation, I will describe how these projects have been incorporated into the physics and earth science programs at Northview High School. I will discus how our teachers and students have benefited from the opportunity to take part in hands-on scientific research under the guidance of university faculty. In particular, I will describe our participation in a regional seismic network through seismic data acquisition, data analysis using seismological software, and students' experiences in a university-based student research symposium. I reflect on the some of the successes and barriers to high-school teachers' and students' involvement in scientific research programs. I conclude with a discussion of a successful student seismology project that was a finalist in the 2003 INTEL International Science and Engineering Fair

ED52A-04 1425h

Earthworks: Promoting authentic classroom science through Earth System Science research in the Rocky Mountains

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Earthworks is week-long teacher professional development workshop in the Rocky Mountains designed to help secondary science teachers create Earth System Science research projects that can effectively be transferred to their students. Participants work closely with scientists who specialize in geology, ecology, meteorology, biology, chemistry and aquatic sciences as they develop and conduct their own small-group research projects. Through fieldwork, observations, small-group discussions, and problem-based learning, participants work in groups to complete their own research project, teach their new skills to one another, and develop implementation plans for the classroom. This workshop allows the participants to be immersed in scientific inquiry that is relevant to their classroom content areas, uses equipment that is realistically available within classrooms, and is appropriate within the time constraints of regular school settings. The program establishes and maintains an ongoing community of teachers, scientists and other peers providing long-term connections and a support network to share ideas and new teaching practices. Important aspects of the project will be described, along with examples of classroom implementation by participant alumni.

URL: http://cires.colorado.edu/~k12/earthworks/index.html

ED52A-05 1440h

Earth Science From a New Perspective: An Online Course for K-8 Teachers

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Can teachers effectively learn Earth science in an online course? Earth Science from a New Perspective is offered in the Lesley University/TERC Science in Education Online Master's Degree Program. The program is delivered online. It is designed for K-8 teachers, emphasizes inquiry-based science, and aligns with National Science Education Standards. This course focuses on the Nile River, and it invites participants to uncover the connections between that river the rest of the Earth's systems. Each Earth science investigation provides the opportunity to explore the river system through observation, modeling, and data analysis. Participants learn to use visual representations such as satellite images, photographs, and maps as sources of data. They analyze precipitation, topography, and hydrology data collected by scientists. As an integral part of their investigations, they use a stream table to model and test hypotheses. We have designed investigations that use web-based tools to enable participants to manipulate, analyze, and interpret data to answer Earth science questions. The participants access electronic science resources and use threaded discussions to collaborate and to report their research results. They ultimately apply their knowledge of river systems, and their skills in data analysis, to an independent investigation of another river. In this presentation we will describe the strategies we use to promote understanding of Earth science in the online environment.

ED52A-06 1455h

Project INSTAR-Integrating authentic marine science research into the K-12 classroom

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Project INSTAR (Investigating Nature through Science Teacher Active Research) is a teacher professional development program that provides participants with new teaching strategies, research skills, field techniques and science equipment that can be effectively integrated into the K-12 science curriculum. Participants work in small groups with marine scientists to explore coral reefs, hydrology, marine animals, coastal ecosystems, and tropical meteorology in order to bring cutting-edge marine science research and technology back to their students. Participants develop research papers and ideas for classroom implementation that they share with each other through formal presentations. The Institute has successfully completed its sixth year of providing teachers with authentic scientific research useful for their classroom teaching. Key strategies relating to the sustainability, evaluation, and long-term success of the program will be discussed.

URL: http://www.projectinstar.org

ED52A-07 1510h

Information Technology in Science (ITS) Center for Teaching and Learning Environment Design Experiment Study for the Development of New Generation Leaders in Science Education

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The ITS Center for Teaching and Learning is a five-year NSF-funded collaborative effort to engage scientists and university and school or district-based science educators in the use of information technology to improve science teaching and learning at all levels. One assumption is that science and mathematics teaching and learning will be improved when they become more connected to the authentic science research done in field settings or laboratories. The effective use of information technology in science classrooms has been shown to help achieve this objective. As a design study that is -working toward a greater understanding of a -learning ecology", the research related to the creation and refinement of the ITS Centerês collaborative environment for professional development is contributing information about an important setting not often included in the descriptions of professional development, a setting that incorporates distributed expertise and resulting distributed growth in the various categories of participants: scientists, science graduate students, education researchers, education graduate students, and master teachers. Design-based research is an emerging paradigm for the study of learning in context through the systematic design and study of instructional strategies and tools. This presentation will discuss the results of the formative evaluation process that has moved the ITS Centerês collaborative environment for professional development through the iterative process from Phase I (the planned program designed in-house) to Phase II (the experimental program being tested in-house). In particular, we will focus on the development of the ITS Centerês Project Teams, which create learning experiences over two summers focused on the exploration of science, technology, engineering or mathematics (STEM) topics through the use of modeling, visualization and complex data sets to explore authentic scientific questions that can be integrated within the K-16 curriculum. Ongoing formative assessment of the Cohort I project teams led to a greater emphasis on participant exploration of authentic scientific questions and tighter integration of scientific explorations and development of participant inquiry projects.

URL: http://its.tamu.edu/

E
D

ED52A-08 1525h

A Curriculum for a Three Year High School Science Research Program

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A three-year high school science research program has been taught in Woodbridge Township School District - Woodbridge, New Jersey, since 1987. The program's focus is to foster originial science research projects for high school students that have shown an aptitude and an interest in science. Students are instructed in basic research skills, including developing and conducting original research projects, statistical analysis, scientific writing, and presentation of research at local and national symposia, and science fairs. Upon completion of the third year all students are required to submit a paper, suitable for journal publication, detailing their research. Participating students have gone on to win awards with Westinghouse, Intel, The National Junior Science and Humanities Symposium, the International Science and Engineering Fair, New Jersey Academy of Sciences, and local and regional science fairs and symposia. Participating teachers have been recoginized by the Sigma Xi Research Society of Rutgers University for excellence in science teaching. New Jersey awarded the curriulum a Best Practice Award for 2003. Goals and strategies of the curriculum are detailed in a guide written for the courses. Professional development for the courses and resources for mentoring programs are the responsibility of the District Science Supervisor, and have been fostered over the years with the assistance of local colleges and universities including Rutgers Univesity, Monmouth University, University of Medicine and Dentistry of New Jersey, Liberty Science Center of New Jersey's Partners in Science Program, as well as local industries including Hatco Corporation, Merck Corporation, Englehard Corporation, and Lucent Technologies. Science Research teachers have conducted developmental workshops for school districts interested in implementing similar curricula.