Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom II

Presiding: S M Pompea, Natl Optical Astronomy Obs, Tucson; G Scowcroft, University of Rhode Island, Narragansett; C E Walker, Education & Public Outreach, National Optical Astronomy Observatory, Tucson

ED52A-01
Improving Geoscience Education through the PolarTREC Teacher Research Experience Model (Invited)

*Warburton, J  (warburton@arcus.org), Arctic Research Consortium of the United States (ARCUS), Fairbanks, AK, USA
Timm, K  (kmobrien@alaska.edu), University of Alaska Fairbanks, Fairbanks, AK, USA
Larson, A M  (alarson@goldstreamgroup.com), Goldstream Group Inc., Fairbanks, AK, USA

Teacher Research Experiences (TRE’s) are not new. For more than a decade, the National Science Foundation (NSF) as well as other federal agencies have been funding programs that place teachers with researchers in efforts to invigorate science education by bringing educators and researchers together through hands-on experiences. Many of the TRE’s are successful in providing a hands-on field experience for the teachers and researchers however many of the programs lack the resources to continue the collaborations and support the growing network of teachers that have had these field experiences. In 2007, NSF provided funding for PolarTREC—Teachers and Researchers Exploring and Collaborating, a program of the Arctic Research Consortium of the U.S. (ARCUS). PolarTREC is a TRE where K-12 teachers participate in polar field research, working closely with scientists as a pathway to improving science education. In just three years, it has become a successful TRE. What makes PolarTREC different than other the teacher research experience programs and how can others benefit from what we have learned? During this presentation, we will share data collected through the program evaluation and on how PolarTREC contributes to the discipline of Science, Technology, Engineering, and Mathematics (STEM) education and pedagogy through a model program conceived and organized according to current best practices, such as pre-research training, mentoring, support for classroom transfer, and long-term access to resources and support. Data shows that PolarTREC’s comprehensive program activities have many positive impacts on educators and their ability to teach science concepts and improve their teaching methods. Additionally, K-12 students polled in interest surveys showed significant changes in key areas including amount of time spent in school exploring research activities, importance of understanding science for future work, importance of understanding the polar regions as a person in today’s world, as well as increased self-reported knowledge and interest in numerous science content areas. PolarTREC provides a tested approach and a clear route for varying levels of researcher participation in the education community, therefore facilitating the types of positive benefits and understanding that ensure increased educator, student, and community understanding of science and the polar regions during times of interrelated global change.

http://www.polartrec.com

ED52A-02
Polar Science: From the Field to the Classroom (Invited)

*O’Neill, M  (moneill@bcbe.org), Science, Fairhope High School, Fairhope, AL, USA
O’Brien, K  (kmobrien@alaska.edu), University of Alaska Fairbanks, Fairbanks, AK, USA

The ARMADA Project was a National Science Foundation Project organized by the Office of Marine Programs of the University of Rhode Island. ARMADA connected scientists and teachers to conduct field research together and share directly with the classroom. In addition to the field research, ARMADA teachers mentored new science teachers to assist in teacher retention and presented at National Science Teachers’ Association National Conventions. As an ARMADA teacher, I participated in two polar research experiences. In 2007, I worked with scientists from the University of Barcelona, Spain in the Arctic off the coast of Svalbard conducting seafloor mapping and sediment core sampling. My second research experience was to Antarctica in 2009 with Dr. Kristin O’Brien and her team studying Antarctic Ice Fish and their tolerance to temperature change. Sharing ship time with Dr. O’Brien was a team of scientists from Duke University studying humpback whales and their feeding behaviors. I was able to join both research teams and share the information with students, colleagues and the community. Connecting directly with scientists in the field has not only increased my personal knowledge of polar science, but has been invaluable to my teaching efforts. While in the Arctic, I was able to conduct a telephone conference with my students and the lead scientist via the satellite phone. From Antarctica I connected with several classes from Fairhope High School in a “Live from Antarctica” video conference. I was able to take them on a “virtual tour” of Palmer Station and Dr. O’Brien and Dr. Crockett answered student questions about Antarctic Fish. During both expeditions, I maintained a daily blog that enabled my students to follow along with my research experience. Being able to bring the most current scientific research into the classroom with these expeditions has been inspiring for the students, colleagues and community.

www.armadaproject.org

ED52A-03
Young Engineers and Scientists (YES) 2010 - Engaging Teachers in Space Research

*Boice, D C  (dboice@swri.edu), Space Science & Engineering, Southwest Research Institute, San Antonio, TX, USA
Reiff, P  (reiff@rice.edu), Physics & Astronomy, Rice University, Houston, TX, USA
During the past 18 years, Young Engineers and Scientists (YES) has been a community partnership between local high schools in San Antonio, Texas (USA), and Southwest Research Institute (SwRI). The goals of YES are to increase the number of high school students, especially those from underrepresented groups, seeking careers in science and engineering, to enhance their success in entering the college and major of their choice, and to promote teacher development in STEM fields. This is accomplished by allowing students and teachers to interact on a continuing basis with role models at SwRI in real-world research experiences in physical sciences (including space science), information sciences, and a variety of engineering fields. A total of 239 students have completed YES or are currently enrolled. Of these students, 38% are females and 56% are ethnic minorities, reflecting the local ethnic diversity, and 67% represent underserved groups. Presently, there are 21 students and 9 secondary school teachers enrolled in the YES 2010/2011 Program. YES consists of an intensive three-week summer workshop held at SwRI where students and teachers experience the research environment and a collegial mentorship where they complete individual research projects under the guidance of SwRI mentors during the academic year. YES students develop a website (yesserver.space.swri.edu) for topics in space science (this year was ESA's Rosetta Mission) and high school STEM teachers develop space-related lessons for classroom presentation. Teachers participate in an in-service workshop to share their developed classroom materials and spread awareness of space-related research. At the end of the school year, students publicly present and display their work, spreading career awareness to other students and teachers. Partnerships between research institutes, local high schools, and community foundations, like the YES Program, can positively affect students' preparation for STEM careers via real-world research experiences with mentorship teams consisting of professional staff and qualified teachers. Acknowledgements: We acknowledge support from the NASA MMS Mission, Texas Space Grant Consortium, SwRI, and local charitable foundations.

http://yesserver.space.swri.edu/

ED52A-04

STaRRS in Yellowstone: Addressing Challenges Facing Student-Teacher-Scientist Partnerships

*Houseal, A (anahouseal@gmail.com), Science Education, University of Northern Iowa, Cedar Falls, IA, USA
Gallagher, R (rgallagher14@gmail.com), Ricks Center for Gifted Children, University of Denver, Denver, CO, USA
Fuhrmann, B (Bob.Fuhrmann@nps.gov), Division of Interpretation, National Park Service, Yellowstone National Park, WY, USA
Sanford, R (rsanford@illinois.edu), Geology, University of Illinois at Urbana-Champaign, Urbana, IL, USA

The literature outlines many challenges faced by Student-Teacher-Scientist Partnerships (STSPs) including cultural differences between the scientific research and education communities. For example, shared vocabulary terms with dissimilar definitions can create communication problems. Other issues include accuracy in data collection, meeting the needs of a very diverse group of partners, connecting students with research science in a meaningful way, and maintaining the infrastructure necessary to develop and maintain these partnerships. Additionally, evidence, other than anecdotal, of the success of these partnerships is limited, especially as school year and research cycles are often on different schedules or have very different goals. Students, Teachers, and Rangers & Research Scientists: Investigating Systems at Mammoth Hot Springs in Yellowstone National Park (STaRRS) was an STSP developed to address some of these challenges, model some solutions within an STSP, and identify some possible outcomes for participating teachers and their students. Three strategies used to address some of these challenges that will be discussed briefly in this presentation include: (a) embedding the STSP in an already existing National Park Service environmental education program; (b) development of three types of research activities connecting teachers, students, and scientists to the research, and (c) a professional development (PD) model that included all partners in an on-going year-long process. Results from an accompanying research study will also be presented. Using a pretest-intervention-posttest design, this study revealed significant changes in attitude regarding science and scientists of participating STaRRS teachers. Student data gathered using a quasi-experimental pretest-intervention-posttest treatment and comparison group design also demonstrated significant changes in their attitudes and gains in earth science content knowledge.

ED52A-05

Pacific CRYSTAL Teacher Professional Development Models: Lessons Learned

*Van der Flier-Keller, E (fkeller@uvic.ca), School of Earth and Ocean Sciences, University of Victoria, Victoria, BC, Canada
Yore, L (lyore@uvic.ca), Faculty of Education, University of Victoria, Victoria, BC, Canada

From 2005 to 2010 Pacific CRYSTAL (Centre for Research in Youth Science Teaching and Learning) has been engaged in community-based research fostering teacher leadership in innovative science education through a variety of approaches to teacher professional development. Pacific CRYSTAL is a University of Victoria based, NSERC funded project founded on a collaborative research model involving scientists, science educators and community members including schools, teachers, community groups and government. Pacific CRYSTAL professional development approaches embrace both in-service teachers and pre-service teachers, and include Lighthouse schools, workshops (ongoing as well as one-time), community-based partnerships in Pacific CRYSTAL research projects, teachers as researchers, and university science courses and workshops for pre-education and education students. A number of common themes, identified through these approaches, should be considered in the development and implementation of future science professional development initiatives. They include; teacher turnover, expanding and adding schools and participating teachers, teacher apprehension, building leadership capacity, further engagement of 'tourist' teachers, continuing professional support for teachers, as well as on-going mentoring.

ED52A-06

Using Participatory Exploration to Engage Classrooms in STEM Learning: A Case Study Using NASA's Mars Student Imaging Project

*Klug, S L (sklug@asu.edu), School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA
Christensen, P R (phil.christensen@asu.edu), School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA
Graff, P (paigev@asu.edu), School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA
Viotti, M (michelle.a.viotti@jpl.nasa.gov), Jet Propulsion Laboratory, Pasadena, CA, USA
Bowman, C (cbowman@sdso-mail.jpl.nasa.gov), Raytheon SDSIO, Tempe, AZ, USA

NASA's Mars Program and Arizona State University’s Mars Education Program have partnered with Mars mission teams and Mars Principal Investigator Dr. Phil Christensen to develop and promote an ongoing STEM-based opportunity for students to become active participants in the exploration of the Red Planet. The Mars Student Imaging Project (MSIP) has, since 2002, given over 15,000 students from grades 5 through early college the opportunity to work with scientists, mission planners and Mars education specialists using the Thermal Emission Imaging System (THEMIS) camera. MSIP participants are involved in authentic Mars research by imaging and researching a site on Mars using the THEMIS visible wavelength camera onboard the Mars Odyssey spacecraft. Students can participate one of three ways: on-site at ASU, through distance learning and using archived THEMIS images. Throughout the period of time that the Mars Student Imaging Project has been operating, many lessons-learned have been accumulated, assessed, and project adjustments have been made. To
meet the needs of a changing educational landscape and audience needs, MSIP is changing as well. Many challenges and barriers are making it difficult for teachers to promote deep, hands-on research projects in the formal classroom. As high stakes testing is again becoming more of the focus for the classroom, there becomes a greater need to understand audience needs (schools, teachers, students) and where new opportunities might emerge for students to participate in authentic and data-driven research. Participatory Exploration is a new exciting way to help teachers bring authentic STEM to their students through our journeys through the solar system. By engaging students through technology and challenging them with space-related research opportunities, we can further enable this generation of technology natives toward STEM literacy in a hands-on, memorable way.

http://msip.asu.edu

ED52A-07

Bringing Students out of the Classroom and into Research Projects: An Undergraduate Team Research (UTR) Program at the University of Southern California

*Coxford, I V  (icox@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Quirk, M  (mquirk@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Culbert, K N  (culbert@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Whitesides, A S  (andrew.whitesides@gmail.com), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Sun, H  (haitai.sun@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Black, C J  (cblack@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Cao, W  (wenrongc@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Zhang, T  (taozhang@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Paterson, S R  (paterson@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Memeti, V  (memeti@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA
Anderson, J L  (anderson@usc.edu), Earth Sciences, University of Southern California, Los Angeles, CA, USA

In 2006, USC Earth Sciences professors Paterson and Anderson created the Undergraduate Team Research (UTR) program, a year-long, multidisciplinary, learner-centered, student research experience. This program is open to all USC undergraduate students, but has also involved a few outstanding undergraduate students from other universities. Since its inception the 47 participants have been a diverse group: 53% women, ~17% minorities, and 43% non-Earth Science majors. To date, 15 abstracts written by UTR participants have been presented at national GSA and AGU meetings and several research papers for publication are in preparation. 12 presentations have been produced at University-sponsored research symposia and culminated in a number of senior theses. The central component of this program is a field-based research experience which involves several weeks of geologic mapping in various locations around the world. During the summer expedition, participants organize themselves into 3-4 person mapping teams consisting of a mix of undergraduate geology majors, non-majors, and mentors (professors and graduate students). At the end of each day, student researchers (with limited mentoring) work together to draft a geologic map while discussing their findings, formulating hypotheses about possible geologic histories, and planning research goals and organizing mapping teams for the next day. Throughout the following academic year, the student researchers continue to work in teams to digitize their geologic map, decide which analyses need to be done, and prepare collected rock samples for various structural, geochemical, and geochronologic studies. Most student researchers agree that they learned more in a few weeks than they often did in an entire semester course. What aspects of the UTR program elicit these high-yield results, even for non-majors that are consistently demographically different from the university? We speculate that three critical elements are important: (1) The most notable is the collaborative nature, both in regards to the research itself and meeting the daily demands of living in the backcountry or a foreign country while working together as a research group. Students divided tasks amongst themselves while instructing and helping each other. Students with more geology expertise were able to reinforce their own knowledge by assisting in the teaching process that led to more rapid learning for the newcomers. (2) Student researchers developed a greater feeling of ownership in the program, which led to a greater commitment to learning and to sharing a broad range of ideas about both science and non-science activities. (3) Researchers are rewarded not only through grades, but through the excitement of daily new scientific discoveries, the joint publications of their research, and recognition by their peers. It is intriguing to speculate on what would happen if classrooms and particularly labs were designed to function as collaborative, student-run exercises with the ultimate goal to not only learn a subject, but also produce research papers on the class material.

ED52A-08

Scaffolding Pre-Service Teachers’ Learning to Conduct Authentic Research with Real-Data

*Slater, T F  (timslaterwy@gmail.com), University of Wyoming, Laramie, WY, USA
Lyons, D J  (danlyons@gmail.com), University of Wyoming, Laramie, WY, USA
Slater, S J  (sslater3@uwyo.edu), University of Wyoming, Laramie, WY, USA
Center for Astronomy & Physics Education Research CAPER Team

The scientific literature on teacher learning clearly indicates that most science teachers do not have strong backgrounds or inclinations to engage in authentic scientific inquiry. In response, we have developed and tested a carefully scaffolded approach to teaching pre-service and in-service teachers how to successfully conduct scientific inquiry. Based on the literature describing cognitive load, our approach of Backwards Faded Scaffolding (BFS) is a method of teaching science as inquiry that focuses on scaffolding the inquiry process to allow learners to develop a deeper understanding of how science is really done. In this BFS approach, the classical “scientific method” is turned upside-down starting with matching evidence to conclusions, scaffolding through five phases, and ending with learners proposing their own research projects and then carrying out research projects to answer these questions. These five phases can be summarized as follows. Phase 1-Exploration Phase: Each lab began with an exploration section to help learners become familiar with both the science content and the laboratory tools, in most cases web-based software; Phase 2-Matching Evidence to Conclusions: Here learners are presented with claims based on evidence they have just collected, then asked to assess how well those claims match that evidence; Phase 3-Making Evidence-based Claims: Learners are presented with data and are required to draw conclusions based on that evidence; Phase 4-Deciding What Evidence is Needed: A research question is posed and learners are required to determine what evidence needs to be collected and how to collect it in order to answer that question; and Phase 5-Carrying Out a Research Project: Learners pose a research collection of their own design, propose a step-by-step propose a plan to pursue evidence, carry out the plan, report the evidence, generate evidence-based conclusions and assessing how well evidence justifies those claims. Using assessment instruments including the Test Of Astronomy STandards (TOAST); the Science Teaching Efficacy and Beliefs Instrument (STEBI Form B); and the Views on Science Inquiry (VOSI), this approach has consistently demonstrated positive enhancements on teachers interest, knowledge, and confidence in teaching science through inquiry based on using authentic scientific data.

http://www.uwyo.edu/caper